

16<sup>th</sup> International Forum on Knowledge Asset Dynamics

# PROCEEDINGS

Managing Knowledge  
in Uncertain Times

1-3 September 2021  
Rome, Italy

IFKAD 2021



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## *Managing Knowledge in Uncertain Times*

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## FOREWORD

### Managing Knowledge in Uncertain Times

Welcome to the 16th edition of IFKAD. This 2021's edition is once more, unfortunately, signed by the implications of the pandemic which has transformed our lives and habits. In the last months, with the enormous effort of science that has provided vaccines in a record time, we have discovered the power and critical relevance of social and relational capital to cope with complex challenges. Thanks to the sharing and combination of Knowledge across countries' institutions, we have been able to create a collective intelligence to face the diffusion and adverse effects of Covid-19. We have seen the importance of creating mechanisms and infrastructure to support knowledge processes to drive value creation. However, the challenges ahead are still numerous. There is a need to learn from this challenging time to develop a capacity to respond effectively to current and future new problematic crises. For this reason, the IFKAD2021 is dedicated to the topic of "Managing Knowledge in Uncertain Times" to point out that the management of knowledge assets becomes paramount when dealing with growth, survival, and sustainability. Indeed, IFKAD's fundamental hypothesis is that Knowledge is the primary driver, from the viewpoint of both flow/process and stock/output, of any organisation's dynamics to prosper in a complex and turbulent environment.

Considering that many delegates cannot travel because of the coronavirus pandemic, IFKAD2021 is managed as a blended event with some sessions to be managed onsite at the University of Rome3, in Rome on the 2nd and 3rd September, and others online.

IFKAD 2021 aims to contribute to understanding the role of managing Knowledge to support organisations to navigate uncertain times. In the management literature, the acronym of VUCA highlight Volatility, Uncertainty, Complexity and Ambiguity, denoting the new reality organisations must face in their operations, and strategic decisions represent the new reality of the business landscape. Organisations have to develop the capacity to handling disruptive innovations, overlapping crises, and transformation to survive and prosper. During uncertain times, organisational business models and traditional working mechanisms are at stake. Organisations must develop strategies and implement management initiatives to respond to the waves of disruptions impacting their businesses.

Understanding the strategies, projects and tools to manage the Knowledge to navigate uncertain times is essential for the survival and sustainability of any private, public and social organisation. The capacity of creating, employing and deploying Knowledge is critical to protect the business and to guarantee that organisations can continuously contribute to the value creation dynamics of stakeholders' wealth creation.

Knowledge management is essential to drive organisations through the crisis. It can help implement change management, optimise operations, and, most importantly, support organisational learning mechanisms that can turn into innovations strengthening corporate systems of responding to a complex socio-economic landscape. The management and assessment of knowledge assets can encourage workplace protection, ensuring employees safety and engagement to find new solutions. A knowledge-based view of the employment and deployment of new technologies can support smart working, the security of employees' expertise from

dispersion, the creation of knowledge communities for innovation, the strengthening of social capital to face the psychological and sociological human tragedies. Knowledge management strategies play a central role in developing supply chains resilience and reorganise operations. The assessment and protection of intellectual capital are critical to reducing the risks of a financial downturn. Finally, knowledge-based strategies can help to maintain relationships with customers and key stakeholders.

At the 16th edition of IFKAD, we wish to extend our theories, findings and business discourses about the role and the dynamics of Knowledge in a time of a growing level of uncertainty. To discuss to what extent strategic knowledge management can support organisations to maintaining resilience, flexibility and agility for sustainable organisational value creation capacity.

With your contribution, we make IFKAD the learning space to advance our understanding of how managing knowledge organisations can face business and socio-economic challenges. The multidisciplinary field of knowledge management can provide valuable insights to help leaders and managers to think and rethink their organisations to equip them with a knowledge management capacity to absorb and react to disruptions and crises effectively.

This year's IFKAD is supported by the LUM University, Rome Tre University and the Chinese Culture University. Moreover, we have the support of SUPSI, which will be the host of IFKAD2022.

The mission of IFKAD is the development of research and scientific conversations aimed at contributing to theory-building as well as to the managerial practice about the role of Knowledge as an organisational value-driven source. Our view is that organisations are primarily in the business of Knowledge and their capacity of managing Knowledge depends on their future business sustainability and value creation capacity.

I want to extend my gratitude to all those colleagues and friends who work to make IFKAD a successful scientific event and a great social gathering where to meet old friends and make new ones. I am sure that IFKAD2021 will continue to inspire a fruitful conversation capable of nurturing our curiosity and scientific expertise. Furthermore, I am confident that all delegates will share insights that can help organisations navigate the difficult time and complex socio-economic landscape generated by the coronavirus crisis.

Prof. Giovanni Schiuma  
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## A Knowledge Strategy for the 'Greening' of Financial Firms

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### Abstract

The research question of the paper is *How can financial firms go green?* Change in banks, fund managers and other financial firms is at the heart of green finance, its role in green economy changes, and rapid responses to significant risks of climate change. This involves purpose led change in complex systems in firms and comprises significant problems of understanding and action. Complexity must be addressed to manage change and problems. This requires closing knowledge gaps in practice and academy.

Field and archival research are used to reveal the main elements, connections, and interactions, in the case financial firms as complex socio-technical systems (Mitleton-Kelly (2003), and in their green change process. The focus of this empirical narrative is on change in nonfinancial aspects and how this changes financial activities.

An interdisciplinary approach (Knights and Willmott, 1997; de Bakker et al, 2019) is adopted to interpret the resulting empirical change narrative and develop an equivalent theoretical narrative. These narratives constitute a conceptual framework in the form of a Green 'Behavioural theory of the financial firm' (green BTTF).

This knowledge strategy (Zack, 1999) directly addresses issues of uncertainty and complexity by closing the knowledge gap (Holland, 2010) between, what academics and practitioners know about the greening of financial firms, and what they need to know. It is a means to close knowledge gaps in practice and academe in co-ordinated ways. This is a basis to develop integrated thinking and promote holistic actions about knowledge dynamics involving green change in the firms.

This holistic narrative approach has potential 'to make a difference' in; learning, knowledge dynamics, thinking, and believing about desirable actions and responses to climate change (Shiller, 2019; King and Kay, 2020) in financial firms and wider systems. These are part of the evolving means to realign value in financial markets with values of wider society (Carney, 2020).

**Keywords** – Financial firms, Climate, Complexity, Knowledge,

**Paper type** – Academic Research Paper

## 1 Introduction

The research question of the paper is *How can financial firms go green?* Change in banks, fund managers and other financial firms is at the heart of green finance, its role in green economy changes, and rapid responses to significant risks of climate change. The green financial firm and its positive impact on climate change is part of the means to protect and restore nature and its biodiversity, and vice versa. This involves purpose led change in complex systems in firms and comprises significant problems of understanding and action. Complexity must be addressed to manage change and problems.

This requires integrated thinking about such change and dealing with problems of knowledge and knowledge gaps. Knowledge gaps concerning financial firms are arising in the field of practice and in the field of academe due to the complexity and rapidity of climate change. This reflects history of change in this sector. The GFC revealed historic knowledge gaps in the field of practice and field of academe concerning financial firms (Turner, 2009; Holland, 2010, Gendron et al, 2013).

Climate change issues have been significant for many years, but Paris 2015 created high awareness of green dimensions to knowledge gaps. The finance only purpose of the firm is being challenged, and major green changes are being made in financial firms and their impact on GHG emissions and global warming.

Practitioners, regulators, the EU and UN, have sought to develop a body of 'knowledge of practice' to enable financial firms to respond to climate change. *This includes* Principles of Responsible Banking (2017-2019); TCFD (Bank of England, 2017); UNEP SDGs and Paris 2015 aims; Green taxonomy (EU, 2020); and GFANZ (2021). However, practitioners still face knowledge problems. It is difficult to develop a holistic view due to the rapid and complex climate change processes, and problems of explaining and managing change in financial firms as complex systems (Mathews, Net Zero Finance Conference, 2021).

A major academic knowledge gap remains. Despite the extensive criticism of finance theory post GFC (Gendron et al, 2013), there is very limited research by traditional finance academics on matters of substantive change in areas of public policy such as climate change (Diaz-Rainey et al, 2017; Hong & Scheinkman, 2020). Finance academics have yet to adapt the dominance of finance theory and financial aims to reflect changes in purpose and function in finance. Finance

theory does not reflect the major changes in finance phenomena concerning climate change, biodiversity, and corporate social responsibility in post GFC era.

The paper argues the gap for 'knowledge of practice' is partially solved by conducting field and archival research to explore empirical phenomenon on how financial firms are 'going green'. The 'academic knowledge' gap is partially solved by using relevant theory and literature sources in an interdisciplinary approach (Knights and Willmott, 1997; de Bakker et al, 2019). This is used to interpret the field based 'green' empirical insights, thus aligning knowledge changes in fields of practice and academe.

These approaches are combined in a *green oriented* 'Behavioural theory of the financial firm'. This knowledge strategy (Zack, 1999) directly addresses issues of uncertainty and complexity by closing the knowledge gap (Zack, 1999, Holland, 2010) between, what academics and practitioners know about financial firms, and what they need to know. This holistic narrative approach has potential 'to make a difference' in; learning, researching, thinking, and believing about desirable responses to climate change (Shiller, 2019; King and Kay, 2020).

Section 2 on research methods outlines sources of data and use of qualitative methods to understand green oriented change in financial firms. Section 3 presents a conceptual framework or 'green behavioural theory of the financial firm' (Green BTFF) as integrated empirical and theoretical narratives. Section 4 outlines the conclusions and explores how the approach in the paper has potential 'to make a difference' when facing complexity and uncertainty arising from climate change.

## **2 Research methods**

The paper uses qualitative research and theoretical interpretation to explain how financial firms can go green. In this research, "field-based stories" or "empirical narratives" (Golden-Biddle and Locke, 2007) are based on empirical findings about financial firms as they changed for sustainability reasons. Two sources of data are used. *Firstly*, public sources are used to develop detailed cases of change in six major financial firms in the period 2010-2021. These include three banks (NatWest/RBS, Lloyds, Wells Fargo), and three fund managers (Schroders, Baillie Gifford, Blackrock). *Secondly*, the author attended eleven major practitioner conferences to gauge change across many financial firms. The practitioner conferences are at the heart of the practitioner and policy debate about change

in green finance. They included Green Finance Summits (2017 to 2021); Ethical Finance Summits, (2018 to 2021), and many others. The data was based on firms committed to sustainability and Net Zero aims (GFANZ, 2021). Presentation of the paper at academic conferences provided many ideas from the academic community. The change narrative covers periods of rapid change, and major problems and crisis from 2010 to 2021 with an emphasis on climate change. Covid-19 pandemic (2020-21) was a novel source of insights. Data processing sought to identify core empirical themes and their connections in wider patterns. This was the basis to develop an 'empirical narrative' (Golden-Biddle et al, (2007) revealing links between common themes identified for financial firms, and stakeholders. The themes concerned; changes in structure, mechanisms, process and interactions, internal working conditions, behaviour, decisions, communication and reporting actions and outcomes; as well as consequences and feedback. The 'empirical narrative' was interpreted using relevant literature to develop an equivalent 'theoretical narrative' and form a 'green behavioural theory of the financial firm' (Green BTFF).

### **3 A Green Behavioural theory of the financial firm (Green BTFF)**

This section shows how the Green BTFF is based on a combination of insights from an "empirical narrative" interpreted within a "theoretical narrative" (Golden-Biddle and Locke, 2007). The narratives reveal the mutual, reciprocal nature of organisational dynamics: between contextual resources (structure and knowledge, control mechanisms, technology), interactions and conditions, and decisions; during change dynamics and operational activities. Financial firms are seeking a subtle combination of, *'What we are (becoming) and what we are for, affects what gets done'* and *'What gets measured gets done'*.

#### **3.1 Financial firms as complex systems**

The empirical evidence in the cases shows that financial firms and their stakeholder networks, operating in financial markets and changing environment, form complex systems made up of core elements and connections, purpose, and dynamic processes (Mumford, 2000; Mitleton-Kelly, 2003; Barile et al, 2018; Holland J. H, 2014). In broad metaphor terms (Morgan, 1997) the financial firm socio-technical system consists of 'Head', 'House', 'Community', and 'Machine' elements. The core elements concern: top teams and purpose ('head'); contextual

resources ('house'); interactions and conditions (in 'community' of employees and others); and a financial 'machine' of connected financial decisions. The clusters of factors form the relatively invisible system which influence how people 'live' and operate in top teams and other teams in financial firms. Dynamics involve many purposeful and multidimensional interactions between employees and with stakeholders. These arise at the top, in the 'house' and in 'communities' (internal, external). The mutual reciprocal interactions involve shared thinking and actions in the firm and external networks. The emphasis is on 'doing the right thing' defined by an explicit green oriented and socially responsible purpose.

These interacting socio-technical resource elements and financial resources are integrated in purposeful ways in **business models**. Firms seek to integrate areas such as green purpose, with changes in firm wide areas such as culture, technology, and control systems, as the basis for success. This integrated system of non-financial and financial resources is the basis for transforming the inputs, through business activities, into outputs and outcomes in a 'financial machine' that aims to fulfil the organization's strategic purposes (IIRC, 2013).

### **3.2 The change narrative**

The above aspects of the complex system are the focus of change dynamics outlined in the cases. Changes in one part of the system such as organisation structure or product design will have an impact on other parts such as culture or customer relations. The financial firm is an open system responding to many change pressures (Holland, 2019). These systems have emergence properties whereby the action of the whole is greater than the sum of the actions of parts (Holland J. H, 2014). As Mitleton-Kelly (2003) argues, change and the evolutionary process moves all the time between micro behaviours and emergent structures and mechanisms, each influencing and recreating each other

Thus, the whole system and its changes must be viewed together during change processes to increase the chances of success. Integrated thinking skills, avoidance of silos, and shared understandings at all levels, are required to align everyone in the firm whole system to pursue desired outcomes. These changes must have strong anticipatory and environmental scanning elements based on quantified scenario analyses and qualitative 'envisionment' perspectives (Mikes, 2012) of future risks. The latter include connected climate change risks, biodiversity, social, and financial risks for long term (2050), medium term (2030)



and short-term horizons (say from one year to 2025 ahead). They include scenario analysis for physical and transition risks and how they can interact and lead to 'tipping points'.

The following subsections includes succinct summaries of insights from four major parts of the integrated 'empirical change narrative'. Each part of the empirical change narrative is supported by a brief theoretical interpretation.

### **3.3 Changes in strategic thinking and top teams (the 'head')**

*The first part of the strategic 'change narrative' starts with change pressures and learning at board and executive team levels. Case firms such as NatWest and Schroders and members of specialist financial sector (Net Zero) alliances (GFANZ, 2021) are making changes to firm purpose, function, and planning. They are changing leadership, and composition and governance of board and executive teams, to create the capabilities to deal with climate change risks. This leads to strategic choices about the green purpose and orientation of the firm, and to performance metrics about Net Zero outcomes. The above changes in top teams - drive co-ordinated changes to contexts, mechanisms, and technology - throughout the financial firm - to achieve sustainability and financial aims.*

*The theory and literature view of the above views case financial firms as a 'learning organisations' (Pedler et al., 1997). This explains how top teams learn how to make strategic choices about new enabling infrastructure and enabling conditions with new sustainable advantages and resilient dynamic capabilities in their firms as complex systems. Top teams "look in" at organisation and knowledge, and "look out" and learn about markets and stakeholders (Pedler et al., 1997). They use learning to think about creating resilience and dynamic capabilities (Teece, 1997) in contextual resources, interactions, conditions, and decisions.*

### **3.4 Changing context as adapted infrastructure and mechanisms**

*The second part of the strategic empirical 'change narrative' explains how firms make green oriented changes in; 'enabling infrastructure' or 'soft' 'socio-technical' contexts (Mumford, 2000; Mitleton-Kelly, 2003) in the existing financial firm 'house' and 'community'. Climate change leads to **three** major clusters of strategic change to firm socio-technical infrastructure. The first cluster includes*

changes to: firm wide social structure, culture as 'organising' means, and to knowledge resources; at both macro and micro levels. The second cluster concerns green changes to control and influence mechanisms. These include communications and storytelling, top team behaviour, training, incentives ('soft' and 'hard' ), formal control systems, as well as changes in culture as a means of controlling and influencing. 'Culture' is used in cases to connect ideas of social organisation and social means of control and influence. The third cluster involves green changes to technology and impact on knowledge and social process.

The *theoretical analysis* of the above discusses how the case firms use their top team learning and planning capability to promote green organisational change in the socio-technical infrastructure in the three clusters throughout the firm. This uses *organisational* literature and theory sources such as Burnes, (2004); Lewin, (1947); Cyert and March, (1963). Schein's (2004) ideas of culture as an important learnt and evolved property of organisation life, plays a role in explaining behaviour and change. From a *system theory* perspective, the firms develop a green orientation to their 'Socio-cultural and technical' elements (Mitleton-Kelly (2003) or soft', technology, and measurement parts of the firm complex system.

Green knowledge resources concern knowledge of climate change risks, social organisation, green finance, and design of new green products. They form intellectual capital (Meritum, 2002) or human, structural, and relational capital. The green oriented influence and control mechanisms form additional ways of organising and integrating firms and enabling behaviour and actions (Gond et al, 2012) . New technology is a key factor in creating new socio-technical systems and conditions (Mumford, 2000). These changes to the socio-technical infrastructure create economic advantages in behaviour and information production. They lead to green changes in transforming risk, return and liquidity of financial resources (financial intermediation) (Buckle, et al 2011; Holland, 2019) and in delivery of financial services.

Thus, all non-financial and financial parts of this complex system are the focus of change. The above analysis explains how the full set of integrated and green oriented socio-technical infrastructure factors embed green change (Lueg & Radlach, 2016) in financial firms. These integrated social and knowledge factors, influence and control mechanisms, and technology, are means to prevent the dominance of financial values and avoid the 'tragedy of the horizon' (Carney, 2015). They are means for financial firms to create incentives for their employees and their customers to place a value on the climate and nature and to act to

protect these (Dasgupta, 2021). They are systematic and connected means for financial firms to control 'crowding out' pro-social behaviour (Bénabou, Tirole, 2006) at a time when a new perspective is required. They are means to promote 'sustainability orientation' and environmental pro-activity (Ditillo & Lia, 2016) in financial firms, their employees, and customers. For example, combining environmental consciousness from green oriented 'soft' context and mechanisms to 'hard' financial incentives such as pay, is critical to changing behaviour of managers and employees to pursue sustainability aims (Narayanan et al, 2021) in their financial decisions.

### ***3.5 Using 'people' interactions –to mobilise mechanism within context – to influence conditions***

*The third part* of the strategic empirical 'change narrative' concerns core dynamics in the change process involving many connected factors and process.

The narrative explains how these resources are mobilised, how changes are enabled and driven by organisation processes (Cyert and March, 1963) as purposeful interactions at individual, team, firm, and network levels. The interactions concern top-down processes such as setting a green 'tone from the top', and promoting green oriented culture (Schein, 1989). They involve individual and teams (and their social and knowledge characteristics) interacting with each other in multidimensional ways (through bottom up, lateral, and network interactions), within green oriented organisational structure and network contexts.

The multidimensional social interactions are the primary means to mobilise the socio technical infrastructure and firm wide controlling and influencing mechanisms, to create desirable or green oriented working conditions. These include emotional enabling conditions such as trust, desire to co-operate, sense of ease of communications, shared sense of purpose, and buy-in to the change narrative. The narrative shows how the case firms create desirable decision and working conditions based on; understanding of climate change risk, the ability to create green information about fund users and suppliers, and to control their own behaviour relative to sustainability and financial aims. The change to working conditions are made to improve each decision team's focus on risk and opportunities relative to Net Zero (GFANZ, 2021) and financial aims. They are

used to change economic advantage and behaviour, and create information for financial decisions.

Thus, new socio-technical structure and organisational process *shape* changes in decision behaviour in teams. Purpose led mechanisms (for control and influence) and purpose led 'people' interactions (multidimensional) *drive* the financial firm 'community'. Collectively, they influence 'ongoing engagement' with employees, customers, and stakeholders, as well as the delivery of new green products.

The *theoretical analysis* of the above uses literature to interpret the mutual reciprocal interactions and co-evolution (Mitleton-Kelly, 2003) in the dynamic system. A select group of significant sources are chosen including Bourdieu, (1990), Schein (1989), Weick, (1995), Boyce, (1996), Statman, (1999), Stones (2005). These explore **how** multidimensional social interactions by employees (top down, bottom up, lateral, and network) within the new green socio-technical infrastructure, are used to mobilise influence and control mechanisms. They are used to exploit change in these social and knowledge structures and mechanisms, and shape and drive new behaviours. The changes and interactions influence interpretation of external events and stimuli, to guide behaviour and decision action. These mutual reciprocal interactions during everyday activities play a role sustaining social and knowledge structures (Bourdieu, 1990; Stones, 2005), and in stimulating further change and evolution over time.

### **3.6 *Changing economic conditions and financial decisions in a financial 'machine'***

The *fourth part* of the strategic empirical 'change narrative' highlights how changes to the non-financial context and working conditions, supports new economic conditions and ways to deliver new financial decision activities and products. The latter concern creation of new green oriented financial assets and liabilities (and derivatives of) in each firm's specialist domain. The new working conditions improve each decision team's focus on risk and opportunities relative to Net zero and financial aims. They change the way financial resources are used in operational activities and financial decisions. They change financial decisions to save, lend, invest, or insure to reduce harm of GHG emissions. They are means to deliver green financial services and functions required by customers, employees,

shareholders, citizens, and other stakeholders in their pursuit of Net Zero outcomes.

The *theoretical analysis* of the above makes use of theory of the firm (Barney, 1991; Hart, 1995; Teece, 1997) and theory of finance (financial intermediation) (Scholtens and van Wensveen, 2003; Holland, 2019).

The existential threat of climate change and regulatory pressures means that top teams seek to create co-operative advantages with their sector peers in other financial firms (GFANZ, 2021) and with client firms in the real economy. In this co-operative context they pursue sustainable co-operative and competitive advantages to create superior financial performance that supports shared climate change aims. Thus, **the resource-based view of the firm** (Barney, 1991; Hart, 1995; Teece, 1997) reflects both co-operation and competition.

Literature from the 'Behavioural finance' perspective (Statman, 1999) indicates that the case financial firms seek to use their new green context, process, and capabilities to reduce behavioural biases in firm employees when making decisions. They can exercise control over behavioural biases in others that lead to increased GHG emissions.

**Theory of finance**, especially financial intermediation, (Scholtens and van Wensveen, 2003) are used to explore how the changes to; 'soft' infrastructure, co-operative behaviour, and competitive advantages; are means reduce major information asymmetries (Holland, 2019). This creates opportunities to source and allocate green funds and make green oriented changes to the provision of 'hard' financial products and financial functions. The 'socio-technical' elements, and co-operative advantages in the firm are necessary means to mobilise use of financial resources in conventional financial intermediation in pursuit of sustainability aims (Holland, 2019).

## 4 Conclusions

The aim of the paper has been to answer the research question *How can financial firms go green?* This involved change in complex systems. It was explored through empirical narratives and theory narratives (Golden-Biddle and Locke, 2007). These formed a conceptual framework as a Green 'Behavioural theory of the financial firm' (green BTTF).

The green BTTF directly addresses issues of uncertainty and complexity. It is part of a knowledge risk management strategy (Zack, 1999; La Torre, 2020) to

understand the complex system and respond to uncertainty (Bratianu, 2020). It is a means to close the **knowledge gap** (Holland, 2010) in both in practice and academe, between, what the firm and others know, and what they need to know (Zack, 1999), when making decisions during rapid change with potential for severe crisis. This is a basis to develop integrated thinking and promote holistic change and actions.

This reduction of knowledge risks (La Torre, 2020) goes beyond conventional knowledge risks concerning financial intermediation, and regulation of financial risks (Holland, 2010); to risks with knowledge of non-financial aspects of firms. This complements financial intermediation theory (Buckle et al, 2011; Holland, 2019) by explaining the role of intangibles in transformation of financial capital and risks and delivering specialist financial functions in economies.

The green BTTF has many potential uses 'to make a difference' in **learning, thinking, and actions**, by financial firms, and by co-operating and competing agents in the finance system and wider society. Agents include 'top teams', the rest of financial firm, advisory policy bodies, legislators, and regulators. They include civil society organisations (CSOs), customers, employees, citizens, and academics. The changes are means to realign value in financial markets with values of wider society (Carney, 2020). They are ways to align financial firms; their suppliers and users of funds (companies and customers); with net zero aims.

Such integrated thinking offers many potential ways 'to make a difference' in **actions** in financial firms, finance system and wider society. In **firms**, the green BTFF is used to argue that firms must clarify the key components, connections, and dynamics in these changes. It is used to argue that significant co-ordinated changes are required in 'deep' or hidden aspects of financial firms and in their specialist roles, to make them 'green oriented' and responsive to the problems. In **markets and society**, the green BTFF provides a shared means for advocates of differing change mechanisms such as *voluntary co-operation, mandatory law, competition, and the 'invisible hand' of markets*, to think how to collectively use them to transform financial firms to go green.

The green BTFF as part of an extended knowledge risk management strategy involving many wider system agents. In Shiller's (2019) terms, it has the potential to limit contagion of uniformed or oversimplified ideas about climate change and the response of financial firms. This reflects Shiller's (2019) call for 'narrative economics' which has the potential to improve the collective ability (in markets, and wider society) to predict, prepare for, and lessen the damage of climate

change as well as financial crises, recessions, depressions, and other major economic events. This reflects King and Kay's (2020) argument that in the face of uncertainty decision makers should rely more on robust and resilient reference narratives, in which uncertainty is embraced as a source of creativity and benefit.

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## Mapping Intellectual Capital and Performance of Knowledge Organizations: an Enriched Systematic Review

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### Abstract

The aim of this work is to carry out a mapping of existing literature on "Intellectual Capital (IC)" and "Performance" and relationships between them with a focus on knowledge organizations, including universities, but not limited to them. We propose an *enriched*

systematic review approach, in order to analyze what we know about the relationships between IC and the performance of knowledge organizations and which indicators have been proposed and are adopted by knowledge organizations to assess their performance.

**Keywords** – Intellectual Capital, Performance, Knowledge Organizations, Multidimensional Assessment, Meta-choice Problems

**Paper type** – Academic Research Paper

## 1 Introduction and contribution of the paper

Knowledge, and in particular Intellectual Capital (IC), represents the main wealth of organizations, especially in turbulent times such as the current ones. Due to the relevance of the topic there has been a rich interest and scientific production on the topic recently collected in several surveys, including Petty and Guthrie (2000), Serenko and Bontis (2017), Dumay et al. (2015) and Garanina et al. (2021).

On the other hand, measuring the contribution of knowledge to the overall performance of knowledge organizations is anything but simple and straightforward. Some authoritative scholars already raised specific challenging issues like the assessment of the productivity of knowledge workers and the sustainability of knowledge strategies (Drucker, 1999). The performance of knowledge organizations has a multidimensional nature and requires a benchmarking based on multiple Key Performance Indicators (KPIs). In addition, the assessment of performance of knowledge organizations is related not only to the IC in its three dimensions of *Human Capital*, *Structural Capital* and *Relational Capital*, but also to other financial and non-financial dimensions. On top of this, as we have shown in Daraio et al. (2020), performance evaluation, including knowledge and IC, is affected by the so-called three-dimensional *meta-choice problem*. This problem refers to i) the conceptual dimension of the performance evaluation model (underlying *theory*); ii) the *methodologies* of analysis that are applied and to iii) the *data* used to calculate the indicators of reference.

The aim of this work is to carry out a mapping of existing information and relationships between “Intellectual Capital” and “Performance” with a focus on knowledge organizations, including universities, but not limited to them. To answer the question “What do we know about the relationships between IC and the performance of knowledge organizations” and “which indicators have been

proposed and are adopted by knowledge organizations to assess their performance, including IC", we propose an *enriched* systematic review approach.

Our aim is:

- (i) provide an updated and complete mapping of IC and performance,
- (ii) identifying a rich set of indicators which integrate the existing literature both published in international peer-reviewed papers and in the *grey literature*, e.g. practical-based reports, produced within knowledge-intensive firms.

## 2 Methodology

We follow the PRISMA statement for systematic review (Moher et al. 2009), a standardized approach for documenting the survey and allowing its replicability in its current version (Page et al. 2020). Nevertheless, considering the topic of our investigation, a typical managerial and complex issue, namely investigating the relationships between IC and performance of knowledge organizations, we appropriately adapt the PRISMA methodology to the typical characteristics of the topic of our analysis, following Tranfield et al. (2003) and Petticrew and Roberts (2006). Tranfield et al. (2003) showed the usefulness of systematic literature reviews in the management area to develop evidence-informed decision support systems. Petticrew and Roberts (2006) illustrate the specificities of systematic reviews applied in the social sciences including management.

For the analysis, the Bibliometrix R package (Aria and Cuccurullo, 2017) and VOSviewer (Van Eck and Waltman, 2017) softwares will be used for mapping the existing knowledge on IC, its components and performance dimensions, and investigate the existing links among them. Existing knowledge will be mapped considering the main contributors and the evolution of the cognitive maps over time. A detailed grid will be developed to collect and empirically investigate the existing knowledge according to the three dimensional framework introduced in Daraio et al. (2020), based on theory, methodology and data dimensions.

Our survey is "enriched" because, differently from many existing reviews, we consider not only published papers in refereed journals but also the rich *grey literature* produced by knowledge-intensive firms on intangible assets and their measurement, not indexed in existing databases (e.g. Sveiby, 1996 and 2002; Brembo, 2007; Leoni, 2018).

### 3 Intellectual capital and performance: Systematic review

To perform a systematic survey, we follow the PRISMA model (Moher et al. 2009). As a first step in the PRISMA model, the eligibility criteria for the papers to be analyzed were identified. In our case, all Journal articles, conference proceedings and book's chapter written in English were considered.

In a second step, we selected the information sources, namely SCOPUS (<https://www.scopus.com/>) and Web of Science (<https://www.webofknowledge.com/>).

In a third step, we identified the search strategy through the PICO model (Shea et al. 2007). This model allows us to select the search strategy, and to construct the queries to be executed in the selected databases, see Table I.

Table I. PICO (Adapted) Model for systematic review Search.

	Population	Intervention	Comparison	Outcome
Key concepts	Universities	Intellectual Capital	ALL METHODS	Rank or Performance
Free text terms / natural language terms (synonyms, UK/US terminology, medical/laymen's terms, acronyms/abbreviations, drug brands, more narrow search terms) Consider: phrase searching, proximity operators, truncation, wildcards, field qualification (e.g. textword)	Universit* HEI Higher education*	Intellectual Capital		Rank* perform* productiv* efficiency* technical efficiency* inefficiency* Multicriter*

Table II and Table III show respectively the Query carried out on Web of Science and the Query carried out on Scopus.

Table II. Web of Science Query last updated search on 2 April 2021

<b>Query Web of Science</b>
AK=( universit* ) OR AK=( hei ) OR AK=( Higher AND Education*) OR AB=( universit* ) OR AB=( hei ) OR AB=( Higher AND Education*)
AND (AK= ( intellectual AND capital ) OR AB= ( intellectual AND capital ) )
AND AK= ( perform* ) OR AB= (perform*) OR AK= ( productiv*) OR AB= (productiv*) OR AK= ( efficienc* ) OR AB= (efficienc*)
OR AK= ( technical AND efficienc* ) OR AB= (technical AND efficienc*) OR AK= ( inefficienc* ) OR AB= (inefficienc*)
OR AK= ( multicriter* ) OR AB= (multicriter*) OR AB= (rank*) OR AK= (rank*)
AND LANGUAGE: (English)

Table III. Scopus Query last updated search on 18 April 2021

<b>Query SCOPUS</b>
( TITLE-ABS-KEY ( ( universit* ) OR ( hei ) OR ( higher AND education* ) )
AND TITLE-ABS-KEY ( ( intellectual AND capital ) )
AND TITLE-ABS-KEY ( ( perform* ) OR ( productiv* ) OR ( efficienc* ) OR ( technical AND efficienc* ) OR ( inefficienc* )
OR ( rank* ) OR ( multicrit* ) ) )
AND ( LIMIT-TO ( LANGUAGE , "English" ) )

After performing the searches and collecting the results derived from the queries (specifically, the results were downloaded in .bib format) we obtained:

321 records in Scopus

256 records Web of Science.

In the next step, we proceeded to merge the results derived from the search in Scopus and WOS. The merging of these papers was performed using the Zotero software (Amhed et al. 2011), which also allowed us an initial elimination of duplicate records.

After obtaining the dataset of merged results, we proceeded to the screening of titles and abstracts of the papers through the Rayyann platform (Ouzzani et al. 2016) and Mendeley Desktop Software (Reoswog 2010), which in addition to the support of the screening phase, allowed us to eliminate additional duplicate papers not identified in the previous steps.

The number of duplicate papers identified by the various software is 144.

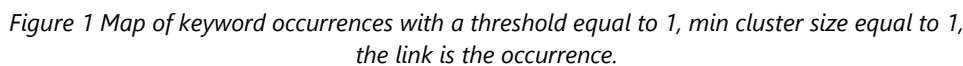
From the screening of abstracts and titles, the obtained results are:

Papers of interest to the work: 119 records

Papers not of interest for the work: 270 records, they were discarded.

In 270 cases identified, the word "university" was present in the abstracts as it identified the university to which the authors belonged, but it was not a keyword related to the content discussed in the paper. Hence, these cases were excluded.

The first analysis relates the co-occurrences of the keywords of the selected papers using VosViewer software.



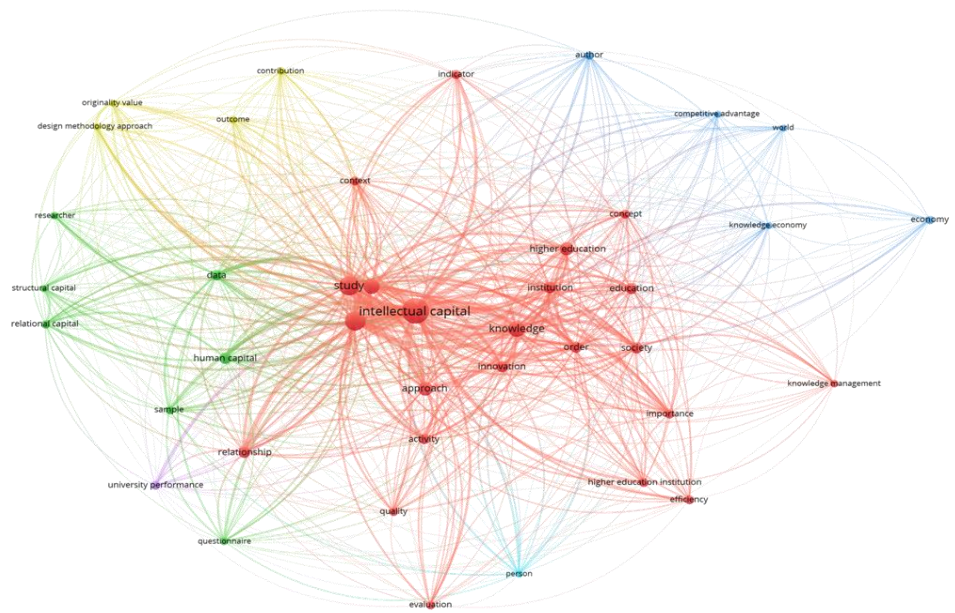
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cluster models). In conclusion, it can be seen that in many works intellectual capital is analyzed according to the structural-human-relational capital approach.

The second analysis relates to the text mining of the keywords and abstract of the selected papers using VosViewer software through which co-occurrence maps can be created.

The text mining analysis highlights 4 main clusters (coloured red, blue, yellow, and green). These clusters identify groups of words that are often used together and can be traced back to concepts such as:

- Red cluster: words that identify the main themes addressed by the papers (intellectual capital, HEI, etc...)
- Green cluster: in-depth themes about the approach and data used
- Blue cluster: themes related to the link between intellectual capital and the knowledge economy
- Yellow cluster: words related to the contribution of the work in the scientific landscape



*Figure 2 Map of co-occurrences using text mining techniques. the first 50 values appearing 8 times are shown. the threshold is 1. The minimal cluster size is equal to 1. The link is the occurrence.*

The third and final analysis is to map the co-words using dimensional reduction techniques. This type of analysis allows mapping the conceptual structure of a



network using the co-occurrences of words in a bibliographic correlation (in our case the author keyword). The analysis was performed by adopting the Multiple Correspondence Analysis (MCA, Abdi et al. 2007) dimensionality reduction technique. This technique is used for nominal categorical data and is used to detect and represent the underlying structures in a dataset. This analysis was performed with the R package bibliometrix.

The results obtained are reported in Figure 3. In Figure 3 we clearly see that the keywords of the papers selected in our review can be distinguished into 3 main groups which can be related to the three-dimensional meta choice framework based on theory, methodology and data dimensions.

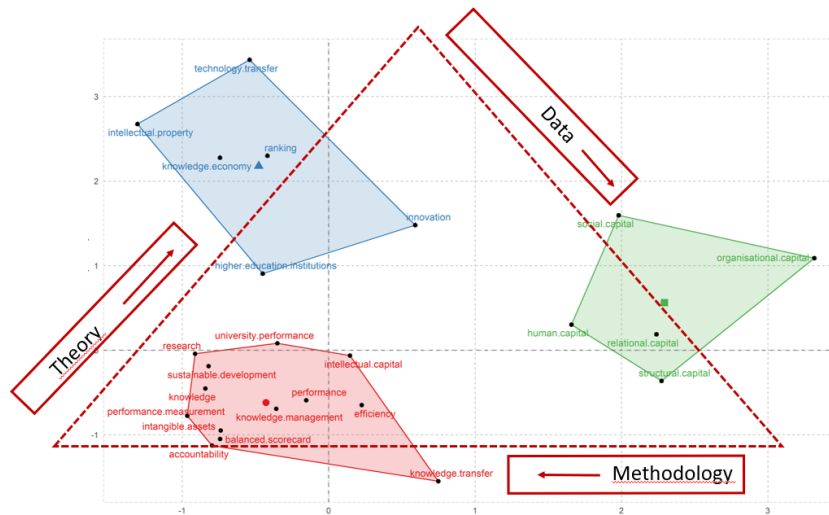


Figure 3 Conceptual Map. MCA (Multiple Correspondence Analysis) results and relationship to the 3 meta choice dimensions of Theory, Methodology and Data.. Number of terms considered 24, Number of clusters obtained is 3.

#### 4 Grey literature on Intellectual capital and performance

In order to “enrich” the systematic survey described in the previous section, we consider the rich *grey literature* produced about knowledge-intensive firms on intangible assets and their measurement, not indexed in existing databases.

Over the years, intangible assets have assumed considerable importance for companies; therefore the academic research collaborated to identify different methodologies to measure them. There are several methods to measure the value of intangible assets (Edvinsson & Malone, 1997; Roos et al., 1998; Sveiby, 1997;

Kaplan & Norton, 1992); the literature offers some classifications of the most used methodologies (Sveiby, 2001). Sveiby (2001 and 2010) provides an overview about the main methods for measuring intangible assets. In particular, starting from the classifications suggested by Luthy (1998), Sveiby (2001) proposes four categories of measurement approaches each of which has advantages and disadvantages:

- **Direct Intellectual Capital methods (DIC):** Estimate the \$-value of intangible assets by identifying its various components. Once these components are identified, they can be directly evaluated, either individually or as an aggregated coefficient.
- **Market Capitalization Methods (MCM):** Calculate the difference between a company's market capitalization and its stockholders' equity as the value of its intellectual capital or intangible assets.
- **Return on Assets methods (ROA):** Average pre-tax earnings of a company for a period of time are divided by the average tangible assets of the company. The result is a company ROA that is then compared with its industry average. The difference is multiplied by the company's average tangible assets to calculate an average annual earning from the Intangibles. Dividing the above-average earnings by the company's average cost of capital or an interest rate, one can derive an estimate of the value of its intangible assets or intellectual capital.
- **Scorecard Methods (SC):** The various components of intangible assets or intellectual capital are identified, and indicators and indices are generated and reported in scorecards or as graphs. SC methods are similar to DIC methods, except that no estimate is made of the \$- value of the Intangible assets. A composite index may or may not be produced.

The set of methodologies is summarized in the following Figure 4.

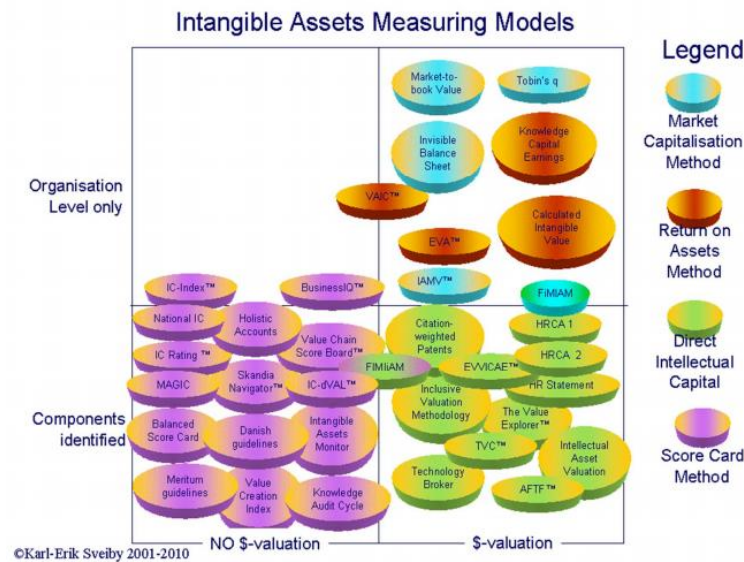


Figure 4. Intangible Assets Measuring Models. Source: Sveiby (2001).

Beyond the methods that each company chooses to adopt to measure intangible assets, the company's goal is to create an *Intellectual Capital Report*. The intellectual capital report is a tool for measuring intellectual capital, useful for internal management and company knowledge management. In practice, this report takes the form of the identification of a series of indicators, not necessarily financial ones.

In line with the purpose of the article, a sample of knowledge-based companies that have presented the intellectual capital report over the years was analyzed and the most recurrent indicators were identified. See Tables 1A and 2A, which summarize the available information, reported in the Appendix.

Anyway, the research highlighted the emerging need of companies to include, in addition to the three known components of intellectual capital, also an aspect related to the environment and the social impact of companies. This has shifted the focus from the intellectual capital report to the *Sustainability Report*; so corporate sustainability reporting is now a mainstream business practice (Ernst & Young, 2014; KPMG, 2013; PricewaterhouseCoopers, 2014, 2018). The sustainability report is a tool to inform investors and other stakeholders about sustainability activity of the company. Companies retain significant flexibility to disclose relevant information in the way that they consider most useful; In this respect, a variety of frameworks can be applied (e.g. European Commission, 2009;

ISO 26000, 2010; United Nations, 2011; OECD, 2018; COP, 2019), however, corporate reports based on GRI-Global Report Initiative (GRI, 2015) represent the main framework applied by organisations to communicate clear standardised information related to their environmental, social and economic performance to all their stakeholders.

But the following two questions arise:

- (i) what is the relationship between the sustainability report and the intellectual capital report?
- (ii) what is the relationship with company performance?

To answer the first question, we analyse the sustainability reports of a sample of knowledge-based companies and the indicators used there. In particular, we used the database "United Nations Global Compact" (available at <https://www.unglobalcompact.org/>) and we considered only companies about sector "Support Service", "Software & Computer Services" and "Financial Service".

The comparison of the indicators shows that the elements of greatest convergence are found in human capital. For instance, Lim et al. (2010) analysed the importance given to 15 human capital indicators in the investment decision-making processes of fund managers; Cinquini et. al (2012) analysed a sample of sustainability report and they found nine of these indicators, and specifically "staff satisfaction index", "ratio of value added per employee", "number of percentage of full-time", "part-time, contract or temporary staff ", "quarterly, half-year and yearly staff turnover", "average years of experience", "average age of management and operational staff", "average years of service with the company", "average educational level of workforce at each functional level" and finally "workforce competency profile".

After all, there are also some aspects related to structural capital, such as the enhancement of investments in R&D or the development of new products. The analysis of intellectual capital facilitates the measurement of the company's social relations; Therefore, we find some points in common with relational capital, such as customer growth and, somehow, the brand image and reputation of the company. Cinquini et. al (2012) offer a list of intellectual capital items on sustainability report, summarized below.

Table 1. List of intellectual capital items on sustainability report. Source: Cinquini et al. (2012, p.543)

<b>Human Capital</b>	<b>Structural capital</b>	<b>Relational capital</b>
Employees characteristics	Intellectual property	Distribution channels
Employees training	Information systems	Business collaborations
Employees skills	Corporate culture and management philosophy	University and research centre collaborations
Employees wellness	Management processes	Company reputation
	Research and development	Customers
		Suppliers
		Financial relations

In our study we have identified the indicators most used by knowledge-based companies, organized according to the three elements of intellectual capital.

**Human capital**

*Training and education:*

Average hours of training per year per employee  
Program for upgrading employee skills and transition assistance programs  
Percentage of employees receiving regular performance

*Diversity and equal opportunity:*

Diversity of governance bodies and employees  
Ratio of basic salary and remuneration of women to men

*Non- discrimination:*

Incidents of discrimination and corrective actions taken

*Human rights assessment:*

Operations that have been subject to human rights reviews or impact assessments  
Employee training on human rights policies or procedures  
Significant investment agreements and contracts that include human rights clauses or that underwent human rights screening

*Employment:*

New employee hires and employee turnover  
Benefits provided to full-time employees that are not provided to temporary or part-time employees  
Parental leave

*Occupational health and safety:*

Occupational health and safety management system  
Hazard identification, risk assessment, and incident investigation  
Occupational health services  
Worker participation, consultation, and communication on occupational health and safety  
Worker training on occupational health and safety

	Promotion of worker health Prevention and mitigation of occupational health and safety impacts directly linked by business relationships Workers covered by an occupational health and safety management system Work-related injuries Work-related ill health
<b>Structural Capital</b>	Purchase of intangible assets and property, plant, and equipment Software licence Software support Research and development
<b>Relational capital</b>	<i>Customer privacy:</i> Substantiated complaints concerning breaches of customer privacy and losses of customer data <i>Socio-economic compliance:</i> Non-compliance with laws and regulations in the social and economic area <i>Market presence:</i> Ratios of standard entry level wage by gender compared to local minimum wage Proportion of senior management hired from the local community <i>Procurement practices:</i> Proportion of spending on local suppliers

Let's now answer the second question. The sustainability report is composed by three dimensions: social, environmental and economic. Obviously, the economic component is the one that most involves the aspects of company performance. Both human capital information and human capital investment decisions are linked to firm performance, reputation and information asymmetry (Wyatt and Frick, 2010) and firms should therefore communicate this kind of information to increase their transparency (Cormier et al., 2009).

Some studies found that intellectual capital plays a critical role between corporate social responsibility and financial performance. In particular, Nikolaou (2019) explains the relationship of corporate environmental and financial performance highlighting the significance of some mediators such as social and environmental responsibility, intellectual capital, innovation and competitive advantage. Trevlopoulos et al. (2021) identified a positive link between intellectual

capital and corporate financial performance. Some performance indicators, found in the sample analyzed, are listed below.

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***Economic performance***

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*Economic:*

- Direct economic value generated and distributed
  - Defined benefit plan obligations and other retirement plans
  - Financial assistance received from government
  - Ratios of standard entry level wage by gender compared to local minimum wage
  - Proportion of senior management hired from the local community
  - Financial implications and other risks and opportunities due to climate change
- 

**5 Discussion and conclusion**

In this paper we have carried out a mapping of existing information on the relationships between “Intellectual Capital” and “Performance” considering in particular knowledge organizations. The questions we addressed relate to the investigation on (i) the relationship existing between “Intellectual Capital” and “Performance” and to (ii) identify the indicators proposed and are adopted by knowledge organizations to assess their performance, including IC. From the mapping exercise we have found that the relationship between intellectual capital and performance can be enclosed within the three dimensional *meta-choice* framework which refers to i) the conceptual dimension of the performance evaluation model (underlying *theory*); ii) the *methodologies* of analysis that are applied and to iii) the *data* used to calculate the indicators of reference.

It appears from our analysis that the performance of knowledge organizations has a multidimensional nature and requires a benchmarking based on multiple dimensions and indicators. In addition, the assessment of performance of knowledge organizations is related not only to the IC in its three dimensions of *Human Capital*, *Structural Capital* and *Relational Capital*, but also to other financial and non-financial dimensions including *sustainability* dimensions.

Companies have shifted their focus from the intellectual capital report to the sustainability report, with the aim of also including environmental and social aspects. Our study investigated the presence of intellectual capital in sustainability reports, in order to offer a set of indicators useful for measuring it.

In the future development of this research, we will provide an accurate screening and a content analysis on the selected full papers identified in the

systematic review to collect the different indicators adopted in this “official” literature. The resulting indicators will be integrated with the rich set of indicators identified in the grey literature summarized in the paper with the aim of offering a complete and updated set of indicators to managers and policy makers interested in monitoring the connection of Intellectual Capital and Performance of Knowledge Organizations and their evolution over time.

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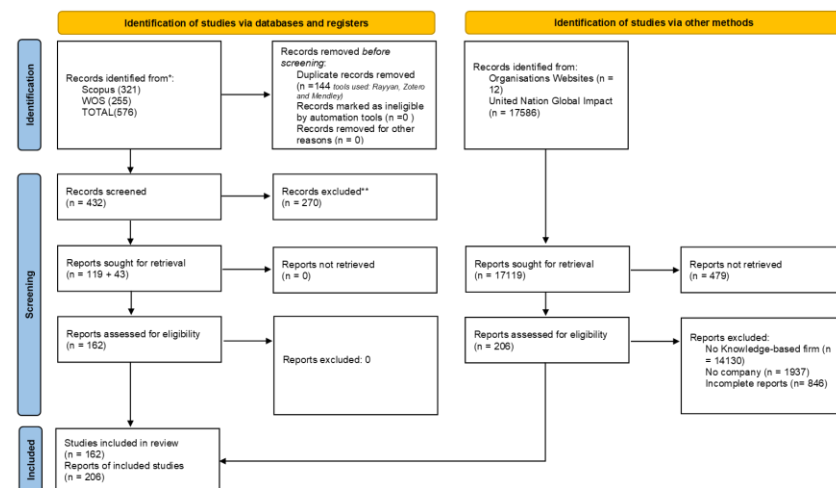
## Appendix

Table 1A. Sample: Knowledge-based companies that have presented the intellectual capital report.

Company	Nationality	Type	Year
Celemi	Sweden	Consulting	2005
WM-data	Sweden	Consulting	1995/1996
PLS Rambøll Management	Denmark	Consulting	2005
Infosys	India	ICT	2007/2008
COWI	Denmark	Consulting	2004
Parco Trieste	Italy	Research	2010

Table 2A. Some of the most used indicators by knowledge-based companies in intellectual capital report.

Relational capital	Structural capital	Human capital
Revenue growth (%)	R&D/Total revenue (%)	Total employees
Clients' growth (%)	R&D/Value Added (%)	Value Added/Total employees
Revenue/Customer (%)	Technology	Value Added/ Professional employees
Revenue new customer/Total Revenue (%)	Investment/Total Revenue (%)	Revenue generated per employee
Sales & Marketing expenses/Revenue (%)	Technology	Recruitment, development and training spend per employee
Brand image	Investment/Value Added (%)	Employee satisfaction
Customer satisfaction	Number of patents	Expert turnover
Reputation of company	Value of new ideas	Staff turnover



Source: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>

Figure 1A. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, register and other sources

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# Performance Improvement in the Business of Knowledge Production: a Natural Experiment from Higher Education

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## Abstract

A natural experiment from a university's teaching context shows that the internet diffusion of the class valuations from the students increases the teachers' performance. Internet allows a high level of transparency. Organizations can leverage the diffusion power of internet to increase the performance. A very high level of transparency as the one guaranteed by the publication on internet restrains the Agency Theory's moral hazard.

**Keywords** – Moral hazard, agency theory, strategy execution, natural experiment, higher education

**Paper type** – Academic Research Paper

## 1 Introduction

'In 1966, Roethlisberger and William Dickson published *Counseling in an Organization*, which revisited lessons gained from the experiments. Roethlisberger described "the Hawthorne effect" as the phenomenon in which subjects in behavioral studies change their performance in response to being observed' (Zaleznik, 1984). The possibility of people observation has been increased in the last decades terrifically. Today behaviors and their outputs can be showed to all the public through internet. Then, what does it happen when organizations share people job performance with everyone by internet? Is the Hawthorne effect valid in the modern context of the internet diffusion of people behaviors?

## 2 Theoretical Background

According to the Dalton et al.'s (2007) review an important root of the Agency Theory is the Smith's work. The prominent author was concerned about the efforts which agents would have put in managing companies owned by principals. These efforts could not be the same of the owners. Dalton et al. (2007) of course acknowledge the work from Berle and Means and mention the central point of their agency approach: the rise of the public companies owned by many shareholders with a small quote of the capital and the targets divergence between shareholders and management. Eisenhardt (1989) recalls the name of this interest divergence: moral hazard. The author also recalls the role of the information systems which shed light on the agents' behaviors and allow the principal to control them. If you can track the firm's activities you can define rules driving the right behaviors. If you can define the outputs of the activities you can fix targets leading towards effective actions. The first form of control is the bureaucratic control, the second form is the market control. You can also inspire correct behaviors by emphasizing the usefulness of them. This is the clan control which needs a community of people (Ouchi, 1979). Actually, a literature review focused on field experiments shows that monetary incentives are not the only ones to increase employees' performance. It identifies other mechanisms: a meaning assigned to a task or social recognition which the organization can manifest, for instance, by awards, praise or showing gratitude; reciprocity because when employers are generous with employees, the latter ones will be more productive to give the favor back to the former ones; social ties which, for instance, prevent employees from running actions damaging friends; the work organization such as working from remote (Levitt, Neckermann, 2014).

This does not mean that the traditional incentives lose their validity (Lee, Puranam, 2017) even though they can be moderated by other factors (Tenhiälä, Laamanen, 2018; Oxley, Pandher, 2016; Feldman, Montgomery, 2015; Chng, Rodgers, Shih, Song, 2012). In particular, a rigorous field study in the agricultural industry shows that a contract guaranteeing a larger percentage of crop for the tenant generates positive effects in terms of tenant's risk propensity and in terms of investments from the tenant. Those effects are the channels through which the production principal-agent sharing increases the level of the production itself with more outputs (Burchardi, Gulesci, Lerva, Sulaiman, 2019). An auto glass company replacing the old payment system based on the hourly wages with a

new one based on the number of installed pieces was the perfect context to run an experiment which shows a positive effect of a pay for performance method on the productivity (Lazear, 2000). In the education industry the role of incentives for teachers is controversial: some do not find evidence of effects on the students' performance (Fryer, 2013) others do. Students' performance based-incentives for instructors create positive effects on students' performance within the context of college education (Brownback, Sadoff, 2020). Schools can reduce teachers' absenteeism and increase children's performance by adopting two leverages together: a camera system controlling teachers' presence and monetary incentives. Children's performances are measured with the test scores and the chances to access the next level of education which the government provides. In this experiment monetary incentives depend on attendance (Duflo, Hanna, Ryan, 2012). Also, when monetary incentives depend on students' achievements, they generate better results in terms of achievements themselves (Lavy, 2009). Students' achievements are short-run benefits coming from the pay for performance interventions which also create long-run benefits measured by the level of employment and the level of wages (Lavy, 2020). In addition, monetary incentive for teachers seems a more efficient policy than the one investing in empowering the teaching services for students. The former policy's benefits in terms of students' results relative to the costs are bigger than the ones from the latter policy (Lavy, 2002). Incentives policy allows a higher students' performance/investments ratio than other policies which provide funds to buy school materials or to hire one more contract teacher. In addition, the incentives policy does not generate negative outputs but it generates complementary positive results (Muralidharan, Sundararaman, 2011). Incentives assigned to students, teachers, and administrators for the same goals generate better performance than the situation where just students or just teachers are rewarded (Behrmann, Parker, Todd, Wolpin, 2015). Accountability does not generate positive effects for all the students. Only the performances of students whose scores really allow the schools to improve their ranking benefit from the introduction of the ranking itself (Deming, Cohodes, Jennings, Jencks, 2016).

Transparency is considered to be the cause of many phenomena. If companies allow customers to visualize the organizational activities, companies contribute to increase utility for both the customers and the companies themselves, particularly for the companies' employees (Buell, Kim, Tsay, 2017). Posting on the web the wages generates salaries reduction in public sector (Mas, 2017). A larger

transparency level defined by a performance feedback including a comparison with their peers reduces the students' performance but the reduction lasts for a short time, it also increases the satisfaction for the courses, perhaps as a positive reaction to the satisfaction for their own relative performance (Azmat, Bagues, Cabrales, Iriberry, 2019). Firms can generate pressure on workers by informing them about their colleagues' relative performances. Performances are expressed in terms of rank-order position which represents an effective managerial tool. It rises the productivity without negative spillovers such as damaging effects on the product quality (Vidal, Nossol, 2011). Firms can implement a policy that informs workers about their colleagues' performances and their own performances. Such a policy helps to improve the performances themselves only if the organization adopts a top-down organizational structure where the power is concentrated at the top which leads the lower levels inspired by egoistic targets. Instead, empowering the bottom with flat organizational structures where a collaborative philosophy is applied dissolve the positive effects of the performance communication on the performance itself. In addition, those effects occur only if the company communicates the name of the worker along with the level of her/his performance. Using an identification code, the effects disappear (Blader, Gartenberg, Prat, 2020). Middle managers are not interested in the historical trend of their performances, they are interested in the peers' performances which push middle managers to generate strategic changes if the peers' performances relative to their own performances become higher (Tarakci, Ateş, Floyd, Ahn, Wooldridge, 2018).

The methods adopted to solve the agency problem are the same mechanisms allowing the strategy execution (Simons, 2014): Management can improve performance by the traditional mechanism which assigns targets to employees and rewards the employees with monetary prizes when they achieve their targets (Corgnet, Gómez-Miñambres, Hernán-González, 2015). Strategy execution is an essential process to benefit from effective deliberate strategies and to trigger strategic learning for improvement (Lee, Puranam, 2016). Its methods belong to the family of the management tools whose importance in terms of economic impact for organizations is proved by rigorous studies (Bloom, Eifert, Mahajan, McKenzie, Roberts, 2013; Bloom, Lemos, Sadun, Reenen, 2015; Bloom, Sadun, Van Reenen, 2012). Management tools help organizational effectiveness which is not strategy because competitors can reproduce it by replicating the imitable management tools themselves (Porter, 1996). 'Competitive strategy is about



being different. It means deliberately choosing a different set of activities to deliver a unique mix of value' (Porter, 1996: 39). At the same time large datasets show that management tools provide competitive advantage which does not disappear in the short-run. Operational effectiveness is something to pursue along with a precise competitive position with the same target: to get superior financial performance (Sadun, Bloom, Van Reenen, 2017). A field experiment examines the flight captains' reactions to management practices. The experiment contributes to the organizational economics by exploring a high professional context and specific managerial practices. An after-before research design shows that monitoring increases productivity. A difference-in-differences design shows that productivity also increases because of target assignment and by informing captains about their performance. Instead, it is not affected by the charity support which the corporation provides to the society if the captains achieve their targets. The monitoring effects last over time, the target assignment effects and the feedback effects tend to disappear. Positive effects on productivity are not balanced by negative spillovers such as delays or safety alterations. Finally, captains' reactions are heterogeneous, the experiment uses several measurements of productivity but the productivity effects do not depend on a group of captains raising the productivity measurements all together. Some captains are able to improve some productivity measurements, other captains affect other productivity measurements (Gosnell, List, Metcalfe, 2020)

Non-financial measurements such as the ones of the balanced scorecard help organizations even beyond the attempt of better shaping the interplay between the principal and the agent, actually they help: (1) to communicate the strategic intentions to the members of the organization, (2) to let them know what the strategy execution means within their specific responsibilities and tasks, (3) to generate reactions from managers and employees which turn unexpected events into a dynamic aligned to the strategic goals and to the organizational values (Gibbons, Kaplan, 2015).

### **3 The Setting**

The fact that also operational effectiveness is central seems true in the higher education industry where competitiveness is measured by international rankings such as the Shanghai ranking which weights the following indicators:

1. 'the total number of the alumni of an institution winning Nobel Prizes and Fields Medals'
2. 'the total number of the staff of an institution winning Nobel Prizes in Physics, Chemistry, Medicine and Economics and Fields Medal in Mathematics'
3. 'the number of Highly Cited Researchers selected by Clarivate Analytics'
4. 'the number of papers published in Nature and Science between 2015 and 2019'
5. 'total number of papers indexed in Science Citation Index-Expanded and Social Science Citation Index in 2019'
6. 'the weighted scores of the above five indicators divided by the number of full-time equivalent academic staff' (<http://www.shanghairanking.com/ARWU-Methodology-2020.html>)

In order to get a better position in the ranking a school needs to improve along the above dimensions which are the same for any organization in the industry. If school leaders aim to get a higher position they have two options: they can try to do something unique or they can increase the level of the operational effectiveness (Porter, 1996; Sadun, Bloom, Van Reenen, 2017). The first choice seems suitable to jump from a low position to a high position over the long-run improving along the first indicators radically. Instead the second choice seems the right one to gain few positions over the short-run improving the last indicators incrementally, particularly the indicator number 5. Then, it seems interesting to examine the tools which implement the strategy and affect the operational effectiveness in the higher education context.

#### **4 Research Design**

Making information public on internet provides an effective treatment to figure out the effects of the transparency on other variables through a natural experiment (Perez-Truglia, 2020).

In 2014 the University of Milano-Bicocca made the results of the courses valuations from the students public. This policy represents a valuable occasion to understand the effects of the personnel valuations' internet diffusion on the performance. Actually, it allows to conduct a natural experiment by dividing the classes' performance into two groups:

1. a group treated by the internet diffusion of the valuations from the students
2. a group untreated by the internet diffusion of the valuations from the students.

The first group corresponds to the performance after the 2012/2013 academic year and the second group corresponds to the performance before. Mathematically:

$$Y = \alpha + \beta X$$

Y= performance

X = personnel valuations diffusion (treatment)

X is equal to 1 for the treated group (after the 2012/2013 academic year) and 0 for the untreated group (before).

This paper adopts a before-and-after research design (Vidal, Nossol, 2011; Perez-Truglia, 2020; Bandiera, Barankay, Rasul, 2007). The dependent variable corresponds to 'customer satisfaction', measured through surveys for the course evaluation from students (Azmat, Bagues, Cabrales, Iriberry, 2019).

## 5 The Dataset

The dataset is pulled from the University of Milano-Bicocca's report on the "Didactic Valuation. Program of Monitoring of the Didactic Activities Academic Year 2014/2015" (Nucleo di Valutazione, Università degli Studi di Milano-Bicocca, n.d.). The report shows the percentage of the positive scores got for each field:

1. "Economics - Statistics"
2. "Law"
3. Medicine
4. "Psychology"
5. "Science"
6. Humanity
7. "Sociology".

The survey for the students includes four levels of satisfaction: "No for sure", "more no than yes", "more yes than no", and "yes for sure" (Nucleo di Valutazione, Università degli Studi di Milano-Bicocca, n.d.: 7). The last two levels are considered to be positive scores in the report. The report shows 11 dimensions of the performance. Those dimensions correspond to the questions in the survey formulated for the students. The dimensions are:

1. Adequacy of the knowledge acquired from the requirements
2. Student's efforts commensurate to the credits
3. Material suitability
4. Exam's format
5. Punctuality
6. Teacher's ability to rise the students' curiosity
7. Clarity in teaching
8. Usefulness of other activities different from the class
9. Availability of the teacher to better explain the content of the class
10. Interest on the class's content
11. Overall satisfaction on the classes (Nucleo di Valutazione, Università degli Studi di Milano-Bicocca, n.d.).

We have four waves: 2011/2012 academic year, 2012/2013 academic year, 2013/2014 academic year, 2014/2015 academic year.

## 6 Findings

The following table (table 1) shows that the treatment increases the performance. The coefficient is highly significant. The treatment increases the performance by almost 2.7. Because of the treatment the students evaluating positively their classes increase by 2.7 per cent.

In this regression we control for the dimensions of the performance (the questions in the survey). This control variable should isolate the effects of the treatment from the fact that we measure the performance with different measurements (i.e. dimensions of the performance/questions in the survey).

Table 1: Results of the Internet Diffusion Policy on the Performance

VARIABLES	Performance
Treatment	2.695*** (0.408)
Constant	75.02*** (0.706)
Observations	308
R-squared	0.670

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 7 Discussion

This paper confirms that the Mayo's Hawthorne effect (Roethlisberger, William Dickson, 1966 as cited in Zaleznik, 1984) works. It acts if the personnel behaviors can be observed publicly by showing the work performance on internet.

The Agency Theory's divergence between the principal's targets and the agents' behaviors (Smith, 1776 as cited in Dalton et al. 2007; Berle, Means, 1932 as cited in Dalton et al. 2007) can be reduced by the public diffusion of information about the agents' performance. Moral hazard (Eisenhardt, 1989) is restricted by the diffusion power available for the organizations in the modern environment.

It is a form of control which leverages information systems (Eisenhardt, 1989). It combines the traditional market control measuring the outputs and the social dimension of the clan control (Ouchi, 1979) without the traditional financial incentives (Lee, Puranam, 2017). Information systems measure the outputs and make them visible to all the people who generate a sort of social pressure on the agents reacting by improving performance.

This form of control can help strategy execution which is always productive because it generates learning and it allows to implement promising deliberate strategies (Lee, Puranam, 2016) differentiating firms for a long run competitive advantage (Porter, 1996). This form of control also can increase the operational effectiveness, another source of competitive advantage (Sadun, Bloom, Van Reenen, 2017). Our experiment contributes to the stream of literature which demonstrates that managerial practices are relevant in economics because they improve performance (Bloom, Eifert, Mahajan, McKenzie, Roberts, 2013; Bloom, Lemos, Sadun, Van Reenen, 2015; Bloom, Sadun, Van Reenen, 2012). This paper's results encourage organizational leaders to leverage the internet diffusion power as a managerial practice which improves performance.

Studies on management practices remark the importance of two aspects:

- 1) It is useful to focus on professional positions with huge skills, a strong sense of responsibility, a clear idea of their role and a strong commitment to the credo of their organization. People think that those positions do not need managerial practices which might be rejected and unproductive but the literature has not studied those positions too much (Gosnell, List, Metcalfe, 2020). Particularly the literature researching the incentive effects targets workers with

modest duties but today many jobs are pretty complex (Levitt, Neckermann, 2014)

- 2) Previous literature demonstrates that the management practices improve performance but they run experiments which implement several management tools all together. Little is known about the effects of each single tool (Gosnell, List, Metcalfe, 2020).

An experiment treats professionally advanced positions: the captains who have the features mentioned above. Those features are similar to the features of other professionally advanced positions such as the ones of doctors or researchers. The experiment finds that the managerial practices increase the productivity in the context of captains (Gosnell, List, Metcalfe, 2020). Our study confirms that the managerial practices improve the performance of professional advanced positions because the experiment treats university professors in the context of the higher education. The experiment confirms the effectiveness of the managerial practices in another specific context with other professionally advanced workers.

The experiment on captains shows the effectiveness of specific practices such as the goals assignment by disentangle a practice from the others (Gosnell, List, Metcalfe, 2020). This paper focuses on a different specific practice which makes the workers' performance public through internet. This paper finds that this specific practice is effective because it increases the performance.

Most of the models employ students' performance (Brownback, Sadoff, 2020; Lavy 2009; Lavy, 2020; Lavy, 2002; Muralidharan, Sundararaman, 2011) or productivity (Burchardi, Gulesci, Lerva, Sulaiman, 2019; Lazear, 2000; Vidal, Nossol, 2011; Gosnell, List, Metcalfe, 2020) as dependent variables to figure out the effects of the management practices in the organizations. This paper adopts a wide measurement of customer satisfaction which is the dependent variable. The measurement captures several aspects of teaching and this paper finds a positive effect of the managerial practice on the customer satisfaction: students get happier for their teachers' work because of the implemented management practice.

Non-financial measurements help to push employees toward the implementation of the deliberate strategy because the employees learn which goals they should achieve within their own task to contribute to strategy implementation. Non-financial measurements also stimulate employees' reactions to changes and those reactions adjust the firm's dynamic in such a way that the strategic targets will be achieved despite the changes (Gibbons, Kaplan, 2015).

This paper tests the effects of transparency on the effectiveness of non-financial control system which measures non-financial performance. The paper shows that transparency makes this system more effective because what the system measures improves. If firms show the results on internet the system works better.

Many studies evaluate the effects of teachers' incentive policies by measuring the students' performance as a reflex of the teachers' effectiveness (Brownback, Sadoff, 2020; Lavy 2009; Lavy, 2020; Lavy, 2002; Muralidharan, Sundararaman, 2011) even though the policies target the teachers' behaviors rather than the students' behaviors. Instead this paper measures the target of the policy itself: the teachers' behaviors which are measured by the evaluations from the students. Because this paper focuses directly on the effects targeted by the policy, it seems less likely that the dependent variable variation is due to other variables different from the policy itself. Instead in the other studies it is more likely because they focus on students' performance which are hit indirectly: through the channel of the teachers' behaviors. It is more likely that students' performance comes from other independent variables affecting teachers' behaviors also.

Transparency is an important lever to improve many aspects such as the value for both the company and the customers (Buell, Kim, Tsay, 2017), the levels of the salaries in the public sector (Mas, 2017). It also improves behaviors of workers (Vidal, Nossol, 2011; Blader, Gartenberg, Prat, 2020) and middle managers (Tarakci, Ateş, Floyd, Ahn, Wooldridge, 2018) when they learn their relative performance: how they perform in comparison with their peers (Azmat, Bagues, Cabrales, Iriberry, 2019; Vidal, Nossol, 2011; Blader, Gartenberg, Prat, 2020; Tarakci, Ateş, Floyd, Ahn, Wooldridge, 2018). Particularly, a study suggests that only a high level of transparency increases performance: if the performances are not associated with the name because they are associated just with a code, the positive effects of their communication to the workers are cancelled (Blader, Gartenberg, Prat, 2020). The level of transparency matters. The transparency increases professors' performance in our experiment also, but our experiment tests the highest level of transparency, actually professors know the performances gotten in their organization but the school also shows the performances to all the public posting them on internet. Our experiment administers the strongest dose of transparency to increase performance and it apparently works.

In addition, transparency about the relative performance seems to work only in organizations based on hierarchical structures, it does not produce positive effects if it is applied in flat organizations (Blader, Gartenberg, Prat, 2020). Instead,

a stronger dose of transparency showing performance on internet allows to improve performance in flat organizations also. Our experiment treats university professors who work with a high level of autonomy. They do not need to follow strict guidelines and rules coming from the top.

Studies on social comparison seem controversial. On the one hand, social comparison is supposed to downsize the performances (Ashraf, Bandiera, Lee, 2014; Azmat, Bagues, Cabrales, Iriberry, 2019). On the other hand, social comparison is supposed to make performance higher (Vidal, Nossol, 2011). Fine-grained analyses seem to reconcile those two opposite results by deeply investigating the specific practices used for social comparison in specific contexts. A reconciliation is possible by showing which tools work and which do not or it is possible by showing where they work and where they do not. It might be that only some practices work or it might be that they work only in certain contexts. This could explain the controversial results from general studies. Deeper analyses show:

- 1) The positive effects of the social comparison using the name of the workers versus the null effects of the comparison using the codes (Blader, Gartenberg, Prat, 2020)
- 2) The positive effects of the social comparison within hierarchical structures versus the null effects of the comparison within flat organizations (Blader, Gartenberg, Prat, 2020).

Also this paper makes an attempt to reconcile the two opposite results with a fine-grained analysis which explores what happens with a particular practice in a specific context. The paper finds the positive effects of the social comparison using the powerful tool of posting the performances on internet in the specific context of the higher education. Farther analyses could examine specific tools for social comparison in specific organizational contexts to figure out if those tools work in those contexts.

In higher education professors are free to choose how to teach and how to improve their performance. As in the case of middle managers, transparency stimulates emergent strategies (Tarakci, Ateş, Floyd, Ahn, Wooldridge, 2018) because in higher education students' satisfaction increase comes from the professors' ideas and it comes from their independent initiatives which are formulated at the bottom of the organization. In addition, professors autonomously implement those initiatives in classes, at the periphery of the firm.



Ranking improves performance but only for a group of students if only that group contributes to affect the ranking with its performance (Deming, Cohodes, Jennings, Jencks, 2016). A selective mechanism which restricts the performance evaluation within a certain group restricts the positive effects within the group itself. A wider mechanism such as the one adopted in our experiment does not restrict the performance evaluation within a certain group of people and the mechanism seems more effective because it does not limit the positive effects also.

On the one hand, we have managerial practices which absorb less resources than the financial incentive policies: prizes and gratitude for instance (Levitt, Neckermann, 2014). On the other hand, comparing investments with results, the incentive policies are more efficient than other policies such as the ones which: (1) improve the teaching services (Lavy, 2002), (2) allow to use more materials or (3) provide another teacher (Muralidharan, Sundararaman, 2011). Posting performance on internet seems a very efficient policy even more than the incentive policies because its costs are very low. The incremental costs are almost equal to zero because the policy just shows already available data.

## **8 Limitations, Alternative Explanations and Future Development**

On the one hand, the downside of the research design is that we have just two groups: before and after. We do not have four groups: treated, untreated, before and after.

On the other hand, the research design's upside is the context whose boundaries are very definable. This study is limited to the University of Milano-Bicocca's classes over four years. In this context it is very challenging to think of unobservable variables because we cannot see other 2014 interventions able to affect teaching performances.

Nevertheless, we identified other schools which were treated before 2014 or they were not treated at all. Then, hopefully we can collect data to run a placebo test on schools which were not treated (Perez-Truglia, 2020) or to run the same experiment with other schools treated in a different year. Those robustness checks should help to make the results more rigorous.

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*Notes: Early versions of this paper were submitted to the BAM annual meeting in February 2019, to the AEA annual meeting in March 2019, and to the SMS Berkeley Special Conference in October 2019. Those versions were very underdeveloped and they were not presented at the conferences. I got some interesting feedbacks from the reviewers of both the BAM conference and the SMS conference. I want to say thanks. This paper is still a work in progress.*

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## Knowledge Governance in Higher Education Research

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### Abstract

This paper aims to presents an exploratory map of Higher Education Research. Using science mapping approach can help to locate a scientific domain of our own interest, and can be a starting point for a deep understanding of themes and subthemes of areas of research activities, and identifying the dynamics of knowledge networks that link institutions, researchers and publications. Instead of considering islands of specialized knowledge we can use maps to link and integrate knowledge and identify gaps. Future developments of this work will provide potential avenues for new studies that will provide answers to the questions that have emerged.

**Keywords** – Knowledge Governance; Higher Education Research; Mapping; Research

**Paper type** – Academic Research Paper

### 1 Introduction

By taken a knowledge Governance approach (Pinho et al., 2019) we can focus on a specific context (Higher Education Research) to begin mapping this field. Higher Education Research (HER) is developed from a complex process with its own dynamics. As a concept HER is not easy to define because it is associated with a sense of belonging and identity, namely that which relates to the communities of researchers who receive and contribute to a multi and interdisciplinary field (Brew et al., 2016; Kehm, 2015; Tight, 2004).

From current literature and using Biglan model of disciplines classification Biglan (1973) we locate each position of diverse academic disciplines along scales based on the dominant paradigm (Chynoweth, 2009).

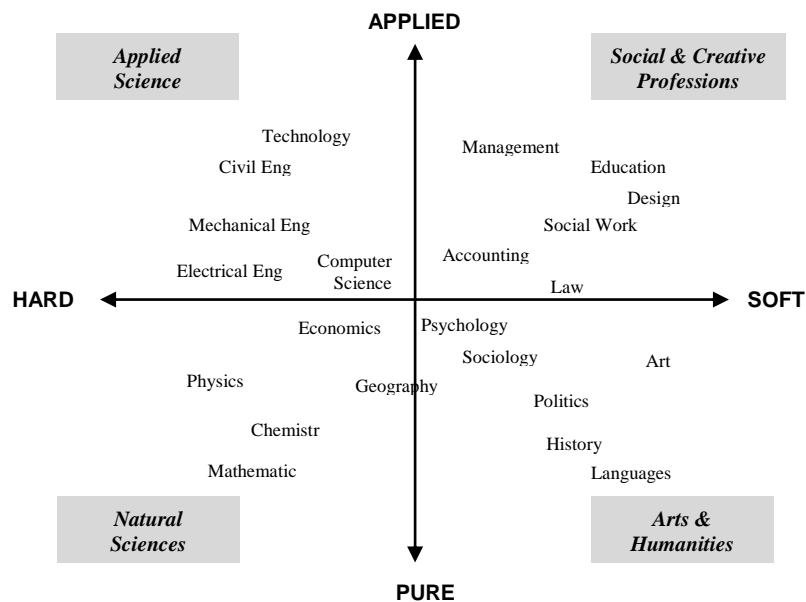


Figure 1- The location of the scientific fields according to the Biglan model  
Source: build from Biglan (1973)

Each discipline has a relative position inside a matrix structured in two axes: the horizontal axis defines a space across "hard" and "soft" scale, while the vertical axis use "applied" and "pure". Scale. Thus, four quadrants are defined where the different disciplines are positioned: Natural Sciences, Applied Sciences, Social and Creative Professions, and Arts and Humanities. Education appears in the upper right quadrant (soft-applied), that is, located in Social and Creative Professions (see Figure 1).

## 2 From isolated islands to knowledge networks

The research agenda in the scientific field "Higher Education" can be structured in a dichotomous taxonomy; we can divide the HER studies into two main areas: a) Policies and b) Teaching and Learning. Each of these areas includes various categories or research themes (see Figure 2).

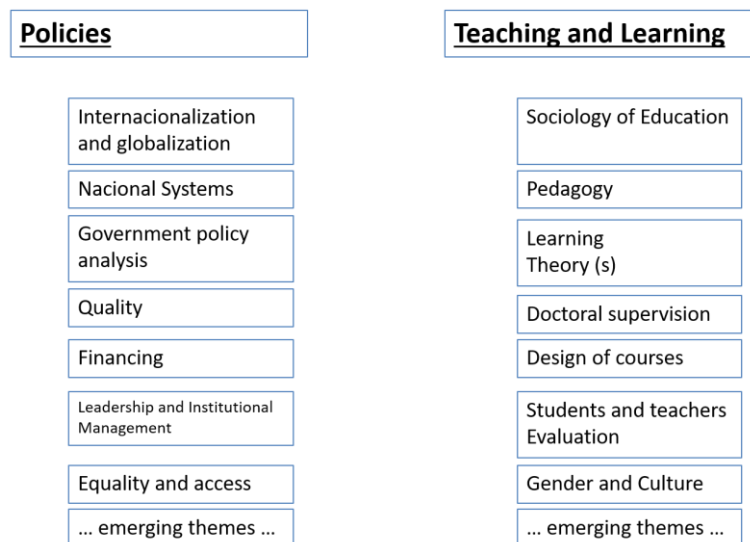


Figure 2 - Main Areas and Topics of Higher Education Research  
Source: build from Tight (2004)

This type of dichotomous taxonomy comes from the idea of working in silos or looking at research areas as isolated and close knowledge spaces (Tight, 2004).

In fact, it may be more elucidating to present Higher Education Research by mapping its themes, methods, and theories as a structure of the field. Using the archipelago metaphor, HER can be seen as "archipelago" formed by islands relatively positioned in two great thematic clusters (Macfarlane, 2012). But, we see these "islands" interconnected through the intersection between themes, models and theories not only within this scientific field as of other fields building networks. Thus networks of knowledge, researchers, and subjects are formed in a dynamic way, sometimes dependent on the demand of society and the very life of Higher Education Research (see Figure 3).

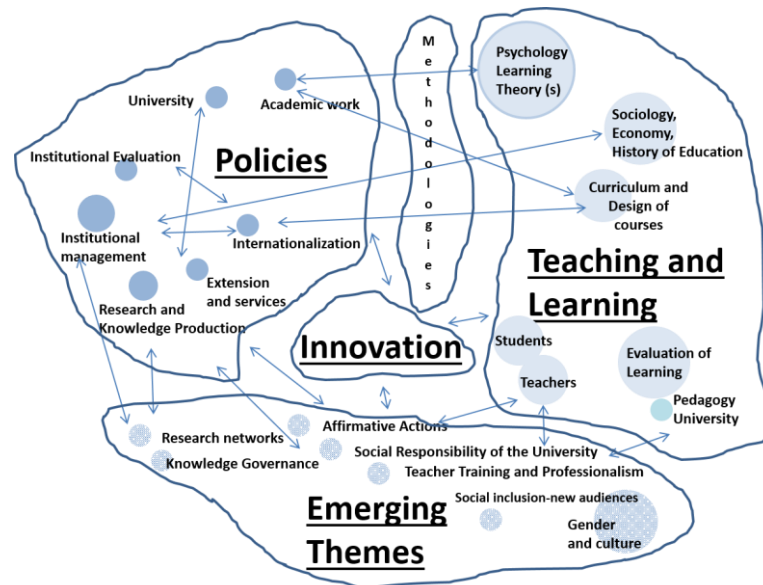


Figure 3 - Networks and Themes in Higher Education Research

Motivated by X SIES debate with relevant HER researchers (International Seminar on Higher Education at Porto Alegre, Brazil in 2017), we assign Emerging Themes to MacFarlane design by creating a new island (Leite et al., 2019; Sérgio et al., 2019). This is a collaborative process by sharing knowledge, by using maps to build and understand the research trajectories of research groups and to facilitate design research agendas (King et al., 2014; Prosser, 2011).

In organizing the design, we visualized symmetries among the themes, some provoked by the research and collaboration networks, and the archipelago, in gathering the themes, acquired the form of a dynamic system. As in the human body, we find the respiratory system, two great lungs - Policies and Teaching-Learning are placed side by side of Methodologies and supported in Emerging Themes. At the center of the system, the 21st-century version breathes with the theme of Innovation, technology and, also, pedagogical.

In short, Higher Education Research is an multidisciplinary field of study, that encompasses studies that focus on the understanding of all aspects of Higher Education and which we can located in four major areas: a) Policies; b) Teaching and Learning, c) Innovation and d) Emerging Themes. The Methodologies constitute the structuring column that legitimizes HER as a consolidated area. Inside Policies area we can classify some subthemes, like Internationalization,



Institutional Evaluation, Institutional Management and Research and Knowledge Production. We can add Education System, National Policies, Comparative policy studies and Funding.

Teaching and Learning area can be considered the core of HER because here we can find its main actors (students and teachers) and the main processes (Curriculum and Design of courses, Learning Evaluation, Pedagogy and Research academic work).

Linking Policies area and Teaching and Learning area is the challenge because sometimes actors work isolated. Teaching and Learning is the social space for the implementation of policies. Innovate ways of teaching and learning, new evaluation approaches, new ways of implementing and monitoring policies can facilitate this link; these themes can be part of the Innovation area, which is at the centre of Figure 3.

Methodologies area, also at the center of Figure 3, is a structural element of HER that need to be improved. There are variations in the popularity of method approaches between the disciplines that perform research on HER, such as surveys and multivariate analyses, documentary analyses and interview-based studies (Tight, 2013).

At the bottom of the Figure 3 we draw the "Emerging Themes" area where some subthemes are located, such as Research Networks (Leite & Pinho, 2017), Knowledge Management (Rego et al., 2009), Affirmative Actions (Silva & Skovsmose, 2019), Social Responsibility of the University (Giuffré & Ratto, 2014), Teacher Training and Professionalism (Carvalho & Santiago, 2015), Social Inclusion (Araujo et al., 2020), new audiences (Pinho & Diogo, 2018) or Gender and Culture (Jordão et al., 2020).

The HER tends to be robust discipline with an international and theoretical background and increasingly performed in a collaborative way (Forsberg and Geschwind, 2016). These studies tend to be interdisciplinary studies and their themes result from the intersection and contribution of traditionally separate fields (Forsberg & Geschwind, 2016).

Emerging themes, such as knowledge networks, co-authorship and collaboration in research (Leite *et al.*, 2014a) show the evolution of HER to a research agenda concerns linked with: a) syntheses local and global application and b) connection of theory with practice (Ertmer & Glazewski, 2014; Pinho, 2018). An example of this research agenda development is the evaluation of collaborative research networks (Caregnato *et al.*, 2018; Leite *et al.*, 2018a; Leite *et*

*al.*, 2014b; Leite & Pinho, 2017; Leite *et al.*, 2018b). As Denise Leite and Isabel Pinho wrote "the global context of science, it is possible to observe changes in its landscape, particularly in terms of new patterns of production (Leite & Pinho, 2017, p. 103). Knowledge production processes involve thinking and rethinking about what researchers do, how they do research and how they publish and create knowledge. Knowledge production processes are enriched and potentiated by the collaboration of multiple researchers. Researchers create collaborative networks that seek to integrate diverse knowledge and expertise. For Katz and Martin (1997, p. 7) "research collaboration is the working together of researchers to achieve a common goal of producing new scientific knowledge". Taken this collaboration view it is possible say that higher education research is an interdisciplinary field of research in which multiple communities of practice operate (Tight, 2004).

### **3 Conclusions and future developments**

Taking the visual metaphor of islands to locate themes in a sea of disciplines that explicated tribes and territories can facilitate the understanding how researchers work and specialize in research (Becher & Trowler, 2001).

The main output of this exploratory study is the map (Networks and Themes in Higher Education Research). This result is a starting point to Reflection-on-action that involves taking the opportunity to draw on the professional knowledge base more explicitly (Thompson & Pascal, 2012). This map can be used to: (1) develop our understanding further; and (2) test and develop the knowledge base.

This exploratory study is the first cycle of our research. By questioning we will start a new research cycle. Next we follow to a process of developing the conceptual framework for exploring relevant literature.

This future study aims to answer some questions at higher education research scope, such as:

- What has been investigated and inherently what are the gaps?
- Who is undertaking this research, and from what institutions or disciplinary locations?
- How is higher education being researched?
- What methods and methodologies are being used?
- What theoretical perspectives are being applied to this research?

- What are the most important scientific clusters formed in the historiographical map of HER publications indexed in WoS or Scopus during 2001-2021?

- What are their subject areas?

- What are the international research trends in the HER and each of its sub-domains in the last ten years?

-What are the patterns of relationships between HER Researchers?

-What are the knowledge networks patterns of relations inside each cluster?

Looking research as an iterative or cyclical process, we need combining qualitative and quantitative methods to give relevant answers (Denton, 2019).

One of the studies that we are going to develop is based on bibliometric analysis the HER main themes to answer research questions, exploring the analysis of keyword co-occurrence networks and document co-quotations. In the case of citation relations, an additional distinction can be made between direct citation, co-citation and bibliographic coupling (Moresi et al., 2021). Another way can be the systematic review that can is a block to build a framework of analysis. If we look at Literature Review as a qualitative research we can use content analysis as a tool to identify relevant literature; those papers can be read and analysed with support of digital tools (Fornari et al., 2019; Pinho & Leite, 2014). Additionally, qualitative content analysis of the relevant publications based on the clustering results can be used.

Both the novice and the experienced researcher can use mapping to locate themselves in the field of research. Research centers can build their Research Strategies and perform their research agendas in a structured and integrated way.

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## **The Transformation of ICT Education with this New Normality after Pandemic in the University of Guadalajara, Mexico**

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### **Abstract**

It's the changed that education made and the introduction of Informatic Technologies (ICT), gave in a drastic way to get ahead with external healt factors such as the pandemic (COVID-19)

It's important to say that the University of Guadalajara has a project named B-learning, this with the objective that the students can work and study at the same time, they have to go only twice a week.

In 2019 it was a pilot test, that became a reality, but the problems came up because here in Mexico we are used to go to school and have classes face to face and also we use ITC just for social media and we don't use it for learning or educational tool.

Early January 2020 this project had a lot of competitive advantages for the University of Guadalajara and now all this projects are being structured, this just for the purpose to support all the students.

Previously the University had inverted classes, this means the student explain all the topics for the class and the professor help with all doubts.

In another aspect, courses were taught as they were previously called mixed and today with the name of hybrid education.

This research are the results of the investigation we did on February 2020 to December 2020, we tried to explain how evolve hybrid education at the University of Guadalajara.

The most important is doing the cultural change in the education of Mexico, we tried to explain that it's possible to make hybrid education and we can make the entire student more competitive. Beside all those closed companies, we think in alternatives for new jobs and strategies to maintain business.

**Keywords:** ITC, Competitiveness. B-Learning, Hybrid Education

**Paper type** – Academic Research Paper

## 1 Introduction

This research is the result from February to December 2020 with the occurrence from the Pandemic (covid-19) and the transformation of education – learning of students from University of Guadalajara, Mexico, CUCEA Marketing and International Business department. How were the changes, strategies that each professor made and all the results from the students from a face to face learning to a hybrid education?

ICT needs more recognition as a learning tool and not just for social media.

In Mexico we have lots of deficiencies which we needed to overcome and this way we could change classes in hybrid education.

On the other side, we need to see the results from graduating students with this new education two semesters and the results of their competitiveness and knowledge are shown in the graduated exam from the University.

Analyze this result to have better students that started the University on February 2020A and 2020B they didn't have face to face classes, they had hybrid education 100%.

We are waiting for the pandemic to stabilize and we could return to the classroom and we could take classes face to face and hybrid at the same time. The changed that all the signature programs had to face because some classes are obligated to be face to face, advertising workshop or international business.

### **1.1 Justify**

One of the conflicts is to educate students that ICT's technologies are not only for social media, they are also educational consultation, research, complication for all kinds of activity. Both for business and the growth of them or the disappearance of them as happened.

For lack of external factor strategies that the world faces.

Based on this contingency the University of Guadalajara saw the need for each of the professors and students to acquire technological skills for development and not a stagnation in higher education.

Another of the problems that we have in Mexico, here we don't have the infrastructure of the internet for the population or the confidence to make purchases online or the use of digital banks. But for the contingency (Covid- 19) increase up to 50% of its use.

An important factor, it's that students don't have the resources for a computer, tablet or smart phone.

This was one of the first problems we had. The University of Guadalajara starts to help the students by lending equipment and giving to them internet.

In Mexican families are made up of at least 3 students of different levels in which they need a computer and internet.

What we can say from hybrid education it's that we were adapting to each of the students to reach a standard and be able to give the sessions together with platforms, multimodal communication for learning.

## **2 Problem, Hypotheses and Rationale of the Study**

In this research, we are waiting for the results from the graduated students that made the exam and another factor are the students that haven't been in face to face classes this 2020 the question it's, their knowledge was appropriate?



### ***Research questions.***

Did the use of hybrid ICT really work?

What are the adequacy of hybrid education and ICT we must change?

### ***Specific questions***

1. - Which platforms were most suitable for hybrid education at the University of Guadalajara, Mexico in CUCEA in the department of International business and Marketing?

2. - Is the use of moodle safer for hybrid education with the application of ICT?

What was the learning of the two semesters compared to 2020A and 2020B with hybrid education?

3. - Teachers who compare can be given with their hybrid education and ICT's?

### ***General Objectives***

Does hybrid education and ICT show good results with the application of the graduate exam?

### ***Specific Objectives***

Determine which factors influenced with hybrid education for students?

What strategies does the University of Guadalajara, Mexico take to train their professors with ICT?

What were the deficiencies of students with the graduate exam this year of pandemic 2020A – 2020B?

### ***Hypothesis***

1. Determine which factors influenced with hybrid education for students?
2. What strategies does the University of Guadalajara, Mexico take to train their professors with ICT?
3. What were the deficiencies of students with the graduate exam this year of pandemic 2020A – 2020B?

### **Congruence chat**

<b>Problem</b>	<b>Questions</b>	<b>Specific questions</b>	<b>Objectives</b>	<b>Hypothesis</b>
In our research we hope await the results of the graduates in the department of International business and Marketing. Those who applied. Another factor: students who have not had a face-face class. The result of your learning is correct.	Did the use of hybrid ICT really work? What are the adequacy of hybrid education and ICT we must change?	1.- Which platforms were the most suitable for hybrid education in the Universidad de Guadalajara, Mexico, in CUCEA en el in the department of International business and Marketing? 2.- Using Moodle is safer for hybrid education with application of ICT's? 3.- Which it was the result hybrid learning 2020A y 2020B 4.- The teacher who results had with the hybrid education and the ICT's	The hybrid learning and ICT's have good results for graduates?	1. The greater the use (e-mail, WhatsApp), the greater the learning result.  2. Having videos recorded by teachers gives students more knowledge  3. The more contact with videoconferences, the more learning.

### **3 Literature Review**



*Education. Microsoft.com 2020*

Virtual environments are those created through the use of information and communication technologies, in order to provide educated people with resources that facilitate their learning process, within these ICT can be quoted the computer, cannot a virtual classroom, the use of the internet where they can access blogs, discussion forums, chat, specialized pages in which young people find fun activities, such as solution to crossword puzzles, puzzle, etc.

Which well employees contribute greatly to the acquisition of learning by the students. Duarte, J. (s.f)

Educative strategies that can be included, Garcia, L (s.f)

The strategies are:

- Collaborative learning
- Simulations
- Elaborations of conceptual maps, mind maps
- Practices in laboratory or workshop
- Conferences
- Demonstrations
- Learning problems.
- Playful activities

In the case of the use of Information Communication technology: The use of internet, e-mail, discussion forums

Classroom plan Lopez; R

It said that some authors said they are 3 steps:

1. - To whom? (students)

What, when, how and why?

2. - What, curriculum content and technology

Curriculum content:

Objective

Learning

Technology content:

Skills to help students

Which type of technology for learning

Which ICT we need

And which digital resources.

3. - How (strategies and actions)

Strategies and actions

Time

### **3.1 Resources**

With this contingency professors are changing their role, now they are not only education mediator they are also tutors for the students.

Taking as a basis that in some subjects it was implemented in making videos and gave a competitive advantage to students who could review the material (video) as many times as they wanted and be able to understand the subject.

In some others, lean on video since they are on some platforms and some companies apply them.

The time came when the teaching- learning was on both sides to understand everything related to ICT and their applications for both professors and students.

According to Marzano (1998) explain on his work named "The five dimensions of knowledge", he mentions that the first dimension is about to the student's attitudes and perceptions and what does it refer to?, he grounds that the students could get a success knowledge, the classroom climate must be taken into account, that is affective factors influence, such as being accepted by their peers, as well as space-infrastructure, refers to feeling comfortable in the phsycial plant.

With this new modality it was hard to apply the five dimensions of Manzano (1998) and this just with the situation of each student and the different factors.

1. - Computer equipment. (How many?)
2. - Cellular
3. - Tablet
4. - Internet service in their home.
5. - An Internet plan.
6. - How many people in their home receive classes at the same time?
7. - A special place to take the classes.
8. - Their camera really work ( complication for the students to know each other)

The mentioned will help us to organized appropriately the teaching – learning process, currently the scenarios have changed, not forgetting that today we can make use of classroom, real and virtual ones, the last one now it's called " new learning environment"

According to UNESCO , for this global pandemic has been affected more than 861.7 millions of kids and young people in 119 countries, that it has occurred this year. Million of families in America have been enrolled at homeschooling with

more than 1.1 million kids. Here in Mexico where the Secretary of Public Education (SEP) has extended the holiday period from March 23 to April 17 2020.

According to World Economic Forum, around 60% of the world population have access to internet. Generating that many institutions seek provisional solutions to this crisis, such as the Mexican educative system, outside private schools or private University, public school didn't have the online learning. Digital divide continue expanding as students in vulnerable sectors keep lag behind in their learning.

### ***3.2 Students through the pandemic***

In almost all the world, a big amount of students have been affected in so many ways. The cancellation of face to face classes and now they should take online learning, a bad organization and not enough time has generated lots of difficulties and it has increased all the process of exclusion and migration. UNESCO said that the world hasn't ready for an educational disruption like this, suddenly schools and Universities around the world should close their doors, thinking quickly of solutions for an online learning and long distance education and continue with the education.

In this global emergency context, Latin America is not an exception, barely 1 of 2 homes has full internet service, without emergency plans to face the change from face- to face model to a distance education model, this has impacted all the people who are involved at high education (Maneiro, 2020).

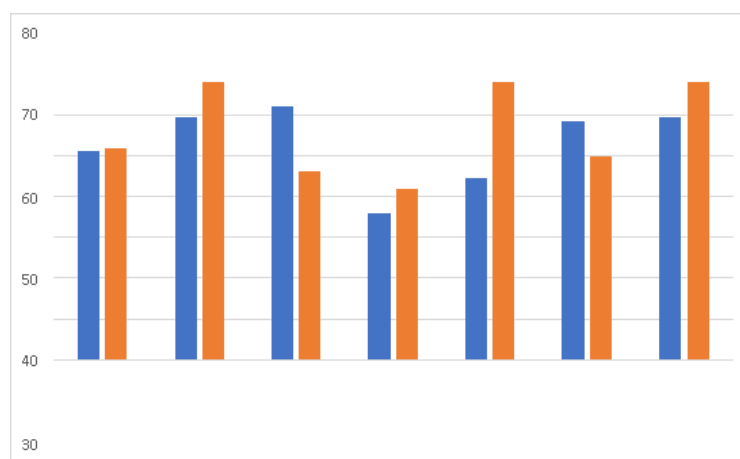
Marion Lloyd present a specific information about Mexico, in the Latin America context.

In both situations, Mexico has a bad reputation. On 2016, Mexico ranked at the 87<sup>a</sup> place in the world and the 8<sup>a</sup> place in Latin America at the access of ICT, behind Uruguay, Argentina, Chile, Costa Rica, Brazil, Colombia and Venezuela, in this sequence, according to indicators of the international Telecommunication Union (UTI), based in Switzerland. Also exist a big digital opening inside the country, only 45% of the Mexicans count with a computer and 53% count with internet access in their home, according with Nacional polls about disponibility and Information Technology use at home (ENDUTIH), 2018. As expected, this access is not distributed equality, only 73% of the urban population has an internet access, compared with 40% of rural population. Even more worrying, only 4% of the rural residents count with internet in their home. (Lloyd, 2020, p.6)

And emphasizes that in the high education case, exist strong inequalities according their socioeconomic condition of the students. For those who are from families with deficit of income, 55% doesn't count with internet nor computer in their home, meanwhile for those with a big amount of income, the number barely are up of 2%, according with National polls about availability and Information technology use at home (ENDUTIH), 2018, it means, that there exist a digital divide of 25 to 1. On average, 18% of University students public or private both of them don't have an internet access. For the medium level, however, it's more significant the difference, 81% of the most poor people don't have internet nor computer, compared with 3% of the richest or average, 40% don't have access of the ICT in their home (Lloyd, 2020, p.6)

In the conditions described between the decisions that students have been taken all around the world, some of them have to cancel their scholarship and other kind of support, this was a need of leave the school, such as a postpone or cancel plans of studies outside the country (QS, 2020, p.8).

According UNESCO students are the ones who has been more affected on their face - to face activities, leaving IES with learning impact. The follow graphic allow to compare results between Iberoamerica and the rest of the world



*The main difficulties of higher education students during the pandemic according to UNESCO*

*Fuente: Encuesta de la UNESCO a las cátedras UNITWIN (2020).*

In Iberoamerica, however, the order of concerns is somewhat different since UNESCO chairs place, above the others, only three priorities: internet connectivity,

financial issues and schedule problems, that maybe can associate in some way with learning and knowledge from school that do not applied the self- learning.

This inequality is reflected in the high dropout rates and not continue with the higher education: on average, only half of the people between 25 and 29 years who were enrolled did not complete their studies, either due they dropping out or because they are still studying. Of those who drop out, half of them did it at the first year (Ferreyra, Avitabile, Botero Álvarez, Haimovich Paz, & Urzúa, 2017).

It's difficult, on the other hand, to anticipate the multiple differential effects that are felt in different profiles of students, regardless of their socioeconomic background, starting with gender.

### **3.3 Supports from the University of Guadalajara, Mexico gives support to students**

The University of Guadalajara launches a program named "from Home", this program lend computers to their students.

"32% of the students at the University of Guadalajara do not have a computer, therefore, we must be sensitive with our students. To reduce this gap, an equipment loan program will be launched for high school students and University centers, so our students can follow up on their training from home" said Rector General, Ricardo Villanueva Lomelí. Gaceta UDG (2020)

With this program, they give 500 iPad and a thousand laptops will be distributed and schools with the greatest number of students without access to a computer will be privileged, both from regional and thematic university centers as well as from Sistema de Educación Media Superior (SEMS) y UDGVirtual.



*Foto: José Díaz*

Laptops will be distribute as follows: 520 computers for the Guadalajara Metropolitan Area (AMG) campuses and 480 for the regional high school.

In order to applu and find out if you can benefit from this program, go to: <http://www.gaceta.udg.mx/desde-casa/>, to consult the institutional directory of the areas responsible for loans in your educational establishment.

The call will be available until July 20, 2020.



*For more information: [www.gaceta.udg.mx](http://www.gaceta.udg.mx)*

Degree modalities at University of Guadalajara

- Academic excellence
- Titulation by average
- Global theoretical-practical exam. ...
- Global theoretical exam. ...



- General Professional Certification Exam (CENEVAL) ...
- Professional training exam. ...
- Reply verbal or in writing. ...
- Educational package.
- By Diploma

The first two, such as academic excellence and Qualification by average, requires students to take the General Professional Certification Exam (CENEVAL), this helps for the Ranking of the University of Guadalajara as it is positioned with the other Universities, either National or International with the parameters that are required is evaluated.

Advantage and disadvantages in the Educative field

### Learning

Learning	
ADVANTAGE	DESADVANTAGE
<ul style="list-style-type: none"> <li>• Cooperative learning. The instruments provided by ICTs facilitate group work and the cultivation of social attitudes as they promote the exchange of ideas and cooperation.</li> <li>• High degree of interdisciplinary. The educational tasks carried out with computers allow to obtain a high degree of interdisciplinarity and a large storage capacity allows different types of treatment of a very wide and varied information to be carried out.</li> <li>• Technological literacy (digital, audiovisual). Today we still get in our educational communities some group of students and teachers who lag behind the advancement of technologies, especially the one referring to the use of the computer. Luckily that group is getting smaller and smaller and they tend to disappear.</li> <li>• Given the needs of our modern world, even the computer is used to pay for services (electricity, telephone, etc.), so that academic activity is no exception.</li> </ul> <p>Student teachers feel the need to update their knowledge and very particularly in relation to digital technology, audio and video formats, editing and montage, etc.</p>	<ul style="list-style-type: none"> <li>• Since cooperative learning is supported by lazy social attitudes, it can influence effective learning.</li> <li>• Given the rapid advancement of technologies, they tend to be discontinued very soon, forcing equipment to be frequently updated and new software acquired and learned..</li> <li>• The cost of the technology is not negligible, so it is necessary to have a generous and frequent budget that allows to update the equipment periodically. In addition, it is necessary to have safe places for storage to prevent theft of equipment.</li> </ul>

INFORMATION FROM AN ANONYMOUS AUTOR <http://webdelprofesor.ula.ve/ciencias/sanrey/tics.pdf>

## Advantage and disadvantages in the Educative field

### Professors

PROFESORS	
ADVANTAGES	DESADVANTAGES
<ul style="list-style-type: none"><li>• High degree of interdisciplinarity. Nowadays the teacher has to know a little about everything, from the instrumental and operational point of view (connection of audio and video equipment, etc.), management and updating of software, web page design, blog and much more. The teacher will be able to interact with other professionals to refine details.</li><li>• Initiative and creativity. Since the teacher has transcended the classic exercise of teaching modernism. That effort requires a lot of initiative and creativity. There is nothing written, the education of the future is being written now and we have the privilege, together with our students, to be the actors and to write history.</li><li>• Use of resources. There are phenomena that can be studied without the need to be reproduced in the classroom. Many times with the projection of a video or the use of a good simulation, they can be enough for learning. On the other hand, the use of paper can be reduced to its minimum expression by replacing it with the digital format. at the moment an encyclopedia, books and reports, among others, can be stored on a CD or pen drive and can be transferred via the web to any place where technology allows it.</li><li>• Cooperative learning. The teacher learns with his students, teachers with teachers, thanks to cooperation and teamwork.</li></ul>	<ul style="list-style-type: none"><li>• Continuous training of teachers is necessary so you have to invest resources (time and money) in it.</li><li>• Often the teacher feels overwhelmed by his work, which is why he often prefers the classical method, thus avoiding commitments that demand time and effort.</li><li>• There are very particular situations where an animation, video or presentation can never surpass the real world, which is why it is only achieved in a well-equipped laboratory or classroom.</li></ul>

*INFORMATION FROM AN ANONYMOUS AUTOR pagina  
<http://webdelprofesor.ula.ve/ciencias/sanrey/tics.pdf>*

## Advantage and disadvantages in the Educative field

### Students

Students	
ADVANTAGE	DESADVANTAGE
<ul style="list-style-type: none"><li>• Use of time. The student can access the information instantly, he can send his homework and assignments with just one "click". You can interact with your classmates and teachers from the comfort of your home or "cyber" using the chat rooms and discussion forums. The teacher can publish notes, assignments and any information that she considers relevant, from the comfort of her home or office and almost instantly through a blog or website. In case of not having adequate instrumental time, the teacher can show you other options to be able to integrate into the activities.</li><li>• Cooperative learning. The students learn with the teacher and with each other interact the new programs and this is based on teamwork</li><li>• Motivation of interest. Students have innate abilities associated with new technologies, so they very naturally accept the use of the computer in their learning activities; they prefer the projection of a video to the reading of a book.</li><li>• Development of skills in the search for information. Barely a few decades spent an entire afternoon consulting and sometimes it was not enough to find it. It is necessary to develop skills to properly select the useful information and filter the useless to keep an amount of information that we can process.</li></ul>	<ul style="list-style-type: none"><li>• Given the amount of variety of information, it is easy for the student to get distracted and waste time browsing pages that do not provide useful. The student may lose his goal and her time.</li><li>• If classmate are lazy, cooperative learning may not take hold.</li><li>• Interest in studying may be replaced by curiosity or exploration on the web in academic activities such as fun, music, videos, etc.</li><li>• Given the variety and immediacy of information, children can feel saturated and in many cases refer to "cutting" and "pasting" information without processing it.</li></ul>

INFORMATION FROM AN ANONYMOUS AUTOR  
pagina:<http://webdelprofesor.ula.ve/ciencias/sanrey/tics.pdf>

### ICT's Technologie- Social impact

During their introduction and establishment, ICT have a double effect, since they transform organizations and people and cause the distancing of those who cannot or do not want to use them.

Among the imbalances produced by technological renovation, we can identify the following points:

Social gap: caused by lack of training during youth or low economic capacity.

Accessibility gap: caused by a lower sensory or cognitive capacity.

Technology gap: outdated caused by the lack of interest in what is new.

Technological bifurcation point: age in which it is considered unnecessary to resort to new technologies.

With this information can be observed what could be classified as a series of opportunities and threats, both general and specific, which are indicated below in the following table, which was obtained from the following address.

Social opportunities and threats

OPORTUNIDADES Y AMENAZAS SOCIALES
<b>Son oportunidades generales</b> <ul style="list-style-type: none"><li>• El aumento cuantitativo de la formación tecnológica a todos los niveles de la población.</li><li>• La creación de iniciativas empresariales en el mercado de los servicios sociales basados en tecnologías de la información.</li><li>• La capacidad de investigación y desarrollo local en áreas industriales.</li><li>• Desarrollar una comunidad tecnológica en TIC, que incluya acciones simultáneas sobre las tres brechas.</li></ul>
<b>Son amenazas generales</b> <ul style="list-style-type: none"><li>• La lentitud en la adopción de nuevas políticas educativas innovadoras y de formación masiva a la población en y con TIC.</li><li>• La consideración de la brecha de accesibilidad como único problema.</li><li>• La alta dependencia tecnológica en TIC y sus costes.</li><li>• La evolución tecnológica rápida y el aumento de la edad de la población.</li></ul>
<b>Oportunidades específicas</b> <ul style="list-style-type: none"><li>• Personalización del uso de la tecnología. Avances en accesibilidad, movilidad, seguridad.</li><li>• Aumento de las ayudas técnicas (brecha accesibilidad) y diseño universal (WAI).</li><li>• Desarrollo de tecnologías que se adecúan al entorno y reducción del tamaño de los dispositivos.</li><li>• Aumento de los modos de comunicación persona-ordenador.</li><li>• Entorno multilingüe y lenguaje natural.</li></ul>
<b>Amenazas específicas</b> <ul style="list-style-type: none"><li>• Aumento de la dependencia de otros por la brecha tecnológica (falta de sensibilización).</li><li>• Formación centrada sólo en el uso básico de la tecnología (falta de competencias personales y profesionales en TIC).</li><li>• Diseño tecnológico ausente de los colectivos afectados por las brechas citadas.</li><li>• Separación de colectivos sociales (tecnificados/no tecnificados).</li></ul>

## 4 Analysis of Results

### 4.1 Methodology

Populations of 300 students were asking about their hybrid education. It will be quantitative and qualitative, using the confiability of 90 and 95% to obtain the results. And we are going to use questioner with Likert scale.

Section	Items	Concept to size
A	6	General data
B	6	Class hybrids
C	6	Recursos, Plataformas (classroom, Videos, Moodle, Meet y Zoom, Otros)
D	6	Resultados de examen de egresos

Note: Measuring instrument. Own elaboration.

We used Likert scale with five options which they were list to 1 to 5, 1 is lower value and 5 higher value.

#### Statistical reliability

Alfa de Cronbach	No. items
.812	30

Nota: Alfa de Cronbach.

Kaiser reports a KMO evaluation scale:

0,90 < KMO <= 1	Very good
0,80 < KMO <= 0,90	Satisfactory
0,70 < KMO <= 0,80	Media
0,60 < KMO <= 0,70	Moderate
0,50 < KMO <= 0,60	Bad
KMO <= 0,50	Unacceptable

Where:

n= sample size , 250 students

Z= Confidence Level (95%)

P= Probability that the event occurs (50%)

Q= Probability that the event does not occurs (50%)

E= Acceptable Error (5%)

Degree modalities at University of Guadalajara

- Academic excellence
- Titulation by average
- Global theoretical-practical exam. ...

- Global theoretical exam. ...
- General Professional Certification Exam (CENEVAL) ...
- Professional training exam. ...
- Reply verbal or in writing. ...
- Educational package.
- By Diploma

The first two, academic excellence and titulation by average, the students have to do the general profesional certification exam (CENEVAL), this exam help the University of Guadalajara being ranked as one of the best University together with other National or International University.

	<b>F</b>	<b>Sig</b>
1. - Which platforms were most suitable for hybrid education at the University of Guadalajara, Mexico in CUCEA in the department of International business and Marketing?	<b>3.21</b>	<b>0.03</b>
2. - Is the use of moodle safer for hybrid education with the application of ICT? What was the learning of the two semesters compared to 2020A and 2020B with hybrid education?	<b>2.121</b>	<b>.035</b>
3. - Teachers who compare can be given with their hybrid education and ICT's?		

In order to continue with this research, an informative development will continue citing the documentation and research that complete all our problems statement, since it is necessary to know why this issue is a problema located within the population mentioned in the point of the approach of the problem and obtain as much knowledge as posible regarding this problem, which affects the development of ICT. The research method will be mixed, quantitative and qualitative research. Use of particular statements and results of observation, experimental and the use of a checklist.

In the qualitative part with the use of the interview instrument and observation to obtain all the data from the research, in the quantitative part, the measurement tool is the survey.

## **4.2 Results**

The degress in the 2020 A calendar were 10% for contingency and 2020B 25%. But where it was the increase for qualification was the modality by diploma that is just take 6 modules and they are virtual groups of 15 students increased to 40 or 45 students.

The response of the students is to be able to understand and confirm their knowledge that they took courses with the virtuality and hybrid modality.

The results of our hypotheses.

## **5 Conclusions**

Determine curriculum improvements and ICT use. To face the changing that the world is facing in the education changes and we could be more competitive with our students with this pandemic and then we could be more prepared to keep going with the hybrid education for the internalization.

## **6 Proposal for future research**

Mexico needs to solve their connectivity, the acceptance of long distance learning and not only face to face learning, but being more competitive and to get better results. We are going to do another comparative research this year 2021A- 2021B to know the result of the new students that haven't being in a classroom and waiting for the graduated result

This results will help us to know which levee the University of Guadalajara are at National and International level, this for the academic exchanges, on high grade like University, master or PhD grade.

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## **Blockchain Technology in Healthcare: Readiness of Different Types of Stakeholders**

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### **Abstract**

With the advent of the Digital Transformation, Healthcare Systems have switched from paper to electronic health records (EMR). However, there are few critical issues related to data governance (e.g., transparency of data, traceability, immutability, privacy and security) that need to be addressed in the upcoming years. Blockchain (BT) is a decentralized digital ledger and an innovative technology with the potential to address such issues.

A pivotal role when implementing a blockchain-based solution, in healthcare as in other fields, is played by the stakeholders involved in the digitalization process, and in their

respective readiness, that can be defined as the availability and capacity of the various stakeholders to adopt the new technology, both individually and collectively.

Readiness represents a factor that affects the correct implementation of blockchain-based solutions and is commonly declined in the literature by means of different dimensions: motivational readiness, engagement readiness, technological readiness and structural readiness.

Readiness is particularly important for those stakeholders who are nodes of the blockchain network, as they have the fundamental role of keeping and exchanging the information necessary for its operations.

However, in the literature we have not encountered any work analyzing the differences between stakeholders that are nodes and those that are not-nodes of the BT network, not only in terms of type but also in readiness.

This work aims at identifying what is the difference between the readiness dimensions of stakeholder-nodes respects stakeholders-non-nodes in BT-based projects applied to EMR and how readiness impacts blockchain-based projects, especially when it concerns the stakeholders that are nodes of the BT network and those that are not.

The chosen methodology is the multiple case studies; three different projects have been selected that use BT in different ways to manage EMRs.

Through semi-structured interviews, it was possible to identify the stakeholders interested in these projects, determine which of these represent nodes of the network and which non-nodes, and identify the different dimensions of readiness that characterize them.

**Keywords** – Blockchain, Electronic Medical Records, Healthcare Organizations, Digitalization

**Paper type** – Academic Research Paper

## 1 Introduction

Digital technologies represent a possible tool to achieve a better healthcare quality (EUR-Lex, 2020). The results of "Digital Transformation: Shaping the future of European healthcare" research performed by the Deloitte Center for Health Solutions (2020), highlighted that the most used technologies in healthcare are connected to the electronic medical record (97% in the Netherlands, 74% in Portugal, 69% in Italy) and the electronic prescription systems (97% in the Netherlands, 13% in Germany, 67% in Italy). Data is, in fact, the core element of this digital transition, which revolutionized economy, society, and health [4]. Through digitalization, healthcare organizations can integrate and improve care, increase quality and make data flow more accessible.

Although there are significant differences among the requirements and objectives of the different digital health systems, there are three main criticalities characterizing most of them.

First, the health structures often use non-homogeneous application architectures, even within their operating units. Moreover, the data extracted from different devices are often heterogeneous and hard to integrate with each other automatically. In this context, obtaining a complete picture of the complete health history of a patient is challenging, and the resulting fragmentation generates inefficient coordination of care, lack of interoperability and potential lack of essential information in case of emergency (Yaeger *et al.*, 2019; Zhang *et al.*, 2018).

Secondly, patient information is generally contained in electronic health records, mainly organized within centralized systems and, for that reason, vulnerable to a single point of failure and information loss, due to natural disasters or information thefts following cyber-attacks (Yaqoob *et al.*, 2021). It's worth recalling that last September, ransomware attack caused a network failure at the University Hospital of Düsseldorf (UKD), which also caused the death of one patient (Ciampanu, 2020).

Finally, current data management systems cannot ensure transparency, reliable traceability, immutability, audit, privacy, and security when managing EMR (Yue *et al.*, 2016).

Blockchain Technology (BT) has the potential to address those issues (Chen *et al.*, 2019; Gordon, 2019; McGhin *et al.*, 2019; Farouk *et al.*, 2019). It is an extremely innovative technology, able to aid the simplification of health data management operations: on the one hand, it allows unprecedented efficiency and reliability in data management (Islam *et al.*, 2016; Chukwu, 2020; Syed *et al.*, 2019; Esposito *et al.*, 2018), on the other, it offers a wide range of important integrated functions, such as data access flexibility, security, privacy, decentralized storage, transparency, immutability, authentication, disintermediation, verifiability, programmability, interconnection (Omar *et al.*, 2018; Hasselgren *et al.*, 2020).

BT is, indeed, a decentralized digital ledger that offers the opportunity to record and share information (Hussien *et al.*, 2019). This data is held on the network through a series of nodes. Any entity connected to the blockchain can be classified as a node. Nodes are a critical component of the infrastructure of a blockchain because they act as further validation for the ledger, allow anyone to transparently view transactions/data conducted or held on the network and their

connection is described by blockchain architecture (Hussien *et al.*, 2019). If the nodes involved in blockchain are already known to the network, then the blockchain is referred to as permissioned, such as Hyperledger Fabric (Androulaki, 2018). When a system is open to the public, any individual or organizational node can be a member of the network; hence, this blockchain is referred to as public, such as Ethereum (Founder *et al.*, 2018) and bitcoin (Nakamoto., 2008; Hussien *et al.*, 2019).

Because of these characteristics, BT seems to be the leading solution to address the healthcare critical issues described above. Nevertheless, it is worth noting that the introduction of new and emerging technologies in any sector can give rise to some problems and challenges (Khan *et al.*, 2021).

The literature unison confirms that blockchain requires a strong synergy among the stakeholders (Lee *et al.*, 2012): not only clinical staff, patients, management, but also suppliers and BT experts, need to be put in place. Therefore, when implementing a BT project, it is essential to assess the stakeholders' readiness, i.e., the availability and capacity of the various stakeholders concerning the adoption of the new technology, both individually and collectively (Savage *et al.*, 2010). Specifically, the literature shows that four dimensions of stakeholders' readiness play a pivotal role: motivational readiness, engagement readiness, technological readiness and structural readiness (Balasubramanian *et al.*, 2021).

However, to our best knowledge, the literature has neglected one important difference between stakeholders: all nodes can be stakeholders, but not all stakeholders are nodes. This means that not each readiness dimension may be as important for every stakeholder and hence that not necessarily all the stakeholders should score high whatever the readiness dimension is analysed. To put it differently, for implementing a BT project, it is important to distinguish if there are differences between nodes stakeholders and not-nodes stakeholders in terms of readiness dimensions. This is indeed our paper's objective, which we deem extremely important in a BT project, in order to avoid assessing readiness dimensions whose role is not critical for a specific type of stakeholder. On this regard, the research questions underlying this research are the following:

1. What is the difference between the readiness dimensions between stakeholders-nodes and stakeholders-non-nodes in BT-based projects applied to EMR?

2. How does nodes-stakeholders' readiness and non-nodes stakeholders' readiness affect the implementation of BT-based projects applied to EMR?

## 2 Background

The fundamental basis of BT is the nodes that constitute its network and that orchestrate all the information necessary for its operation. In the literature, the nodes of the projects implemented with BT are usually referred to as stakeholders or as interested and involved actors on various levels. The distinction between node and stakeholder is not clear and thoroughly defined; very often, it is not even considered that if it is true that all the nodes of the BT network are stakeholders, not all stakeholders are nodes.

Previous studies in the healthcare field have highlighted a plurality of relevant stakeholders for implementing BT-based solutions. For instance, patients (Patel, 2019; Siyal *et al.*, 2019, Yoon, 2019, Khatoon, 2020; Tandon *et al.*, 2020) and Governments (Bell *et al.*, 2019; Dhagana *et al.*, 2019) have sometimes been included as stakeholders. Moreover, business entities (Radanovic and Likic, 2018), regulatory bodies (Nugent *et al.*, 2016), and service providers (Kuo *et al.*, 2017) have been included as actors with a stake in the BT system development.

Hence, the literature, while recognising the diversity in terms of type and interests between the involved actors, identifies a wide spectrum of actors as stakeholders, without taking into account if they are nodes or non-nodes of the blockchain network. For example, in a patient-centric project aimed at improving clinical record management, both the patient – i.e., the owner of clinical data - and hospitals – i.e., data managers - are undoubtedly stakeholders and nodes of the blockchain network. Conversely, the Government, even if recognisable as stakeholder aiming at both ensuring the privacy of its citizens and improving the efficiency of the process, is not necessarily a node in the network.

Savage (2010) and many others explain that when a BT project is implemented, the stakeholders' readiness, i.e., their availability and capacity of adopting a new technology, is important; and it is important in all its four dimensions: motivational, engagement, technological and structural (Balasubramanian *et al.*, 2021; Li *et al.*, 2012). The achievement level of each of the above different dimensions of readiness is an important element that impacts the BT implementation (Balasubramanian *et al.*, 2021).

Motivational readiness is necessary to appropriately address the changes concerning an existing service or circumstance - for instance, in clinical data management, the need to overcome problems related to the quality of service or privacy. Motivational readiness presents strong and different relationships with the stakeholders involved; end-users who receive assistance below expectations, regulatory bodies interested in providing an adequate service to their citizens, corporate entities that, by offering assistance, face the inefficiency of the health system daily.

Engagement readiness refers to the knowledge of new solutions and the explicit recognition of their benefits and potential challenges. For blockchain technologies, this includes knowing how to achieve results, the potential risks to current systems, the potential benefits, the difficulties associated with development costs, and the risks of failure.

Technological readiness is the individual or organizational predisposition to embrace new technologies. Factors contributing to this type of engagement include, for example, the availability and compatibility of existing hardware, software, networks, applications, and other information and communication technology (ICT) resources that facilitate the new technology. Technological readiness regards all the stakeholders, as it refers to the propensity to welcome new technologies and make integration with previous ones possible.

Structural readiness refers to the availability of non-technical resources - financial and human - to be invested in adopting new processes or technologies. Indeed, implementing BT requires valuable resources, such as time, money, and personnel. For the implementation of blockchain, a high level of structural readiness is essential both for government bodies and for the health and blockchain service providers who invest in these projects, but also for end-users, as consumers, regarding the availability and ability to use computers, smartphones and the Internet for daily activities.

We are adamant to claim that the above difference between node and non-node stakeholders within the network play a role when determining the factors that influence the possibility of implementing BT, as in the specific case of readiness in all its four dimensions.

The relationship between readiness and types of stakeholders involved in the implementation of BT-based projects - if nodes or not-nodes - is important to properly assess to what extent the single stakeholder is ready for adopting a new technology. However, the scientific debate does not provide indications. More

specifically, we encountered only three studies about blockchain readiness assessment (Ozturan *et al.*, 2019; Vlachos *et al.*, 2019; Balasubramanian *et al.*, 2021), and only one of them (Balasubramanian *et al.*, 2021) involved healthcare. Furthermore, to the best of our knowledge, no work on readiness assessment has been published that considers the difference between the stakeholders in terms of node or non-node of the blockchain network.

### **3 Methodology**

#### **3.1 Case studies**

We present here a multiple case study: as blockchain-based solutions in healthcare are a new phenomenon and there is a lack of quantitative data, we have chosen a qualitative approach.

We used the database provided by the Blockchain & Distributed Ledger Observatory of the Politecnico di Milano, which mapped the reality of the blockchain worldwide, to identify the state of the art of blockchain initiatives in the healthcare sector and to select the case studies to be analyzed in detail.

Starting from the database containing all the projects, we applied these selection criteria: the level of maturity of the project and their relationship with the medical record, such that we would include only cases with a close relationship with the medical record. The information availability and the general characteristics of the case contributed to the inclusion in the selected group.

The selected case studies are the following:

1. SAFE– [2020; Operating]
2. Medicalchain with the Groves Medical Group - [2018; Operating]
3. Hypertrust X-Chain - [2018; PoC]
4. Toronto Hospital Project - [2020; PoC]
5. IBM Canada project - [2019; PoC]

Following a detailed projects analysis and an initial contact with their respective representatives, aimed at verifying their availability to participate in the interviews, we selected SAFE, MedicalChain and HyperTrust X-Chain.

SAFE was born from the “MedTech Accelerator”, the flagship program of Mayo Clinic, and Arizona State University Alliance for Health Care. Its initial goal was to diagnose and monitor COVID-19, sexually transmitted diseases and some common ailments, such as flu.

The platform, currently used for COVID-19, connects patients, doctors and test providers through HealthCheck, an advanced smartphone and desktop application, which also allows verification of vaccination status. To ensure trust between all stakeholders and independently verify the accuracy of the information reported while keeping privacy intact, SAFE has relied on Hedera Hashgraph, a distributed ledger technology evolving from blockchain, which offers the same benefits as BT, but without its limits. The app includes voice / video telemedicine, services to allow the review, almost in real-time, of diagnostic tests and the option to request tests through interfaces / partnerships with Quest, LabCorp, and Mayo Clinic Labs and ePrescribing, through SureScripts.

Medicalchain is a platform, built in 2018, that allows the exchange and the use of medical data in a safe and fast way, without compromising the privacy of patients, thanks to asymmetric encryption. Healthcare professionals, doctors, hospitals, laboratories, pharmacists, and insurance companies can request permission to access and interact with medical records. Each interaction is verifiable, transparent, and secure, and recorded as a distributed ledger transaction. The platform is based on the Hyperledger Fabric architecture and, through permissions, allows different access levels, with the patients directly controlling who can access to which records and for how long. A smart contract is activated on this platform, which those entitled can allow third parties (e.g., doctors or other health professionals) to remotely access their medical reports through. Access can be granted in a limited form to specific files. Doctors can record, as ledger transitions, notes, scans, and lab results, and, likewise, pharmacists can add medications provided. Medicalchain also offers an innovative way to connect researchers and patients by sharing their data (anonymized), rewarding patients with personalized incentives (MEDTOKEN).

Eventually, with Hypertrust X-Chain, the CAMELOT Consulting Group offers a blockchain-based, patient-centered solution, particularly suitable for personalized treatments, which many stakeholders are involved in, such as in the case of self-transplant therapies. Hypertrust X-Chain orchestrates a distributed manufacturing process using a series of smart contracts, which act on a custom workflow model, stored on the ledger.

The system provides an end-to-end solution to automate, streamline and secure the supply chain for customized treatments, and inform interested parties about upcoming auctions. The system can be easily configured to manage the supply chain steps for autologous cell therapies such as patient enrolment,



apheresis, and treatment appointments planning and monitoring, hospital pick-up appointments planning and monitoring, among others. Hypertrust X-Chain enables safe, efficient, and transparent workflow management for the entire autologous cell therapy process, with far-reaching benefits for pharmaceutical companies and all other stakeholders in the supply and data chain.

The research protocol was drawn up in a semi-structured way, in order to allow the interviewees to speak freely about their projects, stimulate thoughts and opinions on the topics related to the study.

### 3.2 Cross-case analysis

The three case studies and the analysis of the literature allowed us to categorize the main actors involved in blockchain-based projects into four broad categories: governments and regulatory bodies, health service providers (hospitals, health professionals, pharmaceutical companies, laboratories, etc.), blockchain-based solution providers, and end-users.

The case studies confirmed that not all stakeholders are nodes. In fact, all three interviewees identified the same stakeholders, but the substantial difference between the three projects is to be found in the number and type of nodes that make up the BT network; in SAFE, the network's nodes are mainly represented by patients and doctors, in MedicalChain, hospitals are included as well, while in Hypertrust, the network becomes even more extensive, incorporating a series of further actors that concern, for example, the drug supply chain (Table 1).

Table 1: Stakeholder vs Node

MAIN ACTORS		CASE STUDIES					
		SAFE		MedicalChain		Hypertrust	
		Non-nodes stakeholder	Node stakeholder	Non-nodes stakeholder	Node stakeholder	Non-nodes stakeholder	Node stakeholder
Governments and regulatory bodies		✓		✓		✓	
Health service providers	Hospitals	✓		✓	✓	✓	✓
	Doctors	✓	✓	✓	✓	✓	✓
	More	✓		✓		✓	✓

Blockchain-based solution providers		✓		✓		✓	
End-users	Patients	✓	✓	✓	✓	✓	✓

The interviews highlighted the differences between the readiness dimensions relating to stakeholders, both nodes and non-nodes, of each case considered (Table 2).

End-users (patients) are nodes in all three cases and they all agree in assigning greater importance to their motivational readiness, because the drive for change involves the realization of problems pertaining to poor service or the violation of patient privacy.

Regarding health service providers, doctors are nodes for all three cases, hospitals are nodes only for Medicalchain and for HyperTrust, and other entities - such as pharmaceutical companies and transport service provider- are nodes only for HyperTrust. As for doctors, hospitals, and other entities, the motivational readiness and the structural readiness are considered essential; having the awareness of the critical issues related to data management becomes necessary to explore the possibility of using BT as well as expressing any fears or concerns about the use of the technology.

As for the non-node stakeholders identified by all three cases, SAFE and Medicalchain agree on the importance of engagement readiness for the governments and regulatory bodies while, SAFE and Hypertrust agree on technological readiness relevance for the BT- based solution providers, and the importance of structural readiness for both.

The importance of governments' readiness for involvement is related to knowledge, awareness of new initiatives, and a clear recognition of their benefits and potential challenges that drive regulators to change legal frameworks. Structural readiness refers to the availability of financial and human resources that governments invest in the adoption of new processes or technologies.

Regarding BT solution providers, the importance of technological readiness is linked to the availability, ability, and deep-in knowledge of existing hardware, software, networks, applications, and other information and

communications technology (ICT) resources and BT. Structural readiness, on the other hand, is linked to the availability of resources that would make it easier to implement BT.

Table 5 Readiness

CASE STUDY	STAKEHOLDERS AS NODES																											
	Governments and regulatory bodies				Health service providers						End-users				Blockchain-based solution providers													
					Hospitals		Doctors		More		Patients																	
SAFE							✓				✓																	
Medicalchain					✓		✓				✓																	
HyperTrust					✓		✓		✓		✓																	
CASE STUDY	READINESS																											
	M	R	E	R	S	R	T	M	R	E	R	S	R	T	M	R	E	R	S	R	T	M	R	E	R	S	R	T
SAFE			✓		✓							✓		✓												✓		✓
Medicalchain			✓		✓			✓				✓		✓						✓						✓		✓
HyperTrust							✓				✓		✓		✓				✓								✓	✓

The case studies have, therefore, highlighted that the assessment of readiness (with a different specific weight depending on the type of stakeholder and the

type of readiness) of both nodes and non-nodes is an essential variable for the implementation of blockchain.

On the contrary, only the stakeholders who are also nodes play a fundamental role in technological choice (Table 3). In fact, the technological choice depends on the ability of the nodes to send and validate transactions. If all nodes participating in the network can do this, a permissionless platform must be used, as in the case of SAFE, otherwise, if authorization is required to execute a transaction, a permissioned platform is used, as in the cases of Medicalchain and HyperTrust X-Chain.

Tabel 3 Technological Choice

Project name	Platform name	Permissioned/ Permissionless	Private/ Public
SAFE	Hedera Hashgraph	Permissionless	Public
MedicalChain	Hyperledger Fabric	Permissioned	Private
Hypertrust	Hypertrust X-Chain (supported BT: Hyperledger Fabric, Multichain, Quorum, Ethereum (private networks) and Hyperledger Indy)	Permissioned	Private

#### 4 Discussion and conclusions

The goal of this study was to fill a gap in the literature related to the weight that stakeholders, nodes and non-nodes, have in the implementation of BT and the importance of their respective readiness.

We have then shown that the importance of readiness for the implementation of BT projects was confirmed by our qualitative analysis. Using blockchain for secure data access and sharing is effective and reasonable if all parties involved in the process use it; indeed, BT is not owned by a single independent entity and all stakeholders must be part of the chain with a defined role.

The case studies revealed the existing relationship between each stakeholder, node or not-nodes, and between each type of readiness. This step is essential

because it clarifies what factors need to be considered when implementing such solution and how stakeholders could facilitate or hinder the building of BT-based projects.

In this paper, it was also discussed the fundamental importance of nodes for technological choice, and the case studies clarify that from the SAFE project to Hypertrust, there is an increase in the complexity of the network in terms of actors involved, data exchange, and BT functionality. On this imagined scale, one can think of placing SAFE at a low level of maturity of technology adoption, Medicalchain at a medium level, and Hypertrust at a higher level (Figure 4).

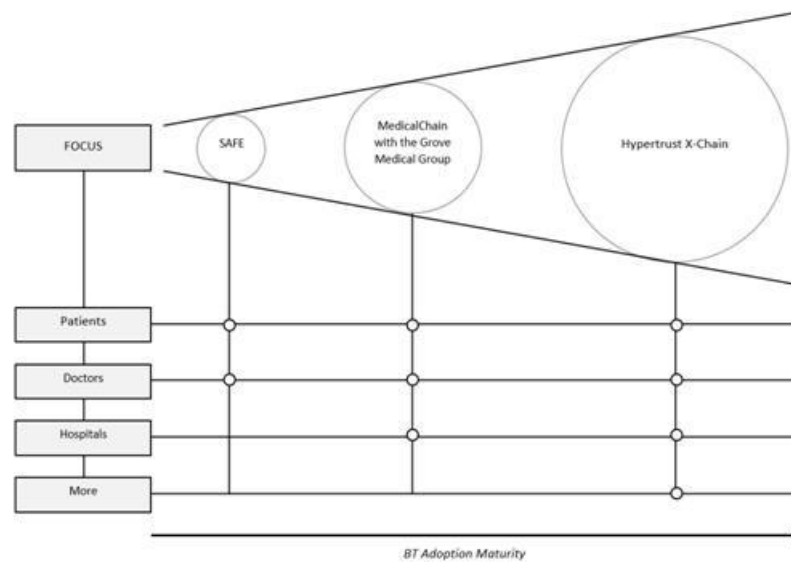


Figure 4 Adoption Maturity

However, a blockchain-based solution can evolve over time, as a consequence of the number and the type of the nodes joining the network, of stakeholders' need, and of the evolution of the external context. Taken together, our study shows that decisions about the BT form need to be taken not only during the startup phase of implementation, but also along the actual implementation and evaluation phases of the project.

Hence, it can be useful:

- to identify, *a priori*, the best solution for starting the implementation;

- to verify, *in itinere*, whether the initial form is still adequate or, according to the evolution, it should be modified;
- to evaluate, *a posteriori*, whether the chosen mode is adequate to the needs and characteristics of the collaboration.

It can also be useful for researchers and academics the *a posteriori* analysis because it may stimulate organizational learning within healthcare organizations and a better understanding of the complex phenomenon of blockchain-based solutions.

The analysis described in this research study is qualitative. We expect that with the increasing popularity and maturity of BT, novel data will be available for quantitative studies and further research should increase the rationality and the objectivity of our study.

For instance, during the selection of the case studies, two other cases were identified which are in the operational stage, as far as we know:

- The UAE Ministry of Health launches the Blockchain platform for medical data
- The HHS obtains ATO for a blockchain-based acquisition system.

It could be interesting both to broaden the investigation, analyzing these cases listed above, and gather more information with other interviews from the cases analyzed in this study.

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## **Social Bricolage and Social Business Model in Uncertain Contexts: First Insights from Minor Cultural Heritage**

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### **Abstract**

The past decade has witnessed a surge of research interest in social entrepreneurship organizations (SEOs). This has resulted in important insights concerning the role of SEOs in fostering social challenges. The crisis of both public and private profit-driven models meet the arising of new initiatives designed to meet the minor and often abandoned cultural heritage consumption need. Drawing on the domain of SEOs and social bricolage framework, these initiatives are able to pursuing the social and the economic mission together and not in a sequential way. This paper aims to analyse how SEOs that use strategies of social bricolage can improve the development and diffusion of social innovation. In this first phase of our research we carried out a comparative case study of fifteen cultural SEOs in the South of Italy. First results show that SEOs in the domain of minor cultural heritage adopt an innovative business model and unravel organizational dimensions falling into the social bricolage. The relation between social bricolage dimensions and social business model criteria produces outcomes in which social innovation can be expressed. Our study enhances current understanding of the social dimensions of business model involved in social innovation production of cultural SEOs.

This research aims to be a benchmark of the social innovation initiatives in the field of minor cultural heritage management.

**Keywords** – social bricolage, social business model, minor cultural heritage, uncertain contexts, social innovation

**Paper type** – Academic Research Paper

## 1 Introduction

Social entrepreneurship is one of the most discussed issue in management literature (Dacin, Dacin & Tracey 2011; Mair and Martì 2009, Zahara et al. 2009; Di Domenico, Haugh & Tracey 2010; Janssen, Fayolle & Wuillaume 2018). As well known and established in the literature (e.g. Mair and Martí 2006; Marshall 2011; Van de Ven et al. 2007; Zahra et al. 2009; Seelos et al. 2011; Mair, Battilana & Cardenas 2012) social entrepreneurship is an umbrella-term that encompasses a variety of organizations pursuing innovations and aiming at diverse social and environmental challenges. Social entrepreneurship is characterized not exclusively by the pursuit of economic goals but also by the pursuit of social and environmental objectives (Dees 1998; Mair, Battilana & Cardenas 2012). This has resulted in important insights concerning the role of social entrepreneurship organizations (SEOs) in fostering social challenges and in creatively and innovatively coping with resource-constrained environments.

SEOs have been identified as a form of social entrepreneurship at community level, an alternative and/or a complement to the action of States, governments, and private actors to address unmet social needs and/or poverty-related social needs.

In the last two decades, several streams of studies have focused on SEOs. A first one have examined their role as significant organizational players in market economies, exploring their contextual and structural dimensions and the sustainability of their economic and social outcomes (Moss et al., 2011; Bacq & Janssen 2011; Zollo et al. 2016).

A second stream has analysed the hybrid forms of SEOs to be innovative (Austin, Stevenson & Wei-Skillern, 2006; Zollo et al. 2016; Zollo et al. 2018). The hybridization of SEOs is basically anchored in the approach of bricolage (Lévi-Strauss, 1967; Janssen, Fayolle & Wuillaume 2018; Davies & Doherty 2019; Ciambotti & Pedrini 2021) that represents a significant opportunity to address

emergent social needs and to offer inclusive services to the communities. Nicholls (2009) argues that the problem-solving attitude of social entrepreneurs, characterized by a continuous generation of innovations, particularly fits with the bricolage behavior. According to Janssen et al. (2018), SEOs and bricolage share important characteristics that make them very close one to another.

Bricolage in social entrepreneurship (also called entrepreneurial bricolage, e.g. Zollo et al. 2018) allows to identify unserved markets in need (Gundry et al. 2011; Bacq et al. 2015) where to develop new contents, to capture new opportunities (Baker & Nelson, 2005), to advance novel approaches, to attract and use relevant resources. Moreover, several scholars (Gundry et al. 2011; Linna 2013, Desa & Basu 2013; Desa & Koch 2014; Bacq et al. 2015) have highlighted that the ability of SEOs to develop social innovation and to produce social change directly depends on their bricolage strategies and bricoleurs' behavior. In particular, we draw on its social dimension and on the model of social bricolage, as "*ad hoc*" theorized by Di Domenico, Haugh & Tracey (2010).

A third important stream of managerial and entrepreneurial studies stress that SEOs' social bricolage engender their business models innovation (Zott & Amit, 2008; Guo et al., 2016; Servantie & Rispal, 2018) and the interdependence between social, cultural and economic outcomes to produce social innovation (Nicolopoulou et al. 2017; Gasparin et al. 2021).

So far, relatively little attention, however, has been paid to the business model innovation of SEOs that use social bricolage. Only a few studies have analyzed which business models SEOs can adopt to combine both economic and social mission by producing social innovation (Mair & Marti 2009; Gundry et al. 2011; Desa & Basu 2013; Gasparin et al. 2021), and how the social bricolage approach influences their business model in order to be sustainable (Desa & Basu 2013). Moreover these studies are mostly focused on BoP markets (Linna 2013; Angeli & Jaiswal 2016), and on transitional and developing economy contexts (Guo, Su & Ahlstrom 2016; Desa & Koch 2014; Gasparin et al. 2021).

This gap in the literature is surprising mainly because SEOs are at the forefront of social innovation, as they attempt to balance a distinct social mission with a strong market orientation (Desa & Kotha, 2006; Koch & Caradonna, 2006). SEOs produce social innovation by innovating content, structure, and governance of transactions and taking advantage of new opportunities, offering adapted products and services (Gundry et al., 2011). Therefore, defining a specific

approach to business model is crucial for sustaining the long-term growth of organizations that develop social innovation.

Drawing on the constructs of social bricolage, social innovation and innovative business model (Bhattacharyya et al. 2010; Yunus et al. 2010; Di Domenico et al. 2010; Zollo et al. 2017; Gasparin et al. 2021) we aim to fill this gap. Our study aims to analyse how SEOs that use strategies of social bricolage can improve the development and diffusion of social innovation.

Much of the previous research into the role of bricolage in SEOs has explored how this process is developed (Di Domenico, Haugh, & Tracey 2010), how it helps SEOs to achieve their social mission (Mair & Marti 2009), and how it affects the development of social innovation (Linna 2013). There are strong and recent calls in the literature for the understanding of the optimization of scarce resources in an innovative way in SEOs (Desa 2012; Desa & Basu 2013; Bacq et al. 2015; Molecke & Pinkse 2017) and their organizational models that make it possible to respond to an unsatisfied social need (Ciambotti & Pedrini 2019; Gasparin et al. 2021).

Moreover there is an interesting call for the application of these concepts in different socio-cultural contexts with multiple case studies and narrative analysis, especially in economically developed countries (Di Domenico, Haugh, & Tracey 2010; Janssen, Fayolle & Wuillame 2018).

In the present study, we draw on the special issue of *Entrepreneurship & Regional Development* of 2018, on the studies of Di Domenico, Haugh, & Tracey (2010), Zollo et al. (2018) and of Gasparin et al. (2021) for the analysis of business models of SEOs.

We see that SEOs using strategies of social bricolage are able to produce social innovation by adopting innovative social business model, in terms of organizational and entrepreneurial choices for social value creation and for emergent social challenges in complex contexts (Angeli & Jaswal 2016; Micheline 2012; Yunus et al. 2010).

We explore our aims by addressing a main research question: "How do SEOs adapt their business model to develop social innovation?"

Employing in-depth multiple comparative case studies and narrative analysis (Czarniawska 1997; 2004), we enhance current understanding of the social dimensions of SEOs and the innovative business model involved in social innovation production.

We focus on the minor cultural heritage in the South of Italy, because in last decade, SEOs play an increasing crucial role in the enhancing of minor and often abandoned (from both the State and private-market actors) cultural heritage sites, restoring them for the communities, generating economic and social value and employment opportunity (Consiglio & Riitano 2015). Moreover, cultural and Third Sector SEOs used to play a crucial role in the South of Italy marked by a socio-economic-structural weakness, intervening in severe situations of social distress being close to the most fragile people, using culture (Borzaga 2020; Consiglio & D'Isanto 2020). Their social infrastructures and their capacity for innovation demonstrated in facing moments of recession, economic difficulties and, currently, the pandemic are essential for the strengthening of communities and therefore for social and economic development.

Our study aims to contribute to the academic debate in several distinctive ways.

Building on these considerations, first, we contribute to the SEOs literature by exploring the main features of cultural SEOs and their social dimensions (Johnson et al., 2008; Yunus et al., 2010; Michelini, 2012).

Second, we extend and enrich studies on social bricolage (Di Domenico Haugh & Tracey 2010; Fisher 2012; Zollo, Pellegrini & Ciappei 2016; Molecke & Pinkse 2017; Zollo et al. 2018). We intend to offer new insights for the study of social bricolage and innovative social business model together for the development of social innovation (Gundry et al., 2011) and optimization of scarce resources in an innovative way. Moreover we further refined the studies by capturing the peculiar industry of cultural heritage in the South of Italy.

Third, by combining three crucial approaches: social bricolage, social innovation and social business model, we try to offer a novel strategic framework for the study of SEOs, where social and cultural goals, as well as the paths to market and economic outcomes, are equally prioritized by them to produce social innovation.

The remainder of this article is organized into four sections. The first section describes the background and framework connecting our three approaches. It analyzes SEOs and social bricolage behavior, examines the role of SEOs in the production of social innovation and develops the concepts of SEO's business model innovation in the literature. The second section introduces the research design and the study site, explaining the criteria for analysis, methodology and procedures for data collection. The third section discusses and compares the

cases and narratives, developing a strategic framework for SEOs in the management of minor cultural heritage. We conclude with a final section discussing contributions and conclusions. We acknowledge the limitations of our research which open up avenues for future studies in the area of SEOs, social innovation and business model innovation.

## **2 Background and framework**

### **2.1 SEOs and the entrepreneurial opportunity of social bricolage**

Social entrepreneurship signals the imperative to drive social change, and it is that potential payoff, with its lasting, transformational benefit to society, that sets the field and its practitioners apart (Martin & Osberg, 2007). Following the definition of Mair & Martí (2006, p. 37), social entrepreneurship is *"the process involving the innovative use and combination of resources to pursue opportunities to catalyze social change and/or address social needs"*.

In so doing, processes of social entrepreneurship often overcome established conventions: span sectorial boundaries (Austin et al., 2006), experiment with different ways of organizing (partnerships, alliances, and joint ventures) (Di Domenico et al., 2009; Seelos & Mair, 2007), and use a range of legal forms including for-profit, not-for-profit, and hybrid legal statuses (Dorado, 2006).

Building on recent literature, we follow the definition of social entrepreneurship, as a field of action involving different kinds of actors where individuals or groups use entrepreneurial tools to solve social challenges (Mair & Martí, 2006; Martin & Osberg, 2007; Zahra et al., 2009; Seelos et al., 2011; Mair, Battilana & Cardenas, 2012).

Yunus (2007) claims that social entrepreneurship is a broad concept about creating innovation measures that can help people in need. Dees et al. (2002, p. 5) have pointed out that *"social entrepreneurship is not about starting a business or becoming more commercial. It is about finding new and better ways to create social value"*.

In this domain, SEOs represent an innovative melting pot of social entrepreneurship combining two traditionally distinct models: on the one hand, a social welfare model that pursues its societal development mission, and on the other side a revenue generation model that pursues profit through commercial activities (Battilana et al., 2012). SEOs can adopt a for-profit or a non-profit legal

form in specific industries, such as, education, healthcare, young/women/migrants inclusion, cultural heritage and in the general field of Third Sector (Mair & Marti, 2006; Seelos & Mair, 2005; Leadbeater, 2007; Seelos et al. 2011; Mair, Battilana & Cardenas, 2012; Mintzberg and Azevedo, 2012). Following Lisetchi & Brancu (2014, p. 90), associations, foundations, cooperatives, social enterprises, mutual organizations and commercial enterprises with a social purpose (e.g. work integrating social enterprises), are "*outputs of the social entrepreneurship process*". According to the European Commission (2020), the concept of social enterprise has been refined over the last decades through relatively intense legislative activities designed to regulate this new type of SEOs.

The scarcity of resources accurately describes the environment in which SEOs evolve. Most SEOs face difficulty acquiring the resources they need to start and growth (Zahra et al., 2009; Austin et al., 2006). In social entrepreneurship literature, bricolage appears to be the dominant approach identified for understanding social entrepreneurship behaviours (Servantie & Rispal, 2018). Desa & Basu (2013) and Mair & Marti (2009) suggest that bricolage is appropriate in social entrepreneurship. Much of the previous research into the role of bricolage framework in SEOs explores how this process is developed (Di Domenico et al., 2010) and how it helps SEOs to achieve their social mission (Mair & Marti, 2009).

Bricolage in SEOs encompasses a set of actions driven by the pursuit of existing and often scarce resources that can be combined to create innovative and valuable solutions that bring positive social change to markets and communities (Gundry et al, 2011).

Building on previous works (Janssen et al., 2018; Desa & Basu, 2013; Mair & Marti, 2009; Baker & Nelson, 2005; Lévi-Strauss 1966), bricolage in SEOs could define as "the making do" with any resources "at hand" to provide innovative solutions for social needs that traditional organizations fail to address in an adequate way.

Indeed, within constrained environments, SEOs may engage in bricolage as a means to discover new and novel ways of solving social problems and meeting needs; access human and financial capital to implement the selected ideas; and remedy any strategic weaknesses that obstruct their pursuit of desired social improvements (Anthony et al., 2008).

In light of these assumption, bricolage has traditionally represented one of the most adopted option used by SEOs (Desa & Basu, 2013; Linna, 2013).



Starting from Di Domenico, Haugh and Tracey (2010), the literature recognizes the “social bricolage” as a concept in its own right and conceptually distinct from other forms of bricolage. The authors extended the constructs of bricolage to define social bricolage as a set of six processes. In addition to the traditional constructs of making do, refusal to be constrained by limitation, and improvisation, they identified three further processes in social entrepreneurship context namely:

1. social value creation, with skills development, social capital and community cohesion;
2. stakeholder participation, with governance structures and engagement in respond to social needs
3. persuasion, which describes the process of persuading other actors to leverage acquisition of new resources and support.

These further processes are closely related to the main dimensions of SEOs analysis. The conceptual framework of social bricolage in the context of SEOs combine to form a contextualized set of social action capabilities that can be leveraged by social entrepreneurs in their effort to create social value (Di Domenico et al., 2010).

Already in the previous literature, it is interesting to note that SEOs tend to adopt behaviors from social bricolage. Zahara et al. (2009) underline that three types of SEOs exist, that differ in how they address social need, how they acquire resources and how they recognize opportunities. The first type is called social bricoleur. Social bricoleurs have intimate knowledge about the local environment and the locally available resources to address small-scale local social needs. Their scope might be restricted, and they might not aim to scale up their ventures. They draw on local experiences and connections to the community. From a wider perspective, social bricoleurs share the common features of social entrepreneurs, namely skillful management of unexpected opportunities, spontaneous innovation, improvised risk, resources differently rearranged to social value creation (Zollo et al., 2017; Bacq & Janssen, 2011; Peredo & McLean, 2006).

Therefore (Di Domenico et al., 2010; Desa, 2012; Desa & Basu, 2013; Bacq et al., 2015; Zollo et al., 2017; Janssen et al., 2018), the concept of social bricolage is an entrepreneurial opportunity to address emergent social needs, in contexts characterized by scarcity of resource, high levels of uncertainty in economic

environments and the seasonality of activities (Langevang et al. 2012), such as that one of minor and abandoned cultural heritage.

Hence, social bricolage behaviors can be found in SEOs' organizational processes, especially in their early start-up stages, but according to Zollo et al. (2017) this approach does not guarantee in the long term the necessary efficiency and sustainability.

However, social bricolage is a suitable solution when adaptability, improvisation and resilience are more important than structural efficiency (Di Domenico et al., 2010). Hence, we stress the importance of the social bricolage processes because relational capacity, network implementation, spontaneous cooperative activities are the main features of the minor culturale heritage field where operating cultural SEOs. These social aspects of bricolage aims at social value creation.

As a consequence, recent scholars argue that the use of bricolage can affect the diffusion of social innovation (Gundry et al., 2011; Desa, 2012; Desa & Basu, 2013). In this sense, it is possible to highlight that the SEOs' use of social bricolage impact on their ability to produce social innovation.

## **2.2 SEOs and social innovation**

SEOs are closely linked to social innovation, however it is important to point out differences and similarities (Phills et al., 2008). The more critical research in social innovation points out that a gap has opened up between the classic social scientific theories of change, which also address social innovation, and the new social innovation analysis, in which the market economy represents an important framework for understanding the phenomenon, and in which social entrepreneurship is one of the principal tools for generating social innovation (Dacin et al., 2011).

Social innovation spans boundaries between different fields (Rao-Nicholson et al., 2017) with the aim of developing "*a novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals*" (Phills et al., 2008, p. 39). Social innovation can be products, services, production processes, technologies, principles, ideas, legislation, social movements, interventions, or a combination of these that address gaps generated by the State and the market failure of public goods (Phills et al., 2008, p. 39). The

goal of social innovation is to create social value beyond the capacity of the existing system (Adams & Hess, 2010) and must be a systemic change. This involves the interaction of social movements, law and regulations, data and infrastructures, business models and entirely new ways of thinking and doing things.

An important characteristic of social innovation is its capacity to involve in the generation of solutions different actors from all sectors and according to the social, economic, environmental, institutional, and cultural context where it takes place.

According to Mulgan (2007), a major difference between social innovation and social entrepreneurship is that *"whilst social innovation certainly occurs through social enterprise and social entrepreneurship it also happens in many other contexts. Conversely, although social entrepreneurship often involves innovation, only a small minority of social entrepreneurs create new models that can then be scaled up, and that process of scaling up often involves governments and larger businesses"*.

Following the European Union/Young Foundation (2010), these definitions aim at highlighting the main differences between the two concepts. Social entrepreneurship *"is used to describe the behaviors and attitudes of individuals involved in creating new ventures for social purposes, including the willingness to take risks and find creative ways of using underused assets"* (p. 15).

Social innovation is a much broader concept than social entrepreneurship, and as the European Union/ Young Foundation note, it will often encompass SEOs: *"... although it will often include one or both of these"* (p. 16).

From a literature overview, social innovation studies include the social processes of innovation itself, particularly those innovations which have a social purpose. It focuses on the process dimension of innovation, on how innovation and change take place, on how they are adopted and spread, and how they can be scaled-up, to address social problems. The social entrepreneurship perspective focuses on understanding the characteristics of individuals that create new solutions to solve social problems (or needs) and create social value.

Therefore, SEOs are seen as agents of social innovation in the society *"who help find solutions to social challenges, through creative and innovative products and ideas"* (Waasdorp & Ruijter, 2011, p. 72).

In summary, social innovation refers primarily to processes of system-building whilst social entrepreneurship is a way of understanding behaviors and

orientations of the individuals who lead that process (Cunha, Benneworth, & Oliveira, 2015).

Gundry et al. (2011) study the impact of social entrepreneurs' use of social bricolage on their ability to develop social innovation. SEOs are constrained to combine existing and limited resources in a creative way in order to tackle social problems (Gundry et al. 2011). In this perspective, bricolage allows developing novel approaches to attract and use relevant resources, identify markets in need and offer adapted products and services (Gundry et al. 2011). In this way, the ability of the social entrepreneurs to provide social innovative solutions directly depends on the extent to which they use bricolage (Gundry et al. 2011).

According to Zollo et al. (2017), recent scholars argue that entrepreneurial bricolage may be interpreted as the way modern entrepreneurs "catalyse" social innovation by effectively 1) combining available resources in an ingenious fashion and 2) entering new markets that are ignored by their competitors and seizing the latent profitable and attractive opportunities (see Desa & Basu, 2013; Kickul, Bacq & Garud, 2013; Bacq, Ofstein, Kickul & Gundry, 2015). In this sense, Zollo et al. (2017) assess that the "*ephemeral social entrepreneurship bricolage strategies*" emerge when SEOs look for sustainable solutions to emergent social problems (Johannisson & Olaison, 2007; Di Domenico et al., 2010; Desa, 2012) and resources mobilization (Bacq et al. 2015).

### **2.3 Business model innovation for SEOs**

SEOs must constantly cope with resource-constrained environment and to persist in designing sustainable business models to overcome these constraints (Linna, 2013).

SEOs pursue an innovation process of their business model to create a greater social value while achieving economic sustainability. This process requires SEOs to develop new knowledge resources to innovate their business model.

Several scholars have explored the business model innovation concept (e.g. Osterwalder and Pigneur, 2010; Yunus et al., 2010), in order to overcome limitations of the traditional frameworks in analyzing new forms of business where the social component is relevant. SEOs, as entrepreneurship organizations, need to define the three main elements of their business model (Zott and Amit, 2008; Osterwalder and Pigneur, 2010): 1) their value proposition that describe the value the company creates for its customers and partners; 2) their value

architecture that explains how they create and deliver products or services, and thus, how the value is generated; 3) their sustainable revenue model.

When coping with businesses endowed with strong social implications, Yunus et al. (2010) argued that business model should be characterized by a consistent view of how an organization generates revenues and profits. Indeed, there are some specific aspects of SEOs' business models (Dees et al., 2002; Seelos and Mair, 2005; Austin et al., 2006; Santos, 2009) that differ from business models of commercial entrepreneurs and business models of traditional non-profit organizations.

The SEOs value proposition is typically linked to address the core of a social need in order to creating a systemic change and providing a sustainable support (Seelos and Mair, 2005).

The SEOs value architecture often engages customers/beneficiaries and partners in the creation of products or services. SEOs build these relationships on shared objectives arising a bond of trust. This can serve two purposes. First, it is an innovative resource mobilization strategy that overcome restrictions caused by resource limitations. Second, the stakeholder participation is based on empowerment and co-creation process and develop a sense of responsibility, belonging and identity in the involved resources. Moreover, the involvement of the stakeholders can be a precondition to the sustainability of the value proposition.

The SEOs revenue model try to generate profit in order to self-sustainability. Maximizing profits is not a priority, financial surpluses are reinvested in the business. They are funded by different sources but usually prefer earned income strategies to reduce dependency of outside funding. Since increasing social value is at the core of SEOs business model, they use price differentiation and cross-subsidization to provide access to customers who could otherwise not pay for the product or service offered.

All these core features described let us to identify the SEOs business model as a social business model. Social business model is useful to organizations that aim to solve social problems by using business methods. These business activities should be undertaken in a way that is self-sustaining, and if some surplus is generated, it should be used to improve the level of attainment of social goals (Yunus et al., 2010).

In last years several studies have offered various perspectives of the social business model concept, highlighting different components (Martin and Osberg, 2007; Yunus et al., 2010; Michelini and Fiorentino, 2012; Michelini, 2012).

Austin et al. (2006) showed the social value proposition as a core concept that enables the exploration of the differences and similarities between traditional and social ventures. The social value proposition focuses on the opportunity '*to create social value by stimulating social change or meeting social needs*' (Mair and Marti 2006, p. 37).

Martin and Osberg (2007) stated that the critical distinction between entrepreneurship and social entrepreneurship lies in the value proposition itself.

Yunus et al. (2010) have identified four components of a social business model: value proposition (stakeholders and product / service); social profit equation (social profit and environmental profit); value constellation (internal value chain and external value chain), and economic profit equation (sales revenues, cost structure, and start-up capital or employed). Yunus et al.s' social businesses are employed by entrepreneurs sharing a social mission with an image of business-like discipline, innovation, and drive.

Michelini (2012) has developed the social value equation that describes the process by which the business could generate a social benefit.

Therefore, drawing on the different explanations of the social business model framework provided by literature (Austin et al., 2006; Martin and Osberg, 2007; Osterwalder et al., 2010; Yunus et al., 2010; Michelini and Fiorentino, 2012; Michelini, 2012; Cicellin et al., 2019) we use four main identification criteria to inform our analysis:

1. social value proposition (i.e. the benefits offered by the business model through products and/or services);
2. social value equation (i.e. the way the business model generates social benefit, in terms of risks and benefits);
3. social profit equation (i.e. how the business model manages the revenue surplus, whether to reinvest or distribute dividends);
4. start-up capital (i.e. the way in which the venture is funded, including through venture capital or start-up capital, and the nature of the entrepreneurship).

Through our comparative case studies and narrative analysis, we will suggest that the combination of the three approaches: social bricolage, social innovation

and social business model innovation, extends and enriches the concept of social bricolage in SEOs for producing social innovation.

### 3 Research Design

#### 3.1 Research setting. The Italian minor cultural heritage context

A great part of the enormous and heterogeneous Italian cultural heritage lacks a careful management and enhancement processes. The inadequacy of the public model and the non-profitability of the private one in the management and protection of the minor cultural heritage has triggered many organizations trying to defend and manage this heritage against from neglect and make it usable and accessible.

Despite the crisis of both public and private profit-driven models, in the last years, new and hybrid initiatives arose, and new projects are designed to meet this social need, drawing on the domain of social entrepreneurship.

The spectrum of social entrepreneurship in Italy includes both legally recognised and de facto social enterprises, as illustrated in Figure 1.

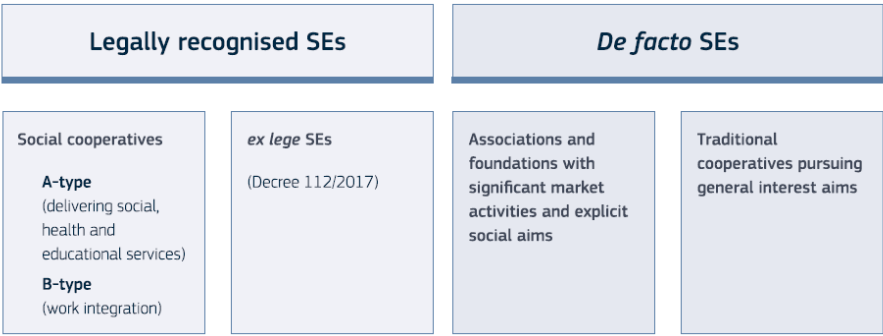


Figure 1. Spectrum of social enterprises in Italy  
 Source: European Commission, 2020.

The societal challenge of the SEOs in the minor cultural heritage field lies in proactive social change processes activated by many and different social innovators, public actors, religious institutions, private organizations and PPPs, citizens that shift from clients to key players resulting in new forms of bottom participation, community relations and work (Consiglio & Riitano, 2015). In this domain, SEOs are able to respond to the social need for a broader cultural

heritage consumption, to make abandoned sites available to citizens and tourists, filling a welfare gap (Pol & Ville, 2009; Murray et al., 2010; Caulier-Grice et al., 2012).

In particular, in the last ten years in the South of Italy we observe a flourishing of organizations that have launched social innovation projects applied to the management of minor and abandoned cultural heritage (Consiglio & Riitano, 2015).

Following these studies, in this paper we selected a deliberately restricted field of observation on the Mezzogiorno of Italy, with the aim of analyzing best practices of a part of the world we belong to, not only from a geographical point of view, but also from a political, human, cultural ones.

### **3.2 Methodology**

Our empirical analysis aimed to investigate the innovative social business models and the strategies of social bricolage of cultural SEOs for social innovation production.

This analysis is part of a wider research project targeting SEOs and Third Sector in different industries in the South of Italy and their ability to develop social innovation. This emerging field of research lacks an adequate theoretical basis, so we chose a qualitative method based on an inductive and interpretative research approach (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). We employed a comparative case study method to provide a structured approach through an in-depth study.

We considered cultural SEOs that have taken one or more sites of historical, cultural and archeological landscape interest and that:

1. manage the cultural sites (e.g. churches, catacombs, historical buildings, villages, marine protected areas, gardens, etc., publicly, privately, ecclesiastical or PPPs owned) previously in a state of neglect and decay, through activities of recovery, promotion and enhancement by the community;
2. guarantee public use;
3. have defined a sustainable business and organizational model, going beyond the only voluntarism.

Special attention has been given to topics such as community engagement, stakeholder participation, and maintaining external legitimacy, all within the



particularly resource-constrained area of cultural SEOs (Gundry et al., 2011a; Gundry et al., 2011b).

Table 1 provides a brief description of the fifteen cultural SEOs from which we gathered data from informants. The organizations were selected to represent different geographical locations within the South of Italy (Campania, Puglia, Basilicata, Sicilia Regions) and a range of different activities in the cultural domain. The cases include SEOs in urban and rural locations.

Table 1 - Main characteristics of selected cases

Cases	Founded in	Legal form	Life cycle phase	Business orientation	Start up capital
#1	2006	Social cooperative A)	Consolidation	Not for profit	Private grant
#2	2012	Foundation	Consolidation	Not for profit	Private grant
#3	2004	Association	Growing	Not for profit	Own capital
#4	2017	Social cooperative A)	Growing	Not for profit	Own capital
#5	1998	Association	Consolidation	Not for profit	Own capital
#6	2005	Foundation	Growing	Not for profit	Public capital
#7	2013	Foundation	Consolidation	Not for profit	Private capital
#8	2008	Social cooperative A)	Consolidatio	Not for profit	Public grant
#9	2010	Association	Consolidation	Not for profit	Own capital
#10	2012	Foundation	Growing	Not for profit	Own capital
#11	2005	Foundation	Consolidation	Not for profit	Own capital
#12	2012	Social cooperative A)	Growing	Not for profit	Private grant
#13	2003	Association	Consolidation	Not for profit	Private grant
#14	2013	Social cooperative	Growing	Not for profit	Public grant
#15	2010	Association	Consolidation	Not for profit	Own capital

Source: our elaboration

We believe that this is a valid way to show events surrounding the emergence of the businesses under scrutiny, their intended scope and the motivation of their founders. This approach of explicit comparison enabled us to go beyond the specificities of a single case in order to identify similarities, commonalities and differences through careful abstraction (Yin, 2003; 2014), providing a coherent and integrated framework to answer our research questions.

The cases were purposefully selected in virtue of being information rich, revelatory and unique (Stake, 1995). We recall that generalizations in qualitative comparison are of a theoretical rather than a numerical kind (Palmberger & Gingrich, 2014).

Drawing on the bricolage framework (Johannisson & Olaison 2007; Zahra et al., 2009; Mair et al., 2007)) we use their main identification criteria to inform our analysis and to select the cases, that are:

1. making do;
2. refusal to enact limitations;
3. improvisation;

and then with the further criteria supported by the construct of social bricolage and empirically identified by Di Domenico et al. (2010):

4. social value creation;
5. stakeholder participation;
6. persuasion.

To collect the cases, we proceeded in stages. First, we started with initial desk analysis to obtain an overview of the cultural SEOs in the Italian context. We mapped all the Italian cultural SEOs that meet the first three criteria above mentioned (p. 17) and then we focus on those located in the Regions of the Southern Italy. This first sample of SEOs was used to identify common behaviour patterns, similarities and differences in the stories, in the organizational and the decision-making processes.

Secondly, we examined the organizations focusing on their social outcome, using the four criteria explained above of the social business model and the processes of bricolage and social bricolage (pp. 19-20). This allowed us to identify organizations that both maximize profit and respond to the unmet social need for cultural fruition.

Thirdly, we selected fifteen suitable cases also based on their willingness to participate and to be involved in our research. Our aim in presenting our cases was to show how cultural SEOs situated within environments that are *de facto*

resource poor justifies an investigation of social entrepreneurial actions organized to counter these constraints and to produce social innovation. Moreover through our case study analysis we want suggest that the strategies of social bricolage enable SEOs to create, extend and strengthen social innovation. This can be traced in the adoption of specific innovative business models creating social and economic value.

### ***3.3 Data collection and procedures***

We analysed empirical material collected, to identify actual experiences in the SEOs in the cultural domain. Data collection used two main methods, all consistent with the theoretical framework:

1. document analysis;
2. semi-structured interviews.

Triangulation allowed us to ensure case studies validity. Normally, data collection methods are triangulated (many methods are combined), but in addition to this, investigators were also triangulated (Denzin, 1978). Issues emerged from the data rather than the data being fitted to predetermined categories. Fieldwork was carried out between January and June 2021.

### ***3.4 Document analysis***

To better contextualize raw data emerging from the field, the author not directly involved in the interviews collected and reviewed information from a series of supplementary sources including organizational charts and further structural elements (in particular, workforce breakdown), annual reports, partnerships, budgets, business plan, social responsibility statements, newsletters, internal communications shared by the organizations, emails, archival material, press review, websites and social networks.

### ***3.5 Semi-structured interviews***

We carried out in-depth interviews with informants from each social enterprise. The choice of the informants interviewed is in line with the qualitative narrative-style approach (Czarniawska, 2004), hence we focused on well-connected and informed respondents, to get an in-depth understanding of a specific and new phenomenon. The first interview at each organization was with either the

Founder, the President, the CEO or the senior manager, and this was followed by further interviews with other informants identified as important by the first interviewee, such as founding members. This approach gave us the access to multiple individuals from each SEO.

All interviews were conducted by two of the three authors which took responsibility for organizing them, through a skype call. In addition to the interviews, site visits and observations have been used to add depth to the case studies. Each interview lasted between 90 and 180 minutes and was carried out between May and June 2021. Interviews were based on an open, wide-ranging, protocol (Holloway, 2005), shared one week in advance, and were guided through a semi-structured questionnaire, including questions about the start-up initiative; social innovation projects, public and private partners and actors involved and partnerships activated; business model; recruitment and selection of staff, training and assessment processes; and impact on the local community, possible venture capitalist, donations, call for bids. The protocol aimed to stimulate interviewees' interest in this participative research process, which is crucial when collecting data in this way. At the end of each interview the authors met to listen and discuss what had emerged. Moreover, the authors compared notes and interviews' records with the internal documentations previously analysed. All the interviews were tape-recorded and later transcribed verbatim, and we have used extracts to build the narratives. Using this approach, we were able to focus on statements underlining the social dimension, the social innovation produced and then we linked issues and features emerged to the main elements of social innovation from the literature, the framework of social bricolage and social business model (Nicholls and Murdock, 2012; Hoogendoorn et al., 2010; Di Domenico et al. 2010). To respect the anonymity of our interviewees, their names and those of the SEOs have been allocated a code (as expressed in Table 1).

#### **4 Main results**

We present first insights from the empirical research to propose an integrated conceptual framework that combine the social dimensions that can be leveraged by cultural SEOs to create social innovation. Therefore, the relation between social bricolage dimensions and social business model criteria in cultural SEOs produces outcomes in which social innovation can be expressed.

Our study contributes to the academic debate in two distinctive ways.

First, we provide reflections on new business models in minor cultural heritage management that arise to overcome the inefficiency of traditional management models and respond to a social need.

Second, in examining the social components of using bricolage in social entrepreneurship, we shed light on a partly jagged topic and aimed to extend and enrich literature on the theme, capturing its ability to be a model that respond to the minor cultural heritage issue and produce social innovation.

Our research empirically fills the gap between social bricolage and social business model in cultural SEOs and offers a conceptualization of the social components that inform new business model in minor cultural heritage management and produce social innovation.

## **5 Discussion and conclusion**

The present research contributes to the stream of literature on social bricolage and social entrepreneurship. Our study extends the concept of social bricolage in two directions.

First, we explore bricolage phenomenon in a contextualized setting, focusing on SEOs located in Italy and embedded in the cultural field, specifically in minor cultural heritage.

Second, we broaden the existing conceptualization on social bricolage by using the social business model framework. A crucial tenet of our reasoning is that the minor cultural heritage consumption need is hard to meet through traditional business model, which are threatened by socio-economic crises and the related public spending cuts and the failure of traditional models public, private, philanthropic (Consiglio & Riitano, 2015).

This study aims to be a benchmark of the social innovation initiatives in the field of minor cultural heritage management. Furthermore, it will help cultural organizations to rethink their strategies according to skills development to respond to the challenges of social change. From a managerial point of view, the main implication of our work resides in the offering new directions for integrating existing business models by incorporating the "social" dimension.

At the end of this first stage of the research study we can already state that

Until recent years, the leitmotif in cultural domain was that if there already was a steady economic growth, then extra resources could be invested in the management of cultural heritage. In other words, culture was regarded as

something subsidiary in the Italian economy. Nowadays culture management is a powerful engine of change for the regeneration of social environments and plays a crucial role in activating economic processes capable of positively impacting on communities (culture that changes the context). Moreover as a result of social context and economic changes occurring, culture is often itself an object of change (culture that changes itself).

The analysis and the comparison of our cases revealed that the investment in the management of cultural heritage has social returns that strongly contribute to the economic growth of our country and to the production of work.

The SEOs adopting innovative social business models represent an important prerequisite for the development of areas such as those of Southern Italy, which although not belonging to BOP or developing markets, offer important implications from a social point of view. Cultural SEOs in the South of Italy are activator of innovative social and organisational responses, which leverage proximity to communities and territories. Although our cases still are limited and circumscribed and reasoning in an overall approach, they emerge as powerful examples of widespread social entrepreneurship with a significant public function, that generate social innovation.

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## **Towards Smart City Challenge: an Observed Case**

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### **Abstract**

Since late twentieth century, the concept of smart city has been a central topic in public and academic debate. The smart city term is commonly used by local administrators and policy maker to promote and to prepare the cities for the future challenges. There are recent definitions of smart city but is very difficult to define the characteristics that describe how to become a smart city and how a local administration is committed to achieving this goal.

Using a project team with multidisciplinary skills is a popular tool in all types of organizations to respond to complex challenges. In this perspective, the project team can represent a tool for involving people and stakeholders in the Smart cities process.

One way of clarifying a team management structure is to consider the work which needs to be done to manage members. Although the details vary between professions and according to the level of gender, age, seniority, competence, knowledge of the members, in principle someone has to be responsible for the management tasks. Descriptions of

different team management are useful for research purposes, but also help teams and their managers to clarify their structure and the options open to them to make improvements. The aim study is to provide a better understanding of the nature of multidisciplinary project teams, out to investigate the important features of a particular multidisciplinary team and understanding how is led and how its member is managed. Infact, multidisciplinary team' is a term used to describe a variety of different interprofessional working arrangements.

A single case study design was used. The study design is qualitative based on participant observation, in depth interviews, and questionnaires. Data were collected by participant observation and semi structured interviews over a period of 6 months on a multidisciplinary team on smart city project of Catanzaro city. The team was observed through action research.

The results of this study describe the implementation process of a smart city project and characteristics of teamwork project. In particular, extensive reflections are employed on the concepts of orientation, leadership and team coordination as well as the skills employed and knowledge management.

The results offer practical indications to policy makers and local administrators on the development of a smart city project through the analysis and use of multidisciplinary teams.

The framework suggests directions and agendas for smart city research and outlines practical implications for government professionals.

**Keywords** - Smart City Project, Italy, Knowledge Management, Participant Observation, Multidisciplinary Project TEAM

**Paper Type** - Practical Paper

## 1 Introduction

During twentieth century, the concept of smart city has been a central topic in academic and policy making debate. Smart city as term is usually used by local administrators and policy maker to introduce and promote future challenges in the cities. In academic debate, there are recent and various definitions of smart city; but is very difficult to define the characteristics that describe how to become a smart city and how a local administration is committed to achieving this aim. A very popular tool – for achieved this aim – is a project team with multidisciplinary. Multidisciplinary team is a term used to describe a variety of different interprofessional working arrangements. Under this perspective, the project team represent a tool for involving people and stakeholders in the Smart cities process.

One way of clarifying a team management structure is to consider the work which needs to be done to manage members. Although the details vary between

professions and according to the level of gender, age, seniority, competence, knowledge of the members, in principle someone has to be responsible for the management tasks. Descriptions of different team management are useful for research purposes, but also help teams and their managers to clarify their structure and the options open to them to make improvements. The aim study is to offer a better understanding on the nature of multidisciplinary project teams, out to investigate the important features of a particular multidisciplinary team and understanding how is led and how its member is managed.

## 2 Theoretical Framework

In last years, information, knowledge and digital technologies have been recognized as key drivers for the development of cities. In this context, smart city projects represent a new challenge of urban development. In effect, the flows of information and digital knowledge are the basis of a continuous improvement in the functioning of urban environments but are also used to tackle problems related to sustainable development (Komminos and Mora, 2018).

Smart city projects were originally used to support participation and social cohesion through the application of ICT (Anthopoulos and Fitsilis, 2015). Only later did the smart city take on a broader perspective, in fact it was not born only to create business opportunities in urban spaces, but also to install technical devices and sensors throughout the city to be incorporated into everyday objects and activities (Andročec, Novak and Oreški, 2018). Various smart city concepts have been developed, some of which, considered significant for the purposes of this work, are shown in the following table.

Table 1: definition smart city

AUTHORS	DEFINITION
Belissent et al., 2010	Forrester defines the smart city as [...] a «city» that uses information and communications technologies to make the critical infrastructure components and services of a city – administration, education, healthcare, public safety, real estate, transportation, and utilities – more aware, interactive, and efficient
Caragliu et al., 2011	The concept of the «smart city» has recently been introduced as a strategic device to encompass modern urban production factors in a common framework and, in particular, to highlight the importance of Information and Communication Technologies (ICTs) in the last 20 years for enhancing the competitive profile of a city

Schaffers et al., 2012	The smart city concept is multi-dimensional. It is a future scenario (what to achieve), even more it is an urban development strategy (how to achieve it). It focuses on how (internet-related) technologies enhance the lives of citizens [...] The smart city is about how people are empowered, through using technology, for contributing to urban change and realising their ambitions. The smart city provides the conditions and resources for change. In this sense, the smart city is an urban laboratory, an urban innovation ecosystem, a living lab, an agent of change
Yin et al., 2015	Smart cities emphasize the integration and connection of the physical, ICT, social, and business infrastructure in a city
Sepasgozar et al 2018	a smart city can be characterized as a complex ecosystem that stresses the application of ICT to make cities a more attractive and a unique place for innovation and entrepreneurship

Source: our elaboration

An improvement in the level of the quality of life is a fundamental part for the main actors in cities, people. (Niu, Dong, Niu and Deng, 2017). Furthermore, smart cities can become sustainable cities with a citizen-centered focus, which could play a critical part within the same project (Albino, Berardi and Dangelico, 2015). The existing literature notes that the smart city not only includes the application of ICT but also has the ability to integrate people, information and technology in building an efficient, sustainable and resilient infrastructure that provides high quality services and promotes the quality of life.

The implementation of smart city projects undoubtedly brings advantages, first of all a higher quality of life followed by an efficient use of resources. (Ismagilova et al., 2019). From all this it follows those higher levels of technology help the city to become more competitive than others (Juan, Wang, Wang, Leckie and Li, 2011). The implementation of a smart city implies a radical innovation that allows the development of a new technological sector in the urban economy and new forms of specialization (Malecki, 2014).

## **2.1 Multidisciplinary Project Teams**

Competitiveness and globalization have led organizations to face increasingly dynamic environments in which survival requires the adoption of flexible measures and structures.

In accord with Hoegl & Parboteeah, (2006) project teams are seen as a resource to respond to these challenges. According to Chiocchio et al (2009),

project management involves pooling and leveling human resources over time, space and organizational boundaries, in order to reduce downtime and thus promote the sharing of skills and the transfer of knowledge often through the use of information technology. Project teams are used in many industries ranging from manufacturing to information systems to research and development (Kloppenborg & Opfer, 2002). According to Kloppenborg & Opfer (2002) project teams also serve to manage change within organizations. The study of Chiocchio, et al (2009), underline that the development of individual and group skills are key factors in promoting the success of the project. The effectiveness of the project depends on the solidity and synergy between the members, in fact the project teams must show cohesion (Hoffman et al, 2002).

To be able to respond to the challenges of the new global market, organizations must be not only technologically enabled, but above all "intelligent" in their ability to enter into collaborations with other partner organizations and share different professional and cultural knowledge. The main building blocks of such organizations are precisely the multidisciplinary teams that work from different places and the team members belong to different organizations.

The study of Cuevas et al (2012) multidisciplinary project teams offer multiple perspectives and a wide range of skills to generate unique and creative solutions for solving various challenges. According to Ratcheva (2009) a multidisciplinary team has the ability to successfully execute a project, this is positively associated with the team's ability of relevant knowledge, skills and abilities that could be distributed among the various team members. Multidisciplinary teams represent new tool of information exchange and relationships. Fong (2003) points out that project team members must constantly absorb new technologies and techniques to remain competitive.

The success of an organization will increasingly depend on teamwork rather than individual excellence; working groups that are made up of individuals with different abilities, personalities, priorities. Collaborating and managing multidisciplinary groups becomes important for the enrichment of business processes.

According to Liston et al (2003) by their nature, project teams unite participants from many and varied disciplines using specific information formats, analysis and visualization tools for their specific work.

Knowing how to work in multidisciplinary teams is a skill to be constantly learned, cultivated and implemented.



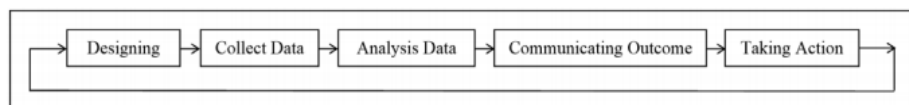
It is a challenge to combine discipline-specific sets of information and representations to support multidisciplinary access, interaction and decision making. The decision-making process of the project teams is multidisciplinary and must take into consideration heterogeneous information sets.

### 3 Method

This study is based on an observed case. The methodological process developed is based on a qualitative approach, according to the methods and instructions suggested by Yin (2009). The data was collected through participatory observation and semi-structured interviews for a period of 6 months on a multidisciplinary team on the smart city project of the city of Catanzaro.

The team was observed through action research. This research approach is particularly suitable for analysing complex real-life events and helps to understand the meaning of people's experiences (Palmberg, 2010).

The documents considered were open access concerning the introduction of the "Smart City" Plan in Catanzaro. Hence, the authors developed a smart urban development planning framework using an action research approach. This paper presents this methodology and discusses the action research process used. Action research will interest professionals and academics. This document reports the lessons learned during the preparation and planning of the Smart City Catanzaro Plan published in 2020/2021. The results and the methodology presented are of great relevance. Action research included design, data collection, data analysis, reporting of results and action steps.



*Figure 1: Action research study framework.  
Source: our elaboration*

The case presented in this article concerns the development and implementation of a Smart City Plan. The main reasons why we have selected this case are the complexity of the project, the multidisciplinary nature of the project team and the number of stakeholders involved.

We have adopted a five-step cyclical process, which can be described as an ideal example of the original action research formulation (Susman and Evered,

1978) for the development of a Smart City Plan. In the analysis and action-taking phase, the researchers collaborated to actively intervene with stakeholders. The five phases of action research included design, data collection, data analysis, communication of results and action phases. During the first two phases functional operational problems were verified in traffic and designed for network services from ICT (Information and Communication Technology) and IoT technologies for the collection of big traffic data. In the third phase, stakeholders can use basic statistics or additional deep learning methods to solve traffic planning, order and road safety problems. In the fourth and fifth phase, the roles and benefits of the stakeholders participating in the service models were assessed and the problems and knowledge of the entire application process from a technological, economic, social and legal point of view were respectively derived and summarized. From an action research approach, AIoT-based intelligent traffic solutions have been developed and verified that allow the MOTC (Ministry of Transport and Communications) and interested parties to acquire large traffic data to optimize traffic conditions in the application of technology. With its implementation, it will finally be able to take a step towards the vision of the smart city. Derivative service models could provide more advanced traffic services to stakeholders, drivers and citizens and improve political work more efficiently and effectively.

#### **4 The Case Study Analysis**

The results of this study describe the project of change from a traditional city to smart city. Smart cities are the requirements of today's world. In particular, the results of this study observed the implementation of a multi-disciplinary teamwork project.

The observed case study is the project of Catanzaro city. The city of Catanzaro is one of the 100 Intelligent Cities Challenge (ICC) will unite EU cities in seizing the opportunity for green smart sustainable growth, improving the quality of life and fostering new opportunities for citizens. 100 cities will gain expert consultant support on the ground, facilitated sessions at several high-profile multi-city events, and a suite of online tools. In addition, they will benefit from the steering of cutting-edge mentor cities who help small groups of participant cities scale solutions together. The multidisciplinary project team is composed of n°1 General Manager City of Catanzaro propose the project; n°3 private consultants and n°1

project manager who are responsible for promoting the culture of interconnection between citizens, businesses and the public administration, the goal being the first approach to the smart city.

Table 2 - Smart city Team Staff

NUMBER OF PERSONNEL	
Project manager	1
General Manager Municipality	1
professionals	2

*Source: our elaboration*

The partners (strategic stakeholders) of the project include: the university; the order of the architects of the city; the trade associations that supported the team in the design and development phase of the project.

The City of Catanzaro have untapped potential, clear aspirations and strong commitment to grow. Cities will be supported to become an intelligent city of the future, today. Through the use of digital and advanced technology, this city will transform this performance, providing a higher quality of life for citizens and improving the competitive environment of businesses.

Smart City team of Catanzaro participated in a series of high-level events where they receive training as a group, learn from peers, and plan together for large-scale change. Along the way, world-class EU and international cities will inspire and orchestrate change. Finally, cities will get exposure to state-of-the-art intelligent city solutions, engage with impactful digital tools facilitating citizen and stakeholder engagement, and on-demand access to a variety of downloadable material.

The team project aims to prepare cities for a transformation, support them through that journey, and grow a community that is larger than the sum of its parts:

1. Phase: Find out **where a city is, where it should go** and who should be involved to get there. Un aspetto importante gestito dal team è stata la regolamentazione della gestione di una Smart City, attraverso l'analisi del contesto urbano con un audit mirato all'analisi di indicatori, in grado di parametrare il livello di inter-connettività, dal quale poi si

sviluppa il progetto dell'infrastruttura o la sua implementazione, dopodiché, misurando l'appeal commerciale e le necessità pubbliche, si è predisposta la proposta. Le giornate dedicate all'ascolto degli stakeholders è avvenuto in più focus Group. L'obiettivo on how to motivate an ecosystem, define a strategy and set a measurable action plan.

2. Phase: Develop a concrete plan to achieve improvements, collaborating with the community, push action with immediate benefits
3. Phase: Get "big moves" **done** and **see results**
4. Phase: Measure success, and commit to **keep connections and improvements going**.

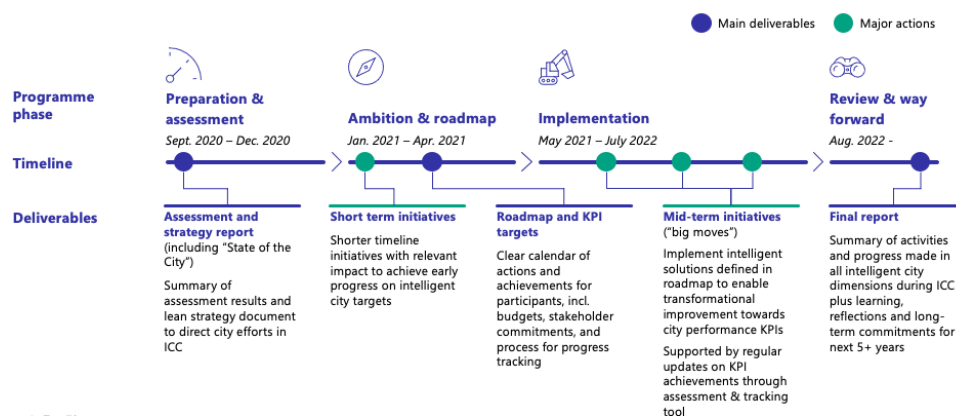


Figure : the programme phase

So, in this moment the City of Catanzaro is situated in the first phase "**Preparation & assessment**". The team chosed a path thematic track and begin the assessment process, drawing on tools including citizen engagement. First, developed an understanding of city needs and possible solutions at a need's assessment workshop. Secondly, understood your maturity of solutions and how your city can grow at the solution assessment and strategy workshop. In parallel, assembled and energise the city's ecosystem with a stakeholder workshop, whit a local launch

## 5 Consideration

This study is a work in progress. In effect the findings of this study are preliminary findings. The aim of this work in progress is not only to provide a ample theoretical framework on this topic, but also to support local governments and public administrations in the effective implementation of smart cities, capable of creating public value and well-being for citizens and environmental sustainability in the urban space.

The ICC is part of a wider EU support contributing to a European Green Deal, an economy that works for people and a Europe fit for the Digital Age. This leads to incorporation of project management in the development of smart cities. This development requires skills and expertise leading to need of project teams. These project team brings lot of challenges with respect to their effective operations. The 2021 is an exciting year for the ICC, starting with the finalization of the preparation & assessment phase and the 2nd city lab and followed by the Ambition & Roadmap phase during the Spring\Summer before we enter the implementation phase.

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## Covid-19: Knowledge Workers in Slippers

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### Abstract

Knowledge workers are often emphatically introduced in the literature as nearly omniscient super workers. Consequently, it can be reasonably expected that these special employees are particularly agile and adapt very well to unusual circumstances. Let us now consider a context where an organizational design known as Holacracy, a framework where hierarchy is downplayed, where self-organizing team are entitled with authority and decision-making, is developed to support knowledge workers in their endeavours. The outcome of such a combination should be exceptional and coping successfully with exceptional working circumstance such as 'forced to be working from home' should not be much of a challenge. Unfortunately, the reality shows otherwise. The current pandemic-induced situation has created an unprecedented context for studying knowledge workers' behaviour under unusual working circumstances. To better understand the true nature of this knowledge worker and the limits of working-from-home, an empirical qualitative study encapsulating 7 semi-directed interviewed is conducted. The knowledge workers interviewed are part of a large telco and information technology company based in the Netherlands. The results show a contrasted reality; some of the very features that constitutes a knowledge worker and her or his work (autonomy and independence; proactivity; knowledgeable, skilled, and doing meaningful work; importance of teamwork; efficiency gains; self-confidence) are confirmed. Simultaneously, other unusual aspects emerged (better efficiency in office context; decrease in engagement and motivation, poorer quality of communication and relationships with peers; lack of work structure; health issues; unsustainable workload; ergonomic and organizational structure issues). The originality of this paper resides in the fact that most of existing studies about flexible working are about voluntary remote working while this paper investigates a compulsory remote working that not all workers are happy with. The results of this study may benefit practitioners and firms that are considering developing working-from-home, partially or totally in designing their flexible and remote working strategy.

**Keywords** – Knowledge worker; Working-from-anywhere; Holacracy; Covid-19.

**Paper type** – Academic Research Paper



## 1 Introduction

The different lockdowns and curfews implemented in different European countries in 2020 and 2021 to limit the spread of the Covid-19, has dramatically impacted the way work is performed in organizations. This new configuration where employees and employers are required to work from home, is calling for revisiting some of the theories developed about the knowledge worker, his inclination for working independently while being engaged and motivated by his work. Knowledge workers are generally characterized as bright intellectuals, men of skill, knowledge, and judgment (Drucker, 1959). This category of workers single itself out of the traditional worker by the nature of its activity (knowledge work) and her or his employment relationship (Adler, 2007). While this group may appear marginal, Drucker (1992: 89) acknowledged that *"the ruling group will be knowledge workers, knowledge executives, knowledge professionals, and knowledge entrepreneurs who have the insight to allocate knowledge to productive use the way the "capitalists" knew how to allocate capital to productive use"*. More recently, Clemons and Kroth (2010) suggested that knowledge workers are viewed as 'nomadic workers' literally able to work from anywhere and anytime. Subsequent to the pandemic-induced socio-economic and institutional context, it can be reasonably expected that more workers join this dynamic 'road-warrior' group.

While the literature on flexible work design (Koroma *et al.*, 2014, Ojala and Pyöriä, 2015 ), its relationship with employee well-being (Hoeven ter and Zoonen, 2015) or mobility of knowledge workers (Migueluez, 2019, Ojala and Pyöriä, 2018), is established, the literature concerning how knowledge workers cope with a forced work from home (WFH) situation is yet to be developed. This paper undertakes to investigate this problem and presents a study of an 'ideal' knowledge worker for which an organization designed a structure supposed to strengthen their natural characteristics: a holacracy. This paper seeks to empirically understand how the knowledge worker, for whom an ad hoc organizational structure is designed in the form of a holacracy, is performing while forced to work from home.

In the following section, a theoretical framework encapsulating a discussion on the themes of knowledge workers and work, working from home, and holacracy, is introduced. After a short methodology, the results of the qualitative study are presented before the paper closes on a conclusion-discussion section.

## **2 Theoretical framework**

### **2.1 Knowledge workers and knowledge work**

Characterizing what knowledge workers are in literature has revealed challenging as no real consensus has been achieved to date (Pyöriä, 2005, Crowley-Henri, 2008). At best, this category of workers is approached from different perspectives, namely with a combination of intrinsic characteristics, original working habits and the environment within which they are supposed to thrive (Khadir-Poggi and Keating, 2013, Mládková *et al.*, 2015). Indeed, Peter Drucker singled out this worker form 'traditional' ones and highlighted her or his intrinsic qualities, locus of activity, and high level of commitment (Schermerhorn, 2012). He described these workers as bright intellectuals, men of skill, knowledge, and judgment. The nature of their professional activity and their employment relationship present also unique characteristics (Donnelly, 2009, Wang and Ahmed, 2003).

Knowledge workers are viewed as knowledge-seeking individuals (Drucker, 1993, Swart, 2007, Reinhardt *et al.*, 2011) that, unlike 'traditional' workers who seek long-life employment, prioritize employability and life-long learning. In other words, they are continuous learners and continuous innovators (Drucker, 1999, Despres and Hiltrop, 1995). They built their capabilities on their work experience, accumulated know-how and proven mastery. Knowledge workers have problem-solving skills which they can apply through research, product design or fabrication and problem-identification skills which they use in marketing, advertising and customer consulting (Swart, 2007).

Where a 'traditional' worker's locus of work is firm-centric, KWs socialize, associate with professions, networks and peers that are not necessarily company-specific and may be outside the boundary of the company. They tend to develop their own social environment and own professional networks and build their own market niche to express their unique set of expertise (Reich, 2002, Wang and Ahmed, 2003). Although knowledge workers personal network evades the constraint of purely inter-organizational connections (Sedita, 2008), firms can definitively benefit from the opportunities these multiple networks can provide.

They are dispersed across organizational structures and around the globe but often linked through the Internet (Davenport, 2005, Defillippi *et al.*, 2006). Thus, knowledge workers play a central role in steering organizational learning efforts.

In addition, the pervasiveness of the use of mobile devices in the working place stimulates continuous exploratory learning behavior and promotes the development of new skills and capabilities that enables adaptation to new contexts (Reyt and Wiesenfeld, 2015).

Knowledge workers are mentally and emotionally committed to the job performed in an organization and highly involved in their professional tasks (Benson and Brown, 2007, Ipsen and Jensen, 2010, Joo and Lim, 2009), although empirical research on their motivation is rare (Mládková *et al.*, 2015). They need substantial autonomy to pursue initiatives and to extend their intellect (Snell *et al.*, 2001, Koslowsky *et al.*, 2012) and are attracted by challenging tasks which requires considerable creativity and initiatives (Alvesson, 2000). In line with the requirements of the post-industrial society, knowledge workers are generally considered as mobile and dynamic or 'nomadic workers' who can work anywhere and anytime (Clemons and Kroth, 2010). This trend is being reinforced by the pervasiveness of new forms of information and communication technologies such as smartphones and tablets (Eurofound, 2016, Popma, 2013). Surprisingly however, this trend did not confirm as expected with changes being in fact more gradual (Vilhelmson and Thulin, 2016) with the working in an office 8 am to 5 pm pattern remains strong (Glorieux *et al.*, 2009, Ojala and Pyöriä, 2015 ).

Going a step further, scholars pointed that knowledge workers' work is usually under-designed and making sense of the latter is considered as part of the job (Alvesson, 2001, Hatchuel, 2002). Drawing on Manz (1986), the notion of self-leadership is put forward to explain how a worker use advanced metacognitive skills to bridge his or her under-designed work. Provided that this work is non-routine and complex by nature (Davenport, 2005), a substantial controlled attentional effort is necessary (Müller and Niessen, 2018), effort seen by Vohs *et al.* (2018) as a depletable resource.

While autonomy is identified with freedom at work (Bäcklander *et al.*, 2018), several scholars highlighted how knowledge workers actually create their own predicament and willingly lock themselves in an exploitation situation (e.g., long working hours) in exchange with the very freedom they seek, situation referred to as 'autonomy paradox' (Ipsen and Jensen, 2010, Muhr *et al.*, 2012, Pérez-Zapata *et al.*, 2016). Somehow, the opportunity to work 'anywhere/anytime' transformed in working 'everywhere/all the time' (Lupu and Empson, 2015, Mazmanian *et al.*, 2013), resulting always in knowledge workers working more (Bäcklander *et al.*, 2018).

## **2.2 Working from home (WFH)**

The context created by the Covid-19 pandemic put to the foreground the 'not working from the office' alleged opportunity for workers. The two concepts that are introduced to represent this trend are WFH and, more recently 'working from anywhere' (WFA) formulated in the second half of 2020 (Choudhury, 2020). Some scholars introduced a quite positive view on WHF. Barrero *et al.* (2021) identified five reasons for which they argue that WFH is a new organizational trend that is here to stay: (i) surprisingly positive WFH experiences; (ii) pandemic-induced investments in physical and human capital supporting WFH; (iii) diminishing stigma associated with WFH; (iv) continued concerns about mingling and proximity with others; (v) pandemic-induced technological innovations improving WFH. Considering this possible ineluctable trend, employers can reasonably fear losses in productivity as workers may be less engaged in their tasks. Contrasting with this apprehension, drawing on an experiment, Bloom Bloom *et al.* (2015) found out that WFH can be associated with higher productivity, improved work satisfaction and less turnover. However, the same authors found out that the perspectives of promotion for these workers, stalled.

Contrasting with this positive view of WFH and the expectations about its widespread adoption in the future, other scholars are less enthusiastic. They found out that, despite having access to mobile technology that facilitates WFH, knowledge workers still tend to favor working in office (Ojala and Pyöriä, 2018). Moreover, while mobile technologies empower knowledge workers (Popma, 2013), it also introduced work in their private spaces and their families to the workspace, creating a struggle for these workers who cannot manage both work and non-work activities. These same authors pointed out that the work domain tends to prevail on the non-work one (Field and Chan, 2018).

## **2.3 Holacracy**

An ad hoc organizational structure facilitating this knowledge workers' work lies in the holarchy of self-organizing teams as opposed to the traditional organizational hierarchy. Holacracy is defined as "*a real-world-tested social technology for agile and purposeful organization. It radically changes how an organization is structured, how decisions are made, and how power is distributed*" (HolacracyOne). This form of organizational structure is designed to overcome the

traditional hierarchical organization and implement a decentralized system (Groth, 2018).

This holarchy of circles is not a set structure but evolves over time to embrace changes. On the people level, this organizational form places an emphasis on the role instead of job titles that are often status-related and not necessarily exactly representative of the work an individual performs in a firm (Kamp de, 2014). Holacracy is viewed as a relatively new trend expected to meet the agility requirement of software companies (Bhandari and Colomo-Palacios, 2019). Considering a working environment characterized by both organizational agility and self-managing systems such as Holacracy, knowledge workers should fit naturally and embrace the potential promised by their intrinsic nature. Indeed, these workers are known to appreciate autonomy in the way they work, independence in making decisions, and a creative working space among other things. Self-managing structures should also stimulate their motivation and engagement at work. The current Covid-19 pandemic has pushed further the dematerialization of a conventional working environment making 'working-from-home' (WFH) or 'working-from-anywhere' (WFA) a reinforcing dimension featuring a supposedly better working environment for knowledge workers.

### **3 Methodology**

Motivated by an endeavor to understand the complex situation within which knowledge workers are evolving since the beginning of the Covid pandemic, a qualitative approach is better suited (Creswell, 2009). The data collection instrument is the semi-directed interview, and a content analysis approach is used to analyze the data. The interview guide was designed with a combination of themes emerging from the literature review and the research objectives. The questions concerned autonomy at work, working from home pros and cons, work-life balance and boundaries issues, health and workload issues, overall feelings, teamwork, appreciation from peers, and alignment between company goals and knowledge workers ones.

Within this undergoing research, the focus is put on the technical team of a large telecommunication and IT company based in The Netherlands. The interviewees occupy different positions at different hierarchical levels (Migueluez, 2019), (e.g., two software architects referred to as conceptualists in a holacracy language-, a team leader designer, a software developer – referred to as

specialist-, two team leaders in 'development' and a major leader) and are all between 30 and 40 years old except for one who is over 40. Except for one, all interviewees were engaged in marital relationships. Two of them had no child while the rest of the sample had between 2 and 3 children. Finally, the persons interviewed were working in the company since at least 3 years except for one. The audio-recorded semi-structured interviews lasted between 30 and 60 minutes.

#### 4 Results

Subsequent to a content analysis where the priority is given to theme emergence, the final coding stage delivered two major categories mentioned hereafter in a decreasing code frequency: working from home issues and limitations and knowledge worker/work or working from home benefits. Table 1 delineates the different sub-themes attached to the main categories; these are respectively developed in the following paragraphs.

Table 1. Content analysis results

Categories	Sub-themes
Working from home issues and limitations	<ul style="list-style-type: none"> <li>• Better efficiency with in-office work (38)</li> <li>• Communication and relationships with peers (35)</li> <li>• Engagement and motivation down (27)</li> <li>• Lack of work structure/rhythm (17)</li> <li>• Health issues (11)</li> <li>• Unsustainable workload (8)</li> <li>• Ergonomic issues (7)</li> <li>• Organizational structure issue (7)</li> </ul>
Knowledge workers / work – Working from home benefits	<ul style="list-style-type: none"> <li>• Autonomy at work and at home (34)</li> <li>• Knowledgeable, skilled, and doing meaningful and creative work (30)</li> <li>• Proactivity (26)</li> <li>• Teamwork (19)</li> <li>• Efficiency gains (16)</li> <li>• Self-confidence (10)</li> </ul>

## **4.1 Working from home issues**

### **4.1.1 Better efficiency with in-office work**

Interviewees found that working in the office is more efficient than remote working. For example, in some instances the same information has to be repeated/explained differently to different employees because of disorganization problem: *"So it's like two, three, four hours of my time. With these different audiences and then still when it came to naming the product..."* (Conceptualist). Results also show that employees are more productive and creative in the office through *"true interaction and true cooperation"* (Team Leader). Spontaneity is introduced as important for creativity. Finally, some of the interviewees noted that WFH was characterized by an altered perception on emergencies with workers realizing when deadlines are reached, the work to be delivered.

Frustration was voiced over the sequential nature of collaboration and work with peers while using digital tools: *"You have to wait until that person is available or you send them a message and you will get something back, but you don't get that kind of dynamic"* (Conceptualist). The whole process of working with a team became much more formal since communication became digital. All communication must be more specific and detailed, function filled by the context when working in office. Spontaneity and efficiency are also hampered as due to technical restrictions, only one person at a time can speak during online meetings: *"I think in my experience, I have better focus when I'm at the whiteboard in office. If I'm on my laptop and have to use application, I have to figure out different tools. (...) And that's distracting. And also, it basically limits you of what you can draw. And with a whiteboard, it's a completely free"* (Conceptualist).

### **4.1.2 Limited communication and relationships with peers**

One of the most important issue that is raised by interviewees is that distance communication limits the transfer of knowledge at two levels. First, the work-related informal communication that rhythms an office day and that contains marginal but precious content, is not available anymore. Working and meeting online creates an absence of context leading knowledge losses and frustration for the employees. More specifically the latter creates a feeling of eviction that is counter-productive among knowledge workers: *"So unless you're in the 'need to know' category, then you don't get to know, basically. Sometimes that info is kind of, can even hurt you. So instead of it being more dispersed, it's more channeled. It's*

*the same with a lot of your colleagues if you don't actively work with them."* (Conceptualist). Additionally, while WFH within a Covid restricted environment, organizational culture is also negatively impacted, particularly for a firm which activity spans over several country as this is the case for the one investigated: *"Do you remember what our values are? It's difficult to build a company culture remotely, like this"* (Major Leader). Overall, people feel less appreciated if they have less social contact. Basically, they seem to miss feedback that would normally come via coffee-machine conversations.

The second dimension that is impacting the transfer of knowledge in this organization, and always related to a missing context or rather an unusual context, is the invisible cement that mundane or non-work-related conversations, create. These moments are referred to as 'coffee-machine' talks, and these are: *"difficult to feel through digital means. (...). I just sense that it's an entire layer of informal communication that is now gone."* (Conceptualist). Employees do miss these times of informal moments as it has a social significance: *"I do miss it. Just a chat, even with a restaurant lady. It's not meaningful to work, but it's meaningful socially. Sometimes you discuss work stuff related at the coffee machine, but usually it's more "how are you are you, are you feeling well?"* (Team Leader). This situation has two negative impacts: (i) team building which represents an important dimension in this company; (ii) people feel less appreciated if they have less social contact. Basically, they seem to miss feedback that would normally come via coffee-machine conversations.

#### *4.1.3 Engagement and motivation down*

More than half of the interviewees felt demotivated and experienced a decrease of their engagement at work. This situation is partly due to a mismatch between company's vision and the ones from the employees as this was signaled on several occasions. A lack of management support has also been underscored. Despite their independence at work, their drive and initiative, the employees expect more leadership from their managers: *"But when it comes down to getting clear projects and definitions coming from the upper circle, I think it's very lacking"* (Team Leader). Finally, a couple of employees shared their fear over not be trusted when WFH and compensated this feeling by sending more emails.



#### 4.1.4 Lack of work structure/rhythm

Interviewees acknowledged that a day at the office had an important structuring power that they struggle to replicate at home. Having a distinct location for work and another one for private life had the effect to set a very clear boundary between private life and office work. When WFH, respecting the boundaries is more challenging. In addition, several employees regretted the absence of commuting as it allowed them to clear their minds: *"Before covid, you were forced to travel somewhere. So. If it takes your mind off things and when your mind is just a bit blank it usually comes up with stuff"* (Team Leader). Basically, it is difficult for these employees to stop thinking about work once they passed the door back home. Commuting time had a switching function. Some would use this time to reflect on the working day and structure their thoughts, others would listen to the music. By the time these employees arrive home, they were 'ready' for private life.

#### 4.1.5 Health issues

The two health issues that were reported by the interviewees while WFH are weight gains and mental struggles. Indeed, employees reckoned that they were moving less and tended to eat junk food. Other mentioned their struggle with isolation: *"I was a little bit fatigued in the winter. Yeah. And I do think that my mental health went down because of the isolation"* (Team Leader). Some interviewees also mentioned increased screen time, but not necessarily related to work. More digital leisure was responsible for this latter increase.

#### 4.1.6 Unsustainable workload

Several interviewees underscored that the workload increased since forced WFH. A substantial amount of time must be spent in planning events. Efforts involved in synchronizing with few people for these events were presented as daunting. This energy and time drag also comes from the substantial increase in the number of meetings (for which employees must synchronize) experienced since the beginning of this situation: *"Well, you just have so many meeting blocks all the time, I have at least four or six hours of meetings, daily, however, that's chopped up"* (Conceptualist).

#### *4.1.7 Home and ergonomic issues*

Most of the interviewees (5 out of 7) mentioned that they invested or reorganized their homes to improve their work: "So as soon as I did that, I could be just as effective at home as I am at work in terms of productivity. So, yeah, that was the first thing I did. I make sure that I have three screens and the same mouse and keyboard because I'm used to it and efficient that way" (Team Leader).

#### *4.1.8 Structural issue*

Finally, the remote working situation highlighted the existence of silos keeping department and people at a distance from each other and preventing productive work.

### **4.2 Knowledge workers / work – WFH advantages**

The category of knowledge worker and knowledge work can be viewed as positive dimension of WFH in a sense where these employees characteristics and the work they operate.

#### *4.2.1 Autonomy at work and at home*

Autonomy is an important issue for knowledge workers: *"What worked for me at least, is that I'm autonomous, so I do like that I can have some freedom"* (Conceptualist). The interviews showed that they considered themselves as very autonomous in their work, deciding about their working schedule at home (*"OK, so last year I just suddenly changed my office hours from 7:00 in the morning to 4:00 in the afternoon, or even 3:30 in the afternoon. And I decided to go swimming after I was finished working. Do I feel free? Well, I've seen people working from India, from Italy, and I was thinking, if I want to go on holiday in December, then probably I need to work one day from wherever (...)"* (Team Leader), the way they work and where they work from. Some have even already planned to work remotely in the future referring to this situation as *"mentality of freedom with responsibility"* (Team leader). This autonomy so dear to knowledge workers is also central to WFH work-private life balance management. This argument came quite strongly in the interviews. Many of these workers learned to put boundaries up between work and private life, mainly lower-level workers. Management kept a boundaryless interface, mixing both work and private life.

#### 4.2.2 Knowledgeable, skilled, and doing meaningful and creative work

Some interviewees described how they proceed with their work and how understanding every aspect of it is important. They are conscious of the weight of the learning curve and how this helps them solve complex problems. Moreover, in their answers, the interviewees highlighted their sensitivity to peers' appreciation, feeling that is less evident as they had to work from home. They also mentioned that doing a meaningful work was part of their *raison d'être*: *"For me, it's meaningful. So, for me, it's important that the work that I do is being used and is being valued, and I know that the things that are being built are being deployed at some point and are being used. So, for me, that's meaningful. So, I'm not developing something that will end up on the shelf and not being used"* (Conceptualist).

#### 4.2.3 Proactivity

Being proactive encapsulates both the strong drive of interviewees to adapt to new situations and the positive attitude they display within challenging circumstances. Thus, WFH is not an issue anymore: *"I think the location doesn't change my motivation. It's more of a challenge I'm working on. And am I working here, I'm now downstairs in the lounge, or in the garden or at the balcony, it doesn't matter. It's more what I'm working towards to, that's more important to me."* (Team Leader). In line with this attitude, interviewees acknowledged that they did not experience any increase in their workloads nor engagement while WFH.

#### 4.2.4 Teamwork

The interviewees were all enthusiastic about working in teams and the support they were getting from peers: *"I think the people I work with are highly supportive. When I want to ask something of them, they will do it. So, it's when I need help and I ask for their help with something, they will be there. So, there's no question, they're not like putting me back on their queue or something like that. They will just do it. So that's quite nice to have"* (Team Leader). The integration with the team is very strong as employees feel safe enough to process their emotional reactions in slack channel: *"(...) so I keep myself sane a bit by a bit. Sure. So, I share the high, so I also share the lows"* (Team Leader).

#### 4.2.5 Efficiency gains while WFH

Interestingly, the interviewees explained that they were better off WFH rather than working from the office as the latter is a distracting environment. More precisely, a distinction is made about the type of work that can be done at the office (e.g., that engages several peers for example), and the one that is better performed from home. In this previous situation, the employees found it easier to stay focused and concentrate on difficult and time-consuming tasks at home. The interviewees also appreciated the flexibility they can enjoy while working as this is more adapted to their personal rhythms of work and personalities.

#### 4.2.6 Self-confidence

Finally, a trait that is well-known among knowledge worker is self-confidence. This feature was clearly noticeable during interviews.

### 5 Discussion and conclusions

This study explores how knowledge workers forced to work from home perform in their work and how they live this whole remote experience. The results showed that knowledge workers faced differently the forced WFH situation. At the two extreme points of the spectrum, one of the interviewees operating from abroad was very comfortable, happy and productive. At the opposite, another interviewee was close to depression. While the highest frequency was recorded for the 'WFH issues', category which is discussed hereafter, the WFH benefit was nearly equally important in terms of code frequency.

The study showed that the interviewees found that they developed a better productivity and efficiency while working in the office confirming a surprising preference for the 8 to 5 working pattern in a traditional office identified by Glorieux *et al.* (2009) and Ojala and Pyöriä (2015, 2018). The 'surprise' is indeed acknowledged as it is not expected from the clear desire for autonomy employees displayed, suggesting that this characteristic presented by Davenport (2005) or self-leadership (Manz, 1986), should be redefined. Instead, the study found that knowledge workers create their own predicament working long hours as some are unable to manage their working day at home, confirming the 'autonomy paradox' (Ipsen and Jensen, 2010). Some of the employees found that, in total they were working more (Bäcklander *et al.*, 2018). Another contrast to underscore

concerns the alleged increase of productivity; this was not unanimous, and the interviewees clearly stated that it depended on the nature of the task, result contrasting with Bloom et al. (2015). Thus, the dynamic 'road warrior' may reveal a myth after all contradicting Clemons and Kroth (2010).

The expectations linked with the promises of technological development were not met and the interviewees voiced a substantial frustration over the quality, intensity and content of online collaboration confirming Vilhelmson and Thulin (2016) contribution. Moreover, a lower engagement and motivation are signaled as the knowledge workers experienced exhaustion (Vohs *et al.*, 2018) after the attention and effort spent online (Müller and Niessen, 2018). Finally, contrasting with Groth (2018), the interviewees described their holacracy organization as siloed, issue that became salient when WFH.

On the positive side, the study confirmed most of the literature regarding the characteristics of knowledge workers and work. A total control of their life (work and home) emerged as the first theme that one interviewee summarized with 'freedom with responsibility' mentality, and confirmed the leading literature (Davenport, 2005; Manz 1986). The interviewees showed that they were well aware of their career progress (Swart, 2007, Wang and Ahmed, 2003), and appreciated to be challenged in their work as their reward was the creation of a meaningful contribution for all innovators (Drucker, 1999,1993, Despres and Hiltrop, 1995, Reinhardt et al, 2011).

This research suffers several limitations besides the usual interpretative dimension inherent to qualitative studies. Although this study is performed in a holacracy with knowledge workers, the group interviewed was only the technical team of the one Dutch company, and this hinders the confirmability of this work. Additionally, it is believed that the context of forced WFH brought in extreme sentiments from interviewees. One must bear in mind that this new working situation was sudden and most of the working world was unprepared. The scale and rhythm of adaption from all parties, including families, was unprecedented in the effort and uneven in its success. However, concurring with Barrero *et al.* (2021), it seems that this trend is here to stay as, during the interview, a subsidiary question was asked to know if the knowledge workers would be happy to continue working from home. The workforce has a clear preference to continue working mainly from home and come to the office a couple of day per week. In contrast, managers' report high dependency on meeting people physically, the need to feel the context through constant communication.

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## Effects of COVID-19 on the Perception of Well-Being, Work and Entrepreneurship in Mexico

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### Abstract

The global coronavirus (COVID-19) pandemic represents a challenge for nations in 2020, not just in health issues, but even in well-being, job adaptation, digital competence for the future and develop new types of entrepreneurship among populations (ILO-OECD, 2020). The impact of COVID-19 on workers, workplaces and homes across the globe have been a digital-changing move, but at the same time drastic (Kniffin et al., 2021). The traditional work dynamics were transformed in short-time and in this new landscape, sudden implications for entrepreneurs, employees, teams and organizations emerged not only in digital issues, but even with the decreased physical and mental well-being status of the people (Xiao et al., 2021).

Even though previous studies pointed well-being and its positive relationship with job performance and satisfaction (Wright and Cropanzano, 2000; Cotton and Hart, 2003; Van De Voorde, Pauwe and Van Veldhoven, 2012). This study is focusing on the impact of the perception of well-being during this pandemic and its objective is understand possible

*emerging changes in work and entrepreneurship derived of COVID-19 lockdown.* In addition, categorical factors of age, gender, educational level, type of work or entrepreneurship, type of income source and the modality of adaptation are included to generate differentiated effects in the sample.

The method used to collect data was an online adapted questionnaire that capture the job dynamics inside homes and lifestyles adequations, changes in income sources and modifications of habits (Pennebaker, Ashokummar and Vergani, 2020). The instrument was deployed online from August 1 to October 1, 2020 and the respondents were mexican people who had the chance of adapting their job or entrepreneurship in remote-work. We received 587 responses valid (age 18-21 years=63.7% and women=65.8% of the sample). Variables of the first section integrated an index, that we named Index of Perception of Well-Being in Covid-19 pandemic (iWB-19) by using a structural equation model to verify the validity of the information (Hair et al., 2010, 2012, 2018; Iacobucci, 2010).

In summary, the lockdown has generated different emotional conditions among people, especially in well-being perception, changes of work dynamics and entrepreneurship perception. However, the future implications of these results are in economic and educational fields. Promotion of well-being habits inside organizations, the digital and resilience adaptation for future careers (Hite and McDonald, 2020) and new challenges for digital-inclusive education, remote working and digital entrepreneurship (Felstead and Henseke, 2017) are the challenges to face to 2030.

**Keywords** – Well-being, remote-work, entrepreneurship, pandemic, COVID-19

**PaperType** - Academic Research Paper

## **1 Introduction**

The well-being and health of people is an important element in the personal development, unfortunately in most cases it is forgotten or undervalued. The disease, the risks of complications of chronic diseases, new physical and psychological diseases shape our social, economic and political dynamics (Bloom and Canning, 2003). Understanding how well-being is linked to our abilities and its direct effect on work requires multidisciplinary research that allows addressing these relationships from multiple points of view for new models of well-being.

Just over a year ago, as humanity we have experienced a new dynamic, unthinkable for the beginning of this new millennium: The COVID-19 pandemic. And with this, we have put the health issue on the global agenda (World Economic Forum, 2020), this has caused a global concern in the prevention of the contagion of this new SARS COV-2 virus, that is why in the majority of countries paused educational and commercial activities, modifying habits and dynamics of social coexistence, step by step entering a voluntary seclusion, which transgressed

the traditional patterns of life related to the well-being of the individual: work, education, food, physical activities and social coexistence. The costs of this social distance have been very high, especially for emerging economies such as Mexico, since not all jobs were able to adapt to these remote working conditions mediated by Information and Communication Technologies (ICT), people who were able to do so, they had to experience unique and drastic changes in their lifestyles and with their perceived well-being.

This global uncertainty effect was transferred to both organizations and individuals. Various ailments, physical and emotional affectations such as sleep, eating and vision disorders were reported by various studies during the COVID-19 quarantine period (Dey and Dey, 2020; Singh *et al.*, 2020).

In this sense, the main objective of the present work is to describe the main behaviours related to the perception of individual and social well-being in the framework of the global health crisis caused by the COVID-19 virus that allows dimensioning work and entrepreneurship from another perspective.

## **2 Perception of Well-being and COVID-19**

The description of well-being in the context of COVID-19 is a challenge that undoubtedly leads us to reflect on the relationship between physical and mental health and the productivity of people who have carried out their work remotely at home. According to the guidelines of some organizations, faced with the complications of the pandemic, many workers have been working from home or entrepreneurs had conducted their businesses in the same way, very frequently without training or the necessary technological tools. In this new scenario, a series of questions are born, for example: how has this transition impacted people's lifestyles? Has your perception of well-being improved or worsened? How has your adaptation to remote work or remote entrepreneurship? Is new kind of entrepreneurship necessary in this remote-digital context?

This series of questions lead us to reflect on well-being, your individual perception and your relationship with work. And for this, it is necessary to define this concept. The perception of well-being is a complex and multifactorial construct, in its historical fabric it is mostly approached by psychology and behavioural sciences. From these areas of knowledge, well-being *is defined as the affective balance, which is obtained by subtracting the frequency of positive emotions and the frequency of negative emotions and perceived satisfaction*

(Diener and Fujita, 1995). That is, the perception of well-being is a subjective concept related to three main characteristics (Wright and Cropanzano, 2000). The first one, as a phenomenological event, that is, a person perceives that well-being, when they think they are in a sensation of that type. Various investigations in this sense point to the perception of well-being as the sensation of being touched in intimate existence (Wright and Cropanzano, 2000; Lundin, Berg and Muhli, 2013). For Lundin et al; (2013), the phenomenon of well-being is deduced by three components: 1) *The feeling of freedom in elections*, 2) *The feeling of pleasure and* 3) *The feeling of closeness to someone or something*. The second characteristic (Wright and Cropanzano, 2000) involves *emotional conditions*, that is, people who perceive well-being are more oriented towards *positive emotions* than negative ones. Third, well-being is defined as a *global evaluation* not only as a part of life, but as a whole (Diener, 1994).

Although, in the theoretical discussion reviewed, well-being seems an individual phenomenon, some authors describe how certain social and contextual situations can facilitate or limit the full development of well-being and the self-motivation that originates it (Ryan and Deci, 2000; Lundin, Berg and Muhli, 2013).

The COVID-19 pandemic has been the *black swan* (Taleb, 2007) of the millennium. It has generated a series of changes in individual and collective decisions in a very short time. Although motivated by precautions in health matters, we cannot ignore the economic, mental health and educational implications that have been generated within the framework of the quarantine period or shelter at home.

For a part of the world population, the home has become a saturated space, where family life, the school room and the office dialogue in a 24/7 dynamic that has had an impact on the emotional development of children, young people (Liu et al., 2020) and for those who adapted their work to virtuality, remote workers (Como, Hambley and Domene, 2020).

Although the perception of well-being has been an issue analysed in the past by the landscape of work (Harter, Schmidt and Keyes, 2004; Netz et al., 2005), in the context of COVID-19, it becomes a strategic element and key to maintaining three elements that shape a human community: *job satisfaction, health care and job performance, and family upbringing*. Elements that have been violated in various ways in this health crisis (Chien-Hung, Chen and Chen, 2017; Möhring et al., 2021; Özmen et al., 2021).

This crisis situation makes palpable the need not only to rethink the issue of well-being as individuals or societies, but also to rethink leadership in this new paradigm in organizations (Deloitte, 2020). A digital leadership seems to be an option, although a leader who possesses broad digital skills (hard-skills): *use of connectivity, open-source technology, mobile devices and platforms* (Damayanti and Mirfani, 2021) is fundamental in this paradigm, both for workers or entrepreneurs. Options that balance the use of technology and the appreciation and meaning of being human (soft skills) will be in the short term a trend in the world of work, especially in the work-life balance (Nam, 2014) and on the borders of both worlds (Currie and Eveline, 2011) to avoid health, emotional or intrusive problems (Adisa, Gbadamosi and Osabutey, 2017).

A *human-technological leadership* seems an option that arises to promote balance even in workplaces or entrepreneur ideas, this proposal seeks to balance between the human and the digital, but primarily it is guided by a *deep and solid sense of well-being and ethical bases in the execution of its actions and results, in the motivation of their teams and individuals and in the sustainable and digital vision of the organizations of the future*. This crisis of the COVID-19 pandemic has taught us that we are fragile, at an individual and organizational level and in this accelerated learning process in which extraordinary technological and managerial adaptations have been experienced (Bartsch *et al.*, 2020). It is time to pause and provide time for analysis and reflection to weave the foundations of a gradual transition towards human-technological leadership in the birth of future digital organizations.

### **3 Wellness and Remote Work and Entrepreneurship**

The relationship between individual and collective well-being within an organization becomes a construct to be addressed, especially for those organizations that seek to excel in their industry by developing a competitive advantage in their staff (Porter, 2007), especially in this time of redefinition of the business world (Donthu and Gustafsson, 2020). Rethink the occupational risks that may exist from remote working, the medical costs of saturated workers, the benefits of the time favoured in physical care by the workers and even the investment in adequate infrastructure, so that there are elements for think in self-care and it will become more than ever an added value to attract and keep talent in an organization or to create an entrepreneur business unit.

This relationship between remote work – entrepreneurship and well-being results in the discussion of two key elements for *a new kind of organizations*: 1) the need for labour strategies to favour the *well-being of the staff* and 2) a *trained workforce* with skills necessary for this PostCOVID-19 economy: *Adaptability in new digital skills for remote work, flexibility in product and service distribution chains and a high capacity for resilience in the face of uncertainty. If these two elements are not found in the labour market naturally, labour phenomena such as the United States could be repeated in other countries* (Olmo, 2021).

Speaking very generally, business owners and small-medium entrepreneurs have going back to the core of their entrepreneurship (Liguori and Winkler, 2020). Even though for the digital entrepreneurs was the opportunity to update some skills in digital issues and create new orientations of their business across the globe. *Adapt or die*, is something related with this scenario, however the adaption process should be pointed to increase the wellness of entrepreneurs and living conditions.

#### **4 Method**

To evaluate the effects of the shelter at home derived from the pandemic on people's perception of well-being, the future implications in remote work dynamics, and the possibility of new leadership appearing in this scenario, a survey of 587 was carried out. People from the state of Guanajuato, México who were of legal age, who were isolated in their homes during the period August-December 2020. The items were adapted from the University of Texas Project called The Pandemic Project (Pennebaker, Ashokummar and Vergani, 2020) and were placed in a form for electronic filling. It was shared by digital means to members of the Guanajuato society for the most part.

To verify and validate the information and the model to evaluate the perception of well-being, a system of structural equations by partial least squares (SEM-PLS) was used (Hair et al., 2010, 2012, 2018; Iacobucci, 2010). The research model has six reflective dimensions (see Figure 1) (Becker, Klein and Wetzels, 2012) and two categorical variables referring to work and educational level. These variables allow us to portray a part of the phenomenon experienced by the participants in their homes in this period and discuss the results in light of the future implications for remote work and new leadership.

It was ensured that the structure of the instrument was careful with the sensations of the participants, for this reason an informed consent of the participant was included, where the items, scope and the response process were explained. The instrument is intended to be an informed, brief and concise document for the participants. Derived from the theoretical review (Cotton and Hart, 2003; Harrison and Stephens, 2019; Como, Hambley and Domene, 2020; Pennebaker, Ashokummar and Vergani, 2020) the dimensions in which the instrument was structured corresponded to (see Figure 1):

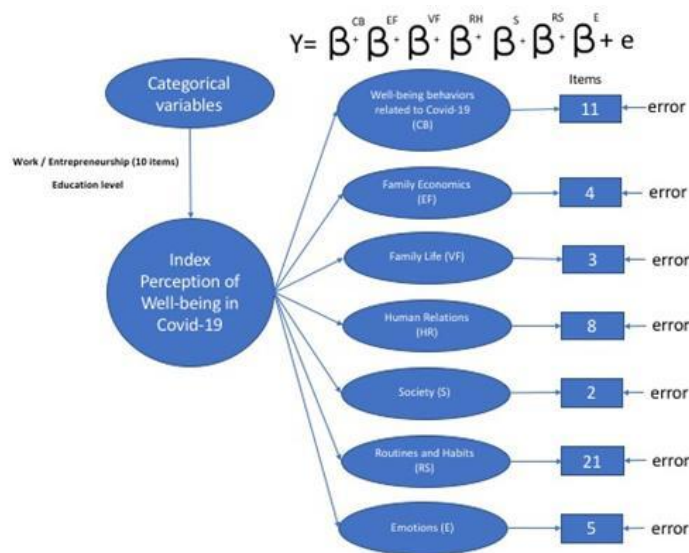


Figure 1. Research Model.

The evaluated dimensions are explained below in these three categories:

a) *Well-being behaviours related to COVID-19*. In this section, 11 questions were asked about elements related to well-being based on the COVID-19 scenario, the levels of concern of the people surveyed about COVID-19 and the time spent in shelter. In the first question, the opportunity opens up for an open response where people express: how do they feel? Where the opportunity to collect the stories of the participants opens.

b) *Adaptation to Remote Work-Entrepreneurship*. In this section, 10 guiding questions were asked about the type of work they have or if they have an own business, how they have carried it out so far, whether they have additional income



options and the modality in which they have carried out their work-business at this time (face-to-face, mixed or virtual). This allows us to know the level of adaptations of the types of work-business that have been done by the surveyed population.

c) *Well-being habits (Family Economy, Family Life, Human Relations, Society, Routines and Habits and Emotions)*. In this section, 43 guiding questions were carried out around the changes in behaviour and habits that the participants have experienced from the shelter at home in the dimensions of: Family Economy, Family Life, Human Relations, Society, Routines and Habits and Emotions. The results of this section allowed us to know the changes in the perception of well-being for the surveyed population.

From the above, 6 hypotheses were derived for this research that correspond to describing the well-being perception construct and its behaviour in reflective and categorical dimensions (Becker, Klein and Wetzels, 2012; Simonetto, 2012):

*Hypothesis 1. The dimension of Well-being Behaviours related to COVID-19 is positively and significantly reflected in the perception of well-being.*

*Hypothesis 2. The dimension of Family Economy is positively and significantly reflected in the perception of well-being.*

*Hypothesis 3. The dimension of Family Life is positively and significantly reflected in the perception of well-being.*

*Hypothesis 4. The Human Relations dimension is positively and significantly reflected in the perception of well-being.*

*Hypothesis 5. The Routines and Habits dimension is positively and significantly reflected in the perception of well-being.*

*Hypothesis 6. The Emotions dimension is positively and significantly reflected in the perception of well-being.*

The application of the PLS-SEM algorithm was carried out in the SmartPLS® software version 3.3.3 (Ringle, Wende and Becker, 2015), where the type I reflective model was designed for the 587 observations.

In the case of this type of model, the evaluation begins with the loading of the indicators. Loads greater than 0.700 indicate that the construct explains at least 50% of the variance of the indicator, which is why the indicators less than this parameter were removed. In the *dimension of well-being behaviours associated with COVID-19 (CB)*, items 7A (0.561), 7B (0.499) and 7C (0.556), related to hygiene and prevention measures, were removed. In the *Human Relations (HR) dimension*, the items that showed this characteristic were 21A (0.569), 21E (0.615),

21G (0.683). In the *dimension of Routines and Habits (RS)*, the items withdrawn corresponded to 24A (0.140), 24B (0.201), 24C (0.509), 24D (0.478), 24E (0.124), 24F (0.347), 25A (0.269), 25B (0.264), 25C (0.253), 25D (0.312), 25E (0.350), 25F (0.322), 25G (0.294), 26F (0.462), 26G (0.579) and 26H (0.335) relative to management practices from stress, changes in perception of reality or changes in purchases and time online. In the *Emotions dimension (E)*, items 27C (0.584), 27D (0.369) and 27E (0.373) corresponding to acting with violence and irritation were removed due to their burden (see Figure 2)

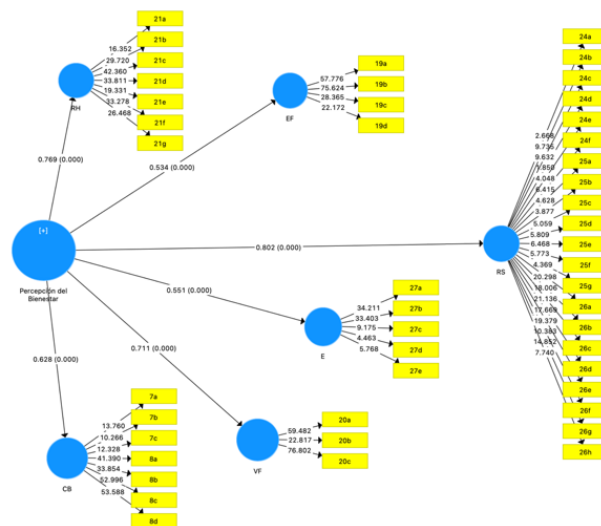


Figure 2. Research Model in SmartPLS  
Own elaboration from the information obtained by SmartPLS® software.

The next step in the validation of the model is to analyse the internal consistency reliability for the use of SEM-PLS is determined through the composite reliability, which determines that for exploratory studies the margins of 0.600 to 0.700 are acceptable, parameters between 0.700 and 0.950 are considered satisfactory and excellent and those greater than 0.950 are problematic.

The dimensions obtained scores greater than 0.850 and less than 0.950 (see table 1).

Table 1. Measurement settings of the Reflective Perception of Well-being model.

Construct / Dimensions		Composite reliability	AVE
Perception of Well-being	Wellness Behaviors related to Covid-19 (CB)	0.925	0.755
	Emotions (E)	0.948	0.901
	Family Economy (EF)	0.873	0.633
	Human Relations (RH)	0.852	0.591
	Routines and Habits (RS)	0.855	0.543
	Family Life (VF)	0.858	0.670

Source: Own elaboration from the information obtained by SmartPLS®

The next validation step corresponds to convergent validity, which is determined by the Average Extracted Variance (AVE). This indicator is calculated by the mean of the square of the loads of all the indicators associated with this construct (Sarstedt *et al.*, 2014). An acceptable AVE corresponds to 0.500 or greater (see table 1). After the previous tests of the model, it is necessary to determine the discriminant validity. The above determines how different a construct is from others in the model. The most conservative way to do this is through the Fornell-Larcker criterion (Hair *et al.*, 2014) (see Table 2).

Table 2. Fornell-Larcker criterion

	<b>CB</b>	<b>E</b>	<b>EF</b>	<b>RH</b>	<b>RS</b>	<b>VF</b>
<b>CB</b>	<b>0.869</b>					
<b>E</b>	0.068	<b>0.949</b>				
<b>EF</b>	0.303	0.208	<b>0.796</b>			
<b>RH</b>	0.320	0.244	0.319	<b>0.769</b>		
<b>RS</b>	0.277	0.450	0.245	0.413	<b>0.737</b>	
<b>VF</b>	0.323	0.240	0.244	0.603	0.441	<b>0.819</b>

Source: Own elaboration from the information obtained by SmartPLS®

Evaluation of the structural model is necessary. For this, the following are evaluated: a) determination coefficient ( $R^2$ ), b) cross-validation redundancy ( $Q^2$ ) and c) path coefficients (Sarstedt et al., 2014) (see table 3).

Table 3.  $R^2$ ,  $R^2$  adjusted and  $Q^2$  structural model.

	$R^2$	$R^2$ <i>adjusted</i>	$Q^2$
CB	0.342	0.340	0.249
E	0.231	0.230	0.201
EF	0.286	0.284	0.173
RH	0.582	0.581	0.335
RS	0.545	0.544	0.288
VF	0.517	0.516	0.337

Source: Own elaboration from the information obtained by SmartPLS®

The  $R^2$  indicator is a measure that allows us to predict the results of the model. Values between 0.660 and 0.330 indicate a moderate explanatory value of the model. The dimensions that possess this characteristic correspond to *Human Relations (HR)*, *Routines and Habits (RS)* and *Family Life (VF)*. Another way to evaluate the predictive relevance of the model as a measure of precision is  $Q^2$ , as a measure, values greater than 0 indicate an acceptable predictive value (Hair et al., 2014; Sarstedt et al., 2014).

Table 4. Hypothesis, path coefficients, t-value and significance of the structural model

	<b>Relationships and Hypotheses</b>	<b>Path coefficient</b>	<b>t values</b>
<i>Index of Perception of Well-Being in Covid-19 pandemic (iWB-19)</i>	Hyp 1. Perception of Well-being -> CB	0.584 ***	15.283
	Hyp 2. Perception of Well-being -> E	0.481 ***	10.541
	Hyp 3. Perception of Well-being -> EF	0.534 ***	13.775
	Hyp 4. Perception of	0.763 ***	38.164

Well-being -> RH			
Hyp 5. Perception of Well-being -> RS	0.738	***	32.885
Hyp 6. Perception of Well-being -> VF	0.719	***	30.306

\*\*\*  $p < 0.001$ . Source: Own elaboration from the information obtained by SmartPLS®

Bootstrapping was carried out with 5,000 subsamples (Hair *et al.*, 2014) obtaining six relationships between the variables (see table 4). Through *the results it can be observed that the perception of well-being is reflected in a positive and significant way with a higher coefficient by the dimensions of Human Relations (HR) 0.763, Routines and Habits (RS) with 0.738 and Family Life (FV) with 0.719.* This is undoubtedly a finding in this pandemic time, which will have implications for the welfare adjustments for remote workers or remote entrepreneurs in purely digital organizations.

## 5 Results

The model and the results indicate that the lockdown process derived from quarantine changed people's perception of well-being and concerns. Descriptively, 17% mentioned feeling very worried about losing their job and 40% mentioned that the confinement derived from the quarantine impacted on their human relationships with their family, friends and co-workers. According to a multi-group analysis, *women and people with a basic level of education reflected changes in the perception of their well-being in the dimension of Family Economy (FE).*

The results indicate the *economic impact of this pandemic in populations with a lower educational level and with a gender bias*, since the women participating in the survey were the most affected in the life-work balance than men. This trend corresponds to other studies conducted during the pandemic (Yildirim and Eslen-Ziya, 2021).

The dimensions analysed had different impacts. Descriptively, 19% of the surveyed population felt angry and irritated and approximately 5% mentioned having acted with violence or abusing alcohol or tobacco. In the analysis of

relationships in the model, it is shown that the *participants with a higher educational level reflect a greater effect of this dimension on the perception of well-being*, that is, it could be inferred that at a higher educational level the changes in the *Emotions dimension* would have a greater relevance in the perception of the individual's well-being (see Table 5). Emotional regulation has been a very important factor for proper work-family management during this pandemic (Restubog, Ocampo and Wang, 2020), especially for remote workers (Wang *et al.*, 2021).

This is a relevant finding for the research, it could be inferred *that the higher the worker's education, there is a greater possibility of exposure to emotionally exhausting tasks or those that require high intellectual concentration skills*, so differentiated strategies would be a good care option. Workers with a higher educational level develop expectations in their work and especially in the care that the organization should take for their personal well-being (Zapf, 2002).

Table 5. Factor Loads of the Well-Being Perception dimensions by educational level groups.

	<b>Basic education</b>	<b>Higher and Postgraduate Education</b>
CB	0.572	0.602
<b>E</b>	<b>0.386</b>	<b>0.589</b>
EF	0.529	0.532
RH	0.744	0.788
RS	0.716	0.753
VF	0.732	0.720

Source: Own elaboration from the information obtained by SmartPLS®

Regarding the sense of community, 35% of the participants answered that the confinement will unite people more and 34.75% mentioned having offered help to other people in this period. Economic changes are the main concern of the participants, 80.6% mentioned not having an extra income during this period of confinement and 8.5% could not perform remote work according to the conditions of their work and 25% continued doing their work 100% in person.

This is an important indicator of the process of adapting from a purely face-to-face job to a remote one.

According to the descriptive analysis, 41.8% of the participants mentioned their ability to adapt their work to virtuality, however 38.3% could not migrate to a remote environment and for 8.6% the scenario was compromised for their economy, since they mentioned having lost their job in this period.

The relationship model demonstrated its reliability and validity (see Tables 1, 2 and 3) thereby checking the hypotheses raised through the validated model (see Figure 3). This is an important finding, since it allows an exploratory panorama of the way in which the perception of the well-being of individuals was impacted by the shelter at home and the construction of the concept of *what is perceived as well-being in this period*.

Although the relationship between well-being and management has been addressed and studied previously (Pagán-Castaño, Masada-Moreno and Santos-Rojo, 2020) during this pandemic, social distancing measures, economic pressures and emotional stress that have been experienced have placed this concept with a greater presence on the agendas of organizations or new entrepreneurs, especially for those who seek to *move to a purely digital and remote model and who are in search of training and attracting leaders or intrapreneurs who understand this new paradigm*.

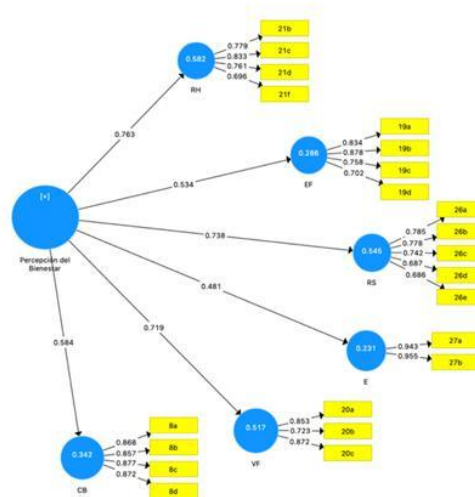


Figure 5. Path model validated about the effects of COVID-19 on Index of Perception of Well-Being in Covid-19 pandemic (iWB-19)

Source: Own elaboration from the information obtained by SmartPLS®.

The model validated in this study describes the perception of well-being as a variable that can be measured and interpreted by this concept with a greater presence in the agendas of organizations and new entrepreneurs, especially for those seeking to move to a purely digital and remote model.

For the surveyed population, the elements that allow them to have a perception of their individual well-being are mainly reflected in the dimensions of: *Routine and Habits (RS)*, *Family Life (VF)* and *Human Relationships (HR)* (See Table 6) . This is a finding that will have implications for economic and organizational recovery in the post-pandemic era. These results will provide information for the design of present and future strategies to reduce impacts in these dimensions.

Table 6. Hypothesis Check.

	<b>Hypothesis</b>	<b>Path coefficient</b>		<b>T Value</b>
Hypothesis 1. -> CB	Proven positive and significant manifestation	0.584	***	15.283
Hypothesis 2. -> E	Proven positive and significant manifestation	0.481	***	10.541
Hypothesis 3. -> EF	Proven positive and significant manifestation	0.534	***	13.775
Hypothesis 4. -> RH	Proven positive and significant manifestation	0.763	***	38.164
Hypothesis 5. -> RS	Proven positive and significant manifestation	0.738	***	32.885
Hypothesis 6. -> VF	Proven positive and significant manifestation	0.719	***	30.306

\*\*\*  $p < 0.001$ . Source: Own elaboration from the information obtained by SmartPLS®

## 6 Conclusions

In summary, *the confinement has generated various emotional conditions among people, especially in the perception of well-being*, especially for remote workers and entrepreneurs. Changes in work dynamics and adaptation to remote work mediated by digitality have been the challenges that organizations have had to



face immediately. However, the implications that arise from will have long-term impacts.

The conclusions of this research work will revolve around three main points, the first of them:

1) *Well-being: a key point in remote work.* The promotion of habits of physical and mental well-being are fundamental in the organizations of the future, especially for remote workers, adaptation towards digitality implies resilience (Hite and McDonald, 2020), space for the care of emotions and for the maintenance of human relations. In this new paradigm, the development of leadership with a focus oriented towards caring for well-being and minimizing technological attention will be a latent element in the training of new executives. Organizations that achieve this process of integration in their mission, vision and values will develop a competitive advantage among their competitors. Taking back a value to the human relationship from the dignity at work and not simply for the market value, one of the dogmas of the destructive hyper-capitalism that we face in this era (Byung-Chul, 2017).

2) *Human-technological leadership: Dignity and Balance.* The challenges involve new leadership skills in digital environments, educational inclusion in the digital world, especially for emerging economies, and life-work-well-being balance in purely digital environments (Felstead and Henseke, 2017). This balance manifests the urgent need for a new leadership to emerge in this paradigm. The denominative proposal of human-technological leadership seeks to be a space for the union of skills that allows a transition of purely digital organizations with a high sense of the human dignity of their collaborators, leaders and clients. An ecosystem primarily human, rather than technological; an opportunity to recover a different use of life, of work that allows a playful and contemplative use that is not simply drowned in doing (Byung-Chul, 2020), but in the promotion of being. *Imagining a leader or entrepreneur who promotes a balanced human-technological relationship between the work relationship and the self-care of workers with a high sense of dignity in the digital organization seems utopian, however, it is a model to which we should gradually orient ourselves.*

3) *Digital Organization: Remote Work and Leadership.* Digital organizations develop in terms of complexity and quantity in recent years, undoubtedly the pandemic allowed to promote more digital services in daily life. Integrating in these organizations the technological part in balance with a leadership with a

high sense of life-work balance will be able to orient better results in the medium term.

The transition to digital organizations needs leaders who adapt to these new contexts and respond with the ability to harmonize between technology and the transition to a more humane organization, aware of dignity and socially interconnected with other organizations locally and globally.

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## Knowledge Management and Circular Economy: Novel Solutions to Cope with Uncertain Times

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### Abstract

Companies are called to cope with increasingly complex challenges. Among all, the reduced amount of resources available on our planet forecasts a dramatic future scenario. Circular Economy (CE) is one of the most promising strategies to manage resources efficiently. But also, the application of knowledge management in ensuring effective transition into a circular economy by developing a circular business model as an alternative to the conventional linear economic model is under-investigated. Knowledge coordination, creation, and dissemination capability of a firm are essential in developing the green industry. Furthermore, the knowledge creation, transmission, usage and sharing capabilities of a firm are critical to developing a sustainable sector. This article adopts a literature review approach to gain circular economy and knowledge management components and then shift to a lexical-analytical system that establishes the link between knowledge management and circular economy.

**Keywords** - Circular Economy, Circularity, Knowledge Management, Lexical Analysis, Principal Component Analysis

## 1 Introduction

One of the challenges in the current socio-economic paradigm for organizations is to adopt resilient strategies to cope with uncertain environments (Sheffi, 2005; Lengnick-Hall, Beck, 2005; Bhamra et al., 2011; Gilly et al., 2014; Linnenluecke, 2017; Korber, McNaughton, 2018; DesJardine et al., 2019; Conz, Magnani, 2020; Hillmann, Guenther, 2021). Uncertainty can result from different sources, such as rapid technological changes, the proliferation of information, and threatening resource consumption. Considering this situation, organizations can only remain competitive and achieve long-term success by confronting uncertainty and adopting sustainable information and resources management models (Van Fan et al., 2019).

"We're drowning in information, but starving for knowledge" (Miller, 2007). Therefore, there is a significant need for systematic management of relevant information obtained from the overabundance of data in the external and internal environments, as well as for their analysis and usage to create holistic knowledge of an organization (Gregoris et al., 2001; Diakoulakis et al., 2004; Ioannis et al., 2004). Another layer of this process starts afterward by creating, sharing, using, and managing an organization's knowledge and information. This stage, called knowledge management, refers to a multidisciplinary approach to achieve organizational objectives by making the best use of knowledge.

On the other hand, to eliminate waste and to strive for the continual use of resources, circular economy-based systems employ reuse, share, repair, refurbishment, remanufacture and recycle to create a closed-loop system, minimizing the use of resource input and the creation of waste, pollution and carbon emissions (Ellen MacArthur Foundation, 2012; Rashid et al., 2013; Su et al., 2013; Ghisellini et al., 2016; Jawahir, Bradley, 2016; Lieder, Rashid, 2016; Blomsma, Brennan, 2017; Murray et al., 2017; De Jesus, Mendonça, 2018; Govindan, Hasanagic, 2018; Korhonen et al., 2018a; Agyemang et al., 2019; Kumar et al., 2019; Pieroni et al., 2019; Geissdoerfer et al., 2020; Mura et al., 2020; Alhawari et al., 2021).

Despite the increasing attention towards the material resources in companies' annual reports and investigating the most efficient usage for them as the application of circular economy, there is still a considerable lack of consideration on efficient management of informational resources. While efficient management of information and knowledge can also contribute to costs and profitability, some

knowledge management components can also have significant social effects. Especially in the recent paradigm in which companies are bombarded with an intensive amount of information and knowledge-based technologies, knowledge management can generate sustainable competitive advantages. Moreover, physical and intangible resources are entangled in many aspects and we can't progress in one of them without simultaneous progression on the other. However, upon assessing state of the art, the lack of studies on the contribution of the two kinds of resource management (physical and intangible), circularity and knowledge management, is detectable.

To fill this gap, in this article, following a brief literature review of both topics, we introduce several components for each of the two strategies mentioned above (knowledge management and circular economy). As for the first one, these components are based on the "knowledge management system process" (Chandra, 2019), including knowledge generation, knowledge using, knowledge transferring, and knowledge sharing. From the perspective of a circular economy, the main components are waste management (Romero-Hernández and Romero, 2018; Nelles et al., 2016), renewable energy (Olabi, 2019; Tsuyama, 2020), reuse of resources (Llorente-González and Vence, 2020; Goyal et al., 2018) and recycling (Haas et al., 2016; Di Maio, Rem, 2015).

Taking the 2020 version of EURO STOXX 50 list of the leading companies of the Eurozone as the basis of the analysis, we will parse the non-financial reports of those companies to assess them for the presence of the aforementioned components of both circular economy and knowledge management. By proceeding deductively, we will fix the categories before the assessment process, and then we will scrutinize the non-financial reports to code everything related to the categories. In this way, we will evaluate how many of the categories of both circular economy and knowledge management are covered in the non-financial reports of each company in the dataset. Then we will move from the qualitative assessment to the mixed methods analysis to understand the connection between the presence (or absence) of the categories in the individual non-financial reports and the size and liquidity of related companies' stocks. We will test whether there is a statistically significant difference between the expected frequencies and the observed frequencies in a set of contingency tables for categorical information using chi-squared tests. For the quantitative measure, we will find in the reports a regression analysis will be performed to understand the possible nature of the relationship between the willingness of a company to adhere to the principles of



circular economy/knowledge management and their scores for the EURO STOXX 50 index. The coded segments will also be visually explored using the MAXQDA Document Map to uncover how companies in the list are distributed according to the attention they show in their reports to the issues of both circular economy and knowledge management.

In this manner, we strive to fill the significant research gap regarding the relationship between circular economy and knowledge management and understand how the two may contribute to a company's financial success. We think our results may be useful to managers and scholars. Moreover, it sheds additional light on the importance of the potential that knowledge management and circular economy have to "shield" companies from the pitfalls of uncertain times.

## **2 Literature Review**

### ***2.1 Knowledge, knowledge management and knowledge management system process***

The enterprise is a social system characterized by continuous changing processes that arise from the need to respond effectively and efficiently to the internal and external environment's self-generative and renewal drivers. A company can improve its competitiveness only if it possesses these capabilities, legitimize itself, increase its social role and, above all, pursue the systemic goal of creating sustainable value. From this point of view, the enterprise is considered a collection of resources (Penrose, 1959) whose endowment can strengthen the process of creation and dissemination of value, as evidenced by the Resource-Based View.

Resources, i.e., the productive assets that the company controls directly or indirectly, are at the basis of the autopoietic process that fuels its evolution. In this context, an essential role is played by the intangible assets of the value chain (Drucker, 1999) resulted from numerous factors, such as the revolution generated by the information age, the change in the international economic scenario, the challenges arising from increasing global competition, the complexity of relations with stakeholders, the growing importance of human capital—especially if highly specialized, the need for the company to grow and develop in an increasingly dynamic and complex economic context, the emergence and

establishment of the so-called "knowledge economy", and the widespread acceptance of innovative techniques of "knowledge management".

These are mainly endogenous elements, usually not transferable or separable from the company system, whose contribution to the creation of value is manifested in the performance differential that the company itself manages to achieve compared to its competitors. These resources tend to sediment over time through various processes within the systemic entity to sustain the acquired competitive position (Dierickx and Cool, 1989). Moreover, these resources generate virtuous developing circles thanks to their use, such as intra/inter-systemic relations, learning, the diffusion of the company's culture, reputational capital, image and above all, knowledge. However, resources tend to perish if the company does not sufficiently manage them. Because if not continuously monitored, fed, renewed and preserved, they can be overtaken by innovations generated by competitors.

In this context, the process of value creation, which represents the meaning of the existence of the enterprise, can be introduced as a process of knowledge creation perceived as the set of cognitive schemas that allow the organization to function (Nonaka and Takeuchi, 1995; Grant, 1996; Vicari, 2008; Roblek et al., 2014).

In other words, enterprises can implement their operational processes because they hold adequate knowledge regarding the realization of products, new technical solutions concerning processes, interpretation of signals from the context, management of exogenous and endogenous relations, and search for new development paths.

In this way, according to Vicari (2008), the economy changes its nature from the science that focuses on the optimal allocation of scarce resources to the science of regeneration and use of growing cognitive resources since they are unlimited and reproducible without cost.

Knowledge then generates a dynamic and collective process, which increases the contributions of individuals because it is transformed from "individual assets" to "organizational assets" (Tardivo, 2008; Kianto and Waajakoski, 2010). This implies an evolutionary dynamic of firms that shapes supply, organizes structures, and generates resources based on the self-generative capacity of knowledge that grows and enhances with use and can be employed indefinitely without running out (Davenport and Prusak, 1998; Rullani, 2004; Brinkley, 2006).

Based on these assumptions, according to Manesh et al. (2021), knowledge is a key resource for gaining sustainable competitive advantages, concretely translated into more efficient business processes and quality improvement, as well as increasing firms' ability to recognize novel solutions and develop products that meet their customers' needs.

However, as pointed out by Tardivo (2008), "the management of the process of creating new knowledge has the definition and sharing of a value system as a fundamental prerequisite, and becomes essential for a company that wants to be and remain successful."

Moreover, knowledge requires the adoption of flexible organizational structures where interactions play a relevant role with exogenous entities and exchange of information and resources, highlights the use of so-called networks. The economy and the market become "passages without territory" where the classic supplier-customer relationship requires the establishment of "alliances" with the transition from an individualistic/hierarchical logic to one focused on interaction and exchange (Tardivo, 2008).

The network economy considers integration as a strategic tool that influences knowledge production and the increasingly important role of information and critical knowledge holders. Indeed, the network facilitates the exchange, co-production, sharing and replication of knowledge, aiming at innovativeness (Audretsch et al., 2020). However, achieving positive consequences from access to external knowledge requires implementing internal innovation practices along with balancing investments in internal and external knowledge (Enkel et al. 2009; Agarwal et al., 2010; West and Bogers, 2014; Tavassoli et al., 2017; Santoro et al., 2018; Audretsch et al., 2020).

Knowledge, according to McElroy (2003), can be metaphorically included in "containers" distinguished in agents (individuals and groups), which highlight subjective forms of knowledge, and artifacts (documents, books, computer systems, etc.), which instead represent objective forms of knowledge.

The logic of the "containers" can also be found in a study by Vicari (2008) who has broken it down into five types: physical capital, organizational structures, routines, individuals and, as far as trust is concerned, the type of relationships implemented by the company.

Depending on the degree of sharing inside and outside the organization, we can determine the value of knowledge. However, in the second case, the appropriate transfer restrictions necessary to avoid the risk of industrial

espionage must be taken into account (Brinkley, 2006). However, the issue that companies must face concerns the modalities of knowledge accretion that usually occurs in various ways (Arrow, 1962; Cohen, Levinthal, 1990; Vicari, 1998; Bhatt, 2001; Tardivo, 2008). These are:

- learning by doing: knowledge is developed by the manufacturer or component supplier during the design and production activity;
- learning by using: knowledge is accumulated through the use of facilities, equipment or products;
- learning by searching: knowledge is developed through the intentional search for new products or process solutions;
- learning by interacting: knowledge is increased through systemic interactions that are established between a multitude of actors, public and private, involved in the process of innovation and dissemination, which to be sources of information, are equipped with different skills, knowledge, skills and resources;
- specific investments of accretion;
- imitation;
- acquisition from the outside through a continuum of opportunities, ranging from the purchase of consulting services to hiring personnel and acquiring an entire company.

Therefore, knowledge as a renewable resource (Brinkley, 2006), is the basis of innovation processes, in which the governing body plays an essential role that must be oriented towards the coordination, sharing and development of the company's knowledge assets (De Long and Fahey, 2000; Yew Wong, 2005; Kavanagh and Ashkanasy, 2006; Singh, 2008; Schumpeter, 2010; Nguyen and Mohamed, 2011; Pinho and Rego, 2012; Donate and De Pablo, 2015; Dayan et al. , 2017; Singh et al., 2021).

Gaimon and Bailey (2013) pointed out that the different performances achieved by firms can be attributed to varying levels of knowledge possessed and exploited for new or enhanced goods and services, new markets, new technologies, new manufacturing methods, and new forms of organizational design.

According to Vicari (2008), "the added value and competitive advantage today lie in the ability to originate new knowledge, in order to increase its value, to appropriate knowledge originated by others." Therefore, since knowledge is inherent in people, it is converted from tacit to explicit and vice versa through the

process of socialization, externalization, combination, internalization (Chandra, 2019). To sustain the acquired competitive advantage over time, however, the knowledge process is circular. Tacit and explicit knowledge is a unity that cannot be separated in the knowledge management process (Chandra, 2019).

In this way, it is possible to understand how knowledge is created, shared/transferred, acquired, stored/retrieved, and applied throughout an organizational system (Hedlund, 1994; Manesh et al., 2021). Indeed, through knowledge management, one can facilitate access to external information and knowledge, including their involvement in the value chain (Cohen and Levinthal, 1990; Davenport and Prusak, 1998; Bandera et al., 2016; Raudeliūnienė et al., 2018).

From a strategic perspective, knowledge management represents "organizational processes that seek a synergistic combination of information processing capabilities and the creative and innovative capacity of people" (Tardivo, 2008).

Kianto et al. (2016) identified the following five processes, which, while interconnected, are easily distinguished by the purpose they serve: knowledge acquisition, knowledge sharing, knowledge creation, knowledge codification and knowledge retention. It is also recognized that knowledge management affects the ability of the firm to develop knowledge through the knowledge management system process (Chandra, 2019). These affect the firm's ability to develop effective decision-making processes, including risk management (Rodriguez and Edwards, 2010; Zipperer and Amori, 2011).

Therefore, a knowledge-based economy requires organizational changes in strategies, structures, and management styles (Zack et al., 2009; Roblek et al., 2014; Kianto et al., 2016).

## ***2.2 The role of knowledge management for the transition to the circular economy***

There is widespread recognition among scholars that knowledge represents the pillar on which sustainable development processes are also based (McElroy, 2003; De Marchi and Grandinetti, 2013; Van Reijssen et al., 2015; Martins et al., 2019; Sanguankaew and Vathanophas Ractham, 2019). They also believe that knowledge management is an essential factor in pursuing a sustainable competitive advantage for businesses (Omotayo, 2015).

It is recognized that the implementation of sustainable business also depends on the adoption of a circular economic model (Ghisellini et al., 2016; Geissdoerfer et al., 2017; Formisano, Fedele, 2020; Kavalic et al., 2021). Circularity represents an evolved approach reconciling the maximization of economic goals with environmental and social goals, performed by firms through effective and efficient management of resources (Ellen McArthur Foundation, 2012; 2014; Ghisellini et al., 2016; Lieder, Rashid, 2016; Elia et al., 2017; Kirchherr et al., 2017; Manninen et al., 2018; Formisano, Fedele, 2019). It is, therefore, an opposite logic compared to the linear economic model of "take-make-consume-dispose" or "extract-produce-use-dump material and energy flow" (Fonseca et al., 2018). The linear economic model, which is based on the assumption of the infinity of the resources, raises obvious questions regarding sustainability (Blomsma and Brennan, 2017; Korhonen et al., 2018b). In addition, as argued by Fonseca et al. (2018), resource scarcity fosters higher price value and volatility, which negatively impacts value creation and capture. Moreover, consumer preferences change towards more environmentally friendly products and new sharing models versus ownership models.

The circular economy is credited with increasing business competitiveness and reducing the risks taking, protecting the environment and minimizing the exploitation of scarce resources, contributing to long-term sustainable economic growth with tangible and intangible benefits for businesses and their stakeholders (Ghisellini et al., 2016; Fonseca et al., 2018).

However, the transition from the linear to the circular economic model requires knowledge acquired through a network of stakeholders, including external and internal (Ritzén and Sandström, 2017; Govindan and Hasanagic, 2018; Lahti et al., 2018; Prieto-Sandoval et al., 2019). According to Klapalová (2020), acting in this way, not only new knowledge will be created by new actors and new processes, but also new patterns and new processes will emerge demonstrating how to acquire, capture, analyze, utilize, store and share the knowledge.

However, from Klapalová's study (2020), it emerges that within the theories related to the circular economy, there are still few references to knowledge management.

### 3 Methodology

In order to understand to which extent both circular economy and knowledge management are incorporated into standard practices of best-performing organizations and to uncover nested dynamics between the two novel concepts, we performed a set of extended lexical searches within the non-financial statement of major European companies. The non-financial statements in question refer to the year 2019 (the most recent available at the time of the analysis). The choice of the companies was not arbitrary. The list of EURO STOXX 50 companies was taken as the basis for the analysis. EURO STOXX 50 is the index denoting fifty of the largest and most liquid stocks of the Eurozone. In this way, besides hindering the arbitrary selection, we were sure to analyze only the undoubted leaders of their respective markets. Indeed, we expected these companies to be the most detailed regarding novel topics of circular economy and knowledge management in their non-financial statements. It is not to say such a selection criterion is flawless. On the contrary, the list of companies seems to be skewed towards French (36%) and German (45%) companies. Nonetheless, as the primary goal of the analysis is the identification of nested dynamics between circular economy and knowledge management initiatives (and not the detailed analysis of their effects in terms of profitability/viability on single companies in the list), the asymmetry of the distribution of single EU states was not considered relevant with respect to the outcomes. Three Italian companies have made into the list: ENI, ENEL, and Intesa Sanpaolo.

Fifty individual non-financial reports were then downloaded and subsequently analyzed using MAXQDA qualitative and mixed methods data analysis software. Given the sheer amount of information present in non-financial statements, it was deemed impossible to scrutinize each and every report individually. The extended lexical search tool was instead used to count each and every occurrence of the circular economy and knowledge management-related information in all the documents jointly. For this purpose, a set of keywords was identified accordingly to the exploratory literature review of the previous section of the paper. As a result, two sets of keywords were established, one pertaining to circular economy concepts and another one to knowledge management. More specifically, keywords pertaining to the circular economy domain denoted typical circular economy concepts: recycling, renewable energy, reuse, and waste management. For each concept, several more specific keywords were identified. Additionally, a

more general "circular economy" keyword was also used. Keywords pertaining to the knowledge management domain denoted basic components of knowledge management: knowledge gathering, knowledge sharing, knowledge transferring, and knowledge usage. For each, a set of keywords was also defined accordingly to the literature review carried out in the previous section. Once again, a more general "knowledge management" keyword was also used to account for the additional information on the topic within individual non-financial reports, not pertaining to the specific domains of interest.

MAXQDA extended lexical search allowed us to count specific occurrences of keywords within all 50 non-financial reports for each and every component of circular economy and knowledge management as defined above. Not only specific keywords were searched, but the results were extended to take into account the lemmatization (that is, different inflected forms of words, i.e., "knowledge using" and "knowledge usage"). Moreover, upper case results were separately counted as well. This process resulted in the dataset relating each individual company on the list (rows) with the number of times a specific component of a circular economy or knowledge management (columns), i.e., waste management or knowledge using, is mentioned in the respective non-financial report of the year 2019.

Thus, the amount of effort each individual company is dedicating to issues of circular economy and knowledge management was operationally defined as the frequency with which the main components of circular economy and knowledge management are mentioned in the company's non-financial reports. Such a simplified operational definition has the merits of generalizability given the absence of homogenized indicators to measure the companies' involvement in both circular economy and knowledge management. However, we think the development of such indicators will be crucial in the future, especially given the current need, brought to the light by scholars, of a homogenized framework to which all non-financial statements of companies should adhere. As for now, no one-best way (commonly accepted by every player on the market) to estimate the individual impacts in terms of knowledge management and circular economy initiatives exists.

According to the developed methodology, only the ordinal ranking of companies is, in reality, possible. For example, in total, in Siemens' 2019 non-financial report, different components of the circular economy were mentioned 141 times. On the other hand, ENEL mentioned different aspects of circular



economy 72 times in the same year. That is not to say Siemens is twice more involved in circular economy issues. Assuming the length of individual financial reports to be non-influential, we may only conclude that Siemens is more devoted to circular economy initiatives and issues than ENEL (at least, in its reporting). However, for the purpose of the analysis, we assume certain ordinality do exist, albeit imprecise.

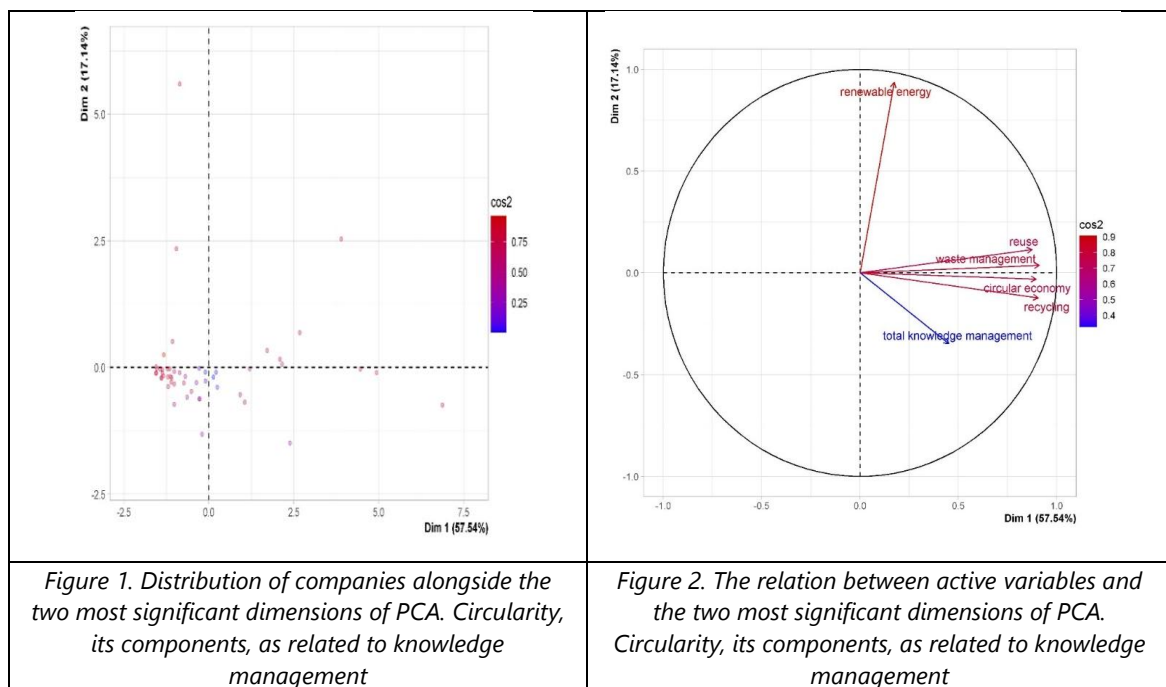
Individual components were then summed across fifty companies. According to the results, Inditex, the biggest fashion group in the world, was the most attentive to circular economy issues during 2019 (293 mentions of circularity in the report), followed by Schneider Electric (265 mentions) and Iberdrola (240 mentions). The fourth and the fifth rank were occupied by Vinci and Telefónica (another French and Spanish company, respectively). For what concerns knowledge management, the first three companies invested in its reporting for the years 2019 were CRH plc, ING group, and Santander (with the total amount of mentions equal to, respectively, 38, 29, and 26).

Two specular principal component analyses were then performed. Firstly, we analyzed individual components of circular economy (circular economy, recycling, renewable energy, reuse, and waste management) jointly with the total amount of mentions for knowledge management (calculated as the sum of individual knowledge management components' mentions). In a specular way, each individual component of knowledge management (knowledge management, knowledge gathering, knowledge sharing, knowledge transferring, and knowledge usage) was jointly analyzed with the total amount of mentions for the circular economy (once again, calculated as the sum of individual circular economy components' mentions).

The first PCA produced six uncorrelated dimensions, with the first two accounting for almost 75 percent of the total variability of the phenomenon. While the interpretation of the second dimension might be interesting, it accounted for only 15 percent of the total variability. Hence, the first dimension resulted in being the only one capable of shedding some light on the dynamics within individual financial reports. Reuse, circular economy, waste management, and recycling variables turned out to be unsurprisingly correlated within financial reports. Total knowledge management was only mildly correlated with the first dimension. However, the correlation was positive. Overall, the presence of circular economy topics in financial reports was a mild predictor of the presence of knowledge management topics within the same reports. One component of

circular economy (renewable energy) was, however, uncorrelated with others. Siemens (northernmost dot on the individual factor map) was the most successful implementor of renewable energy initiatives, according to the frequency of mentions in non-financial reports. From the analysis, it seems that companies think of renewable energy issues as a separate class of problems, not related to the circular economy. Moreover, it seems that tackling the renewable energy issue gives companies a sort of carte blanche for avoiding all other circular economy-related issues equally crucial for both environment and society (reuse, waste management, and recycling). From this point of view, the only truly "balanced" non-financial report was that of Iberdrola, assessing all circular economy-related topics with an equal amount of weight.

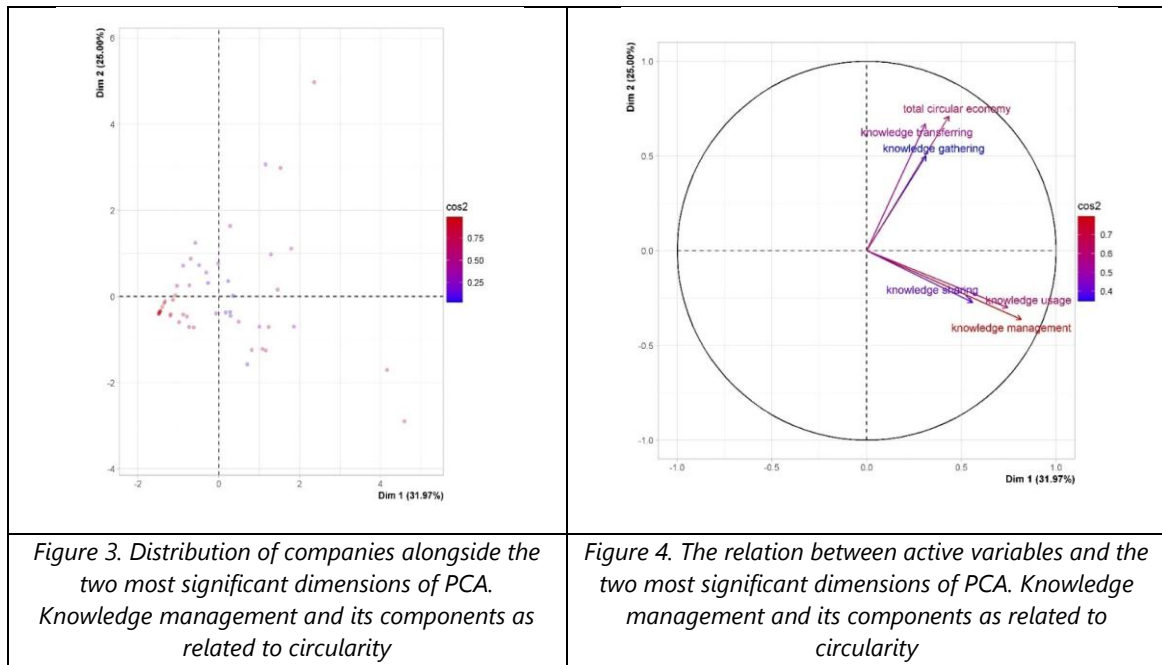
Figures 1 and 2 show the distribution of individual companies alongside the two dimensions and the correlation circle denoting the correlations between single active variables and the two most important dimensions. Cos2 measures the quality of representation of both individual companies and active variables on the map.



Source: Our elaboration

A specular second principal component analysis was performed. This time, individual components of knowledge management were assessed with respect to the total amount of circular economy mentions in non-financial statements of EURO STOXX 50 companies. Once again, the analysis produced six uncorrelated dimensions, and the consideration of the first two dimensions was deemed sufficient for the goals of the analysis. Jointly, the first two dimensions accounted for almost 57 percent of the total variability. This time, the distribution of variability between the two dimensions was more even (32% for the first dimension and 25% for the second). Thus, a more careful interpretation of both dimensions was required. Unlike in the previous case, all the variables were significantly correlated with the first dimension. However, the differences were more marked alongside the second dimension. Indeed, only knowledge transferring and knowledge gathering were positively correlated with the total amount of circular economy keywords mentioned in the non-financial report. It seems that the dynamics of input and output of information, and not the ways in which information is elaborated, are crucial for the due attention to the circular economy initiatives by the companies.

Figures 3 and 4 show the distribution of individual companies alongside the two dimensions and the correlation circle denoting the correlations between single active variables and the two most important dimensions. Once again,  $\cos^2$  measures the quality of representation of both individual companies and active variables alongside the two most important dimensions of PCA.



Source: Our elaboration

#### 4 Discussion and conclusions

As can be deduced from the results obtained in this study, it can be assumed that there is a correlation between circular economy and knowledge management within the assessed companies. However, this correlation is too mild to be reliable. Therefore, PCA was applied to scrutinize the relationship between the components of two concepts. Both circular Economy and knowledge management can be viewed as the two enabling pillars of companies towards uncertainty. The effect of these two on each other is, however, debatable. For example, we may think of a company as systematically applying circular business models without relying on substantial and efficient knowledge management and information flow. To overcome the issue and shift the focus towards the more significant problems within the state of the art, a suggestion is considering information as one of the company's resources, even if not intangible. This approach can boost the application of circular business models on these kinds of assets to elevate both circularity and knowledge management on the same conceptual level and make them equally important for both enterprises and

researchers. Too often, the previous research efforts overlook circularity in knowledge in companies, making it the proverbial "elephant in the room."

The developed methodology allowed us to rank the most prominent companies of the EU according to the number of mentions on knowledge management initiatives and circular economy initiatives on their non-financial reports. Whether the indices of knowledge management and Circular Economy perfectly capture the real situation is left to the further analysis of the "goodness" of fit between operational definitions of knowledge management and circularity (as defined by both indices) and the reality itself. What mattered for us was to obtain a way to rank the companies in the dataset according to some universal criteria to transcend the variables that only matter within the local context. The indices we obtained through the methodology do not (and should not) merit being the most precise or proximal. This comes as no surprise, once again, given how heterogeneous are perceptions of circularity and knowledge management within the state of the art.

Interesting are the results of the regression analysis. The mild positive linear relationship between knowledge management and circularity reveals that the issues of being efficient in managing tangible and intangible assets are connected. Among the specific components of circular economy, only renewable energy seems not related to the knowledge management index. But also, this component does not correlate with circular economy and other components of it. This makes sense, as what seems to count for companies in circularity issues is the efficient management of tangible materials used in the production. To prevent the company from a one-dimensional approach to the circularity issues (by focusing on renewable energy strategies or vice versa), we suggest that new circular business models should be introduced to apply circular economy principles to all groups of assets, including energy, information, material, etc.

As for the contribution of specific components of knowledge management to the circularity of a company, all components are correlated in the first dimension, while along the second dimension, only knowledge gathering and knowledge transferring are correlated with circularity. It seems, applying the principle of circularity on information and knowledge management is more feasible in terms of inputs and output rather than information processing levels. It can be because of the complexity of the knowledge creation procedure in a system. Here we can suggest a systematic approach to the concept of circularity in information and

knowledge, introducing the concept of knowledge circularity in each phase of the knowledge-creating procedure.

From a managerial point of view, the obtained results imply a set of important implications.

Firstly, circular economy issues should not be neglected because of focusing on one or limited components of it as renewable energy in our case. The same is valid for issues related to knowledge management.

Secondly, most big European companies are ready to implement circular economy and knowledge management initiatives; however, only a minority of them scored highly on both indicators. The other ones are clustered near the origin of the axes. From the PCA maps of individual companies, it becomes clear that circularity issues are addressed more frequently than knowledge management issues. We advise decision-makers to consider circular economy initiatives applicable to various assets rather than only materials used in the production. This approach will increase the competitive advantages of the company as well as its profitability.

Thirdly, a presence of a well-developed knowledge infrastructure will undoubtedly benefit the future circular economy initiatives of a company. While planning for both circularity and knowledge management, decision-makers should consider the synergetic relationships between them.

Given that the companies' dataset was not based on a random selection, there is an obvious limitation to the analysis results. The above conclusions and suggestions apply to companies of considerable size in the EU and already adopt knowledge management and circularity initiatives.

The generalization of the results is impossible unless the company in question presents similar characteristics to big generic companies of the European Union.

More in-depth statistical validation of both is needed regardless of the good face validity of the indices of knowledge management and Circular economy. Further replication studies should also be performed to assess the reliability of indices. The principal component analysis revealed itself as a good method to uncover the latent relationship between the indices and formulate the model inductively. However, to validate the model, a more formal and structured analysis of its components is needed. This can be achieved in future studies by applying a more formal and standardized statistical framework, like structural equation modeling.

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## **The Influence of Digitization on Organizational Resilience: Black Swans and Antifragility**

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### **Abstract**

Nowadays, organizations are constantly facing new challenges and threats that may come in various forms, from both inside and outside companies' boundaries. Natural disasters, pandemic diseases, terrorist attacks, economic recession, equipment failures, hacker attacks and human error are just a few examples of catastrophes that present them with new challenges and threats, both inside and outside the company borders. Such events, unpredictable and anomalous, with a huge impact on a large scale and completely unexpected, are generally labelled as Black Swans. The impacts experienced by such events transcend borders and geographic dimensions and negatively affect governments, businesses, transport, economic sectors and people.

The era of digitization represents a new challenge for organizations, a means that could provoke new Black Swans and at the same time prevent others, multiplying the situations in which organizational skills are tested and creating highly competitive environments. Digital can therefore be considered on the one hand a driving force for the development of an organization, on the other a challenge for its resilience and antifragility. Technological change must be analysed not just as regards new business opportunities, but also with respect to potential vulnerabilities.

The aim of this work is to understand the real effects of the digital transformation on the resilient characteristics of organizations.

The research is based on a framework that articulates resilience into its key indicators, in order to create a link between organizational resilience and the trade-off of threats and opportunities caused by digitalization. The resilience transformation framework was used to analyse a case study in which evidence was provided of how the model can be applied in a backwards perspective, in order to understand how digitalization consolidates resilience in a real context and in the middle of the Covid-19 pandemic crisis.

The research shows that in the new millennium the company has transformed its business model, adopting a strategy that places sustainability at the centre of the value chain, making digitalization a key element at all levels and in all processes within company. The results clearly reflect the steps taken and the deep transformation of the company, accelerated in some way by the situations of profound turbulence caused by the pandemic. Indeed, the case study shows a highly connected digital infrastructure with a very high level of resilience.

**Keywords** – Digital Transformation, Case study, Resilience, Risk Management

**Paper type** – Academic Research Paper

## 1 Introduction

The environment surrounding organizations increasingly challenges them by posing different threats in various forms. Natural disasters, pandemic diseases, terrorist attacks, economic recession, equipment failures and human errors are just a few examples that help to understand how many different events can undermine the stability and security of an organization and its environment (Bhamra *et al.*, 2011).

From a managerial point of view, resilience can be defined as the ability of individuals or organizations to successfully recover and overcome adverse situations, stressful conditions or unexpected events (Rirkin & Hoopman, 1991; Horne & Orr, 1998; Coutu, 2002). This skill, expected by organizations operating in complex, dynamic and changing contexts, can allow adaptation to situations of crisis, economic, social or political instability, without compromising significantly the organization effectiveness (Starr *et al.*, 2003; Smit & Wandel, 2006; Syrett & Devine, 2012).

Unexpected and unpredictable event, called Black Swan, can have a huge negative impact on the entire organization, the organizations should be resilient and antifragile in the sense that could gain from disorder and even improve thanks to the event they faced (Taleb, 2007; Taleb; 2012).

Digital technologies transform the way we work and live. They provide new business worlds and health systems and augment human sensory systems. The humanity's creation of digital environments has the potential to lead to new forms of interactions with the human environment (Sholz, 2017). Furthermore, mastery of electron and semiconductor physics has allowed for seemingly limitless economic storage capacity, which has made digital tools available to all domains of society (Sholz, 2016). The unlimited accumulation of Big Data by many social media organizations is a major security threat as vast data sets tempt cyber attackers.

As stated by (Helbing, 2015), if on the one hand it tends to undermine the privacy and information security of individuals, on the other hand the extraction of socio-economic data has great potential in terms of acquiring a better understanding of the problems that our economy and society are facing, such as financial instability, lack of resources or conflicts. Without large-scale data mining, progress in these areas borders on the impossible. Our research aims at creating a link between organizational resilience and the trade-off of threats and opportunities caused by digitalization.

The research is articulated as follow. In section 2, we provide a brief review of the theoretical background about digitalization and organizational resilience together with the organizational resilience transformation framework and the research questions. In section 3, the methodology is described in detail and section 4 contains the discussion and conclusions of the study.

## **2 Theoretical Background**

### **2.1 Digitalization**

Digitization is interpreted as "the changes that digital technology causes or influences in all aspects of human life" (Satalkina & Steiner, 2020). The digital age started with the beginning of the millennium (Sholz, 2017) and today digital information and data are covering each domain of the human life. Potentially any action taken by someone will be digitally recorded (Sholz, 2016).

According to Manyka *et al.* (2013), leaders, both in government and in business, need not only to know what is on the horizon, but also start preparing for its impact, in order to understand which technologies will be important to them and prepare accordingly. If business and government leaders waited for



these technologies to exert their full influence on the economy, it would be too late to reap the benefits or react to the consequences.

Some guiding principles can help companies plan for the effects of disruptive technologies. Disruptive technologies can change businesses, creating entirely new products and services, as well as shifting pools of value between manufacturers or from manufacturers to consumers. Organizations will often need to use business model innovations to acquire some of that value. Leaders must plan a series of scenarios (Sholz, 2017), abandoning assumptions about where competition and risk come from, and not be afraid to look beyond established models.

## **2.2 Organizational Resilience**

The organizational resilience, defined by Mangas *et al.* (2020) as the characteristic that allows organizations to adapt their behavior before the succession of changes, disorders and traumatic events, is emerging as a basic skill and characteristic (Comfort *et al.*, 2010) that differentiates some organizations from others (Burnard & Bhamra, 2011; Annarelli & Nonino, 2016; Moran, 2016), and this allows them to make changes in their behavior in the face of a succession of changes, disorders and traumatic events. It is not only to achieve the survival and operational capacity of the organization, but to preserve the intellectual and social capital that allows the lasting success of the organization and its adaptation to the new realities resulting from the crisis situation (Lampel *et al.*, 2014).

It is necessary to consider specific actions that reinforce the precipitating factors of the resilience within the organization. Indeed, while individual resilience can be promoted through personal actions, organizational resilience will imply that mechanisms are put in place to achieve collective effectiveness (Sutcliffe & Vogus, 2003).

Therefore, building resilience while maintaining the competitiveness and stability of business operations becomes the optimal course of action for large complex systems (Linkov, 2014; Annarelli *et al.*, 2020a). Resilience, as a property of a system, include a vast range of choices (from a password to an operational paradigm for the management system of any organization), therefore, it becomes a key challenge for companies to implement measures to build organizational resilience and at the same time maintain competitiveness and ensure business sustainability (Annarelli *et al.*, 2020a).

### *2.2.1 Adaptive resilience and antifragility*

Taleb (2012) extends the concept of resilience introducing the concepts of black swans and antifragility. In order to face a random unexpected negative event (black swan), sometimes being resilient is not enough, as everything that has a minimum vulnerability breaks, given the cruelty of time. It is needed to be antifragile, a neologism that, being the opposite of fragility, express the ability to improve in face of stresses, volatility and disorder.

Of course, there is always a limit threshold beyond which being antifragile is no longer possible, the crucial question lies precisely in trying to raise this threshold as much as possible. The critical infrastructure of our society certainly has a very low threshold (including but not limited to cyber, energy, water, transport, and communication sectors) and therefore lacks an adequate degree of resilience, generally losing essential functionality following adverse events (Linkov, 2014).

Su (2016) distinguished two different conceptions of the term resilience: balance resilience and adaptive resilience. While balance resilience deals with the idea of "bouncing", adaptive resilience, associable with the concept of antifragility, embraces the idea of "moving forward" in such a way that the disturbed system evolves into a more robust one after the recovery. According to Fisher *et al.* (2015), there are more than 70 definitions of resilience in the scientific literature that vary between two extremes of equilibrium (or recovery) resilience and adaptive resilience.

Unfortunately, all these different definitions of resilience make its meaning ambiguous (Nyström *et al.*, 2008) and, although there has been considerable research in recent times to fill these gaps, many of these questions remain open to discussion and further research (Oladokun, Proverbs, & Lamond, 2017).

In this analysis, for simplicity, we will identify the term "resilience" also as an adaptive approach, thus incorporating the concept of "antifragility" within it. So, if a resilient system is subjected to stress, at worst it returns exactly to its original state thanks to its ability to absorb and restore, at best it exploits the shock to improve its original condition through a process of positive transformation.

### *2.2.2 Resilience transformation framework*

The concept of resilience includes the intrinsic characteristics that the organization must possess in a preventive manner to an adverse event (pre-event) and the characteristics for which the importance is understood only once

the adverse event has occurred i.e. the ability to adapt (post-event). Hence resilience is represented in our framework by these two indicators: pre event ability and post event ability. National Academy of Sciences (2012) defines four phases that organizations must follow to be resilient, later recalled by numerous scientific contributions (Linvov *et al.*, 2013; Linvov *et al.*, 2014; Annarelli *et al.*, 2020b).

The phases to be resilient are: (1) Plan/prepare i.e. lay the foundation to keep services available and resources functioning during a disruptive event (malfunction or attack); (2) Absorb i.e. maintain the function of the most critical resources and the availability of the service by rejecting or isolating the interruption; (3) Recover i.e. reintroduce all resource functions and service availability to pre-event functionality; (4) Adapt (or transform) i.e. using knowledge of the event, change the protocol, system configuration, staff training or other aspects to become more resilient.

The only pre-event phase is the first (plan and prepare), which has been further divided into 5 dimensions derived from the seven general principles for the design of more resilient systems by Biggs *et al.* (2015). The 5 pre-event dimensions identified are: maintaining redundancy, connectivity management, feedback management, unpredictability acceptance, participation of actors.

The post event dimensions are absorb, recover and adapt.

It is important to emphasize that the five dimensions of the pre-event indicator are static in nature, so they can be seen as actions that can be undertaken in every moment, while the last three phases are dynamic in nature, so they are chronologically consecutive. In the present study, a system cannot be defined as resilient if it totally lacks one of these eight dimensions and the absence of one cannot be compensated for by increasing the quality or quantity of the others.

In Figure 1 we proposed our resilience conceptual framework containing these eight dimensions and the interdependences between them:

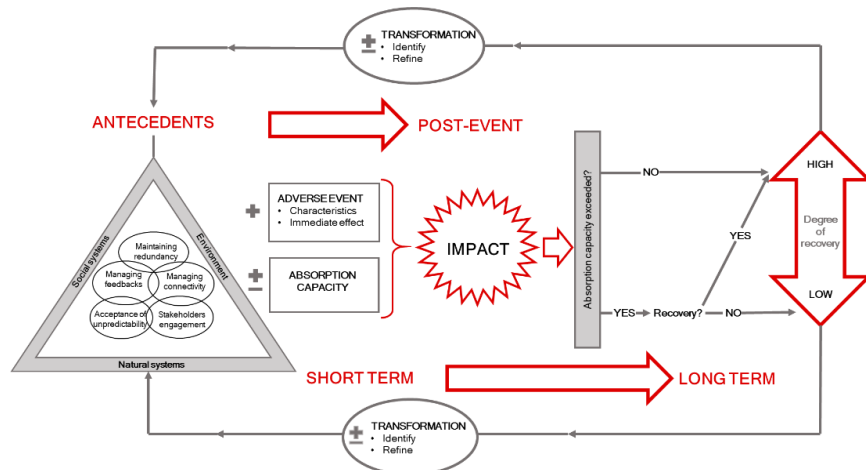


Figure 1 – Resilience transformation framework  
(inspired by Cutter et al., 2008)

The framework's structure was derived from the disaster resilience of place (DROP) model of (Cutter, *et al.*, 2008), originally designed to address natural hazards, but the authors themselves state that it could be adapted to other fast-onset events such as the dangers of digitalisation, terrorism or slow-onset natural hazards such as drought. Antecedent conditions can be viewed as a snapshot in time or as a static condition, while the post-event processes built into the model allow for the conceptualization of dynamic resilience.

Observing Figure 1, it can be seen that in the preceding conditions (represented inside the triangle), there are not only the five intrinsic dimensions of the framework (what we have), which are presented with a slight overlap so that they are not totally mutually exclusive or totally mutually inclusive, but also the exogenous variables (social systems, built environment, natural systems), which correspond to the surrounding environment understood as a constraint (where we are).

The antecedent conditions interact with the characteristics of the adverse event to produce immediate effects. Characteristics of the event include frequency, duration, intensity, amplitude, and speed of onset, which vary with the type of event. The immediate effects are mitigated or amplified by the presence or absence of the organization's absorption capacity, which depends on how the five intrinsic dimensions are put into practice at the same time as the event. This is represented in the model with a plus (amplified, if there is poor absorption capacity) or a minus (attenuated, if there is good absorption capacity). The total

impact of the event (impact) is a cumulative effect of the antecedent conditions, the characteristics of the event and the absorption responses.

The absorption capacity or threshold can be exceeded in two ways. First, if the adverse event is so great that it overwhelms the organization's capacity and is therefore impossible to stop; secondly, if the event is less catastrophic, but the existing absorption responses are insufficient to manage the impact, the absorption capacity will then be overcome by pushing the organization closer to disaster. In both cases, the organization can carry out any restoration (what we do), through the detection of the impact and the definitive restoration. The impact detection uses alarm mechanisms (automatic or not) to understand when the absorption was not sufficient. Final restoration is the phase in which we try to re-establish the optimal operating conditions possessed in the pre-event phase. Furthermore, Cutter *et al.* (2008) state that the degree of recovery can be thought of as a continuum that goes from high to low. If an organization's absorption capacity is not exceeded, higher recovery rates are rapidly achieved. If the absorptency is exceeded and the recovery process does not occur, a lower degree of recovery may result. However, if the absorption capacity is exceeded and the recovery process occurs, the organization is more likely to achieve a high degree of recovery. Regardless, overall recovery is an ongoing process and can go on until the next event.

The last phase of the framework that occurs between one event and another is the transformation phase, which consists in learning from the crisis that has just occurred. This phase is reactive and proactive at the same time, as an organization should strengthen its resilient characteristics in a reactive manner to the past adverse event and proactively to any future adverse event, probably different from the previous one. This is the reason why in the diagram the transformation is represented both in the case of a high degree of recovery and in the case of a low degree of recovery, in both cases there can be an effective diagnosis that can lead to an improvement of internal processes. Only if an organization rides the danger to improve itself can be defined as antifragile.

### **2.3 Research gap and aim of the study**

Digital systems can cause unwanted side effects and destroy the foundations needed to build sustainable social rules, or they can lack robustness, for example, in storing vital data (Sholz, 2017).

Furthermore, digital technologies are responsible for rapid changes in all social and economic structures. For Sholz (2016), in-depth, discipline-based interdisciplinary research is needed with the aim of developing the basic knowledge to create and manage resilient relationships between organizations and their digital environments.

According to Helbing (2015) digitization is a tool that has two faces: it can be at the same time a Black Swan and the means to defeat it by consolidating organizational resilience. Organizations must be able to manage this trade-off, generated in a forced manner in the last decades.

In general, the era of digitization therefore represents a new challenge for organizations, multiplying the situations in which organizational skills are tested and promoting highly competitive environments. Therefore, it is necessary to develop heuristics that provide a vast amount of information on the intervention strategies that can be proposed and that can guarantee comparison with the new social, economic, political and cultural circumstances produced by digitization (Mangas *et al.*, 2020).

This study aims to definitively link the two important research fields of digitalization and resilience by answering the following research questions:

*RQ1: How can digitization consolidate organizational resilience?*

*RQ2: How can digital companies be more resilient?*

### **3 Methodology**

#### **3.1 Case study analysis**

The research work was carried out using the methodology of the illustrative (and explanatory) case study (Yin, 1984; Eisenhardt, 1989) involving a multinational company operating in the energy sector, which in the new millennium has shown a considerable effort of digital transformation.

The case study analysis was designed with an inductive construction effort, according to the indicators obtained from past literature.

The documentation includes primary data (resulting from interviews) and secondary data (press, official company documents, such as websites and archival sources).

The proposed method is the open-ended interview, considered one of the most effective as the researcher can formulate questions of a general nature, with

which some key informants are invited to present personal points of view on the subject of study or on significant events.

### **3.2 Interview protocol**

The interview protocol was structured in eight sections, one for each dimension of the framework. Therefore, each interviewee was asked questions concerning not only the strategies to confer static resilience to the company, but also the actions and protocols to follow to react to any periods of crisis, with particular reference to real events (for example the Covid-19 pandemic, but also natural disasters or hacker attacks).

To give coherence and solidity to the research, the same interview protocol was proposed to each interviewee; of course, each tended to dwell more on the key issues in his field. In addition, to give quality and breadth to the research, an important differentiation of the people to be interviewed was opted (detailed in the next paragraph), making sure that they operated in complementary areas but at the same time being involved in the digital transition process that is taking place in the last years. In this way, it was possible to analyze the effect of digitalization across the entire company complex and over time (pre and post adverse event).

### **3.3 Sample**

With about 70,000 employees worldwide and a turnover of about 75 billion, the main objective of the company in which we conducted our case study is the production, distribution and supply of energy. Furthermore, it is one of the companies that is investing most in digitization. In fact, the digital revolution is one of the cornerstones of its industrial strategy and it is considered a fundamental tool for the development of smart grids and value-added services.

In order to give solidity to the research, this study focused on a series of face-to-face interviews involving exclusively internal employees. A total of 7 people were interviewed through a semi-structured interview: 5 high-level managers and 2 junior employees. More specifically, the 5 top managers were part of the following areas: human resources manager of the digital area (HRD), Responsible for power generation of the digital area (PGD), Responsible for organizational

transformation (OT), Responsible for planning and organizing the digital area (POD), Responsible for strategy and relations with stakeholders (SRS).

Two junior employees were interviewed at the same time, respectively part of the innovative area (in particular the field of electric mobility) (JrIA) and the relationship with suppliers (JrSR). These last two have been an important source of information for analysing some dimensions, as some issues can be better addressed with those who are directly in contact with operations.

## **4. Discussion and conclusion**

### **4.1 Results**

The case study analysis reveals that digital tools have helped to consolidate resilience, the emblematic example being the ability of the organization to automate the management of interventions. The issue of technological unemployment was also discussed, concluding that in this case too, digitization should not be seen as a tool that replaces human skills, but simply modifies them and ensures that human resources perform activities of greater added value.

In fact, this question has been partially answered with the review of the past literature, identifying, and selecting all the most important characteristics applicable to a resilient organization. But to give even more solidity to the research, we tried to understand with the analysis of the case study what dimensions were most used in practice to develop a resilient structure. Being part of the utilities sector, the respondents gave particular emphasis to the issue of infrastructure redundancy, connectivity and long-term perspective. In fact, it emerged that there are three closely related characteristics. The organization has responded optimally to the pandemic precisely because it has a well-redundant level of connectivity and has always been able to prepare well in advance for any type of situation, trying to outline more than one future scenario and not betting on a scenario in particular as many organizations still do today. In fact many organizations, in order to maintain good relations with shareholders, limit themselves just considering the level of revenue in the short term, without considering the increasingly changing environment in which they are immersed, which necessarily requires a great reactive capacity.



Obviously, digitization must be managed appropriately because it could entail a series of disadvantages highlighted in the literature and confirmed by the case study:

- Excessive fragmentation of work that risks to fail the global identification of the problems;
- Difficulty in establishing the conditions of empathy with the user to allow to deepen the latent problems;
- Loss of non-verbal communication that hinders the global understanding of the problems;
- Need for specialized training of professionals in the handling and use of these types of tools;
- Greater exposure to hacker attacks from outside, causing a consequent increase in corporate vulnerability.

Therefore, digitization helps but must be managed in the right way, because it is a tool and not an end. If an organization is hyper-digitized, this hyper-digitization inevitably brings with it an increase in vulnerabilities. The skill lies in identifying them and mitigating them. The proposed model can be a useful tool to support resilience planning and the actions to be taken to exploit digitalization in the best possible way.

In fact, as stated by OT, the crucial question is: "eliminate digitization or find a way to use it in the right way?", "If you want to have a resilient structure with a long-term vision, you must necessarily exploit digital, because if it is used in the right way it can only bring benefits " Therefore, this study acts as a link between digitization and organizational resilience, which are two macro-streams of literature widely treated but which had never yet been correlated with an accurate analysis of a case study.

#### ***4.2 Limitation and future research directions***

The study obviously leaves some gaps that suggest future research directions. First, it only focuses on three dimensions for post-event adaptive capacity; in particular, the absorption dimension has within it a series of nuances that could be analyzed in more detail. Secondly, only one case study was used to support the proposed model; future research work should adopt a wider variety of cases, in order to test and confirm the validity of the tool in different contexts and

sectors, to see if its applicability is still effective or if there are some contextual factors that could impose changes and loss of meaning to some aspects.

So far, the organizational dimensions where the impact of digital transformation seem to be more evident (information, innovation, leadership and elimination of traditional dividing barriers) are not perceived as a key element for the survival and adaptation of organizations. The perceived low importance of these factors indicates that the concept of resilience still needs to be deepened and rooted in business realities. This study is the basis for developing heuristics in the future that provide a vast amount of information on the intervention strategies that can be proposed, and that can guarantee comparison with the new social, economic, political and cultural circumstances produced by digitization. In other words, the organizational transformation must be at the same time digital and antifragile.

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## Knowledge Management, Digital Transformation, and Industry 4.0: Exploring Relationship and Solutions

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### Abstract

This paper provides a structured literature review (SLR) on knowledge management (KM), digital transformation, and Industry 4.0. The study aims to define all the interactions, ties, and interdependencies between the three research streams. As an essential role in a progressive discipline, our research summarises the state of the art of past and current literature using the Massaro's et al. (2016) methodological paper. The researchers adopted the Scopus database and their analysis as tools for the Bibliometrix R package to collect bibliometric data. The analysis reveals 561 peer-reviewed of English articles. The study shows some research clusters that coincide with the following survey areas: KM and ICT, KM and frontier technologies, KM and decision-making, KM and Industry 4.0, and KM and innovation. Finally, this article's originality emphasises the crucial role of digital transformation for KM development in Industry 4.0, addressing future research perspectives.

**Keywords** – Knowledge management; digital transformation; Industry 4.0; Bibliometric analysis

**Paper Type:** Academic Research Paper

## 1 Introduction

The scholarly debate under knowledge management, digital transformation and more general innovation increases in the last years (Cabeza-Pullés et al., 2020; Di Vaio et al., 2021). Despite some companies still attempting to resist change, technologies and digital transformation models increasingly gain space in this scenario by creating ideas and prototypes (Bao, 2009). Technological tools have impacted companies' transformation regarding innovation and business management (Andersson & Karlsson, 2007). In the last period, companies are mainly experimenting with how Industry 4.0 with new data management and manufacturing processes tools can enhance Industry 4.0 (Bordeleau et al., 2020). Despite the interest among the two research streams, the literature does not provide quantitative and qualitative variables on these two topics due to its recent concept (Tortorella et al., 2020).

Additionally, as Paul and Criado (2020) suggested and Massaro et al. (2016), a review article can help enhance the knowledge and address future research challenges in recent research streams. This study analyses the relationship between knowledge management and digital transformation for Industry 4.0 implementation for all these premises. Therefore, the research team will provide an in-depth analysis of the literature using the approach proposed by Massaro, Dumay, and Guthrie. In this vein, the Structured Literature Review (SLR) is an approach that combines several research methods and approaches with a thorough research protocol and allows the replicability of results (Massaro et al., 2016). The process joins the content and bibliometric analysis rules, enabling to reduce errors in the paper's collection and interpretation. Therefore, as suggested by Secinaro and Calandra (2020) and Zaheer et al. (2019), SLR allows creating interdisciplinary, rigorous and emerging research stream-oriented reviews. Furthermore, the bibliometric review is implemented using "*Bibliometrix*" package with R software (Aria & Cuccurullo, 2017). The analysis also considers the co-occurrence network, allowing creation nodes and the emergence of significant research streams (van Eck & Waltman, 2014).

After adopting a structured keyword research methodology, which will be comprehensively analysed in the method section, the article explores 561 scientific papers.

Our paper has interesting implications. We provide an in-depth discussion of the results, giving future research tools to inform researchers, offering more

insights for future studies on Industry 4.0 and KM for companies. From a practical perspective, entrepreneurs can consult this paper to recognise the links among KM, technology, and Industry 4.0. Managers could benefit from this analysis by seeing all the relevant topics and discussion among the three themes under investigation.

## **2 Background**

The development of KM can be divided into four phases. In the first one, extending from the early 1960s to the early 1990s, researchers concerned with codifying knowledge, storing explicit knowledge, and emphasising learning through best practices and lessons learned (Gaviria-Marin et al., 2018; Roper & Love, 2018).

The second stage runs from the 1990s to the early 2000s; knowledge is conceived as a fundamental economic resource of the knowledge society (Drucker, 1993). This means that organisations aiming to cope with the dynamics of change need to create information and knowledge, not just process it efficiently. At this stadium, researchers have focused more on the study and description of the processes of knowledge sharing and conversion of tacit knowledge into explicit knowledge to increase intellectual capital (Serenko, 2013).

Subsequently, from the 2000s to early 2018, research focuses on social networks, autonomous media, and human-machine interaction and understands that KM is strategic for organisations (Gaviria-Marin et al., 2018; Tzortzaki & Mihiotis, 2014).

Nowadays, several bibliometric analyses have been done on KM. Sanguankaew and Vathanophas Ractham (2019) uses different keywords than the present one to describe KM and correlates it with sustainability. Two other bibliometric analyses focus on specific analysis of a few journals whose central theme is KM, namely Journal of Information & Knowledge Management (Alajmi & Alhaji, 2018) and Journal of Knowledge Management (Gaviria-Marin et al., 2018).

According to Stolterman & Fors (2004), digital transformation can be understood as changes that digital technology causes or influences in all aspects of human life. Westerman *et al.* (2011) defined digital transformation as technology to radically improve companies' performance or reach and create new business opportunities using data and digital technologies. However, digital transformation is a disruptive change process and begins with adopting digital

technologies, progressing to an implicit or deliberate holistic conversion of an organisation to pursue value creation (Henriette et al., 2015).

The different definitions of digital transformation can be divided into three categories. Firstly, the technological aspect involves digital transformation is based on the use of new digital technologies, such as social media, mobile devices, analytics or embedded devices (Horlach et al., 2017). Subsequently, digital transformation's organisational perspective requires a change in organisational processes or new business models (Westerman, 2016). Finally, the social transformation aspect is defined as a phenomenon affecting all aspects of human life, such as improving the customer experience (Karagiannaki et al., 2017).

According to Wang (2018), digital transformation can drive towards a knowledge-based economy. This sets the basis for the fourth industrial revolution, also referred to as Industry 4.0, which relates to technological evolution and futuristic paradigms using smart and smart systems, automation, and digitised manufacturing (Ouamer-Ali et al., 2017). Industry 4.0 is used to move beyond a production model where machines are merely operationalising digital production routines, where devices can interact and work individually (Massaro et al., 2020). The main aim of Industry 4.0 is to ensure better production efficiency, productivity, and flexibility through the intelligent use of emerging technologies (Manesh et al., 2020).

However, the effects of these changes and their relation to KM have been erroneous, and the parameters involved are usually ambiguous (Meski et al., 2019). As a result of this operation, unstructured data and knowledge warehousing information system has increased considerably (Bishop, 2018). Therefore, organisations should also enhance their KM methods to truly benefit from this digital transition to search and identify useful information and create more sophisticated uses of this knowledge.

### **3 Methodology**

This paper is based on the structured literature review (SLR) of Massaro *et al.* (2016). According to D'Adamo and Rosa (2019), Dal Mas *et al.* (2019), Secinaro *et al.* (2020) Secundo *et al.* (2020) and Zaheer *et al.* (2019), this method allows a rigorous and consistent analysis of sources under study. Additionally, SLR will enable researchers to explore main research trends contributing to highlight young stream as the case of Industry 4.0 applied to the KM field (Tortorella et al.,



2020). Starting from Tranfield et al. (2003), who stated that a review should require structured and replicable processes. Despite the proliferation of literature reviews methods, the authors suggest that the SLR is the best option to join multiple ways and creates a research protocol. This method collects several multidisciplinary publications in high-ranked and multidisciplinary journals (Dumay et al., 2015; Massaro et al., 2015; Secundo et al., 2020). As reported by Secundo et al. (2020), the analysis is based on five crucial steps:

1. Write a literature review protocol.
2. Define the questions that the literature review is setting out to answer.
3. Determine the type of studies and carry out a comprehensive literature search.
4. Measure article impact.
5. Define an analytical framework.

The first elements to address consider developing a rigid research protocol based on the following items shown in Table 1.

Table 1: SLR review protocol

<b>Review protocol elements</b>	<b>Authors' consideration</b>
What is already known?	Based on the need, there is the potential for a structured literature review investigating how knowledge management and digital transformation contribute to Industry 4.0 implementation.
Research topic	The paper deals with two essential streams of literature. On one side, several authors highly investigated the KM literature by considering systematic reviews or bibliometric analysis, the digital transformation field, and the recent Industry 4.0 field.
Motivation	Disruptive technologies also face conventional KM methods even more considering the new Industry 4.0 paradigm.
Journals' research	We have decided not to limit the research to an individual scientific journal because of the still young scope. Therefore, our analysis is broad in terms of themes under investigation.

Source: Authors' elaboration

According to Zupic and Čater (2015), bibliometric research in the business and management field introduces *"measured objectivity into evaluating scientific literature"*, increasing rigour of study and decreasing review's biases. For the analysis of the quantitative data, we used R and the Bibliometrix package (Aria & Cuccurullo, 2017). Also, we used VosViewer software to conduct the keywords'

analysis. This program is also used for the keywords' cluster analysis (van Eck & Waltman, 2014).

The second step in an SLR is research questions' selection. Considering the introductory gap, research questions address are:

*RQ1. What are the characteristics of the literature for KM and digital transformation in Industry 4.0?*

*RQ2. What is the focus of this literature in terms of key concepts?*

*RQ3. What are the future directions of research in this field?*

In the third position, the authors used the Scopus database to extract all the relevant sources. The database incorporates relevant and updated references, and has the same scientific validity as Web of Science (Okoli & Schabram, 2010). To select the appropriate scientific flow, we consider a keywords analysis, including a structured research strategy. Based on the paper of Rosa *et al.* (2020), the research team uses the following research strings:

"Knowledge management" AND "Industry 4.0" OR "Additive manufacturing" OR "Cloud manufacturing" OR "Internet of Things" OR "IOT" OR "cyber-physical system" OR "Augmented reality" OR "3d" OR "Industrial revolution" OR "fourth industrial revolution" OR "Simulation" OR "Smart production" OR "Smart manufacturing" OR "Data mining" OR "Digital" OR "Smart".

Additionally, to increase the focus of our analysis, we include relevant search limitations selecting only peer-review articles on the business, management, and accounting area written in the English language. The analysis was conducted in December 2020 and, to ensure the inclusion of relevant articles, four authors independently verified that the extracted items were related to the study's scope (Grafton *et al.*, 2011). The first analysis reveals 12,108 documents, after the application of research limitations, we consider only 3,306 peer-review articles, then only the area of business, management and accounting is considered. Therefore, the final sample consists of 561 English scientific articles.

The fourth point, considering the selection of article with an impact in the field of analysis, the paper will begin to consider the most cited papers in the area. The data selection biases can be avoided with bibliometric analysis due to the quantitative analysis that could help researchers focus on the primary and relevant papers (Zupic & Čater, 2015).

Fifthly, we improve a coding framework based on the previous literature (Dal Mas *et al.*, 2019; Massaro *et al.*, 2015). Table 2 shows the analytical framework created for the analysis.

Table 2. Analytical framework

<b>Category</b>	<b>Variables</b>	<b>Specifications</b>
<i>Bibliometric data</i>	<i>Main information</i>	<i>Years</i>
	<i>Authors</i>	<i>Citations</i>
		<i>Collaborations</i>
	<i>Sources</i>	<i>Journals</i>
		<i>Citations</i>
	<i>Keywords</i>	<i>Occurrences</i>
<i>Coding analysis (a = 0.667)</i>	<i>Authors</i>	<i>Collaboration</i>
	<i>Authors' background</i>	<i>Mixed</i>
		<i>Practitioner</i>
		<i>Scholar</i>

Source: Authors' elaboration

## 4 Results and discussion

The purpose of this section is to present the results of the study of the paper pools under investigation according to point nine of Massaro, Dumay, *et al.* (2016) methodological paper.

### 4.1 Characteristics of literature on KM and digital transformation in Industry 4.0.

To answer the first research question regarding the literature's characteristics on this topic are presented in the first paragraph. Table 3 ranks preliminary information regarding the data under analysis. As shown, the first year of scientific production in this field is 1988. In this regard, it is possible to point out three periods of research from 1988 to 1998 with low scientific production in this field. Second, from 2000 to 2010 with increased interest of researchers in this field. Third, from 2011 to 2020 with a significant increase in scientific production three times compared to the previous decade. Articles are published in 200 scientific sources, and the average publication rate is 6.68 articles per year. The authors then used 27,473 references from other authors and 1.875 keywords showing the relevant debate under this theme absent in others research field (Bhatt et al., 2020) Besides, the number of articles by multiple authors confirms that the scope of research is extremely collaborative. Only 93 have single author signatures. The collaboration index also demonstrates it for 2,82.

Table 3. Main information about data

Description	Results
Timespan	1988-2020
Sources	200
Documents (Articles)	561
Average years from publication	6.68
Average citations per documents	20.19
Average citations per year per documents	2.818
References	27.473
Keywords Plus (ID)	2.374
Author's Keywords	1.875
Authors	1.394
Authors Appearances	1.531
Authors of single-authored documents	93
Authors of multi-authored documents	1.301
Single-authored documents	99
Document per Author	0.402
Author per Document	2.48
Co-Authors per Documents	2.73
Collaboration Index	2,82

Source: Authors' elaboration

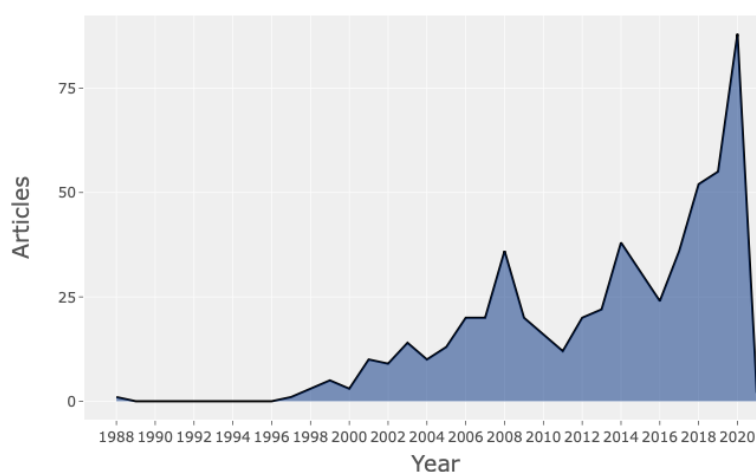


Figure 1. Annual Scientific Production

Source: Authors' elaboration

Table 4 shows the ten most cited articles of the cluster, which represented a milestone in the field. Kanawattanachai and Yoo (2007) develop a model for the KM of virtual team considering expertise location, task-knowledge coordination, and cognition-based trust and the impact on the team's performance. On the same side, Kane and Alavi (2007) studied the effect of information technology (IT) in organisational learning (OL), exploring the different learning processes. More business focus is the contribution of Hsieh *et al.* (2006) and Shaw *et al.* (2001), which tested KM considering data mining for psychological purchase detection by customers. These two papers introduced a new research field extended by the years from several authors.

Table 4. Most Global Cited Documents

<b>Paper</b>	<b>Total citations</b>	<b>Total citations per year</b>
(Kanawattanachai and Yoo, 2007)	382	27.2857
(Hsieh <i>et al.</i> , 2006)	376	28.9231
(Shaw <i>et al.</i> , 2001)	361	18.0500
(Barrett <i>et al.</i> , 2015)	341	56.8333
(Gibbert <i>et al.</i> , 2002)	314	16.5263
(Pavlou and El Sawy, 2010)	280	25.4545
(Angelidou, 2015)	259	43.1667
(Kane and Alavi, 2007)	250	17.8571
(Nemati <i>et al.</i> , 2002)	244	12.8421
(Xu, 2011)	205	20.5000

*Source: Authors' elaboration*

Source's analysis in Table 5 shows the highest number of published articles 34 from the Journal of Knowledge Management as a primary Journal in this field. Subsequently, other journals interested in the area are the Decision Support Systems Journal with 30 publications and the Knowledge-Based Systems and the Technological Forecasting and Social Change journal with 18 publications.

Table 5. Most relevant sources

<b>Sources</b>	<b>Articles</b>
Journal of Knowledge Management	34
Decision Support Systems	30
Knowledge-Based Systems	18
Technological Forecasting and Social	18

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Change	
Vine Journal of Information and Knowledge Management Systems	17
International Journal of Production Research	16
International Journal of Knowledge Management	15
Industrial Management and Data Systems	12
Information and Management	12
Knowledge Management Research and Practice	10

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*Source: Authors' elaboration*

## **4.2 Keyword's analysis**

To analyse the information structure in this area and answer the second research question, the researchers analysed the keywords of the published papers using the Vos Viewer software (van Eck & Waltman, 2014). Our results determine five research nodes considering KM and ICT, KM and frontier technologies, KM and decision-making, KM, Industry 4.0 and finally, KM and innovation.

### **4.2.1 KM and ICT**

As we can see, the blue area of Figure 2 focuses on KM and ICT. According to Turulja and Bajgoric (2018), information technology (IT) changes business and manages human resources. For the authors, IT can enhance human resource management by improving KM in this vein. This relationship creates benefits also for business performance. More specific are the results of Park *et al.* (2015), which develop a KM framework considering the firm's size. Their results suggest that a fast IT learning process is aimed at when internal learning processes are slow. Therefore, learning mechanisms can benefit from external sources as internal electronic communication networks, external communication networks, company knowledge repositories/portals, and inter-organisational knowledge repositories.

### **4.2.2 Knowledge management and frontier technologies**

Interesting are the results of the second research strand coming from the yellow area of Figure 2. Our results suggest that new frontier technologies are emerging. For instance, Nemati *et al.* (2002) 's contribution gives a broad idea about decision support systems and new tools such as data warehousing

supported by artificial intelligence. Therefore, through innovative architectures for companies, it is possible to validate, store, organise and disseminate data and knowledge for workers. Lei and Wang (2020) propose an efficient methodology for transferring and managing corporate knowledge based on artificial intelligence in this line of study.

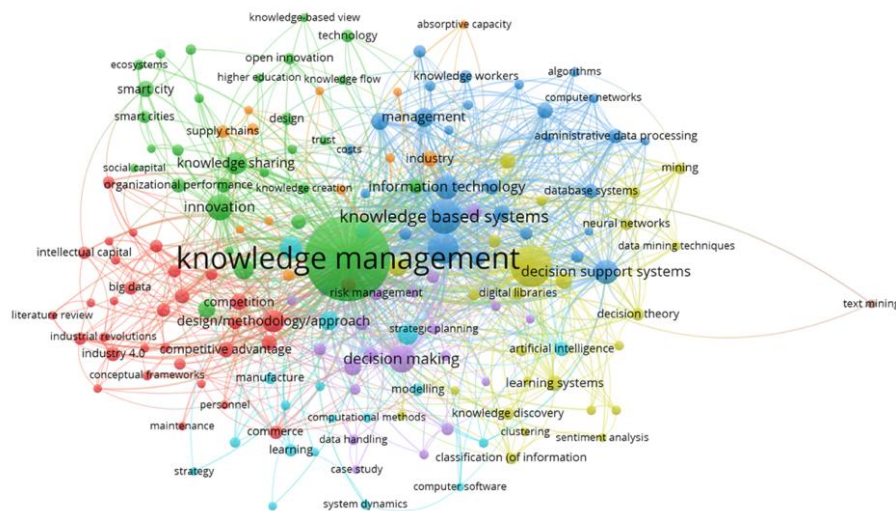


Figure 2. Co-occurrence keywords  
Source: Authors' elaboration using VosViewer software

### 4.2.3 Knowledge management and decision-making

The third strand of research (purple area, Figure 2) demonstrates a strong link between KM and decision-making. Among the earliest contributions, Balasubramanian *et al.* (1999) research models and implements a framework to describe the KM processes that lead to relevant business decisions. A few years later, Howells *et al.* (2004) discuss the externalisation of corporate decision-making knowledge. Based on case studies, the article develops a possible external knowledge model to support internal decisions. Looking more internally, Ghrab *et al.* (2017) show that corporate data improves ability, decision making and knowledge sharing between companies in the same group or geographically distant

#### 4.2.4 Knowledge management and Industry 4.0

The fourth research strand (red area, Figure 2) addresses the link between KM and the Industry 4.0 paradigm. This topic has seen increasing interest from researchers (Massaro et al., 2020), this trend is also confirmed in this research area. Recently, Meski *et al.* (2019) define Industry 4.0 as a paradigm within ICT and propose a conceptual framework based on business data exploitation. Schott *et al.* (2020) describe the boundaries of knowledge by specifying that KM and Industry 4.0 primarily refer to technologies for manufacturing production processes. Thus, the Industry 4.0 context can increase the complexity of data managed at the production level and provide practical knowledge inputs.

Finally, the research links become even more structured with Tortorella *et al.* (2020), who show how learning capacity at the firm level is a positive mediating factor towards Industry 4.0. Therefore, the authors conclude that learning and knowledge sharing can further increase with the new Industry 4.0 paradigm.

#### 4.2.5 Knowledge management and innovation

Finally, the fifth strand of research (Green Area, Figure 2) analyses KM and innovation. For example, Garcia-Morales *et al.* (2018) 's investigation contributes to the literature by creating a structured model of how social media can drive technological competencies to enhance and leverage corporate innovation capacity. Along the same lines is Manville *et al.* (2019), who investigated KM processes using balanced scorecard theory as a monitoring tool. More specific is the research by Santoro *et al.* (2018) in the context of the Internet of Things (IoT). Here, the authors invent a model of developing firms' internal capabilities for KM as a disruptive point for firms' ability to innovate. Alongside this, several studies focus on knowledge collaboration between firms creating a specific research strand of KM and open innovation (OI) (Randhawa et al., 2017; Simeone et al., 2017).

## 5 Conclusion

This section aims to conclude the present paper by providing insights, critiques, and implications for the research stream investigated.

The literature analysis identified a gap related to the lack of quantitative and qualitative variables on the reference topics (Tortorella et al., 2020). As suggested by Paul and Criado (2020) and Massaro et al. (2016), a review article can improve



knowledge and address future research challenges. Therefore, our SLR aims to analyse the relationship between KM, digital transformation, and Industry 4.0.

The implementation of the SRL method (e.g. Dal Mas et al., 2019) collects several multidisciplinary publications in high-level, multidisciplinary journals (e.g. Massaro et al., 2015). The study used bibliometric analysis, which Zupic and Čater (2015) used to increase the study's rigour and decrease review bias.

The 561 papers' analysis indicated the highest number of articles was published by the Journal of Knowledge Management, 34. Additionally, notable are the 30 publications in the Decision Support Systems Journal and the 18 in Knowledge-Based Systems and Technological Forecasting and Social Change Journal. Among the relevant authors are Kanawattanachai and Yoo, Kane and Alavi, Hsieh, and Shaw. Specifically, these last ones tested KM by considering data mining to detect customer purchases' psychological detection. The topic does not yet appear to be fully involved in the KM stream. Indeed, our keyword analysis distinct five research streams related to the topic: KM and ICT, KM and frontier technologies, KM and decision-making, KM and Industry 4.0, and KM and innovation.

Based on this, several theoretical implications were found. This paper contributes to linking KM, digital transformation, and Industry 4.0. This allowed finding that the paradigm of Industry 4.0 can increase companies' data, even if it is in an early phase of development. Specifically, companies bring increased business knowledge and management of it through technological innovation. Although the flow of research between KM and Digital Transformation is widely developed, critical analysis reveals that the more subtle the links with Industry 4.0, the better.

As well, numerous practical implications were found. The study allows managers and Chief Technology Officer (CTOs) to view current connections in the literature and understand the new technological frontiers. It has also uncovered areas of inquiry not yet explored in practice, such as data mining.

Like any research, the present one has limitations. Primarily, it records the use of only the Scopus database to perform a bibliometric analysis of the literature. Next, the use of keywords limits the full understanding of the topic and its knowledge.

Therefore, to answer our third future research, scholars may deploy an essential number of case studies, in which researchers are hired within companies to examine KM in highly digital environments. Furthermore, it will be informative to implement comparative analyses across geographic areas and countries to verify

any distinct variables on the topic. Also, consider researching to check the level of connection between the expectations of professionals and researchers. Furthermore, starting from the study of Cabeza-Pullés *et al.* (2020). We believe that research insights could resolve the debate on KM processes in private organisations by showing collaborations in the context of Industry 4.0. Furthermore, considering the results of Wu *et al.* (2013), more studies could be conducted to investigate how KM related to Industry 4.0 translates in different sectors by showing valorisation and digital innovation mechanisms activated in them. Finally, future researchers could investigate whether KM in highly digitised companies with Industry 4.0 applications can increase companies' marginality and how this value is distributed to stakeholders from a quantitative research perspective.

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## **A New State of the Art – a Business Paradigm Led by Knowledge Management**

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### **Abstract**

This article aim is to review existing research on knowledge management (KM) in the context of contemporary digital transformation and its implications for business model innovation (BMI) in a hyperconnected environment. Using a systematic approach to literature review, this study contains papers that were collected from WoS and Scopus databases. 22 peer-reviewed articles formed the basis of analysis. The findings of this study suggest that KM is a key function in redesigning a firm's business model and together with the use of the new digital technologies can promote the effective adaptation to an ever-changing environment. Thus, organization ought to make the necessary modifications in their KM processes to make the new ever more often digital knowledge accessible, as well as to shape existing knowledge in order to redesign their business models towards continued BMI.



**Keywords** – Knowledge Management, Hyper-connectivity, Business Model Innovation, Digital transformation.

**Paper type** – Academic Research Paper

## 1 Introduction

In the knowledge management literature, knowledge has long been defined as a set of information; the context of which is provided by individuals and groups and their management in an organization (Dahlberg in 1995; Drucker, 1999; Firestone, 1999; Houlthouse, 1999). Numerous studies underline that KM is both a key resource for the company (Friedrich, Becker, Kramer, Schneider, 2020; Uden & He, 2017) and a process aimed at supporting the continued and sustainable development of organizations and their members (Durst and Zieba, 2020). However, knowledge management is acquiring a new dimension, a new role in a dynamic development economy (Rot & Sobinska, 2020) according to the new era. What is new is that modern technologies generate ever more reports loaded with data and information that need to be put in contexts and filtered to detect relevant information. In this kind of a hyperconnected world, knowledge management (KM) is becoming important in new ways (Valentim, 2002).

The latest fast-paced and worldwide developments regarding the ongoing pandemic COVID-19 underline the need for a paradigm shift to integrate digital technologies into KM (Ikpe, Didier and Dong-Heon, 2020) to improve the sustainability. Scholars advise to go for digital transformation, big data, virtual intelligence, and robotics in their KM (Barbosa, 2020). A research gap that has been identified within this context is what will be the role of the new digital-transformed KM and business model innovation (BMI) (Valentim, 2020). More specifically, there is a paucity of “full scope” (Manesh et al., 2021) or comprehensive studies addressing companies’ digital transformation in KM and progressive pursuit of BMI (Manesh et al., 2021). It thus is expected that KM can take its rightful place as a dynamic resource that can also have a decreasing meantime, so the implications of the on both KM and Knowledge Management Systems (KMS) need to be rigorously studied (Durst and Zieba, 2020). Against this background, the aim of this paper to systematically review current research on

KM in the context of contemporary digital transformation and its possible implications for BMI in an increasingly hyperconnected environment.

This paper considers knowledge as a critical and dynamic resource that evolves as the environment itself evolves (Durst and Zieba, 2020; Friedrich et al., 2020); that is, this paper reviews systematically new roles of KM given new technologies and digital transformation that enrich possibilities for BMI for the purposes of integrating them in a unified framework. The paper also emphasizes the need for sustainable business operations also after the COVID-19 pandemic (Peeri et al., 2020; Guerreri et al., 2020; Bhattacharyya et al., 2021) or contexts in which companies take up in their KM new technologies, making decisions against the clock, adapting their operations for circular business models, and downsizing their supply chains (Akpan et al., 2020; Derevyankina et al., 2020). It is also assumed that business model innovation (BMI) is crucial for reaching a sustainable competitive advantage (Evans et al., 2017; Haaker et al., 2021). Business model innovation has been summarized as a process of creating and developing new architectures to improve the sustainability of companies (Amit and Zott, 2012).

The paper is structured as follows. The next section briefly sets the frame of the paper. This is followed by the presentation of methodology used for doing the systematic literature review (SLR). Then, the proposed framework is presented showing the link between KM and digital transformation and BMI and which was derived from the analysis of the papers. The paper terminates with a conclusion.

## **2 Literature background**

“Uncertainty is the only certainty, change is the only constant” (Nonaka, 1991). Knowledge society and the new digital economy have emerged because of constant change (Turulja et al., 2018). Companies need to develop new understandings in business model redesign and innovation to maintain sustainability of their business operations (North and Kumta, 2014; Paoloni et al., 2020), and innovation in KM (Hsu and Sabherwal, 2011). Although it is not enough to acquire knowledge and new understandings as well as the capacity to apply them properly is needed to achieve a market advantage through knowledge management (Carneiro 2000; Kalotra 2014; Darroch 2005).

Value for the firm from such a KM system enables BMI and the company to survive and have sustainable competitive advantage in the contemporary context

of hyperconnectivity (Ferraris et al., 2017; Santoro et al., 2018; Bogner & Bansal, 2007; Lee & Choi, 2003; Tanriverdi, 2005).

Nonetheless, KM, digital transformation, and BMI have been studied mostly separately in the literature, the concepts combination is viewed as a promising topic (Rot et al., 2020). A company that is successful in taking advantage of all these three aspects is able to create new knowledge, engage in BMI, and in turn create new value (Nonaka, 1991; Quintas, Lefrere, et al., 1997; Vaiappuri et al., 2016). Within this context, this research analyzes recent research on KM and how it in the hyperconnected world coevolves with digital transformation and BMI. By taking a SLR approach, this understanding shall be determined. Based on that the following primary research question is posed primary RQ1: what is the role of KM in the current era of digital transformation and hyper-connected markets based on business transformation? i.e., what role of the new digital-transformed KM plays in business model innovation (BMI)?

In this light, the article proposes a theoretical framework of KM which is the output of a reviewing of 22 articles identified.

### **3 Methodology**

In our review process, the research briefly adopted the principles of a SLR as recommended by Jesson, Matheson, and Lacey (2011), namely: (1) mapping the field through a scoping review, (2) comprehensive search, (3) quality assessment, (4) data extraction, (5) synthesis, and (6) write-up.

First, we developed a research plan to answer the primary RQ1: what is the role of KM in the current era of digital transformation and hyper-connected markets based on business transformation? i.e., what role of the new digital-transformed KM plays in business model innovation (BMI)? Also, we have investigated each article to answer the remaining research questions (see Table 2).

e II). We comprised keywords, and a set of inclusion and exclusion criteria.

We from the start at conceptual research, focusing mainly on recent systematic literature reviews, to determine the current role of the KM within BMI considering the influence of the digital transformation. Articles that included the keyword combinations "KM"; "KM and SRL"; "Digital transformation"; "Digital transformation and KM" "strengths"; "KM and Digital transformation" "Business model innovation"; "Business Model Innovation and KM"; "KM and Business model innovation" were included.

In addition, we specified inclusion and exclusion criteria. Inclusion criteria were publications in the period 2005-2021, academic articles giving priority to those systematic reviews already carried out on the role of KM, English language, and WoS and Scopus databases. The SLR approach allowed us to follow advances and trends within the chosen discipline field and to include them in the conceptual paper and literature (Merigó et al., 2016). Sometimes these studies guide scholars in researching more influential disciplines (Godin et al., 2006) with WoS being an essential platform for this type of research (Carvalho et al., 2013).

The systematic literature review on KM built on some relevant SLR already conducted such as those by Durst et al. (2019, 2020); Martins et al. (2019); Paoloni et al. (2020); Bamel et al. (2021); Di Vaio et al. (2021). This provided us a conceptual framework in the state of art allowing to build and question the theoretical body of concepts (Meredith, 1993) – in this case, a dynamic model of KM (Durst and Zieba, 2020; Bamel et al., 2021). This type of reviews follows a series of procedures (see Table 1) oriented to answer a previously relevant research question (Green, Johnson, & Adams, 2006; Kitchenham & Charters, 2007; Klein et al., 2021).

Papers published prior to 2005 included reports and non-academic research, also in other languages than English, as well as research published on journals in areas other than business and KM represented exclusion criteria. We produced an excel sheet consisting of the key aspects related to the research aim which were name of author(s), publication year, research aim/objectives, method, and main findings.

The third step was a review of the abstracts to make sure that it was within the pre-defined scope. This procedure yielded a final selection of 22 articles, giving priority all the SLR relevant conducted regarding the selected keywords to help with this approach to any inconsistency in the analysis and the conclusion drawn from there. Fourth, the preliminary draft of the article was jointly discussed involving all authors. Such debate enabled the authors to rethink the findings under themes which, in turn, helped to clarify what is the role of KM into BMI since the advent of the new technologies. Fifth, a Synthesis procedure and the final stage of the review process was the write up the findings.

Table 1 outlines the parameters that forms the basis for the analysis process to help us developing a theoretical framework to connect KM and its role in BMI in the current moment of digital transformation.

Table 1 Systematic review: Reproducible research protocol parameter (adapted from Klein and Todesco, 2020)

Parameter	Value
<b>Research Question (primary)</b>	(Q1) what does the role of knowledge management join to digital transformation in a hyper-connected market based on business transformation, is a key element in BMI? i.e., what role of the new digital-transformed KM plays in business model innovation (BMI)?
<b>Objective</b>	This article aim is to review the existing field of research on knowledge management (KM) in the context of contemporary digital transformation and its implications for business model innovation (BMI) in a hyperconnected environment.
<b>Combination of keywords (in title or abstract)</b>	"KM"; "KM and SRL"; "Digital transformation"; "Digital transformation and KM" "strengths"; "KM and Digital transformation" "Business model innovation"; "Business model innovation and KM"; "KM and Business model innovation"
<b>Virtual Bases</b>	Web of Science/Scopus
<b>Type of materials</b>	Scientific papers, chapters, conference papers, open-access materials
<b>Year</b>	2005 to 2021
<b>Selection Criteria</b>	1. Preference on journals from management field of study 2. Search for keywords in title and abstract 3. The most cited materials 4. Preference SRL on those keywords selected
<b>Data extraction method</b>	Text/content analyses: Focus on objectives and main results
<b>Search refinement</b>	Keywords were searched more than once to include newest publications (since the pandemic is still going on)
<b>Total No. of articles analysed</b>	22

## 4 Findings

The findings of the SLR are presented in Table 2. They are presented according to themes which were the outcomes of the process described in the previous section.

Table 2 Themes identified

Theme	Authors and subject of interest	Research Questions
<b>Awareness arising/GAP</b>	<p>Di Vaio et al., 2021 pointed out the relevance of researching KM and KMS as critical resources that contribute and lead the company's strategy to create value through new and innovative business models in a digital innovation era.</p> <p>Di Vaio et al., 2021 underline that there is a gap is regarding KM's role as a source of sustainability for companies in the BMI process, given hyperconnectivity a digital transformation in of markets and much of the world at large.</p> <p>Durst and Zieba 2020 set that KM can take its rightful place as a dynamic resource that can also have a decreasing meantime, so the implications of the on both KM need to be rigorously studied</p> <p>Gaviria et al., 2019 discuss of the arrival of a fourth generation in which the KM should take on new roles.</p> <p>Klein and Todesco 2020 present the question of how SMEs can cope with a constantly changing society due to digital transformation through knowledge management to adapt to these new demands.</p> <p>Serenko 2021 stresses a further development in the body of knowledge management.</p> <p>Turulja and Bajgorić 2018 propose that the effect of knowledge management and product innovation in the business performance should be analysed.</p>	<p>What are the emerging approaches in knowledge management in the literature? What role the new digital-transformed KM plays in business model innovation (BMI)?</p>
<b>Framework to improve GAP</b>	<p>Birasnav 2014 notices a direct connection between knowledge management and organizational performance. Specifically, a suitable knowledge management has a positive implication on it, even helping to predict future scenarios.</p> <p>Birasnav 2014 identify that the improving business performance requires the research of the linkage between KM and organizational model innovation.</p> <p>Durst et al., 2019 draw that the role of KM is relevant in the innovation process.</p> <p>Durst and Zieba 2020 stress the importance of connecting KM to the sustainability of companies' operations, environmental changes, and knowledge risks all factors that influence organizational success and sustainability.</p> <p>Klein and Todesco 2020 describe that knowledge is relevant to understand the new consumption (Klein et al., 2021) and organizational patterns followed by firms in their business models. To adopt new understanding on the changes in the environment and how to cope with</p>	<p>What should linkages be address in the future research to cope the existent GAP?</p>

them, during and after the pandemic, is a concern that KM, along with digital transformation studies, can help illuminate better ways of doing business.

Klein and Todesco 2020 draw that the Knowledge is a source of competitive advantage, but it is more relevant to put it in context with digital transformation.

<b>Initial definitions for analysing the linkage between the KM, DT, BMI.</b>	<p>AlGhanem et al., 2020 observe that the creation, communication, and application of knowledge through knowledge management is the key driver for improving organizational performance.</p> <p>Bamel et al., 2021; Durst and Zleba 2020 define KM as it has been conceptualized as a type of dynamic capability/resources and source of competitiveness and innovations,</p> <p>Di Vaio et al., 2021 show that the business model of innovation seeks to adapt firms to the changes in a global market by making use of knowledge as the key element in that innovation process. Since the reconfiguration of knowledge and its creation make up the innovation process.</p> <p>Fowler 2000 considers that the knowledge is not limited to the dimensions of tacit and explicit.</p> <p>Haaker et al., 2021 highlight that business model innovation (BMI) aims to provide sustainable competitive advantages to firms.</p> <p>Rot and Sobinska 2020 the firms that innovate their business models improve their performance and achieve sustainability.</p> <p>Vaiappuri et al., 2016 invite to go further within the dimensions of knowledge since the article considers, supporting other author's theory as Koenig, that the classification into explicit and tacit is too simplified. Therefore, the role of KM is still to be developed.</p>	<p>What current definitions are taken as a starting point for research on KM in the context of digital transformation and its implications for BMI? - in reference to knowledge management, digital transformation, and business model innovation?</p>
<b>KM in Hyperconnected world</b>	<p>Bamel et al., 2021; Paoloni et al., 2020, both articles highlight that the survival of companies depends on adapting to new ways of configuring information and knowledge in this knowledge-based society. The authors point out that knowledge management is the process that allows the necessary configurations of knowledge to improve the competitiveness of companies in this hyperconnected world.</p> <p>Birasnav 2014 suggests that the hyperconnected world makes for turbulent international markets and demands companies to innovate in their KM to create and reconfigure existing knowledge into organisational knowledge that adds value and competitiveness to the company.</p> <p>Giovanni 2010 describes that the arrival of globalization, internationalization, partnership, supply chain management and dynamics make the role of KM critical.</p> <p>Durst and Zleba 2020 identify that knowledge is a dynamic resource that evolves over an average period, a hypothesis that seems to gain strength in the case of new technologies, it is logical to consider that knowledge management is key to the sustainability of companies in a hyperconnected world. Therefore, needs to be updated to become a positive burden for the company.</p> <p>Turulja and Bajgorić 2018 draw that knowledge society and the new</p>	<p>How does the hyperconnected world affect in both KM and its impact in the firms?</p>

digital economy have emerged because of constant change.

Vaiappuri et al., 2016 sign that the organisation and its environment co-evolve to maintain a competitive advantage in an uncertain environment. Success depends on knowledge and the ability to both shape the existing and create the new according to changes in the environment itself by making use of KM.

#### **KM and Digital Transformation**

AlGhanem et al., 2020 present that the new technologies allow knowledge management tools to enable the process of sharing, creating, and organizing knowledge despite contexts such as the current pandemic. In short, knowledge tools make the management and generation of knowledge through IT implementation simple.

Durst and Zieba 2020 propose that KM has found a broader framework full of opportunities since arrived of new information and communication technologies.

Fakhar et al., 2021 The use of technologies during the pandemic was key to enable knowledge sharing within and outside the company, technological advancements have driven together with the KM the knowledge economy.

Gaviria et al., 2019 state that digital transformation and its new technologies determine the knowledge flow of the company and together with KM have a positive influence on the company's activities. KM should be considered together with technologies as an integral process.

Herschel and Jones 2005 addressed the idea of modern KM allow to search, organize, select the relevant aspects, and extract value from multiple sources of information using new technologies.

Ikeda et al., 2021 the study considers that now we are moving towards an IoT ecosystem that allows turning knowledge into wisdom, connectivity that enables to detect changes in the environment and provide a response to these changes quickly. The digital transformation support KM in a highly dynamic environment.

How has KM been shaped by new technologies, and has it had a direct impact on its implementation?

#### **Digital-transformed KM in BMI**

Giovanni 2010 mentions that KM supports the business by contributing to their components in the innovation process.

Di Vaio et al., 2021 emphasize that business models that are characterized by an open platform for the exchange of knowledge with the environment and other companies are moving towards innovative and sustainable models through the adoption of KM and DT guiding the firms towards business model innovation improving the organizational performance.

Durst and Zieba 2020 stress that on the outside, consumers continuously change their preferences. The market is characterized by uncertainty. On the inside, a company will rethink its business model, innovate as to sources of knowledge and KM, to adapt and to main sustainability of its operations.

Jang et al., 2020 found that BMI relates to changes in one or another building block where the changes are coming from a reconfiguration of corporate choices pushed and driven by knowledge.

Klein and Todesco 2020 point out that this is a concern where KM

What is the role of KM in the current era of digital transformation and a hyperconnected world based on business transformation, a key element in BMI? i.e., what role of the new digital-transformed KM plays in business model innovation (BMI)?



together with DT studies can help shed light. New knowledge configurations together with technologies can bring new insights on how to adapt to a changing environment by redesigning business models.

Paoloni et al., 2020 conclude that the companies need to develop new understandings in business model redesign and innovation to maintain sustainability of their operations in the market.

Turulja and Bajgorić 2018 link KM and innovation since Knowledge forms part of the basis of innovation and is considered key to both business success and survival in a highly dynamic business model environment.

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Overall, the extracts from the papers reviewed draw a promising approach as the researchers addressed the idea of KM from a new innovative perspective to be developed. Indeed, KM is stressed as main element to ensure the company's sustainability and one of the first part to considering redesigning the business model to survive in a hyperconnected world.

The papers studied can be assigned to the following broad themes: awareness arising/GAP within knowledge management discipline, framework to improve GAP, Initial definitions for analysing the linkage between the KM, DT, BMI, KM in Hyperconnected world, KM and Digital Transformation and Digital-transformed KM in BMI.

In the light of the findings of this systematic literature review we support that the driver of changes in the context of creating new and innovative business models is mainly information and communication technology and better and more effective ways of sharing and creating organizational knowledge (Parnell et al, 2018; Rot, A; Sobinska, M., 2020) through knowledge management for redesigning better business models that enable companies to be sustainable in a hyperconnected environment.

## **5 Conclusions**

There is an agreement that KM is a management process that is a source of competitive advantage (Heisig et al., 2016; Bamel, 2018), and a dynamic resource in both ways (Bamel, 2018; Obeso et al., 2020) where phenomena as globalization make the role of KM increasingly critical and dynamic (De Giovanni, 2010). Furthermore, digital transformation becomes relevant since new technologies have a key role in the acquisition, creation, generation, sharing, diffusion, and utilization of knowledge (Malik et al., 2020). During the COVID-19 pandemic, the same technologies have enabled sharing and creation of knowledge through socialization, externalization, combination, and internalization (Nonaka and

Takeuchi, 1995). However, during the recent pandemic, socialization was restricted.

Therefore, the starting point of this article is to set a broader understanding of the existing body of knowledge management with emerging issues such as digital transformation and innovation in business models. The inclusion of digital transformation for KM has led to an improvement in the way the information is processed, new knowledge is discovered, and projects are collaborated on globally, regardless of geographic location and speed of decision making within the firm (Davenport and Prusak, 1998). This, in turn, improves the sustainability of the firm through rethinking its business models (North and Kumta, 2014). As a result, knowledge management has acquired a new dimension and a new role in a dynamic development economy. This happened because limiting knowledge management to the human factor is an approach that seems too narrow and should be extended to technological and organizational aspects (Rot, A; Sobinska, M., 2020).

The growing interest in knowledge management is acquiring a new dimension as well as a new role in a dynamic economy of development. Therefore, it is important to ask what the role of knowledge management in response to digital transformation in a hyper-connected market based on business transformation. For example: what role does the new digital-transformed KM play in business model innovation (BMI).

Nonetheless, there has been a gap regarding the role of KM, as a source of sustainability for companies (Turulja et al., 2018; Di Vaio et al., 2020) since the advent of new technologies in the BMI process. The framework provides a better understanding of the importance of KM in a hyperconnected world (MacInnis, 2011) and sustainability (Durst, 2020) for BMI, and thus can guide us towards future research directions.

Based on the final number of 22 articles reviewed, it is determined that companies will not survive in the current environment if they do not engage in BMI (Turulja et al., 2018) through KM-related innovation (Darroch and McNaughton, 2005). Consequently, KM is a key element within the building blocks within BMI (Friedrich, Becker, Kramer, Wirth, and Schneider, 2020; Uden and He, 2017). Proper implementation of KM helps the companies to identify what is considered as crucial knowledge, how the sustainability can be increased, and how they can participate better in BMI (Chew and Gottschalk, 2013; Lopez et al., 2017).

Given that knowledge is the key and dynamic resource for innovation (Jackson, 2019; Castro et al., 2011; Durst and Zieba, 2020), the increase in information generated by technologies makes KM increasingly relevant. KM is the key to achieving and maintaining a competitive advantage (Gandoni and Haider, 2015). Any alteration in KM is a source of innovation for the company redesigning its business model resulting in business model innovation.

In conclusion, we consider that KM is a key building block that, together with the adoption of new technologies, allows companies to adapt to the changing environment. In addition to reconfiguring knowledge into new forms (Du Plessis, 2007), KM can create organizational knowledge, innovate value, and guide BMI. Thus, KM is directly involved in business model innovation in the pursuit of business sustainability. The improvement of strategy, dynamic capabilities, innovation, knowledge creation, and knowledge exploitation (Ferraris et al., 2017) has a positive influence on KM and digital transformation which affects BMI and sustainability.

### ***5.1 Managerial Implications***

Linking KM, new technologies, and digital transformation for BMI relate to entrepreneurship and implementation and innovation. Knowledge is relevant to understand the new ways of consumption (Klein et al., 2021) and organizational patterns followed by firms in their business models. KM research should enable entrepreneurs to develop a broader approach to address the ongoing pandemic (Ravindran and Boh, 2020). To adopt the changes during and after the pandemic as well as understanding the environment and how to cope with it, KM with the digital transformation studies can help illuminate better ways of doing business (Klein et al., 2021). In short, KM and new technologies encourage both rethinking and innovation of business models (Arkan, 2016; Erbert and Duarte, 2018; Mahraz, Benabbou, and Berrado, 2019) and thus prepares better for eventual new crises (Ravindran and Boh, 2020).

A company must make the necessary modifications in its KM system to implement as many processes as possible to create new knowledge and exploit existing knowledge in its BMI. The company will benefit from reacting proactively, recognizing changes in the environment, and ensuring sustainability in today's hyper-connected world. Our understanding is that the entrepreneurial ecosystem

of the future will set emphasis on KM as one of the building blocks of BMI and sustainability.

### ***5.2 Theoretical Implications***

The findings suggest that most authors have limited mentions of the theoretical framework used for defining the role of KM with new technologies and business models.

From a theoretical standpoint, this article engages a broader study of KM that considers emerging issues such as digital transformation and innovation in business models. This is also supported by several authors. In 2000, Carneiro stated that KM increased the performance of companies. Shujahat in 2019 determined KM as the key element in the exploitation of the innovative potential of firms.

Additionally, it also supports the open innovation theory (Alexy, Bascavusoglu-Moreau, and Salter, 2016; Di Vaio et al 2021). It considers an open culture development within a firm to enable knowledge management in conjunction with the use of technology. This, in turn, leads to business sustainability over time through innovation, where firms can and are encouraged to use external ideas with internal ideas. Therefore, the article draws knowledge sharing and knowledge management as a critical part of a dynamic environment both internally and externally for the innovation process.

In summary, this article contributes to the existing literature by approaching KM from the perspectives of digital transformation and innovation, pointing out the need to increase understanding about the role of KM and its implications for organizational sustainability in the contemporary era of digital transformation.

### ***5.3 Future Research Trends and Limitations***

As with any research, this one has its limitations as well that open the passage for future research developments. Further research is needed to refine and empirically test the framework. An example of this might be testing the SMEs during the ongoing COVID-19 pandemic. Furthermore, the terms such as KM risks and Knowledge Management Systems (KMS) might also contribute to enriching the presented framework.

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## ANNEX

Title	Author (s)	Year	Research/aim/objectives	Method	Main findings
The role of KM in enhancing AI algorithms and systems. <i>Advances in Science, Technology and Engineering Systems</i> , 5(4), 388–396.	AlGhanem, H., Shanaa, M., Salloum, S., & Shaalan, K.	2020	shows the relation between KM processes and AI systems from a higher perspective, giving different options to apply other KM processes for the same AI algorithm to reduce any implementation challenges and enhance the adoption level.	Systematic review	The main finding of the research was the massive impact of some KM processes like knowledge acquisition and knowledge creation on the different types of AI systems and algorithms to give an additional option for organizations during the implementation
Knowledge management within a strategic alliances context: past, present and future. <i>Journal of Knowledge Management</i> , December.	Bamel, N., Pereira, V., Bamel, U., & Cappiello, G.	2021	This paper aims at reviewing the extant knowledge management (KM) research field within a strategic alliance context to understand the historical roots, its temporal progression, current state and potential future in a meaningful way	Data for this study was retrieved from the Scopus database using a systematic literature search process.	The findings of the study suggest that the publication in the field have been growing with an average rate of 8.48%.
Knowledge management and organizational performance in the service industry: The role of transformational leadership beyond the effects of transactional leadership. <i>Journal of Business Research</i> , 67(8), 1622–1629.	Birasnav, M.	2014	This study examines a comprehensive model comprising of various relationships between transformational and transactional leadership, knowledge management (KM) process, and organizational performance.	Exploratory factor analysis and hierarchical regression analysis	The results indicate that transformational leadership has strong and positive effects on KM process and organizational performance after controlling for the effects of transactional leadership.
The impact of knowledge tasks and roles on firm success and performance: A structural model. <i>International Journal of Knowledge Management Studies</i> , 4(3), 265–280.	De Giovanni, P.	2010	This paper investigates the benefits gained by firms when driven by the Knowledge Manager (KM).	Quantitative Analysis	Finally, the research ends providing the scales of the most important roles and tasks, underlining which of them impacts mostly on firms' success and economic performance.
The role of digital innovation in knowledge management systems: A systematic literature review. <i>Journal of Business Research</i> , 123(September 2020), 220–231.	Di Vaio, A., Palladino, R., Pezzi, A., & Kalisz, D. E.	2021	This article investigates the literary corpus on digital innovation in knowledge management systems (KMS) to understand its role in business governance.	Bibliometric Analysis	These findings especially highlight the links between innovation and sustainability



Unlearning: A systematic literature review. <i>International Journal of Business and Globalisation</i> , 24(4), 472–495.	Durst, S., Heinze, I., Henschel, T., & Nawaz, N.	2020	This paper aims to provide a systematic review on the topic of unlearning (and	Systematic review	The findings contribute to a more holistic understanding of the topic and complement extant literature on unlearning.
The linkage between knowledge risk management and organizational performance. <i>Journal of Business Research</i> , 105(August), 1–10.	Durst, S., Hinteregger, C., & Zieba, M.	2019	The purpose of this study is to examine the effect of knowledge risk management (KRM) on organizational performance, with measures considered as “softer” measures of performance, i.e. innovativeness, responsiveness, sustainability, and agility. Data	Data collection, questionnaires	They could use the results to design their KRM practices accordingly. To the authors' best knowledge, this paper is the first empirical study that has investigated the relationship between KRM and organizational performance with a broad organization sample.
Knowledge risks inherent in business sustainability. <i>Journal of Cleaner Production</i> , 251, 119670.	Durst, S., & Zieba, M.	2020	The aim of this conceptual paper is to address two main questions: What are the potential effects of knowledge risks on the three dimensions of sustainability in organizations? and How can organizations cope with knowledge risks to become truly sustainable? Taking	Conceptual paper	To conclude, the paper offers a new perspective on business sustainability, i.e. the perspective of knowledge risks and in a broader sense, KM. On the basis of the presented analysis, it seems that the underlying notion of KM is predestined for the underlying notion of sustainable business development.
Knowledge Management in the Fourth Industrial Revolution: Mapping the Literature and Scoping Future Avenues. <i>IEEE Transactions on Engineering Management</i> , 68(1), 289–300.	Fakhar Manesh, M., Pellegrini, M. M., Marzi, G., & Dabic, M.	2021	the present article investigates the intellectual structure and trends of KM in Industry 4.0.	Bibliometric analysis and a systematic literature review	The results reveal six clusters of keywords, subsequently explored via a systematic literature review to identify potential stream of this emergent field and future research avenues capable of producing meaningful advances in managerial knowledge of Industry 4.0 and its consequences.
The role of AI-based technology in support of the knowledge management value activity cycle. <i>Journal of Strategic Information Systems</i> , 9(2–3), 107–128.	Fowler, A.	2000	The paper evaluates the phenomenon of knowledge management (KM) and its relationship to the artificial intelligence (AI) technologies of knowledge-based systems, case-based reasoning and neural networks.	Data gathered through interviews and multiple visits	The study thereby illustrates both the potential and the limitations of AI technologies in terms of their capability to support the KM process.

Knowledge management: A global examination based on bibliometric analysis. <i>Technological Forecasting and Social Change</i> , 140(March 2017), 194–220.	Gaviria-Marin, M., Merigó, J. M., & Baier-Fuentes, H.	2019	This article presents a bibliometric overview of the academic research on KM in the business and management areas. Various	Bibliometric method	The results show that research in this field has increased significantly in the last ten years and that the USA is the most influential country in all aspects in this field. It is important to consider, however, that science continues to advance in this and in all fields and that data rapidly change over time. Therefore, this paper fulfills an informational role that shows that most of the fundamental research of KM is in business and management areas.
Business model innovation through the application of the Internet-of-Things: A comparative analysis. <i>Journal of Business Research</i> , 126(December 2020), 126–136.	Haaker, T., Ly, P. T. M., Nguyen-Thanh, N., & Nguyen, H. T. H.	2021	To better understand emerging IoT business models in Vietnam through identifying and interpreting business model design options and choices.	Morphological analysis and	The research provides insights into the commonalities and discrepancies of IoT-based business models. Also, it provides a novel application of morphological analysis to business model innovation to create a generic business model for IoT applications in emerging markets.
Knowledge management and business intelligence: The importance of integration. <i>Journal of Knowledge Management</i> , 9(4), 45–55.	Herschel, R. T., & Jones, N. E.	2005	The purpose of the paper is to provide a thorough analysis of the difference between business intelligence (BI) and knowledge management (KM) and to establish a framework for relating one field to the other.	A review of the literature from approximately 1986 through 2004 time period	BI focuses on explicit knowledge, but KM encompasses both tacit and explicit knowledge. Both concepts promote learning, decision making, and understanding. Yet, KM can influence the very nature of BI itself. Hence, this paper explains the nature of the integration between BI and KM and makes it clear that BI should be viewed as a subset of KM. Originality/value
The relationship between the Internet of Things and knowledge management in smart ecosystem development. <i>Knowledge and Process Management</i> , April 2020, 1–14.	Ikeda, E. K., da Silva, L. F., Penha, R., & de Oliveira, P. S. G.	2021	To explore the relationship between IoT and Knowledge Management (KM) when generating a Smart environment. Herein,	Systematic Literature Review	Evidence that the IoT is composed of a set of technologies that enable KM and KM processes can facilitate the development of IoT Smart environments. Thus,

Classifying the Business Model Types of International Construction Contractors. <i>Journal of Construction Engineering and Management</i> , 146(6), 04020056.	Jang, Y., Song, K., Park, M., & Ahn, Y.	2020	Understanding existing business model types is a crucial part of business model innovation since business model types represent the status of current business models and hint toward business model innovation.	Empirical	The results suggest the existence of three business model types used by international construction contractors and indicate significant performance differences among them. Our
COVID-19 crisis and SMEs responses: The role of digital transformation. <i>Knowledge and Process Management</i> , December 2020, 1–17.	Klein, V. B., & Todesco, J. L.	2021	This article discusses the general weaknesses, strengths, challenges and opportunities for SMEs to face this pandemic, and how the field of knowledge management (KM) can help. Based	Systematic Literature Review	As practical implications, research raises awareness of digital transformation's role as a set of tools to adapt during and after the pandemic, along with resilience engineering and knowledge management principles.
Knowledge management, intellectual capital and entrepreneurship: a structured literature review. <i>Journal of Knowledge Management</i> , 24(8), 1797–1818.	Paoloni, M., Coluccia, D., Fontana, S., & Solimene, S.	2020	The purpose of this paper is to analyze within the knowledge management (KM) stream the relationship between KM and intellectual capital (IC) and entrepreneurship (E). IC	Systematic Literature Review	There is an urge to move the focus of KM and IC research toward new models of their interconnection, by including the social capital, namely, knowledge capabilities (explicit or not) which are able to turn knowledge in innovation and competitive advantage, from an accounting perspective (recognizing IC's components affecting the performance of firms, among which knowledge is the most important) and from a theoretical point of view (reducing the misalignment between the epistemological concept of KM requirements and the effective perception of organizational KM activities to extract value from KM initiatives).

Challenges for Knowledge Management in Digital Business Models. 2020 10th International Conference on Advanced Computer Information Technologies, ACIT 2020 - Proceedings, 555–558.	Rot, A., & Sobinska, M	2020	To analyze the impact of new technologies and digitalization of businesses on knowledge management processes in organizations. The	Conceptual paper	Managers should create knowledge management systems conducive to building trust between entities cooperating in the virtual network, sometimes entities deprived of face to face contact.
A structured literature review of scientometric research of the knowledge management discipline: a 2021 update. <i>Journal of Knowledge Management</i> , December 2020.	Serenko, A.	2021	The purpose of this study is to conduct a structured literature review of scientometric research of KM discipline for the 2012–2019 time period	Scientometric research	Stakeholders should realize that the KM discipline may successfully exist as a cluster of divergent schools of thought under an overarching KM
Knowledge acquisition, knowledge application, and innovation towards the ability to adapt to change. <i>International Journal of Knowledge Management</i> , 14(2), 1–15.	Turulja, L., & Bajgorić, N.	2018	To provide important empirical evidence to support the role of individual knowledge management processes and separate innovation types within firms.	Empirical	The direct impact of product and process innovation on business performance. In
An empirical view of knowledge management. <i>Handbook of Research on Global Supply Chain Management</i> , May, 452–466. <a href="https://doi.org/10.4018/978-1-4666-9639-6.ch025">https://doi.org/10.4018/978-1-4666-9639-6.ch025</a>	Vaiappuri, S. K. N., Kamarulzaman, N. H., Vijayan, G., & Mukherjee, A.	2016	To understand about the concepts of knowledge, knowledge management, and knowledge management systems. The	Chapter book	Understanding the entire process of knowledge creation helps make knowledge management more efficient and effective. It is time for the top level managers to make use of it to increase the efficiency of their organisational operations. Effective

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## **Understanding Czech Consumers' (from the Pilsen Region) Regional Food Buying Preferences Using the Decision Tree Method**

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### **Abstract**

Regional labels are intended to be a credible signal that helps simplify the information flow between the food producers and consumers about certain food products' characteristics (mainly origin and quality). Presented paper shows results of the research on the consumer buying behaviour towards regional food in Pilsen Region in the Czech Republic and their recognition of the regional labels. The main goal of this study is to identify critical factors for regional food consumers' segmentation that would be of assistance to small and medium enterprises (SMEs) in the Pilsen Region, the food producers that want to improve their marketing approach on the regional food market. Results add to a longitudinal research that aims to study evolution of Czech regional labels and their role in support for

the local SMEs. The paper builds on the qualitative data gathered on this topic previously and on-line quantitative research that was conducted in January – February 2020 in the Pilsen Region. Data from 258 respondents were processed. The application of decision trees analysis demonstrates the dominant influence of socio-demographic factors, such as age and education, on the respondents' buying choices of the regional food.

**Keywords** – customer buying behaviour, regional food preferences, decision tree analysis

**Paper Type** - Academic Research Paper

## 1 Introduction

Emphasis on the regional origin of food products and traditional manufacturing methods is becoming a solid alternative to the mass production and consumption (Bryla, 2015; Fraser and Balcombe, 2018; Meyerding et al., 2019). It is evident that consumer decisions are complex and multifaceted and only some prioritise origin above all factors when shopping for food (Delicato et al., 2019; Sadílek, 2019). However, a focus on regional origin and quality, demonstrated by the use of the regional label, may be a viable marketing strategy, especially for the small and medium food producers (Hashem et al., 2018; Imene and Georges, 2014; Gracia and DeMagistris, 2014). In general, the food labels inform consumers about certain aspects of the food or its production method, often with a logo or a statement on the product (Bingen, 2012; Doherty and Campbell, 2014). It provides information that the food meets given standards (e.g. it is produced in a certain geographic area), or is in accordance to additional requirements (Eldosouky et al., 2019; Weinrich and Spiller, 2016). Regional labels represent a strong connection between the product and its place of origin, signalling above all authenticity and genuineness (Fonte, 2010; Forney and Häberli, 2016). Food producers may use built and established associations consumers have with the region, which will help create a specific image for their production (Ilbery et al., 2005). Regional labels also have undeniable importance for consumers, as they provide strong safety and quality assurance, and contribute to their simpler orientation on the market (Cichocka, Oleniuch, 2017).

The Czech food market is highly competitive, and the food producers may choose from the wide range of food labelling systems that signal origin and quality (Bošková et al., 2016; Chalupova et al., 2021; Vokáčová et al., 2017). According to Stoklasa and Pitrunová (2020), regional food is strongly preferred by

the Czech consumers, but their research has indicated that there is a discrepancy between how the regional labelling schemes communicate about the labelled regional food and how consumers perceive them. The authors suggested that the regional labels should compromise and present the labelled regional food as a product that is unique, yet traditional, also more expensive, which reflects a good quality and environmental friendliness, and it represents a form of support of the region. Some researches (Chalupová et al., 2016; Margarisová et al., 2018; Velčovská, Del Chiapa, 2015; Rojík et al., 2016) also suggest that the regional labels in the Czech Republic still suffer from relatively low awareness among customers. According to Sadílek (2019), price, origin and appearance are the most important factors for the Czech consumers when buying food. Almost a quarter of all respondents expressed a positive attitude towards food quality labels, they were primarily men with a university education, living in two- to five-person households, claiming to have above-average earnings. Research of Stoklasa and Pitrunová (2020) also showed that the respondents with university education favor regional labelled food; they fall into the age groups of 26-35 and 36-45.

It is apparent that there is a steady interest among professionals in the Czech Republic about consumer preferences regarding regional food, yet the studies about the regional food buyers' preferences and attitudes in specific regions are quite limited. The aim of this paper is to identify important factors for regional food consumers' segmentation that would be of assistance to SMEs in the Pilsen Region, the food producers that want to improve their marketing approach on the regional food market. Results will add to longitudinal research that aims to study an evolution of Czech regional labels and their role in support for the local SMEs.

## **2 Regional Labelling Systems in the Czech Republic**

There are three major umbrella regional labelling schemes in the Czech Republic. At the EU level, there are schemes of geographical indications: Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI). At the national level the project Regional Food of the Ministry of Agriculture of the Czech Republic (and its State Agricultural Intervention Fund) has a major role. It was established in 2010, it runs as a top-down scheme. As an important outcome of this project is the label 'Regional Food' present in all the Czech regions at the NUTS 3 level. It has a form of competition for local small and

medium producers and agriculturists, it operates as a top-down scheme. The project's strategic goal is to improve the consumers' awareness of the regional food and using the marketing communication to promote its benefits, emphasizing the advantages of the local food preference in relation to the development of a region - support of employment, tourism and sustainability (Czech Ministry of Agriculture, 2021). Association of Regional Brands (ARB) is a nonprofit organization that associates the coordinators of the member regional labels representing 27 regional and micro-regional labels, it runs as a bottom-up scheme. The first regional labels in the Czech Republic were established in 2005 (Krkonoše, Beskydy Mts. and Šumava Mts.), the Association has been created three years later. All of the labels associated in ARB are recognisable with the unified graphic design and common granting principles. The products and services need to have a guaranteed origin, respect for the environment in all phases of both production and sale proportion of manual or mental work and local raw materials is being required. The certificates can be obtained by SMEs, producing food and handicraft, and service providers within tourism (Čadilová, 2011). Other labels based on the similar principles as ARB designation (but operating outside the Association), are representing the micro-regional level, include Lužické Mts. and Macha Region Regional Product, Jizerske Mts. Regional Product, Quality from the Hlinec Region, Real Walachian®, Bile Karpaty Tradition, Traditional Product of Slovacko, Vltavotynsko Regional Brand) and Original product of Sokolovsko (Vokáčová et al., 2017).

### **3 Pilsen Region and its Regional Labels**

The Pilsen Region lies in the southwest of the Czech Republic, the region is ideally positioned between the capital of Prague and western European countries. It is the the third largest region in the Czech Republic, the center of the region is the city of Pilsen. Typical feature of the area is the high number of small settlements, almost third of the region's population resides in small towns and villages (Pilsen Region, 2021). There are four regional labels in the Pilsen Region: Regional Food Pilsen Region (as a part of the project Regional Food of the Ministry of Agriculture of the Czech Republic), Šumava Regional Product is part of the ARB (Šumava Mts fall geographically into both Pilsen and South Bohemia Regions) and Local Product from West Bohemia and Český les (Czech Forrest) labels are administered by the Local Action Groups (see Fig. 1).



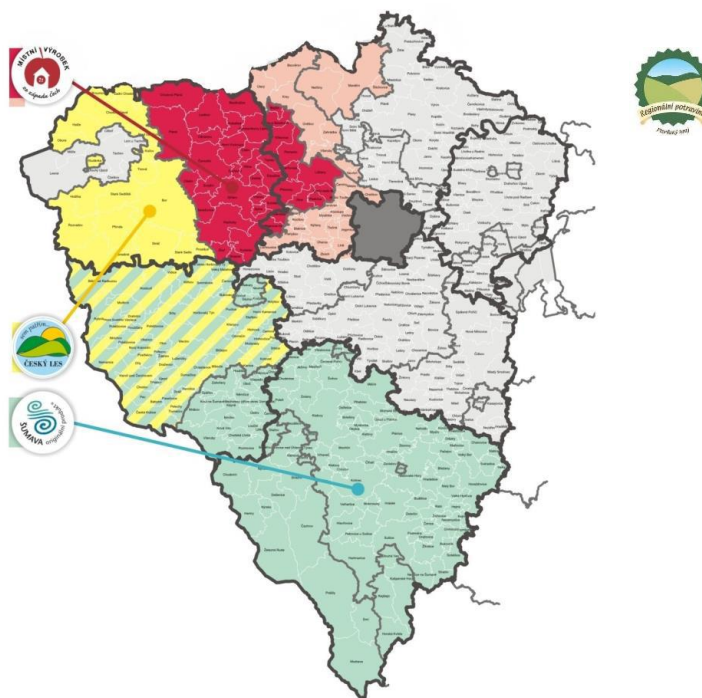


Figure 1 Regional Labels of Pilsen Region

Local Product from West Bohemia	Český les (Czech Forrest)	Šumava Regional Product	Pilsen Region Regional Food

Source: [www.mas.cz](http://www.mas.cz), 2021

The Pilsen Region Regional Food of the label supports small and medium-sized producers of agricultural and food products in the region. The label is administered by the Ministry of Agriculture, which also awards the label in the form of a certificate based on the decision of the evaluation committee in the relevant region. The coordinator of the label for the Pilsen Region is a public service company Úhlava. The products awarded this label are promoted not only

in the region of the Pilsen Region where they were produced, but also throughout the Czech Republic. Nationwide, around 100 producers receive the Regional Food award each year, and in the Pilsen Region there are 8-9 producers each year. (Regional Food, 2020)

The label Šumava - Original Product is part of the ARB, it is awarded to artisanal products (including food), agricultural products and natural products by the Šumava Regional Development Agency, which is the coordinator of the label. The label can be awarded also to accommodation and catering services, experiences and traditional events. The Šumava region was one of the first regions to join the labelling project and the first certified products appeared as early as 2006. In May 2021 there were 74 certified products.

The Český Les (Czech Forrest) regional label helps consumers to identify products originating in the Český les region since 2013. The local inhabitants of Domažlice and Tachov support the preservation and creation of new traditions with their products. Certified regional products guarantee the origin of the products and its quality, they must also be unique, original products with a tradition of more than 50 years in the region. In May 2021 there were 22 certified products.

The Local Product from West Bohemia label began to be awarded in 2010 to local producers, craftsmen, farmers, and other small businesses operating in the territory of the Local Action Group Český Západ (LAG Czech West) and its surroundings. In order to be certified, products must meet at least two of the specified criteria: the use of local ingredients, recipes and processes; the use of handicraft, artisanal or intellectual work of local people; and production and sale in the micro-region. In May 2021 there were 25 certified products.

#### **4 Materials and methods**

The research has been made with the use of on-line questionnaire in January-February 2020 among inhabitants of the Pilsen Region in the Czech Republic. Data from 258 respondents were processed, the chosen socio-demographic characteristics included gender, age, education, monthly income (see Table 1). The questions also focused on the buying behavior (frequency, preferred type of retailers) and the importance of the selected attributes that the regional food labels represent.

Table 1 Socio-demographic characteristics of the respondents

Criterion	Respondents from Pilsen Region		
	Group	Abs. frequency	Rel. frequency
<b>Total</b>	<b>Population aged 19-51+</b>	<b>258</b>	<b>100.00</b>
<b>Gender</b>	Male	91	64.7%
	Female	167	35.3%
<b>Age</b>	19-35 years	172	66.7%
	36-50 years	58	22.5%
	51+ years	28	10.8%
<b>Education</b>	High school without a graduation	44	17%
	High school with a graduation	112	43.4%
	University degree	102	39.6%
<b>Household income</b>	Less than 25,000 CZK/month (approx. 1000 EUR)	42	16.3%
	25,001 – 50,000 CZK/month (approx. 1001 – 2000 EUR/month)	142	55%
	More than 50,001 CZK/month (2001 EUR/month)	74	28.7%

Source: Authors

Data in Table 1 show that the largest group of respondents were women aged 18-35 with a net monthly income of CZK 25,001-50,000 (approx. 1001 – 2000 EUR/month), and the highest level of education attained was university or high school with a graduation.

Obtained data were processed using decision tree analysis, processing them using CHAID (Chi-squared Automatic Interaction Detection) in IBM SPSS that allows identification of the important factors affecting consumers' decisions (O'Flaherty, Heaven, 2015; Song, Kim, 2018). Decision trees generally follow a top-down approach; every internal node in a decision tree contains a question about one particular feature (f.e. buying decisions) and every branch shows the result of the statistical testing using Chi-square for the categorical dependent variable and the F-test for the continuous variable (Jovanović et al., 2017).

## 5 Results and discussion

We have focused on identifying variables that the respondents' regional food buying choices are dependent on. As it is visible from Figure 2, the regional food

preference in the Pilsen Region depends strongly on age. Among the respondents who belong to the age groups within the interval of 35 and 65, only 1.2% don't prefer the regional food. On the other side, age was the sole dependent variable (the preference of the regional food is not dependent on other examined variables, such as education, income and gender).

When examining respondents aged 18-35 years, their preference of the regional food is quite strongly influenced by their education. Slightly more than 22% of respondents with the university degree always prefer the regional food. Also researches by Sadílek (2019) and Stoklasa and Pitrunová (2020) suggest that the education plays a crucial role when making decisions about the food purchases (in terms of the preference of its origin).

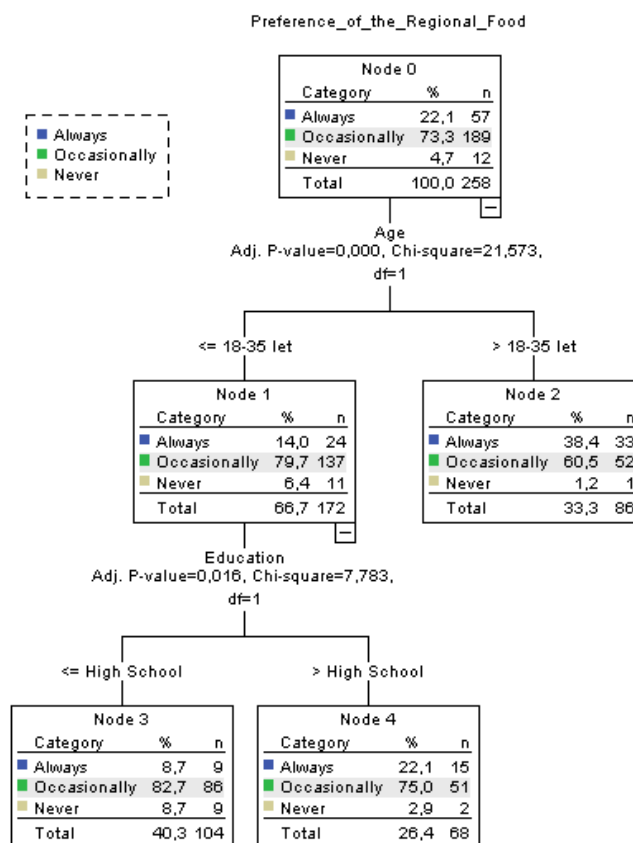


Figure 2 Preference of the regional food in the Pilsen Region in dependence on the chosen sociodemographic characteristics  
Source: Authors

Test of aided awareness of Pilsen Region regional labels showed that the respondents know the most about the existence of Regional Food Pilsen Region as 73% (187) claimed that they noticed the logo when shopping for food. It is not surprising as the Regional Food label has gradually gained a significant importance on the Czech market, being present in every region and using a extensive marketing support from the Czech Ministry of Agriculture (Margarisová et al., 2018). Other examined regional labels (which represent micro-regions within the Pilsen Region) are being recognised significantly less. Only 12% (30) of respondents indicated they are aware of the Czech Forrest label; 35 (14%) have come across Šumava Original Product label and only a minimum of respondents, 8% (21), have claimed they have noticed the logo of Local Product of West Bohemia. Similar situation has been observed in the Vysočina Region (Chalupová et al., 2016) and South Moravia (Rojík et al., 2016).

Awareness of the Pilsen Region regional labels was also tested with dependence on chosen socio-demographic characteristics of respondents, using decision tree analysis. As it is visible from Figure 3, awareness of the regional label Czech Forrest depends on the respondents' income level. Respondents with an income at the level above 50,000 CZK/month (approx. 2000 EUR) recognise the label the least (only 2.7% of them know it) compared to the income group up to 50,000 CZK/month where the awareness of the brand is at the level of 15.2%. In the income group up to 50,000 the awareness of the label also depends on the age. The brand is better known among the respondents within the age group over 35 years (25% of respondents in this group claimed to be aware of the label), than in the age group within the range of 18-35 (only 10.9% of respondents have recognised it).

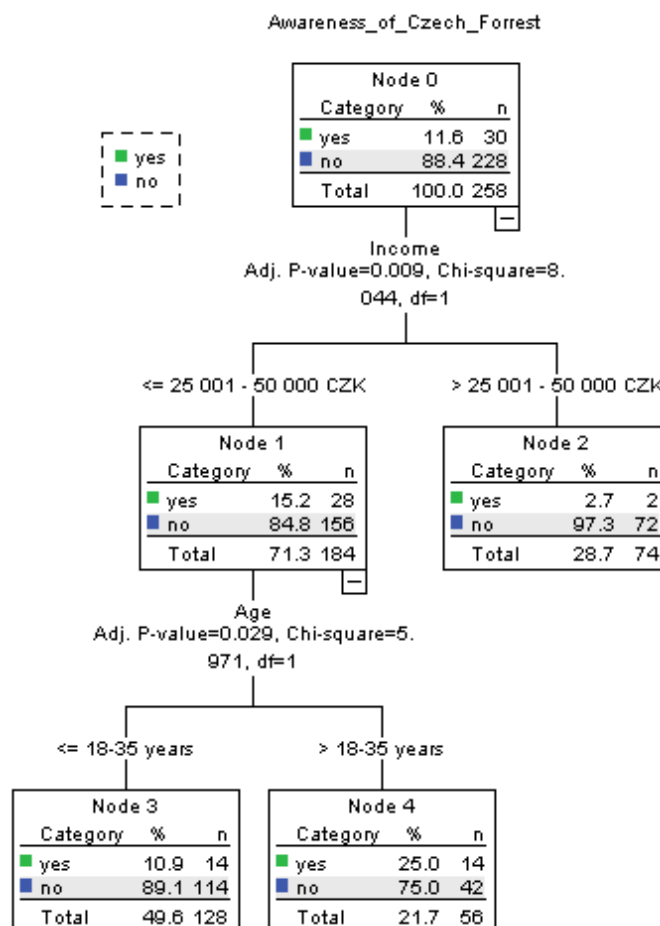


Figure 3 Awareness of the regional label Czech Forrest in the Pilsen Region in dependence on the chosen socio-demographic characteristics  
Source: Authors

Awareness of the regional label Local Product from West Bohemia also depends on income level (see Figure 4). Respondents with an income at the level up to 50,000 CZK/month (approx. 2000 EUR) recognise the label better; 11.1% of respondents have noticed it when shopping for food. Only 1.4% of respondents with an income higher than 50,000 CZK/month have come across it. Within the respondents with the income at the level up to the 50,000 CZK/month, the familiarity with the logo also depends on gender. Women (14.5%) are more likely to know the brand than men (4.8%).

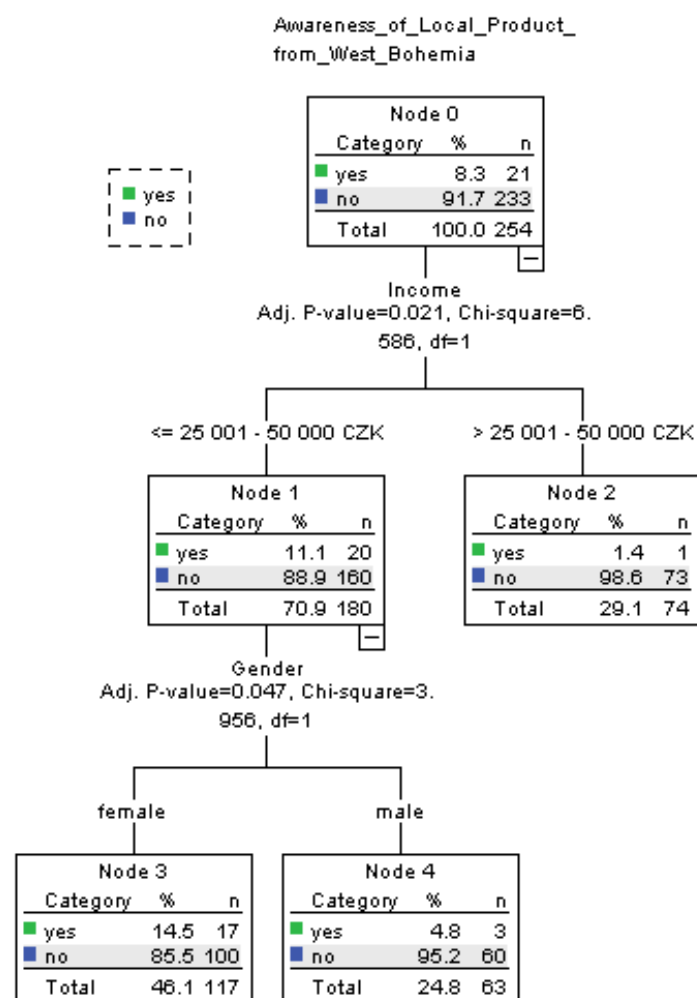


Figure 4 Awareness of the regional label Local Product of the West Bohemia in the Pilsen Region in dependence on the chosen sociodemographic characteristics  
Source: Authors

We did not find any statistically significant dependencies on age or income group, gender or education for the other two regional labels.

Our research has also focused on the consumers' perception of the labels. The coordinators of the regional labelling schemes make an effort to connect the labels with the higher quality and environmental friendliness, presenting the winners of the labelling competitions as the holders of the prestigious label (Vokáčová et al., 2017). Figure 5 shows that the respondents view the labels predominantly to support their region: the most substantial connection is to the

label Šumava Original Product (80%) and Regional Food Pilsen Region (73.5%). Respondents have connected the ecological characteristics of the products more significantly only with the label Local Product of West Bohemia (22.7%).

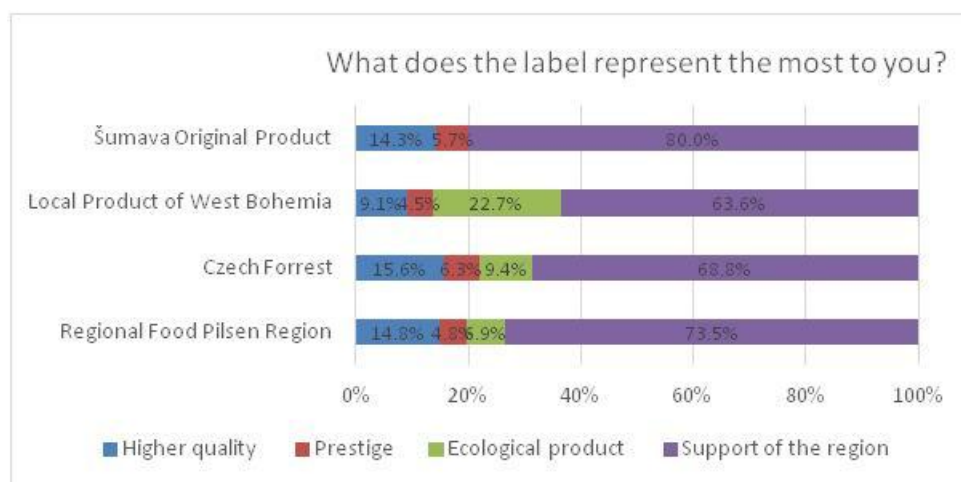


Figure 5 Regional labels in the Pilsen Region – how respondents perceive them  
Source: Authors

Only few respondents view the presented regional labels as a signal of prestige or higher quality. It is in line with the research of Stoklasa and Pitrunová (2020), who have pointed out that there is a discrepancy between the marketing communication of the regional labelling schemes about the labelled regional food and how consumers perceive it.

## 6 Conclusion

As any other customer-centred company, food producers in the Pilsen Region should understand their customers and make marketing decisions based on the data about them. Our research indicates that the regional SMEs should focus their attention on the segment of the customers within the age group 18-35, with the higher education level and net monthly income of CZK 25,001-50,000; with the inclination to support their region. As the awareness of the regional labels is relatively low (except the label Pilsen Region Regional Food), coordinators of the regional labelling schemes of Czech Forrest, Šumava Original Product and Local Product from West Bohemia should invest more in their marketing campaigns to gain wider general knowledge among the inhabitants of the Pilsen Region.



We would suggest that also they should better target their activities and improve their brand marketing regarding the labels' positioning, focusing on the connection of the labels with their specific parts of the Pilsen Region, representing its support, building on already strong existing association. It could be a way to build more vital awareness and trust in the regional labels. Our results should be interpreted in the context of the limitations of the research. As it is based on self-reported data, it is understandable that the respondents tend to overestimate their awareness of the labelling and their buying decisions of the regional food. Another limitation is the sample of respondents, as the largest group of respondents were women aged 18-35. These limitations have a potentially significant impact on the generalizability of the findings, and thus on the contribution of this study toward a better understanding of consumers behaviour related to regional food labels in the Pilsen Region. In the future, the research is repeated with a larger sample of respondents and a better structure of specific demographic categories, with a focus on the respondents' attitudes toward the region. Information from the research could be applied in marketing communication campaigns and help SME food producers make proactive and knowledge-based decisions.

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## Knowledge Management Practices in Supply Chains: Identification and Categorization of Barriers

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### Abstract

These days, business competition is more among supply chains (SCs) than between individual firms. So, knowledge is a critical resource that must be managed properly not only in single companies but also across SCs. Indeed, managing knowledge within a SC can help companies to promote better use of resources and gain value for customers. From a knowledge management (KM) perspective, this implies a shift of focus, from traditional intra-organizational KM practices to inter-organizational KM. Despite the increasing importance of KM in SCs, its implementation can still encounter several barriers, which must be investigated. This can help both research and practice on this topic. However, the current KM literature is very varied, and in the available studies, there is a lack even of basic definitions and classifications. In line with this, barriers affecting the implementation of KM practices in SCs are not presented in a comprehensive and consistent way, and not systematically categorized in line with KM practices in a way where firms can manage them easily. This study aims to highlight the contribution of previous related studies and investigate and re-categorize the potential barriers affecting the introduction and development of KM practices in SCs. An in-depth and up to date systematic literature review (SLR) was carried out as a means of evaluating and interpreting all available

research relevant to the research topic. A total of 831 papers indexed in international citational databases (Scopus and WoS) were undergone evaluation process, and the content of a selection of papers was classified and analysed. This study makes a first attempt to provide a comprehensive list of 51 KM barriers re-classified into three categories namely, barriers related to the use of KM methods, barriers related to the KM application of IT tools, and barriers related to the KM-enabling supportive management measures. Theoretically, this study proposes a fresh contribution to explore the KM literature in SCs, specifically barriers to KM implementation. The main points that emerged which are particularly important include: i) summary of existing studies on barriers; ii) identification and re-classification of potential barriers which are the key factors affecting the adoption of successful inter-organizational KM. This will also help managers to systematically manage hindering factors and use properly the potential practices in their KM programs collaboratively with their SC partners.

**Keywords** – Knowledge management, KM barriers, KM practices, Supply chain, Systematic Literature Review

**Paper type** – Academic Research Paper

## 1 Introduction

In the current knowledge-based and digitalization era, knowledge is a critical resource of firms that has to be managed properly and strategically for performance improvement and competitiveness. Bolisani *et al.*, (2017) states that though the issue of how companies should plan their knowledge management (KM) activities is still a debated issue, recognition of KM as a strategic element of today's companies is increasing.

Indeed, KM applications can be seen either at intra-organizational or inter-organizational level. The majority of KM studies covers the intra-organizational level, where inter-organizational KM has been less studied (Cerchione and Esposito, 2016; Lim *et al.*, 2017; Thomas *et al.*, 2017). In addition, intra-organizational studies of KM have covered all the main KM aspects (Edwards, 2015), i.e., Knowledge content, Processes, People, Technology/KM System, and Structure and knowledge strategy. Whereas, studies focusing on inter-organizational KM tend to focus on specific aspects of KM such as processes of knowledge sharing and transfer, technologies for knowledge transfer, and collective learning (Kassaneh *et al.*, 2020). The importance of inter-organizational KM is related to the need to manage knowledge across the organizational boundaries. Knowledge must be managed not only in single companies but also

across SCs, because competition is more and more among SCs than between individual firms (Attia, 2015; Shakerian, Dehnavi and Shateri, 2016). In addition, knowledge in SC connections can require special measures to be managed (Rodríguez-Enríquez *et al.*, 2015; Thomas *et al.*, 2017).

Scholars increasingly see the development of “knowledge-based SCs” as an opportunity to improve value for customers (Wadhwa and Saxena, 2005) and to promote better use of resources in knowledge-intensive and multi-cultural enterprises (Samuel *et al.*, 2011). However, while SC management and KM are two important research streams, few works have treated the link between them (Samuel *et al.*, 2011). During the past 20 years, especially in the last decade (Kassaneh, Bolisani and Cegarra-Navarro, 2021), key contributions have been published and some studies (Marra, Ho and Edwards, 2012; Lim *et al.*, 2017; Chen, Ellis and Holsapple, 2018) support that there is a growing interest in applying KM to SCs.

In addition, despite this rising interest, the implementation of KM in SCs can still encounter several barriers, which must be investigated since it can contribute both to the theory and the practice. On this issue, the current literature is very varied. In the available studies, there is a lack even of standard definitions and classifications. There are limited studies on KM practices exercised by firms in SCs, and on the associated potential factors affecting KM adoption and development in SCs (Cerchione and Esposito, 2016; Inkinen, 2016; Li and Kang, 2019). Specifically, there are some studies on KM barriers in SCs (such as: Patil and Kant, 2014b, 2014a; Zerbino *et al.*, 2018; Batista *et al.*, 2019) but these provide fragmented views, and a unified vision or perspective has not emerged so far.

Thus, this review aims to highlight the contribution of previous studies and investigate the potential barriers affecting the introduction and development of KM practices in SCs. Further, the paper describes an attempt to classify KM barriers in line with a recently proposed classification of KM practices (Kassaneh *et al.*, 2020; Kassaneh, Bolisani and Cegarra-Navarro, 2021). From a scientific perspective, the achievement of this objective could fill the literature gaps we highlighted and could provide an up-to-date overview of the barriers to KM implementation in SCs. From a practical viewpoint, a study on KM barriers, that hinder companies’ effort to properly interact with the SC partners for a collaborative learning, will provide lessons to managers on how to handle these barriers and improve practices for knowledge creation, sharing, protection, and KM application for better firm and SC performances.

The article is structured as follows. Section 2 briefly describes the methodology. Section 3 presents the analysis of selected papers, and the discussion part. In this section, a descriptive quantitative analysis of the literature is presented, followed by a content analysis. The analysis of the contribution and limitations of the previous studies on KM barriers in SCs, and the identification and re-categorization of these barriers are included in this section. Section 4 proposes a brief comparison to other existing literature reviews on the same topic. The final section summarizes importance of the study, for research and practice, and the future directions of research.

## **2 Review Methodology**

An in-depth systematic literature review (SLR) was used. It is an overview of primary studies that uses explicit and reproducible methods (Greenhalgh, 1997) following a rigorous procedure of searching, with a five steps strategy (Xavier *et al.*, 2017; Martins *et al.*, 2019) which includes:

- i. Formulation of the research question
- ii. Studies location (searching studies using keyword definition and data base selection).
- iii. Selection and evaluation of studies using inclusion/exclusion criteria.
- iv. Analysis and synthesis of the selected articles and findings.
- v. Reporting and use of results for further action.

### **2.1 Research question for the SLR**

Based on the research goals and gaps mentioned in section 1, the following two research questions are addressed in this SLR.

*RQ1: How does the trend of KM for SC look and which topics (related to the factors) are most importantly covered (or not covered) in the area?*

*RQ2: Based on the current literature, what are the potential barriers affecting firms' KM practices in SCs?*

### **2.2 Paper search strategy using keyword definition and database selection.**

Since the general focus of the study is to see the KM issue in the SC perspective, the articles must contain both KM and SC issues. Accordingly, the selected keywords included: "knowledge management", "knowledge creation",

"knowledge acquisition", "knowledge storage", "knowledge sharing", "knowledge transfer", "knowledge application", and "Knowledge protection" in combination with "supply chain". Web of Science and SCOPUS were used as they are two authoritative large databases and have multidisciplinary articles.

### **2.3 Paper selection process**

The retrieved papers were further selected based on the following criteria:

- Focus of the paper: one or more KM practices, or KM adoption and development factors, technologies, methods/tools, strategies in SC perspectives.
- Articles in peer-reviewed journals indexed in the SCI or SSCI index (Web of Science database), and the Scimago index (Scopus)
- Articles in subjects: business and economics, management, operations research and management sciences, industrial engineering, information system, and related fields
- Articles written in English language and published from January 2000 to December 2019 (to see the research trend in the last two decades)

According to the above-mentioned search strategy and inclusion/exclusion criteria, a total of 831 papers were undergone the initial evaluation process (i.e., article title reading, abstract reading and full paper reading). Finally, 65 papers were considered pertinent and were selected for further descriptive and content analysis.

### **2.4 Analysis and synthesis of selected papers**

Descriptive and content analysis were conducted. In the descriptive analysis, the papers were categorized by the following three perspectives to give a summary view of the selected papers and the research field.

1. By publication year (to see the trend of the research field)
2. By unit of analysis (firm level, SC level or network level)
3. By the type of factors covered in the studies (enablers/critical success factors or barriers)

In the content analysis, papers were reviewed and studied in-depth and important points regarding KM associated barriers were extracted. The main issues in this part, which are reported in the subsequent section, include: context,



categorization, limitations of studies, identification and re-categorization of influential barriers hindering firms' KM practices in SCs.

### 3 Result and discussion

#### 3.1 Descriptive analysis

##### 3.1.1 Categorization of papers by publication year (20 years trend)

Figure 1 shows that for the past 20 years, there has been an increasing trend of papers focusing on "KM in SC". Specifically, in the last decade, the trend displays a significant growth and a promising need for further study.

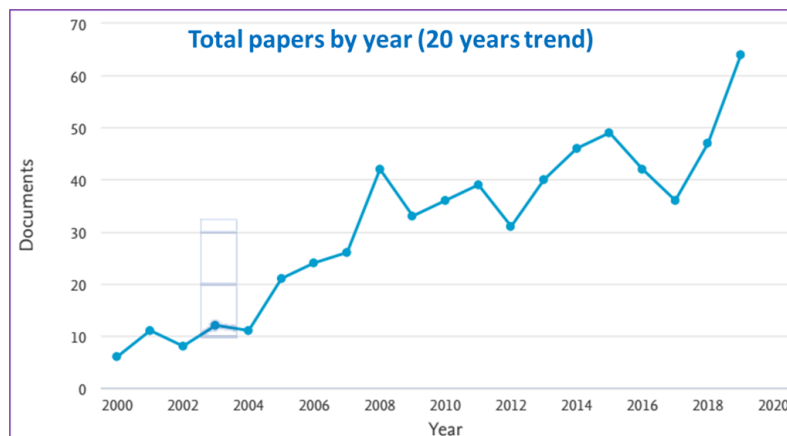


Figure 1. Distribution of papers by publication year

##### 3.1.2 Classification of papers by unit of analysis

Papers were also classified by the unit of the analysis i.e., firm level, SC level or network level. With this respect, most papers (54%) have a firm level focus as shown in figure 2. Here, it can be noticed that analysis of KM issue at SC level or network level is difficult as it is not easy to manage knowledge across all SC members compared to managing knowledge in a single firm. This signals that KM practices at SC level or network level are at low level of implementation, and thus, the need for the investigation of the associated barriers is significant.

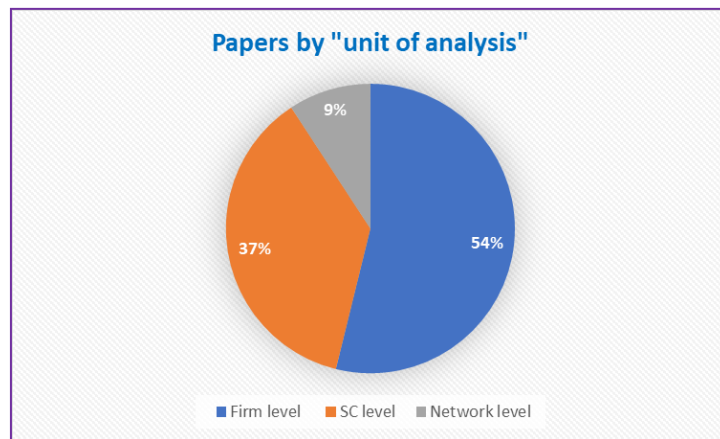


Figure 2. Classification of selected papers by unit of analysis

### 3.1.3 Analysis of papers by the type of KM factors considered in the studies

This analysis was conducted to investigate how many papers in the KM-SC field have considered "factors affecting the KM activities" in their studies. In this case, about 65% of the studies (figure 3) included the issue of KM factors in their discussions and the rest of the studies do not considered it. However, very few studies (8 papers or 12%) discussed the barriers affecting KM in SCs while most studies have focused on KM enablers. In the case of limited implementation of KM in SCs, further research on factors hindering KM is necessary, and more attention must be given to this research topic.

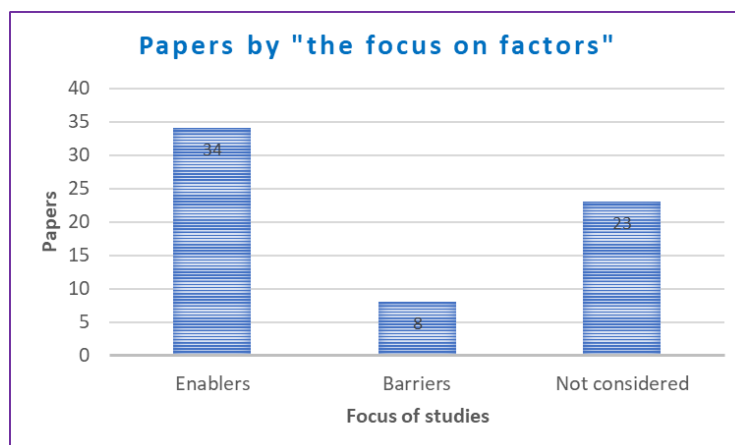


Figure 3. Classification of selected papers by their focus on factors

### 3.2 Content analysis

#### 3.2.1 Barriers affecting adoption and development of KM in SCs

Before we dive into the investigations of potential barriers, it is first necessary to summarise the lists of barriers that the (few) previous studies identified regarding KM in SCs, how they are categorized, and the possible associated limitations. From the preliminary literature review, it was found that there was little research on factors (both enablers or barriers) influencing KM adoption and development in SCs (Cerchione and Esposito, 2016). Some studies (Zerbino *et al.*, 2018; Li and Kang, 2019) indicate there are some studies of KM enablers or success factors, but very few papers on barriers to KM (only 12% of the sample, as presented in section 3.1.3). In this regard, our review highlights the contribution and the limitations of these previous studies on barriers to KM in SCs. A summary is presented in table 1.

Three important papers (Patil and Kant, 2014a, 2014b; Zerbino *et al.*, 2018) analysed KM barriers in SCs, and strategic and organizational barriers such as: lack of top management commitment, KM not integrated in business processes, and lack of proper organizational structure were found the most important barriers of KM adoption in SCs. On the other hand, it is necessary to remark that the studies have limited scope, insufficient empirical validation, and tend to present country specific cases. This shows that there is insufficient coverage of the possible challenges specific to KM related business activities. This is also supported by the findings of the SLR made by Cerchione and Esposito (2016) which states that the barriers to the adoption of KM in SCs are scarcely analysed and there is a need for a systemic approach to identify and analyse the whole set of barriers. Thus, this lack of study of barriers affecting KM practices in SCs in a more comprehensive view is a key issue.

Table 1 Summary of previous studies on barriers for KM in SCs

Authors	Authors' contributions	Limitations
Bagheri, Kusters and Trienekens, (2019)	Identified 9 barriers for customer knowledge transfer	Focus only on Customer knowledge transfer challenges in a value network setting
Batista <i>et al.</i> , (2019)	-Identified 10 KM processes implementation barriers and classified in to 3 categories (technology, organization & people related) -Knowledge Creation related (2), storage related	Focus only on barriers faced by an SME attempting to implement KM (adoption phase) in the food SC

	(4), application related (2), Sharing related (2)	
Kovács and Spens, (2010)	Suggested 'Competition b/n organizations as a barrier for Knowledge sharing in relief SCs	Not full focus on barriers
Li and Kang, (2019)	Investigated that the competition or rivalry side of the "co-opetition" r/ship acts as the major barrier for knowledge sharing due to the sharer's concern of knowledge leakage	Not full focus on barriers but proposal of a single factor
Mclaughlin, (2009)	Recommended 'Over dependency on technology' as a barrier for Knowledge sharing	Not full focus on barriers but proposal of a single factor
Patil and Kant, (2014a, 2014b)	-28 total barriers were identified and categorized as strategic, organizational, technological, cultural, individual. -Barriers were also ranked based on importance	-Limited to a few Indian firms and done before 2014 (needs an update). -KM method related factors are not considered
Ruel, Shaaban and Ducros, (2019)	Lack of use of collaborative tools and the difficulty in calculating the return on investment of a KMS due to priorities for other programs are suggested as barriers	Not fully focused on barriers but proposes two factors
Zerbino <i>et al.</i> , (2018)	-Singled out 75 barriers to KM adoption and/or development in Port Community Systems (PCSs)-enabled ports -Classified to 6 groups (strategic, organizational, technological, cultural, individual, knowledge characteristics) -Ranked the Strategic, Organizational, and Technological classes as most important	-Study is specific to port system in maritime logistics and barriers were ranked with FGD, single port area was considered. - Limited empirical study, limited applicability to other business sectors

### 3.2.2 Identification and re-categorization of KM barriers

Apart from the lack of a comprehensive or whole set of barriers, the categorizations made in the previous studies have its own limitation. First and foremost, these are generic classifications where the specificity to KM field is unclear. For instance, in the main studies of barriers, Patil and Kant, (2014a, 2014b) and Zerbino *et al.*, (2018), all used generic category names: strategic, organizational, technological, cultural, and individual barriers. Moreover, these studies did not consider barriers related to the adoption and use of explicitly defined KM methods or techniques (such as: knowledge café, community of practices, etc) which are, instead, among the main ingredients of KM programs used to manage knowledge development (Cerchione and Esposito, 2017); thus, investigating the associated barriers to the adoption of these methods is necessary. For these reasons, there is an evident need to re-categorize the barriers to KM in SCs.

A new categorization of KM barriers in SCs, in line with a recently proposed classification of KM practices (Kassaneh, Bolisani and Cegarra-Navarro, 2021), is therefore proposed here. The assumption is that it will be easy for firms to manage in parallel both the adoption of some KM practice and its associated barriers. According to the mentioned classification, KM practices are conceptualized with a triple-part classification, namely: KM methods, KM applications of IT, and KM-enabling management measures. In line with this, we proposed a taxonomy of KM barriers into these three categories (figure 4), namely: barriers related to KM methods, barriers related to KM applications of IT, and barriers related to KM-enabling management measures. This categorization has two important points. Firstly, firms can easily trace and develop a specific mechanism to alleviate the barriers related to the implementation of a specific category of practices. Secondly, this category considers the possible barriers related to the KM methods/techniques which have a direct impact on the introduction and development of a KM program in firms' SC. It will also contribute to research in the area because it proposes a common notion of KM practices and associated barriers.

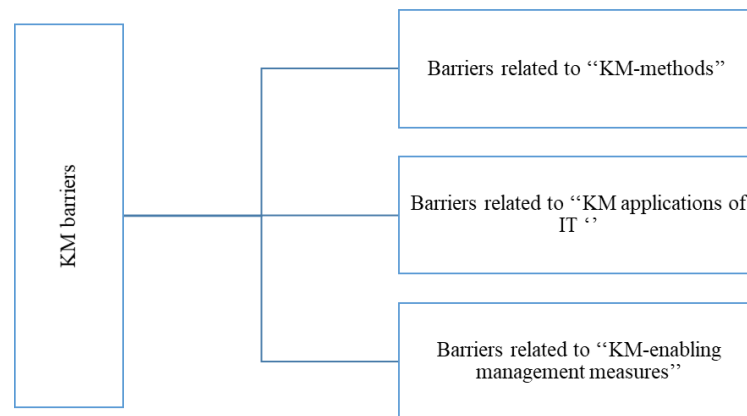


Figure 4. Categorization of KM barriers

When we say barriers related to the “KM methods”, this refers to factors that hinder the adoption of KM practices that are explicitly and directly targeted to the management of knowledge resources in a company, such as: barriers affecting the implementations of approaches to learning and exchanging knowledge contents; practical or mental toolboxes for favoring the systematization and access to knowledge resources; organizational arrangements which can be

employed to facilitate knowledge sharing among people, etc. For instance, “lack of intangible mechanisms like unscheduled meetings, informal seminars, coffee break conversations”, “lack of use of recent and user-friendly knowledge creation and sharing methods”, etc., are examples of barriers under this category.

Barriers related to the “KM applications of IT” refer to the factors hindering the use of IT systems that can support the management of knowledge contents in some form – for example, explicit knowledge in the case of database repositories and automatic analysis, or tacit knowledge in the case of communication-enabling systems. Lack of technical support on IT based systems to SC partners, lack of trust in system’s security, and lack of use of recent and user-friendly knowledge storage/retrieval and sharing technologies are examples of barriers related to this category. In the third category, the barriers related to the “KM-enabling management measures” are factors hindering the implementation of the purposeful KM-related managerial activities that may not directly refer to the management of knowledge but, anyway, can help to set the appropriate organizational context that facilitates the application of KM - for example, appointing KM officers, rewarding KM initiatives, providing leadership and top management support to KM programs, etc. Barriers under this category includes insufficient linkage between KM and corporate strategy, lack of commitment and support from top management, and lack of willingness and sharing spirit among SC members.

Accordingly, based on the analysis of the literature and its current gaps, this study singled out a provisional list of 61 possible barriers and they are classified into the above mentioned three main categories. After a cross-analysis and revision of these lists, to eliminate substantial replications and to highlight the focus on SCs (which is the main topic of this paper), there is a total number of 51 barriers of which 7 barriers are related to KM methods, 10 barriers are related to KM applications of IT, and 34 barriers are related to KM-enabling management measures. Further categorization was found important for the barriers classified under the third category. As this category is broad in nature and for the ease of management by firms, we made four sub-categories namely: strategy related (10 barriers), organization related (9 barriers), culture related (5 barriers) and individual or human resource related (10 barriers) (as used by Patil and Kant, (2014a, 2014b)). The detailed results which show the complete list of potential barriers along with their categories and sub-categories, and the references supporting their application to KM in SC, are presented in tables 2, 3 and 4.

Based on the literature review, the top five most frequently cited barriers to KM in SCs includes “lack of proper organizational structure that foster KM activities”, “KM not integrated with existing SC business processes”, “Time and resource constraints to provide adequate knowledge sharing opportunities to employees”, “competition or rivalry side of the “co-opetition” relationship - due to the sharer’s concern of knowledge leakage”, and “lack of support and commitment from the top management to work in collaboration with SC members”.

Our finding is more or less similar to the findings of Patil and Kant, (2014a, 2014b) and Zerbino *et al.*, (2018) where they are, however, included into the same category, namely “barriers related to the KM-enabling management measures (strategic and organizational related)”. This is due to the fact that most literature focuses on barriers related to management measures, i.e. it is assumed that a successful adoption of KM generically requires that strategic and organizational barriers need to be overcome. In addition, it shows that the other categories, specifically the barriers related to explicit KM methods and those related to KM applications of IT, are not well considered by the authors in most of the studies. This gives the opportunity for fresh empirical research.

Table 2. Barriers related to the “KM Methods”.

Category	Factors (barriers)	Reference
Barriers related to KM methods	Transmission, formalization and exchange of knowledge/information methods are currently not very effective, which creates several problems	Ruel, Shaaban and Ducros, (2019)
	Lack of use of collaborative mechanisms or tools between SC members	Ruel, Shaaban and Ducros, (2019)
	Lack of intangible mechanisms like unscheduled meetings, informal seminars, coffee break conversations	Riege, (2005); He, Qiao and Wei, (2009); Hutzschenreuter and Horstkotte, (2010)
	Insufficient support in capturing, evaluating and communicating lessons from past mistakes for fostering a learning effect	Riege, (2005); Cerchione, Esposito and Spadaro, (2015)
	Knowledge retrieval mechanisms that are hard to remember and do not avoid information overload	Alavi and Leidner, (2001)
	Difficulty to find a systematic method to acquire knowledge and use when applicable	Batista <i>et al.</i> , (2019)
	Lack of use of recent and user-friendly knowledge creation and sharing methods	Cerchione, Esposito and Spadaro, (2015); Cerchione and Esposito, (2017)

Table 3. Barriers related to the “KM applications of IT”.

Category	Factors (barriers)	Reference
Barriers related to KM applications of IT	Lack of technological infrastructure to adopt KM	Wong and Wong, (2011)
	Inhibition effect on learning due to KM systems	Zerbino <i>et al.</i> , (2018)
	Failure to develop a transactive memory system	Rosen, Furst and Blackburn, (2007)
	Lack of familiarity and experience with the new IT tools	Riege, (2005); Zerbino <i>et al.</i> , (2018)
	Lack of regular training concerning the new interactive KM IT based tools	Riege, (2005); Zerbino <i>et al.</i> , (2018)
	Lack of integration between IS/IT and business processes	Zerbino <i>et al.</i> , (2018); Riege, (2005)
	Lack of compatibility among different IS/IT tools	Zerbino <i>et al.</i> , (2018)
	Lack of trust in system’s security	Gunasekaran and Ngai, (2004) ; Zerbino <i>et al.</i> , (2018)
	Lack of technical support to SC partners	Hutzschenreuter and Horstkotte, (2010); Riege, (2005);
	Lack of use of recent and user-friendly knowledge storage/retrieval and sharing technologies	Cerchione, Esposito and Spadaro, (2015); Cerchione and Esposito, (2017)

Table 4. Barriers related to the “KM-enabling management measures”.

Category & sub-categories	Factors (barriers)	Reference
KM supportive management measures - strategy related barriers	Insufficient linkage between KM and corporate strategy	Blumenberg, Wagner and Beimborn, (2009); Zerbino <i>et al.</i> , (2018)
	KM not integrated with existing SC business processes	Zhao, de Pablos and Qi, (2012); Patil and Kant, (2014a, 2014b); Cerchione, Esposito and Spadaro, (2015); Ahmad and Daghfous, (2010); Nätti and Ojasalo, (2008);
	Lack of clear understanding of KM in SC	Shih <i>et al.</i> , (2012); Patil and Kant, (2014a, 2014b); Aziz and Sparrow, (2011)
	Lack of support & commitment from the top management to work in collaboration with SC partners	Patil and Kant, (2014a, 2014b); Cerchione, Esposito and Spadaro, (2015); Bandyopadhyay and Pathak, (2007)
	Legal issues (IP and related protection laws that hinder access and share among SC members)	Bagheri, Kusters and Trienekens, (2019); Cerchione, Esposito and Spadaro, (2015); Zerbino <i>et al.</i> , (2018)
	Lack of fund for KM system development	Ahmad and Daghfous, (2010); Zhao, de Pablos and Qi, (2012); Patil and Kant, (2014a, 2014b)
	Lack of a KM measurement framework	Batista <i>et al.</i> , (2019)
	Competition or rivalry side of the "co-	Batista <i>et al.</i> , (2019); Li and Kang, (2019); Kovács



	opetition" relationship, due to the sharer's concern of knowledge leakage	and Spens, (2010); Cheng, Yeh and Tu, (2008)
	Difficulty in calculating the return on investment of a KMS due to priorities for other programs	Ruel, Shaaban and Ducros, (2019)
	Lack of roles and responsibilities of SC members on KM programs	Nätti and Ojasalo, (2008); Patil and Kant, (2014a, 2014b)
KM supportive management measures - <i>organization related barriers</i>	Lack of rewards or recognition for contributing and sharing insights	Riege, (2005); Rosen, Furst and Blackburn, (2007); Zerbino <i>et al.</i> , (2018); Hutzschenreuter and Horstkotte, (2010);
	Lack of balance of the knowledge flow between the provider (source) and the knowledge seeker	Alavi and Leidner, (2001); Riege, (2005); Zerbino <i>et al.</i> , (2018)
	Communication and knowledge flows are restricted into certain directions of SC	Shih <i>et al.</i> , (2012); Patil and Kant, (2014a, 2014b); Zerbino <i>et al.</i> , (2018)
	Lack of proper organizational structure that foster KM activities	Riege, (2005); Ahmad and Daghfous, (2010); Nätti and Ojasalo, (2008); Alavi and Leidner, (2001); Patil and Kant, (2014a, 2014b)
	Limitation on KM leadership and managerial skills	Bandyopadhyay and Pathak, (2007); Batista <i>et al.</i> , (2019); Bagheri, Kusters and Trienekens, (2019)
	Low priority in knowledge retention of highly skilled/experienced staff	Fletcher and Polychronakis, (2007) ; Zerbino <i>et al.</i> , (2018)
	Insufficient education and training programs	Blumenberg, Wagner and Beimborn, (2009)
	Lack of adequate knowledge of functioning of other SC members	Nätti and Ojasalo, (2008); Aziz and Sparrow, (2011)
	Time and resource constraints to provide adequate knowledge sharing opportunities to employees	Ahmad and Daghfous, (2010); Zhao, de Pablos and Qi, (2012); Bagheri, Kusters and Trienekens, (2019); Aziz and Sparrow, (2011)
KM supportive management measures - <i>culture related barriers</i>	Lack of a shared cultural meaning of KM activities	Beesley and Cooper, (2008); Bagheri, Kusters and Trienekens, (2019)
	Lack of an organizational culture/norm that fosters knowledge sharing	Riege, (2005); Nätti and Ojasalo, (2008); Hutzschenreuter and Horstkotte, (2010); Shih <i>et al.</i> , (2012)
	Lack of trust and commitment among SC members	Bagheri, Kusters and Trienekens, (2019); (Samuel <i>et al.</i> , 2011); Shih <i>et al.</i> , (2012)
	Insufficient common understanding	Bagheri, Kusters and Trienekens, (2019)
	Lack of willingness and sharing spirit among SC members	Hutzschenreuter and Horstkotte, (2010); Patil and Kant, (2014a, 2014b)
KM supportive management measures - <i>HR/person</i>	Lack of time or opportunity to share and to apply knowledge	Davenport and Prusak, (1998); Aziz and Sparrow, (2011)
	Lack of willingness to share knowledge	Bagheri, Kusters and Trienekens, (2019); Zerbino <i>et al.</i> , (2018); Patil and Kant, (2014a, 2014b)

<i>related barriers</i>	Fear of publishing something confidential	Paroutis and Saleh, (2009); Zerbino <i>et al.</i> , (2018)
	Fear of losing knowledge and IP ownership	Patil and Kant, (2014a, 2014b); Bagheri, Kusters and Trienekens, (2019);
	Unawareness of what knowledge has to be shared and how to systematically share it.	Patil and Kant, (2014a, 2014b); Batista <i>et al.</i> , (2019)
	Lack of trust in people	He, Qiao and Wei, (2009); Riege, (2005); Rosen, Furst and Blackburn, (2007);
	Lack of absorptive capability	Zerbino <i>et al.</i> , (2018); Patil and Kant, (2014a, 2014b)
	Differences in experience, age, gender, and education levels	Riege, (2005); Zerbino <i>et al.</i> , (2018)
	Fear to share incorrect information	Pillai and Min, (2010); Zerbino <i>et al.</i> , (2018)
	Technophobia	Lin, Wu and Yen, (2012); Zerbino <i>et al.</i> , (2018)

#### 4 Summary and comparison to previous literature reviews

As mentioned, there are some previous reviews that treated a similar topic, and particularly three papers (Bhosale and Kant, 2016; Cerchione and Esposito, 2016; Pérez-Salazar *et al.*, 2019) on KM in SC in general, and three specific studies on barriers affecting KM in SCs (Patil and Kant, 2014a, 2014b; Zerbino *et al.*, 2018). In this section, a summary and comparison of these studies is proposed to highlight their contribution, to show their limitations, and to provide useful comparisons. Also, the SLR proposed in this paper differs from the previous studies because it clarifies and extends their results especially by adding these points:

- A classification of papers by “factors”, i.e., enablers or barriers, to know which one is covered or not covered.
- A classification of papers by “unit of analysis”, i.e., firm level, SC level and supply network level
- A re-classification of the barriers related to each specific category of KM practice (the previous studies just proposed generic taxonomies of barriers with no direct connection with specific KM practices)
- An addition of further barriers related to explicit KM-methods or techniques, which have not been considered before but have a significant impact on KM introduction and development.

In addition, this review is “topic-specific” because it focuses on KM barriers that affect the management of knowledge resources and processes of firms with their SC partners.

## **5 Conclusion and future directions**

The analysis of selected papers in the last 20 years shows an increasing trend, especially in the last decades, which implies the importance of studying KM in a SC perspective. Indeed, competition is nowadays more among SCs than between individual firms. In spite of its importance, the implementation of KM in SCs can encounter several barriers, which must be investigated and presented in a complete way. This can help both research and practice on this topic.

The available studies on KM barriers in SCs already provide useful insights but fail to provide a consistent and complete classification of barriers which considers all the typologies, and thus a unified vision or perspective on this topic has not emerged so far. Thus, this paper makes three scientific contributions. First, it provides an up-to-date in-depth systematic review of barriers to KM in SCs. Second, it makes a first attempt to provide a systematic identification and re-classification of KM barriers in consistent categories that are relevant to KM implementation. Third, in the previous studies, the explicit KM methods and the related barriers have not been investigated, and this study tries to include them in the analysis to provide a comprehensive list of barriers.

As for a practical implication, the complete list and categorization of KM barriers can be significant for managers and KM consultants in their effort to introduce and adopt various KM practices in SC management. Our categorization can help company executives to identify and manage these barriers because they are clearly associated with each specific category of KM practice. Indeed, as mentioned, competition is more and more among SCs and networks of firms rather than single companies, so managers must know and overcome the potential barriers to successfully manage knowledge at the level of SCs.

Understanding these hindering factors is an important prerequisite for the competency development of both management and staff for a successful implementation of KM programs in SCs. However, the proposed categorization of KM barriers needs a further empirical validation for assessing the applicability and relevance, streamline the number of barriers and identifying if other new barriers are being faced by firms. It is also important to rank the barriers based on an

empirical evidence to identify the most influential barriers and help organizations to concentrate on these barriers and develop KM based strategies to tackle them on priority and achieve competitive advantage. This can be the object of future research.

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# A Model of Goal-Oriented Knowledge Discovery based on Human-Computer Symbiosis

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## Abstract

Our study arose from a need to discover new knowledge about two types of language units: German modal verbs and medical terms of disease descriptions. The paper focuses on creating and enriching knowledge bases of language units' meanings and their definitions and designing information technology providing the discovery of new knowledge. The discovery is based on a model named information technology-oriented (hereafter – ITO model), and its particular case called the filling model. There are three main differences between these two models and the spiral model. First, the ITO and filling models distinguish between two explicit knowledge representations: by words and computer codes. Second, the models include four additional transition processes: visualisation (computer codes → words), digitalisation (words → computer codes), conceptualisation, and annotating apart from processes already present in the spiral model of knowledge creation. Thirdly, they serve as a theoretical basis for developing information technology of goal-oriented discovery of new knowledge in large digital collections. The models combine the automatic and expert stages of enriching knowledge bases in the paradigm of human-computer symbiosis. The paper aims to consider the filling and ITO models. The latter is positioned as the digital transformation outcome of the spiral model of knowledge creation.

**Keywords** – Goal-oriented knowledge discovery, Knowledge base, Filling model, Human-computer symbiosis, ITO model.

**Paper type** – Academic Research Paper

## 1 Introduction

There is a large corpus of literature investigating the impact of artificial intelligence (AI) on the definition and solution of problems related to knowledge management (KM). The literature review by A. Zbucha et al. (2019) provides a



multi-faceted analysis of relationships between AI and KM. Since 2012, the International Workshop on Artificial Intelligence for Knowledge Management has been held eight times. Relations between AI and KM are reflected in the name of the workshop. Its objective "is to gather both researchers and practitioners to discuss methodological, technical and organisational aspects of AI used for knowledge management" (Mercier-Laurent, et al., 2021).

In 2021, the workshop highlighted the relevance of using human-AI systems for knowledge management (Mercier-Laurent, 2021; Monsone, 2021). According to Mercier-Laurent (2021), "The balance between the use of technology and human capacity should be preserved. <...> We have to design applications able to enhance human intelligence without switching it off". Together, human and artificial intelligence would help not only to enhance the usability of current AI systems (Blasch, et al., 2019) but also deal with those KM problems that cannot be solved without human-computer symbiosis or its special case named human-AI one (Licklider, 1960; Jarrahi, 2018; Trunk, et al., 2020; Stephanidis, et al., 2021; Elgendy, et al., 2021). We have developed the filling and ITO models for solving one of such KM problems: discovering new language units' meanings based on human-computer symbiosis combining the automatic and expert stages of enriching knowledge bases.

Note that Licklider formulated the concept of symbiosis between human and computer over 60 years ago. In 1960, he created a concept named Man-Computer Symbiosis (Licklider, 1960). According to Abbass, Licklider "used the word 'man' since at that time it meant 'males and females', whereas, since the 1970s, it has been used to refer to 'males' alone and has been replaced with the gender-neutral word 'human'. Licklider predicted that by 1980, AI will have the ability to think and solve problems and that by 1985, humans and AI machines will coexist, working in harmony together. <...> The evolution of AI has not matched Licklider's vision. The year 1980 did not record any serious implementation of AI that could compete with humans. The year 1985 did not witness human-computer symbiosis. The year 1993 only saw an AI winter. Nevertheless, hope started to rise again with the IBM Deep Blue program winning against Kasparov in 1997" (Abbass, 2020).

The paper aims to correlate the developed ITO model with the spiral model of knowledge creation (Nonaka, 1991; Nonaka and Takeuchi, 1995). The ITO model generalises the filling model (Zatsman, 2020) described in the following section. In section 3, prerequisites for creating the ITO model are characterised. In section

4, the ITO model is considered as the digital transformation outcome of the spiral model.

## 2 Filling model

The model arose from a need to find and fill in lacunas in a knowledge base supporting translation research, which influenced the choice of the name for it. The filling model describes the processes of enriching the knowledge base about studied language units. The enrichment is based on conceptualising potential sources of new meanings of language units. In our linguistic projects, the potential sources are parallel text sentences (Tabl. 1). The conceptualisation (=concept creation) provides an opportunity to discover new meanings of language units in texts in a goal-oriented way and represent the meanings by headings of the knowledge base and their definitions.

Table 1. Sentence-aligned German-Russian parallel texts

<b><i>German sentence</i></b>	<b><i>Russian translation</i></b>
Don Quijotes sollen wir wohl alle sein, wenn wir nur ein wenig das Herz auf dem rechten Fleck haben und ein Körnchen Verstand unter der Schädeldecke.	Мы все Дон-Кихоты, если у нас честное сердце и под черепной коробкой крупица разума.
Ich glaube an die Gerechtigkeit und an die Menschheit, der diese Gerechtigkeit dienen soll.	Я верю в справедливость и в человечество, которому должна служить эта справедливость.
<i>[Friedrich Dürrenmatt. Der Verdacht (1953)]</i>	<i>[Translated into Russian by N. Savinkov (1990)]</i>

The initial conditions of the development of the filling model were obtained in observing translation research of linguists. They analyse and annotate studied language units along with their contexts and translations and simultaneously enrich the knowledge base by new headings and their definitions if new meanings of studied units in parallel text sentences are discovered. Linguists discover new meanings and represent them by entirely new headings of the knowledge base or change existing ones. At the same time, they create the definition of the new heading or change the existing definition.

Let's summarise the initial conditions for creating the filling model, obtained as a result of observing the work of linguists:

1. The discovery of new knowledge about studied units is a goal-oriented iterative process
2. Linguists analyse and annotate contexts and translations of studied units to discover new meanings and represent them by updated or new headings
3. Obtained annotations, including contexts and relevant headings, are stored in a database
4. New headings created by linguists are added to the knowledge base

Any heading added to the knowledge base represents a new concept of only one linguist; this concept and a relevant heading are individual. In the general case, different linguists may generate unlike individual concepts and relevant headings created during the conceptualisation of the same context. A group heading concept is formed in the process of discussing individual headings and their definitions by the group of linguists who enrich the knowledge base. The purpose of the discussion is to create a consensual definition for a heading concept within the group. The group concept has to cover the new consensual meaning of a studied language unit discovered in parallel text sentences. Therefore, the proposed filling model should describe two procedures of enriching the knowledge base, namely:

- Discovering and representing new individual meanings of language units by headings and their definitions
- Creating and representing consensual definitions for heading concepts within the group of linguists

The proposed filling model is based on the four following ideas. First, in addition to internalisation, socialisation, and externalisation as transformation processes of the spiral model (Nonaka, 1991; Nonaka and Takeuchi, 1995), the filling model includes four processes: *visualisation* (computer codes → words), *digitalisation* (words → computer codes), *conceptualisation* (texts → concepts), and *annotating* (concept contexts → annotations), but without using the process of combination. Second, the model covers three media of different nature: mental, informational, and digital (Zatsman and Buntman, 2015). Third, transformation processes of visualisation and digitalisation are anchored to the boundary between informational and digital media (Fig. 1). And finally, the process of conceptualisation covers mental and informational media and the

boundary between them. To simplify Fig. 1, the process of conceptualisation is depicted in the informational medium only and annotations are shown without processes of annotating concept contexts.

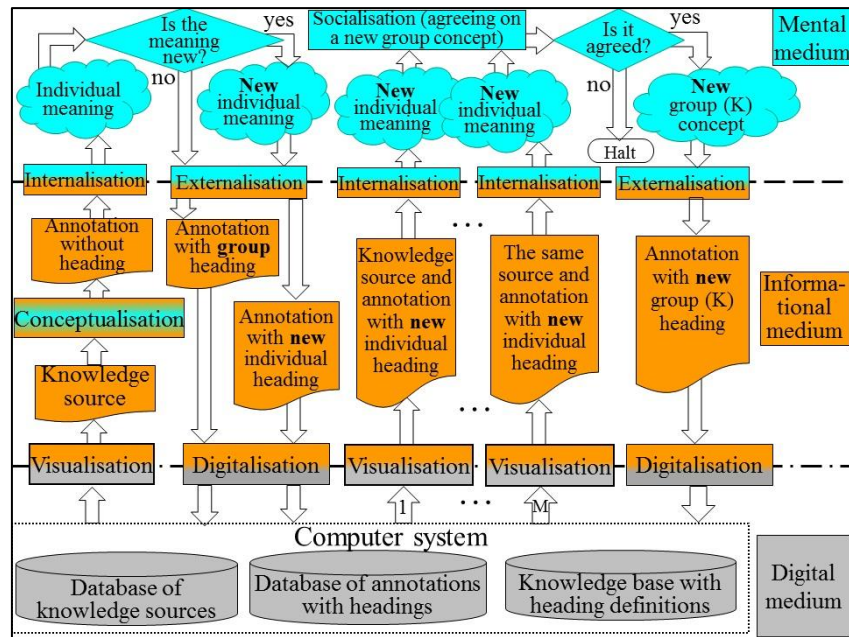


Figure 1. The filling model

Now we give a brief depiction of all the seven processes of the filling model, which consists of two submodels. The first submodel describes the iterative work of one linguist discovering new individual meanings of language units and annotating their contexts (see the left part of Fig. 1; the process of annotating is not shown in Fig. 1). Each iteration includes the following steps:

- The first pair of parallel text sentences with a studied language unit and its context is extracted from the database of knowledge sources and converted into its perceptual form (designated as "Visualisation")
- A linguist semantically analyses the extracted pair and tries to discover and describe the meaning of the language unit within its context ("Conceptualisation")
- If the linguist cannot recognise the meaning of the language unit in question, then the iteration of processing the first pair stops (it is not shown in Fig. 1), and the linguist begins the next iteration

- If the linguist recognises the meaning, then he or she represents it in the form of an annotation without any knowledge base heading ("Annotation without heading")
- The annotation without heading is semantically analysed to internalise the meaning represented ("Internalisation")
- The linguist compares his or her meaning with *group* heading concepts represented in the knowledge base ("Is the meaning new?")
- If the meaning is new ("yes"), then the linguist creates a new individual heading and its definition in the knowledge base, the concept of which would cover the meaning, and adds the heading to the annotation ("Externalisation"), which is recorded in the annotation database ("Digitalisation")
- If the meaning isn't new ("no"), then the linguist adds the relevant *group* heading of the knowledge base to the annotation ("Externalisation"), which is recorded in the annotation database ("Digitalisation")
- After digitalisation, the linguist begins the next iteration

The linguist performs the listed steps for each potential knowledge source found. If these processes were repeated M times for the same source by M different linguists, then up to M different annotations with individual headings can be formed.

The second submodel describes the work of M linguists to create a single consensual heading (see the right part of Fig. 1) based on the same knowledge source and M different annotations. The creation process includes the following steps:

- M annotations with new individual headings created by M different linguists are retrieved from the database of annotations and converted into perceptual forms together with the pair of parallel text sentences as their source of discovered new knowledge ("Visualisation")
- M annotations are semantically analysed to internalise the meanings represented ("Internalisation")
- M linguists try to create a single consensual heading, the concept of which would align M meanings of a studied language unit described by M linguists ("Socialisation")

- If linguists cannot create any consensual concept of a heading ("no"), the socialisation process stops for these M individual headings (see the terminal «Halt» in Fig. 1)
- If the single consensual concept of a heading is generated by K from M linguists ( $1 < K \leq M$ ), then the socialisation process is completed by creating the definition of the heading whose socialisation index equals K ("yes")
- Linguists create a new annotation with the heading ("Externalisation")
- They add the heading with its definition to the knowledge base, and the annotation is recorded in the annotation database ("Digitalisation")
- Then the listed processes of the second submodel are performed for series of individual headings formed for other knowledge sources.

There are four main differences between the filling model and the spiral model. First, the filling model distinguishes between two representation modes of explicit knowledge (by words and computer codes). Second, it includes four additional transition processes apart from three ones (internalisation, socialisation, and externalisation) already present in the spiral model. Third, the filling model covers the conceptualisation of sources of new meanings of language units (texts → concepts). And finally, it is a theoretical basis for designing computer algorithms and information technology for goal-oriented discovery of new knowledge about language units in digital text collections. See Fig. 1-3 with algorithms in (Zatsman, 2020) which is the basis for developing information technology.

Using the filling model, our team has developed a computer system that enriches the linguistic ontology about meanings of German modal verbs and their exemplary translations into Russian. A German-Russian dictionary that reflects the state-of-the-art level of knowledge about these studied language units was selected to apply the computer system. To show the feasibility of goal-oriented enrichment of the linguistic ontology, our team has designed a knowledge base with the initial version of the ontology created based on the dictionary by linguists.

The database of potential knowledge sources has been loaded with parallel texts of several hundred books. The downloaded texts of the books have been aligned so that one original sentence corresponds to its translation. Sometimes several sentences of the original text were put in correspondence with their translation, which may include one or more sentences. Thus, downloaded texts are divided into potential sources of new knowledge, as shown in the example of

the two pairs in Tabl. 1. For all books downloaded to the database, 535140 pairs as potential knowledge sources have been formed computerised.

Translations of German modal verbs are the subject of the study. They include the verbs dürfen, können, mögen, müssen, sollen and wollen. Out of 535140 pairs, 109130 contain these verbs, and in 14155 of them, the verb sollen is used. Tabl. 1 shows two examples of potential sources from 14155 pairs that contain the verb. Up to May 5, 2021, 5366 out of 109130 pairs containing these six verbs had been analysed by linguists. Eight new meanings of verbs were discovered during the analysis, and their definitions were agreed amid five linguists. The definitions of eight group concepts with their headings were added to the knowledge base.

If the filling model is compared to the list of the four above-mentioned initial conditions for its creation, it will be noticed that the second condition is only partially reflected in the model. Namely, linguists discover new meanings and represent them by entirely new headings of the knowledge base or changed existing ones. In the filling model, new meanings are only being represented by *entirely new headings*. To eliminate this drawback, a generalisation of the filling model was proposed, presented in section 4 in juxtaposition with the spiral model.

### **3 Prerequisites for creating the ITO model**

Besides eliminating the noted drawback, the ITO model as a generalisation of the filling model arose from a need to discover new knowledge for creating and updating a medical knowledge base (KB) of terminological profiles of diseases. If in the linguistic knowledge base about modal verbs, the number of modal verbs was known in advance (six verbs) and only the number of meanings of each verb could change, in the medical KB, both the number of profile's terms and the number of meanings of each new or existing term can change. Our medical KB comprises the terminological profile for only one disease (breast cancer).

The proposed ITO model is a design base of information technology enriching the medical KB using machine learning. Let's consider resources and prerequisites for creating the model. To enrich the medical KB, we use the outcomes of processing a large collection of medical documents. Our project uses the PubMed Central (PMC) database as a digital collection containing more than 6 million full-text records on biomedical and life science literature (PMC, 2021).

The principal prerequisite for creating the ITO model is that the growth of scientific knowledge represented in medical texts sometimes results in new terms which need to be regularly annotated and added to the medical KB. The annotation of each term contains: 1) a structured definition of each meaning of the term, 2) the retrospective of each definition variants, 3) its subsumption relations, meronymy and other relations, 4) term contexts extracted from full-text records, 5) a linkage between each context and its record, 6) term synonyms, 7) term associations with disease stages.

A term with its contexts discovered during the automatic processing of full-text records describing a disease can belong to one of five groups of terms formed according to the following criteria:

- 1) terms are not related to the disease in question or are common to several diseases (irrelevant to our project);
- 2) term contexts indicate a new *synonym* for one of the existing terms of the medical KB;
- 3) extracted contexts of an existing term indicate the need to renew the *definition* of its some concept in the medical KB;
- 4) extracted contexts of an existing term indicate the need to add a *new concept* of medical knowledge and its *definition* to the existing term annotation of the medical KB;
- 5) a discovered term is new, and its contexts express the *new concept* of medical knowledge (a new *annotation* of the term should be entered into the medical KB)

The whole cycle of processing full-text records describing the disease in question includes five stages:

- 1) the formation of an array of records that describe the disease;
- 2) automatic discovery of terms and their contexts in scientific texts, which can update the medical KB;
- 3) computer-based generation of the five listed groups of terms based on machine learning of the classification of terms;
- 4) expert analysis of each group of terms and clarification of the composition of each group;
- 5) expert enrichment of the medical KB by new synonyms, updated definitions, new definitions or annotations of new terms according to the proposed ITO model.



The first three stages are designed to automatically process full-text records and narrow the range of potential sources of new knowledge. A significant range narrowing is necessary at the first three stages so that the experts can execute the last two stages in an acceptable timeframe. In this case, the symbiosis of human and artificial intelligence allows updating the medical KB according to the ITO model.

#### **4 ITO model**

The filling model, as the particular case of the ITO model, describes one kind of representation of discovered meaning by its definition. The ITO model has to describe any number of kinds of representation. For example, the ITO model should describe enrichment of the medical KB by four kinds of representation of discovered knowledge: a new synonym, an updated definition, a new definition or the annotation of a new term.

The creation of the ITO model is implemented as the digital transformation of the spiral model (Nonaka, 1991; Nonaka and Takeuchi, 1995) based on seven principal pillars:

- the model should not depend on the number of kinds of representation of the discovered knowledge
- four processes of the filling model (visualisation, digitalisation, conceptualisation, annotating) and four processes of the spiral model (internalisation, socialisation, externalisation, combination) should be integrated by the model
- eight processes take place in three media (mental, informational, digital) and/or on their boundaries
- the processes of visualisation and digitalisation are anchored to the boundary between informational and digital media
- the process of conceptualisation takes place in the mental and informational media and on their boundary (the process is depicted in the informational medium only)
- there is a digital collection of texts which is relevant to the goal of new knowledge discovery from the texts
- in the digital medium, there is a knowledge base for representing new knowledge, e.g., the linguistic knowledge base or medical KB

In the first stage of the digital transformation of the spiral model, we will consider only the mental and informational media. The four types of knowledge of the spiral model are distributed among these two media: tacit knowledge is in the mental medium, and explicit knowledge is in the informational medium. Socialisation takes place in the mental medium. Externalisation and internalisation correspond to the boundary between the mental and information media, and the combination takes place in the informational medium (Fig. 2).

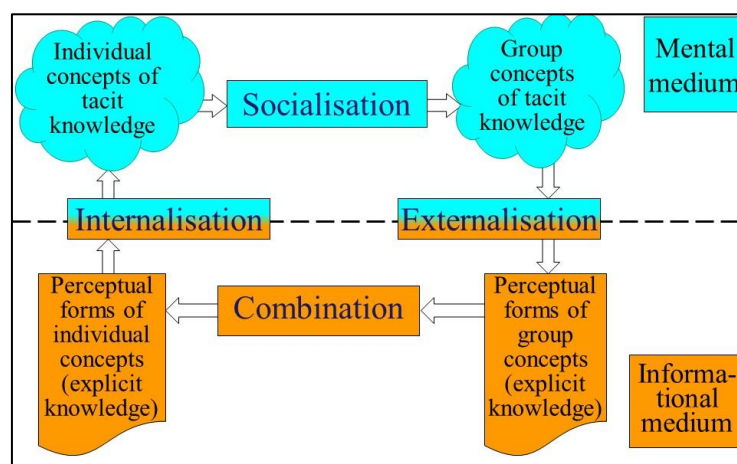


Figure 2. The mental and informational media of knowledge generation

The source of new concepts is a large collection containing digital texts. The collection is stored in the digital medium added to the mental and informational media (Fig. 3). Adding the digital medium is the second stage of the digital transformation of the spiral model. The collection of texts is a source of new knowledge in the digital medium. However, in Fig. 3, this source is not yet integrated with the process of discovering new knowledge. To integrate it, we need to use three more processes (conceptualisation, annotating, and digitalisation) added at the final stage of digital transformation, completing the creation of the ITO model (Fig. 4).

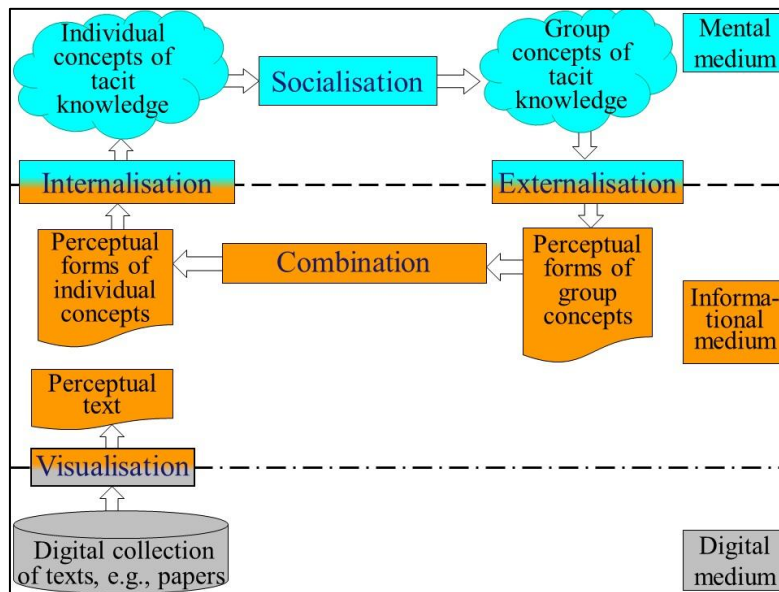


Figure 3. The mental, informational, and digital media

To perform a semantic analysis of a text potentially containing a new term, it is necessary to find the needful text in a digital collection and represent it in a perceptual form. The digital text's transformation into its perceptual form is denoted by the word "Visualisation" (Fig. 3&4). Questions about finding texts with new terms are not discussed here. The goal of the semantic analysis performed by an expert and indicated in Fig. 4 by the word "Conceptualisation" is to discover new knowledge from a text and represent it in a knowledge base.

After completing the semantic analysis process, the expert renews an existing annotation adding a new synonym, a new or updated definition, or creates the annotation of a new term in the knowledge base (see word "Annotating" in Fig. 4). This personal annotation is digitised and entered into the knowledge base.

To form the group concept, personal annotations are retrieved from the knowledge base and converted into their perceptual forms. Further, combination, internalisation, and externalisation processes correspond to the spiral model of knowledge generation with one significant difference: the perceptual form of a group concept is digitised and entered into the knowledge base. If there are several personal annotations formed by different experts based on the same context, they are retrieved from the knowledge base and converted into their perceptual forms.

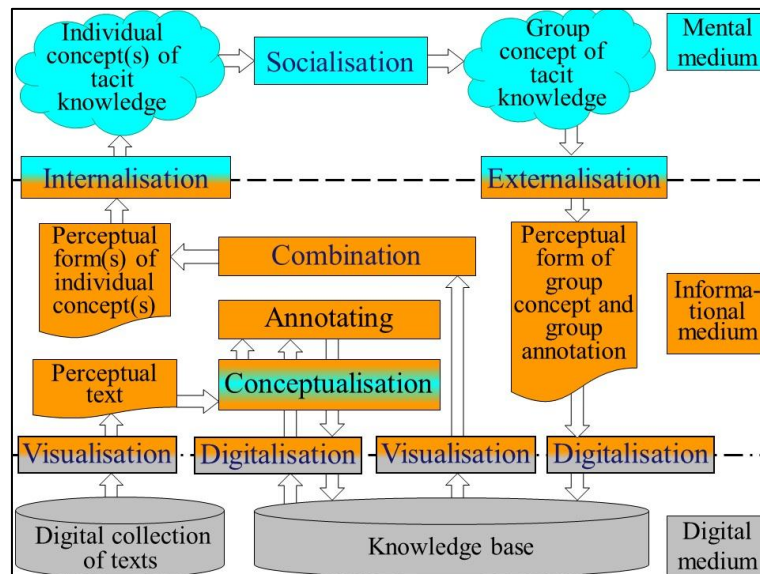


Figure 4. The ITO model

There are four main differences between the ITO model and the spiral model (Nonaka, 1991; Nonaka and Takeuchi, 1995). First, the ITO model distinguishes between two representations of explicit knowledge: by words and computer codes. Second, the model includes four additional processes: visualisation, digitalisation, conceptualisation, and annotating. Thirdly, the ITO model has the explicit standard of the novelty of discovered knowledge (it is not shown in Fig. 4). And finally, the model is a theoretical basis for developing information technology for goal-oriented discovering new knowledge in texts.

## 5 Conclusions

On the one hand, the ITO model is a generalisation of the filling model. On the other hand, it was obtained as an outcome of the digital transformation of the spiral model. To develop computer algorithms and information technology for discovering new knowledge based on the ITO model or the filling model, we should describe five items:

- studied language units, e.g., modal verbs or medical terms
- the goal of discovering new knowledge about them
- the large digital collection of texts which is relevant to the goal

- the standard of the novelty of discovered knowledge (a dictionary, thesaurus, and so on) that reflects the state-of-the-art level of knowledge about studied language units
- the number of kinds of representation of discovered knowledge

As noted above, for German modal verbs, the goal is to enrich the linguistic ontology of meanings of the verbs and their exemplary translations into Russian. The digital collection includes several hundred books with 109130 usages of modal verbs. A German-Russian dictionary that reflects the state-of-the-art level of knowledge about modal verbs was selected. The number of kinds of representation of discovered knowledge is one (only new definitions of modal verb meanings). After describing these five items, algorithms and information technology were designed based on the filling model for goal-oriented discovering new knowledge about meanings of modal verbs by linguists (Zatsman, 2020).

For medical terms of disease descriptions, the goal is to enrich the medical KB of terminological profiles of diseases. The digital collection is the PMC database which "contains more than 6 million full-text records, spanning several centuries of biomedical and life science research" (PMC, 2021). The National Cancer Institute Thesaurus (NCIt) reflected the state-of-the-art level of knowledge about medical terms was selected (NCIt, 2021). The number of kinds of representation of discovered knowledge is four (a new synonym, an updated definition, a definition of a new concept, the annotation of the new term). After completing the description of these five items, we are now designing algorithms and information technology based on the ITO model to discover new knowledge to enrich the terminological profile of breast cancer.

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## Project Organizations – Evolutions between Theory and Reality

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### Abstract

The faculty of Innovative Technologies of the University of Applied Science of Southern Switzerland (SUPSI), started in November 2020 a study for assessing the importance and the diffusion of a project management structure in the Swiss and north Italy small to large size companies.

The study has been based on a structured survey, written in Italian, sent to a huge pool of Switzerland and Italian companies and it aims to understand how the organizational structure has been affected by the pandemic time we are living and by the management knowledge relating to managing projects. More precisely, the following research study focuses to analyze the organizational structure into the different operational contexts of the inquired companies and therefore its correlation with the project management maturity and the most relevant factors responsible for the project's success or failure during this uncertain time.

The research will provide objectives and results showing which is the common organizational structure related to a working context and its relations with management knowledge and project' success achievement, clarifying how companies have been affected by the global pandemic situation in terms of managing projects.

**Keywords** – Project Organizations, Project Success, Methodologies, Maturity, Uncertain Times

**Paper type** – Academic Research Paper



## **1 Introduction**

Every Organization adopts a different structure in which they are working, to achieve their goals according to their corporate objectives.

The well-defined organization structures in accordance with the business context make it possible to achieve the objectives, allocate the correct resources and influence the success of the projects and subsequently the success of the company.

The literature [1] shows how organizations can apply different organizational project structures and how these affect the benefits or disadvantages compared one to another, this is regardless of the context in which the company operates.

In fact, it is not the activity which is carried out by the company that defines the type of structure chosen, but it is the result or product which influences the choice of the Organizational Structure (OS).

The OS creates a reference framework that allows the interaction of all those who are involved in the project and which are necessary for the execution of the project. The support of the OS is responsible for a smooth progression and therefore to be as efficient as possible, this responds in a clear definition of roles, tasks, responsibilities and the allocation of the necessary skills.

Project organizational structures are distinguished by their ability to determine the availability of resources and influence how projects are managed and conducted.

The main forms of OS are:

- Functional organizations
- Dedicated functional organization
- Organization for projects
- Matrix Organization (weak/balanced/strong)
- Project Management Office (PMO)

### **1.1 OS theory vs. reality**

The Organizational Structure (OS) is the major factor that plays a fundamental role in guiding and defining the ways in which the organization carries out its operation, in the same way they are responsible for determining the hierarchy of people, their function, the workflow and the reporting system. In relation to the different sectors in which they operate the organizations shape their structures to

optimize their results to obtain the needed resources and to optimize it for the marked demand.

### ***1.2 OS and the success of the project***

The failure of a project often occurs in the absence or unclear organizational structure. With time passing, technological innovation and the market demand for increased specific skills, organizations are meeting often new challenges like new, unusual and limited in time. Furthermore, the current pandemic situation creates new challenges to which companies must adapt relatively quickly. In this scenario the classic organization is unable to cope with this kind of commitment: here a specific organization and/or strategy is required for the project management.

### ***1.3 Training and knowledge management***

With the advancement of technologies, the markets in the various fields of application are confronted with a sudden change and with increasingly specific and ambitious requests. It follows that the organizations have to keep up with the times, the organizations are in need to hire highly specialized professionals which bring the know-how and are able to handle the required tools and methodologies which are currently available and who have the flexibility to adapt to changes.

The type of OS applied within the company influences the role of the PM and the respective skills required, this can have a range from the simple coordinator/expediter (administrative PM) towards the real project manager with full decision making power.

Nowadays the resources that are sought by organizations are no longer limited to an in-depth knowledge of the subject, these so-called hard skills are well trained resources with a well developed behavioural and leadership skill. The so-called soft skills on the other hand are additional internal training courses, these are often held by specialized external organizations in the field of training. It is often necessary to introduce new training for a changing market demand, this creates a benefit for the company because it creates new professional figures, new tasks and a reorganization within the company structure.

## 2 Methodology

We decided to collect the necessary data for our study by sending an email survey to Italian companies located in Switzerland and northern Italy. It was sent to small, medium and large companies which are operating in different sectors on a national and international scale. To interview people out of different sectors has brought us many advantages, one of these is a wide view of different organizational structures.

Being in a situation of health and economic crisis because of the COVID-19 we took the opportunity to evaluate the effectiveness of the methodologies in this particular situation and if the trend of the same approach received any change.

To perform this survey we used the tool "Google form" and the survey consists of 21 questions, divided into 4 categories:

- 7 general questions, these are used to identify the type of company and their general idea of project management.
- 3 questions on how the projects are structured. These questions are used to identify how projects are managed within the organization.
- 8 questions on how the projects are managed, these questions allowed us to measure how far these organizations deviate from the OS in practice.
- 3 questions about the degree of success of internal projects. These questions are used to get an idea of the degree of success depending on the organizational strategy.

General identification	Project structure	Project management	Achieved results
In which environment operates the company?	Who manages the projects in your company?	What kind of organizational structure comes closest in your company?	How do you rate the success rate of the projects and are the results satisfying?
What's the size of your company	Does the Project Manager or Project representative have specific training for his role ?	On which standard is your project management methodology inspired by ?	If there are problems, which areas are most frequently touched?
On which scale of useability refers to the core business of	In your project management methodology, what	Are the projects part of a program or portfolio ?	In your opinion, what are the causes of possible failures?

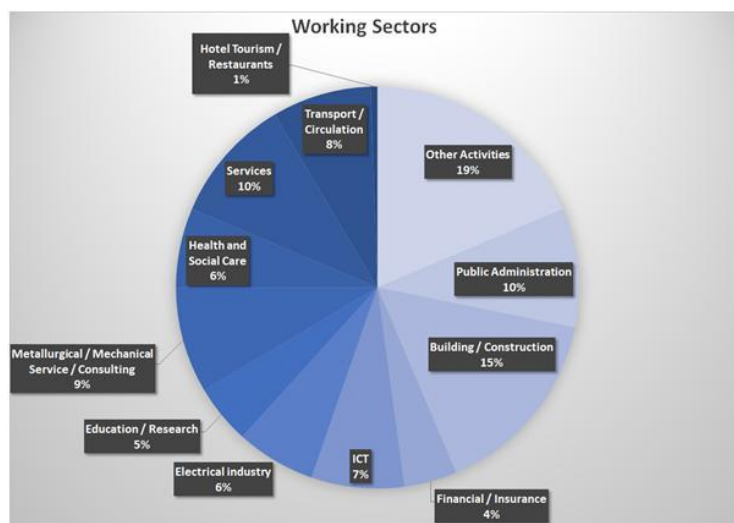
your company?	level of decision making does the project manager / project representative have?		
Who is in charge of the project management organization?		Is there a central organization (PMO) in your company responsible for project management?	
Is there a common and clear strategy in your company?		In case of an existing PMO, what role does it cover?	
How many years has project management been introduced?		Does the organization ensure adequate allocation of human resources for ongoing projects, taking into consideration the qualitative and quantitative need of multiple projects?	
Indicatively, what percentage of the projects are covered within respect of the company operations (routine/daily business)		The project management methodology is always identical or varies according to the project (complexity, duration, sectors touched)	
		How often the company project procedures will be updated?	
7	3	8	3

Finally the results will be analyzed, interpreted and summarized in the following chapter.

### 3 Results

In this chapter we will describe the results obtained by considering the interaction between the survey questions according to the objectives set.

Referring to the general framework, the results show that among the companies surveyed, there is a majority of respondents from the building or construction sector in general, from the Public Administration and Services sector, as well as from sectors not properly defined by the list provided.



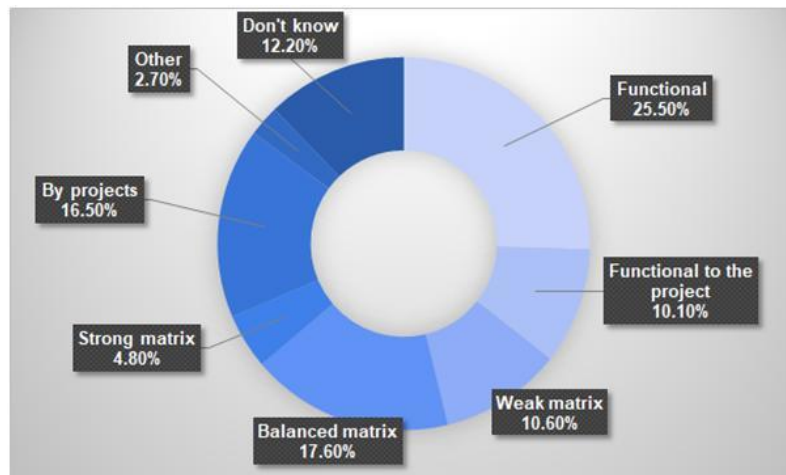
The vast majority of organizations that took part in the survey have a size of 1000 employees or more (large organizations), while most of the other have between 250 and 999 employees (medium organizations); the core business with the greatest influence is that which refers to an international scale of users (38%), but it can be seen that on a national scale also has a certain importance (32%).

With reference to project management, it is recorded that around 53,5% of the organizations have introduced this methodology over ten years ago, while around 30% have been doing so for less than five years.

From the data we also found that specific project management tools also follow this trend. In 40% of the companies where specific project management tools or tools adapted to the company's needs are used, project management has been introduced more than 10 years ago.

From an initial analysis, it can be seen that large companies, and those that are also looking at users outside the country, have had a project management methodology in place for years.

In relation to the work areas examined, it can be seen that the organizational structure that is most used is the Functional Project Organization.



This Project Organization is mostly used in the areas of Public Administration, Health and other activities not properly described in the list provided. In this way, it can be seen that a project-based organization is preferred in the construction industry.

As mentioned previously, the specific organizational structure mostly used by the interviewed company is the Functional, around 26% of the cases. This structure is organized by "silos" where decision making is referred to a functional manager. The other structure mostly used is the balanced matrix around 17%, where we can find an equal distribution of the decision making between the functional manager and the project manager. However, it should be noted that all matrix versions added together (weak/balanced/strong) we talk about 33% of the interviewed companies. As mentioned, the balanced matrix prevails just over 17% of the total, followed by the strong matrix (10.1%) and last but not least the strong matrix (5.5%) of the preferences.

It should be noted that in absolute terms almost one sixth of the companies (15.6%) use an organization for the projects and another 11.1% a functional

organization for the project. Almost 12.1% of the interviewed participants were unable to indicate what kind of organizational structure their company has. In large companies almost 23% are organized in a functional manner, although it can be noted that 22% are oriented toward a balanced matrix organizational structure. Smaller companies on the other hand prefer project based organizational structure in which the project manager has a wide range of competences and a high authority.

### ***3.1 Project Management Methodology***

In absolute terms the most used project management standards in the analyzed samples are

- Agile - 27.6%
- PMI - 25.1%

ICB/IPMA, Prince2 and Hermes all down below 10% each.

23% of the interviewed participants use a standard not mentioned in our questionnaire, as many as 26.1% of the participants told us that they do not use a standard of any sort for their project management.

In general, it is noticeable that companies that have been introducing a project management methodology for less than ten years do not rely on one of the recognized methodological standards. In particular, the tendency is to have a methodology in the early years that is close to Agile or PMI and then turn into a customized solution that can no longer be assimilated to a standard in the first ten years.

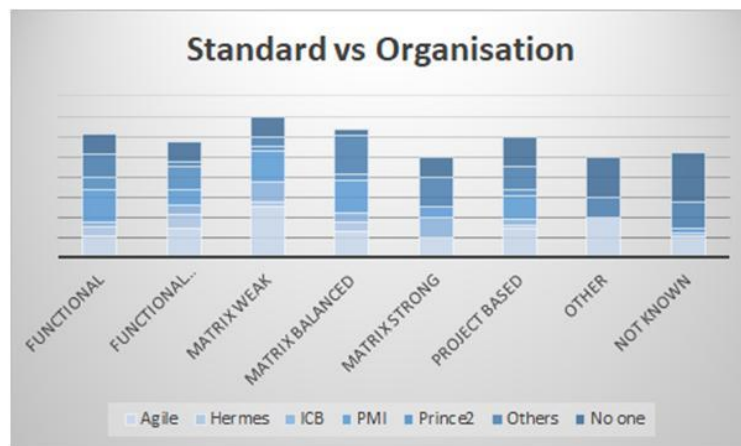
In many cases the complexity of standard methods and their vastness can push companies to create a lean-system that gradually creates more and more distance to the official standards, although there is a tendency to use Agile in some areas.

### ***3.2 Relationship between standard used, organizational structure and working sector***

We cross referenced the received data about the organizational structure of the companies and their used standard, to see if there are any correlations between the two data sets.

Agile is the most used standard by the companies organized in a weak matrix or by project oriented. The standard most often used by for example functional

organizations is the PMI standard. It should be noted that project organizations indicated that they use (besides Agile 29%) a not recognized standard. Probably their organization is determined by the project, this forces them to create a personalized methodology not further specified by a strictly formalized standard.



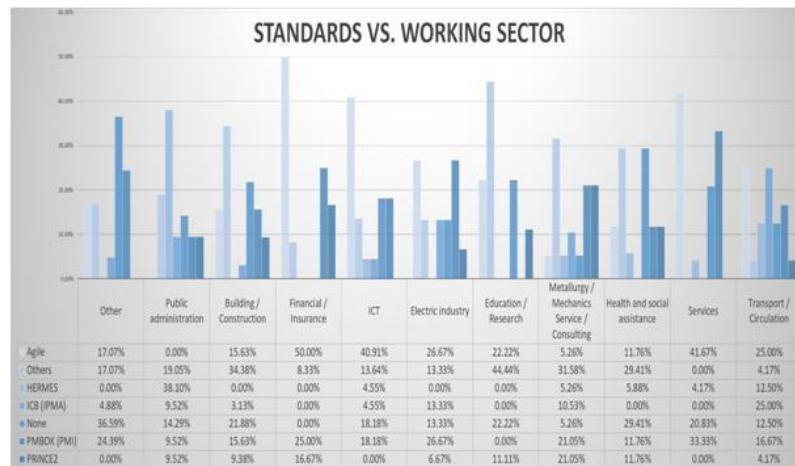
Comparing standard used and working sector we would notice that in the Public administration obviously the most used standard is Hermes (the PM method developed by Switzerland's Federal Administration).

Agile, born in the software development sector, is the most used standard not only in ICT and Services sectors as expected, but in Financial/Insurance and Transport/Circulation sectors, too. PMBOK (PMI) is widely used in quite all the sectors analyzed, even if it is never the most used.

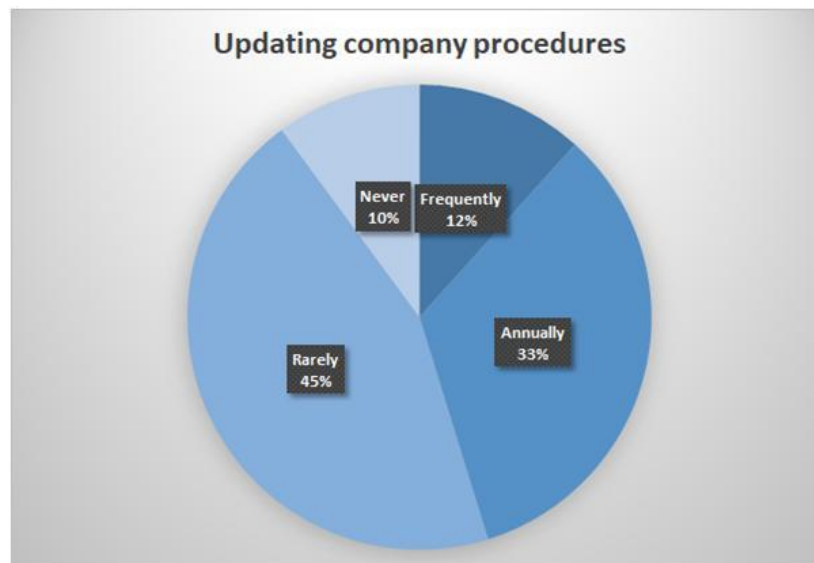
Health and social assistance sectors have probably very specific and wide needs, so they use quite all the standards but mostly customized ones ("others" or "none" answer).

Most working sectors use all standards to varying degrees, others are focused on only a few (Tourism, Services, Education, Financial).





### 3.3 Project management maturity



The data shows that most companies rarely update their processes (45%) and some never update their processes (10%).

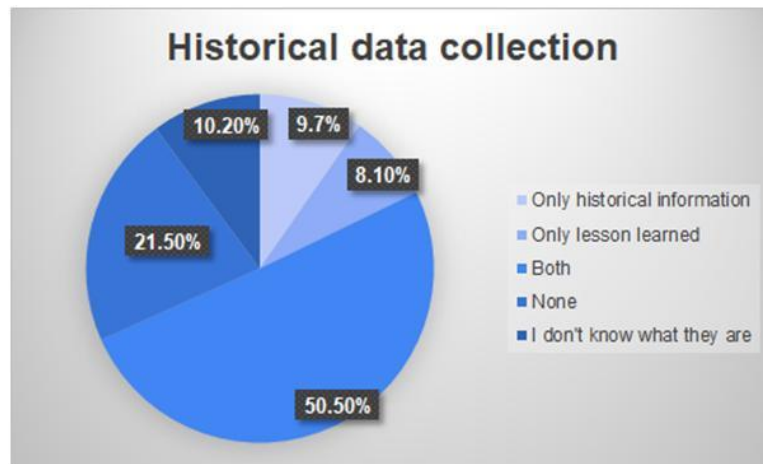
Business processes are the key that describe how a company operates in its day-to-day life. To understand whether our processes allow us to be efficient, we compare the frequency of process updates with the efficiency perceived by employees. In companies where process changes are rarely made, the assessment

was either partially efficient (69%) or not very efficient (15%). On the other hand, companies where processes are frequently updated are rated very efficient (92%).

A large proportion of the SMEs questioned in a study by the Swiss Federation for Adult Learning [2] believe that continuous training is very important in order to respond to the impacts of the pandemic. The skills required of employees have changed considerably. One third of the companies surveyed stated that employees are now required to have new or different skills (half of the companies said that the skills had remained the same, while 15% could not answer, suggesting that they have difficulty in assessing developments in this area).

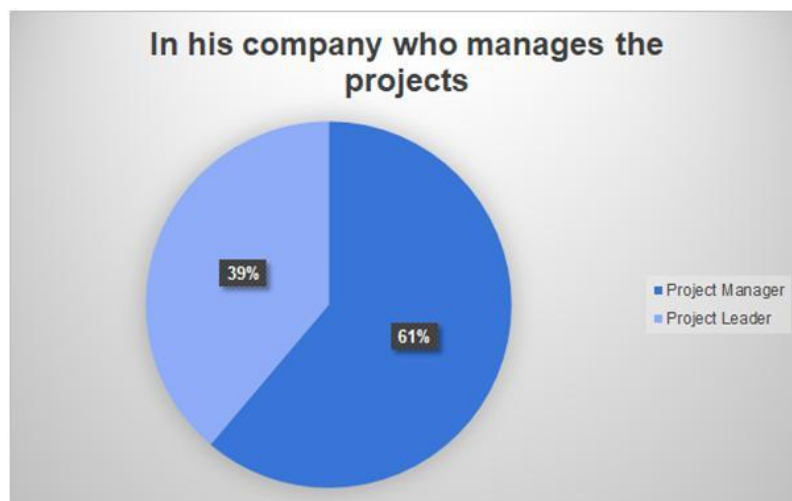


From the graph it can be seen that as many as 87% of the companies only occasionally and regularly carry out training courses to improve their skills in relation to the tasks they perform within the organisation and only 12.9% never carry out training. Furthermore, a deeper analysis of the data showed that the smaller the company, the more likely it is to carry out training courses, while interest decreases slightly as the size of the company increases. This leads us to think that small organisations with growth objectives invest more in training in order to achieve greater competitiveness compared to companies that have consolidated their position in the market.

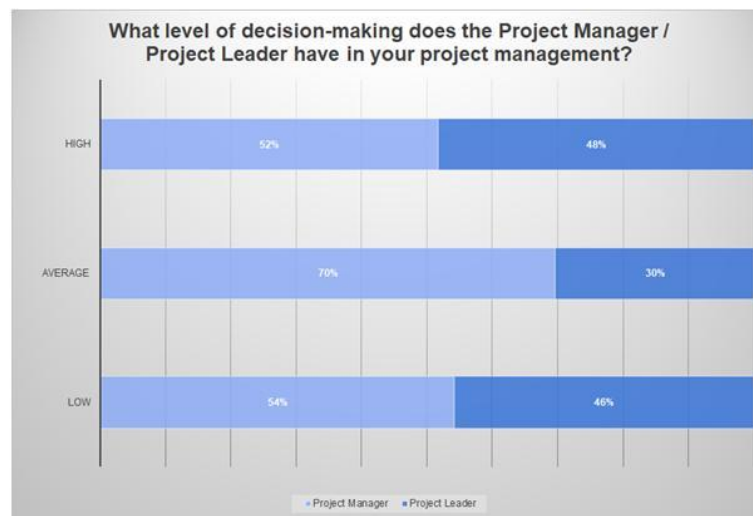


Only half of the organisations collect and use both Historical Information and Lessons Learned during project management. An interesting relationship emerges when comparing the collection of Lesson Learned and historical information and project success, with 53% of those who collect and use Historical Information and Lesson Learned responding that they almost always achieve project success.

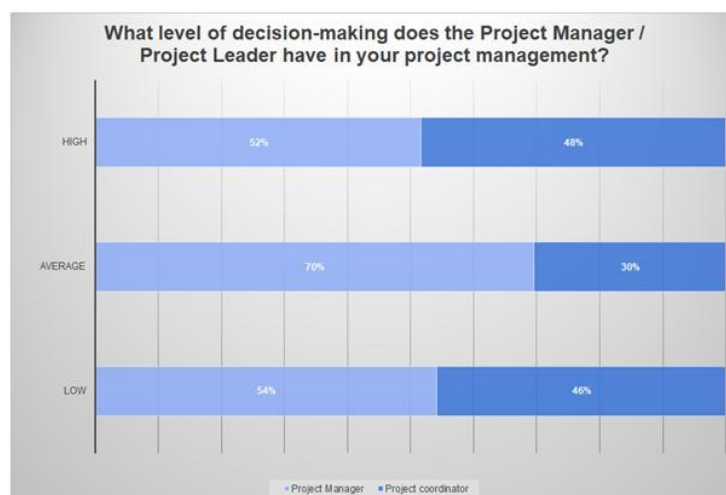
### **3.4 Project manager vs Project Leader**

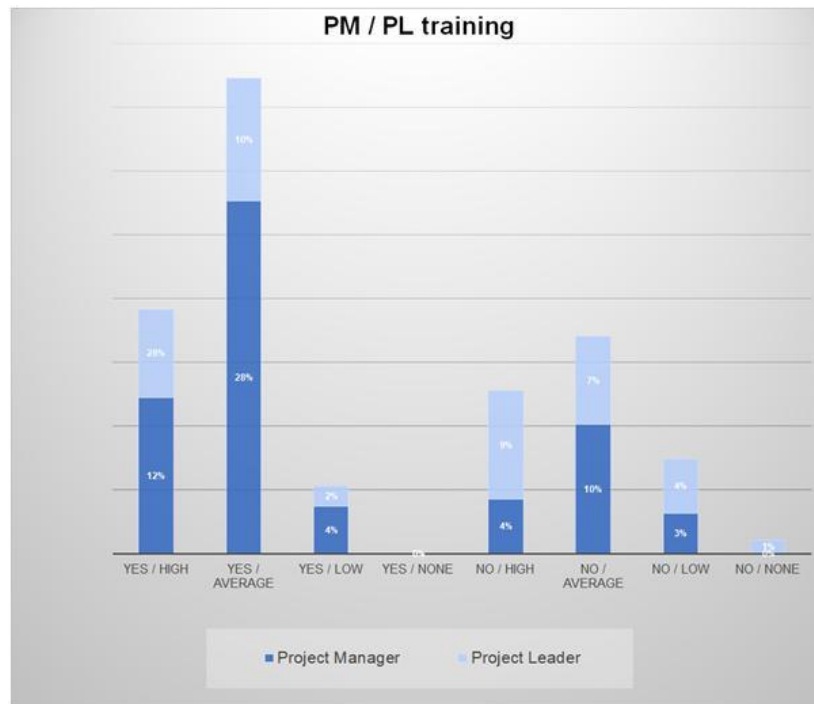


From the chart you can see that more than 61% of the projects are managed by the Project Manager while the remainder are managed by a project coordinator who coordinates the project. In the next points we will analyze in more detail.



It can be seen that the level of decision-making is generally medium to high, while for project referents the decision-making power is similarly situated but more balanced. In dept, the high decision making is half and half for both PM and PL the same result for the low decision making.





The chart above relates whether or not a PM or PL is trained, and of these how much decision-making power they have. It can be seen that in 28% trained PMs, they also have a fair amount of decision-making power. In comparison, the PL generally does not have specific training.

On the whole, we notice that those who have specific training also have high decision-making power regardless of whether they are PM or PL. On the other hand, those without project training have only a low level of decision-making power. From these data it can be assumed that adequate training in project management is useful in order to be able to have more leadership in the execution of projects.

The graph illustrates that medium and large (>250) companies generally have staff with good decision-making power, and this is a general trend, where the larger a company is, the more they need adequate staff to lead projects.

### 3.5 Program e Portfolio

From the responses received, it emerges that 64.7% of companies manage projects by also using Program and/or portfolio management.

26.7% state that they do not use these tools, while 8.6% state that they are not familiar with them. The sum of these two percentages - 35.3% - is higher than the percentage - 26.1% - of those who said they did not use any standards. This leads to the assumption that even those who do not use a formalized standard, but do use their own methodology, consider it useful to use the techniques of program and portfolio management to coordinate and distribute resources on the various projects followed.

### ***3.6 The Project Management Office (PMO) and its influence***

The project management office (PMO) is a support structure that helps the organization to monitor and control their projects.

A PMO is a group within or outside the organization that defines, maintains and ensures standards for project management within that organization.

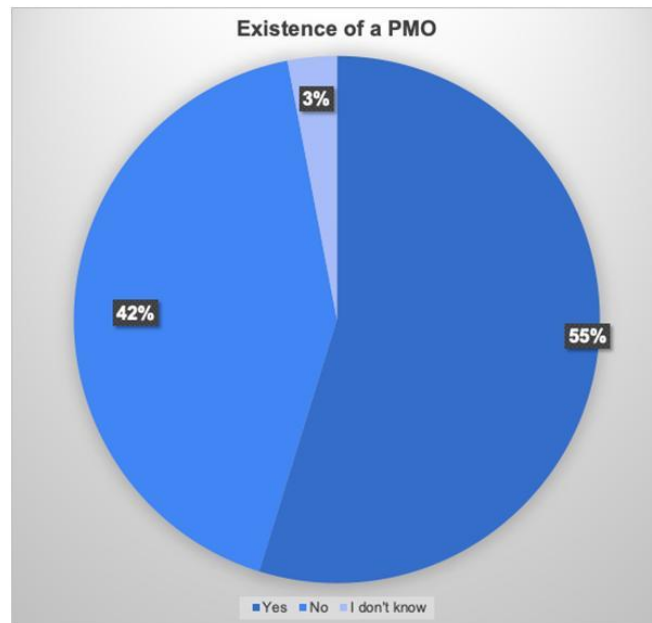
It is a centralized overseer and manager of best practices, status and direction of projects.

The influence of the PMO on the organization and the management of the respective projects depends on the type of PMO applied, moving from a more supportive PMO to a managerial PMO with complete control and management of the projects.

In periods like ours, conditioned by both organizational and economic uncertainty, having a PMO is an advantage but can also be a disadvantage.

An advantage is that it allows you to centralize and manage various PMs in a coordinated manner regardless of whether they work locally in the company or in the home-office. But it allows you to keep the status updated and keep it in line with the situation of the projects relative to the business strategy.

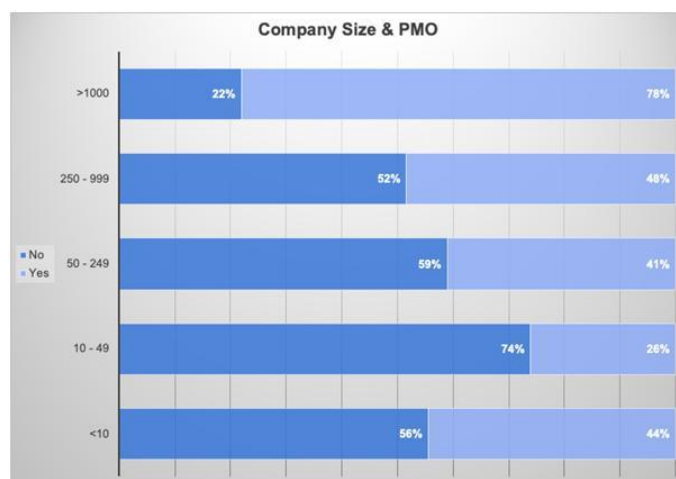
The disadvantage is that having a PMO involved are the large costs which are harder to bear in an economically difficult situation. In this chapter we will analyze the behaviour of companies in respect of the adoption of a PMO in this period of uncertainty and how it will affect projects in the company.



The results show that the culture of having a PMO office is not prevalent or widespread.

In fact, 55% of participants have a PMO office for their organization, compared to 42% who do not have a corporate PMO office. 3% of respondents are unaware of what a PMO is or do not know if one exists within their company.

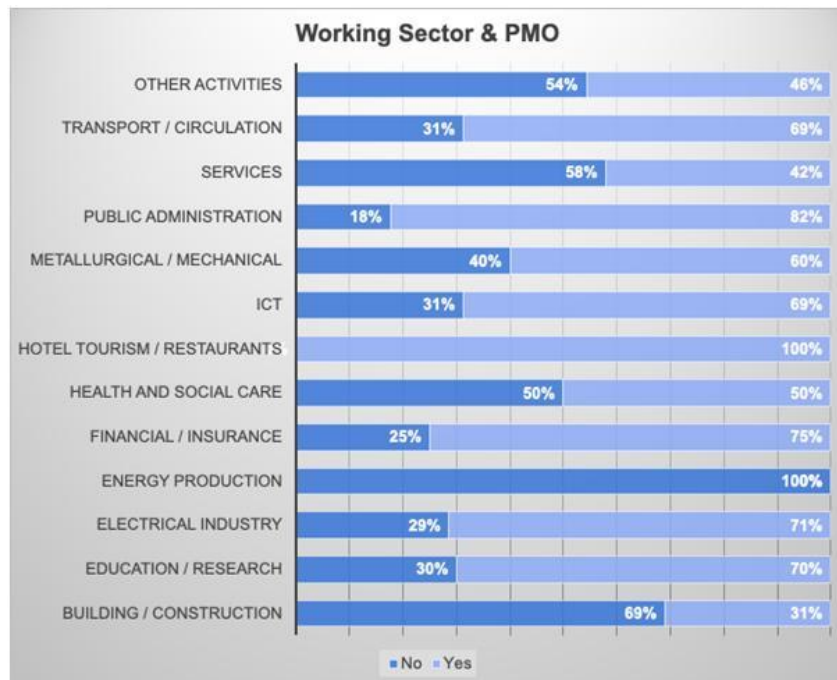
By relating the above figure to the size of the organization we can understand if this has an influence on whether or not they have a PMO office.



The results show that the use of a PMO office is widespread in companies with more than 1,000 employees (78%), while for smaller companies it is not so widespread, with a prevalence of not having a PMO office.

This result can be explained from the fact that using a PMO office has a cost, which is easier to support for companies of large dimensions in contrast to companies of smaller dimensions.

Going into further detail, by aggregating the data related to the application of a PMO office and the industry in which the organization operates, we can understand whether the business environment affects whether or not to have a PMO office.



In almost all sectors, the prevalence is to have a PMO office, and this is little affected by the context in which the company operates. In fact, although with different percentages, the existence of a PMO office is present in practically all sectors in which companies operate.

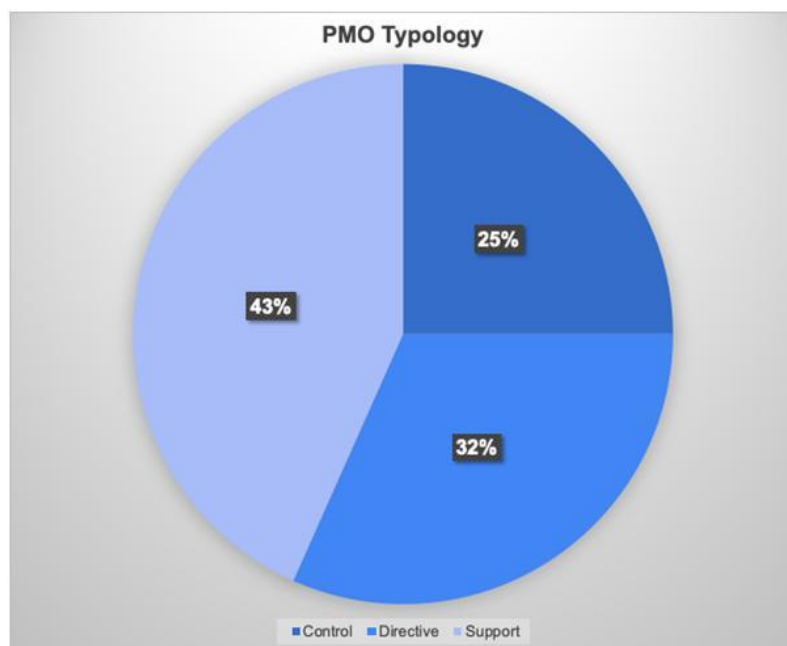
There are, however, contexts where this practice is more widespread, such as Tourism, ICT, Education and Research, Finance and Insurance, Public Administration and Transport and Circulation.



Some sectors, however, are still oriented towards project management without PMO support, such as the Building and Construction, Electrical Manufacturing and Services sectors.

As mentioned earlier, the PMO can take three forms, which more or less influence the organization and its respective project management:

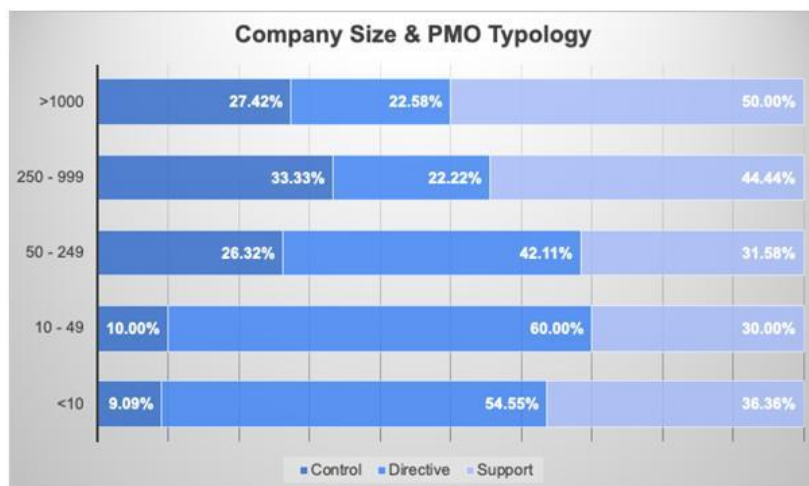
1. Supportive PMO, with a low degree of control. It has an advisory role to projects, providing best practices, templates and access to historical information and lessons learned from other projects.
2. Controlling PMO, with a moderate degree of control. Ensures support and compliance with project management best practices by adopting specific frameworks or methodologies.
3. Directive PMO, with a high degree of control. Assumes direction and control of the projects themselves, with authority to act as an integrated stakeholder and decision maker during a project.



Analyzing the data shows that the majority of organizations that have a PMO have a Support PMO (43%), followed by a Directive PMO (32%) and finally a Control PMO (25%).

The reason for these results could be due to the fact that, as indicated above, having a PMO is not yet standard practice among organizations. Since the support PMO is less onerous to introduce, it is also the first type introduced in organizations that want to have a PMO and then possibly evolve into the control and management types.

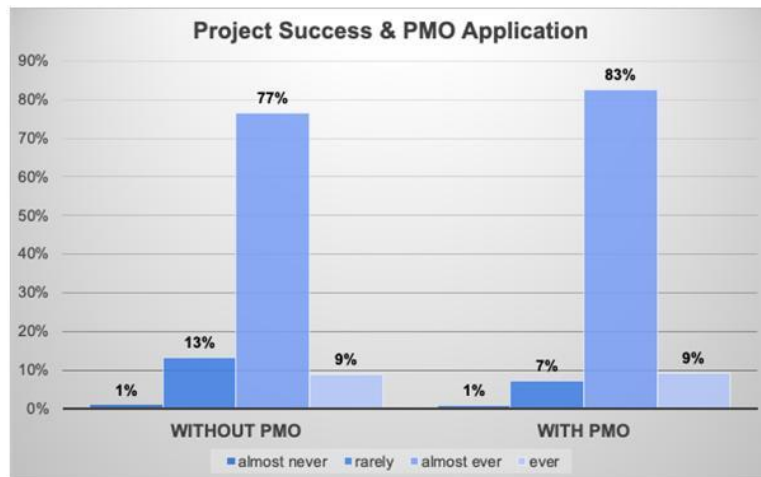
The following chart shows how the type of PMO is linked to company size.



The trend that the results show is that larger companies use a more supportive PMO. The smaller the company size decreases, the more they move towards a management-type PMO.

This result shows how the size of the company affects the type of PMO introduced, a plausible explanation is due to the fact that in smaller companies those who manage projects and those who lead individual projects, as PM, are the same entity and as a result there is a managerial PMO who acts as both manager/coordinator and PM.

Understanding whether the introduction of a PMO office leads to more successful projects being conducted is one of the most interesting outcomes to evaluate.



From the results obtained it seems that the success of projects is not strongly influenced by the presence or absence of a PMO, however, bringing benefits on the success of projects as companies that have a PMO office have approximately 6% more success for the projects carried out.

Organizations that have a PMO, the success of projects (values always and almost always) is 92% compared to the 86% obtained by companies that do not have a PMO office.

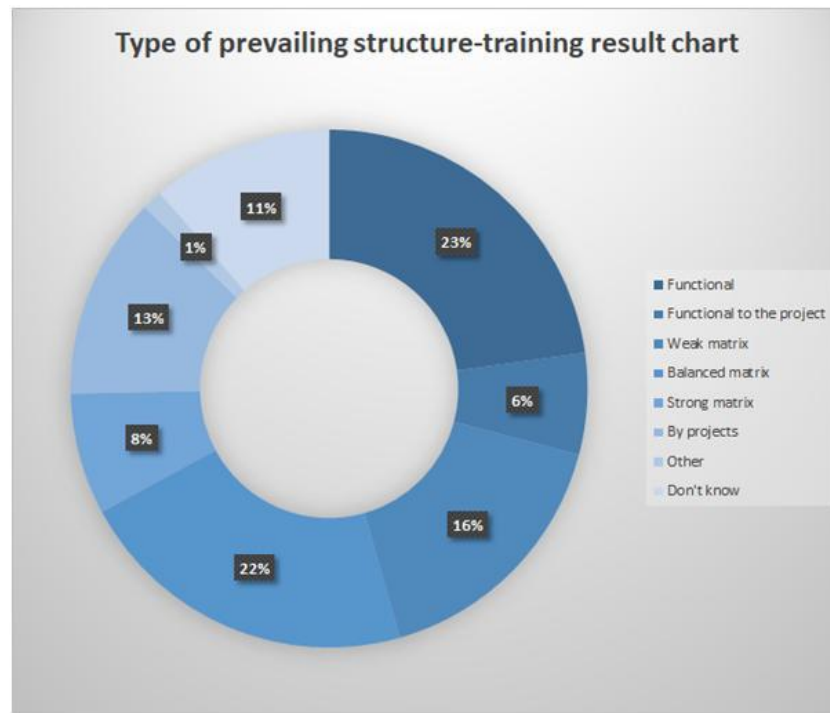
Similar results are also obtained for project failure, where values settle at 14% for organizations without a PMO, as opposed to 8% for companies with a PMO office.

### 3.7 Projects Satisfaction and Projects Success

If and how the OS evolves in organizations and in the various sectors (OS standard for all) and by which factors they are influenced (culture, training, success a.s.o.)

- Depending on the work environment and which OS is preferred (Discussed in the chapter)
- The need of training or courses (Discussed in the chapter)
- How all these factors are related to each other (Discussed in the chapter)

An analysis of the data on the success rate of the projects shows that 80% are considered to be satisfied despite the fact that most have encountered problems of different sorts, only a small amount have achieved the goal without difficulties.



Most of the problems encountered mainly timed coordination (24%) and sticking to the budget (18%), but the share related to times and financial resources (29%) is even greater, while the remaining is divided into the combination of factors (23%) and a small amount (6%) is dedicated to problems with the product.

The projects with the greatest satisfaction are led by a project manager (64%) with specific training. In any case the training of the project manager is carried out occasionally for 50% and regularly for 40%, a minority never followed a professional improvement course.



The best managed projects are those who are led by project managers with a high decision-making power.

On the other hand, the projects that did not achieve their purpose correctly (20%) are managed by unskilled people (59%) with medium to low decision-making authority and without the use of industry specific standard methodologies.

This causes the failure to achieve the goal and this led to higher costs in distributed and poorly managed resources, the underestimation of costs and uncontrolled expansion of the project (scope creep).

#### **4 Conclusions**

The vast majority of organizations that took part in the survey have a large size, while most of the others have medium size; the core business with the greatest influence is that which refers to an international scale of users, but it can be seen that that on a national scale also has a certain importance.

Medium-sized and large companies took part in the survey, and the results show that they have already introduced or are preparing to introduce the culture and methodology of Project Management. It can be seen that four out of ten of these companies have their core business at an international level and one out of three at a national level. On the whole, 25% of the companies have a functional structure among which we find the Public Administration and Health and Social Care, and a good 20% have a balanced matrix among which we find mainly the

construction sector and the mechanical and metallurgical sector. As companies face the global market in a pandemic regime, their PM culture has to evolve and keep up with the times. In order to expand their market and/or core business, this adaptation is essential for the survival of the company itself, given the high level of competition that increases complexity in this period of great uncertainty.

The results show that there is an increasing need to invest in PM methodology. In fact, the survey showed that half of the companies have adopted an Agile and/or PM methodology and that in companies that have been operating for more than ten years it has been converted into a customised solution. Further analysis showed that this trend is also followed for the use of specific tools for project management as well as for the management of PM methodology. In most companies, where specific tools for project management or generic tools are used, the introduction of project management has been introduced for more than 10 years and the high decision making is half and half for both PM and PL, the same result for the low decision making.

A high degree of efficiency was found in companies where business processes are updated frequently.

A further investment to improve business efficiency is the creation of the Project Management Office, which can bring a significant advantage in project management. Due to its complexity and the economic effort generated, the PMO is only adopted in medium and large-sized companies. Companies that have introduced the PMO have been able to make a marked improvement in project management. One point that should not be overlooked is that the project management culture must be passed on from the top-management to the entire company in order to solidify the basis for proper project management. In project management the decision-making power of the person in charge of the project is one of the key factors for the success of the project. A careful analysis of the results shows that people who are trained in project management are also the ones who have the most influence and authority in the running of projects, resulting in a significant benefit in achieving project objectives.

This organisational efficiency achieved by applying these methodologies will certainly be the key to success in tackling the current covid-19 global health and economic crisis that is literally changing the whole of business management.

From the educational institution's point of view, the analysis of the results shows us how important it is to have leaders who are trained in terms of project management if we want to carry out successful projects standards such as Agile

and PMI still serve as a basis for most of the companies interviewed, but the tendency over the years is to customise the standard by adapting it to the needs of the individual company. In these terms the university must provide the necessary targeted training according to PM and business sector needs, so that companies can then understand which tools to implement for managing their projects in order to be facilitated in this changing transition.

As well as, the introduction of Smart Working and Home Office in the organisational realities gives the input for the universities to create specific courses at the request of companies or simply online events to promote the culture of project management.

Also courses specified for top management can evolve the culture of project management, if top management increases the knowledge on project management this knowledge will then be disclosed within the company.

## **References**

- [1] The PMBOK, 6<sup>th</sup> Edition, Project Management Institute (PMI), 2017
- [2] Effets de la pandémie du coronavirus sur la formation continue dans les petites et moyennes entreprises", Sofie Gollob, Swiss Federation for Adult Learning, May 2021

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## **An Overlap of Knowledge Management and Business Process Management: a Systematic Literature Review**

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### **Abstract**

Although many authors (e.g., Seethamraju & Marjanovic, 2009; Antonucci, 2015; Kokkonen & Bandara, 2015; Antunes & Tate, 2019) recognize a vital role of knowledge in BPM, only a few articles study KM and BPM together. Due to the lack of attention to the topic in the existing literature, defining the scope of possible intersections between BPM and KM could bring an evolution in the research in both areas. To provide detailed grounds of the situation, we reviewed studies simultaneously focusing on KM and BPM. We used the systematic literature review method that consisted of three subsequent stages: literature search, analysis, and interpretation. The literature search goal was to form a sample of articles relevant to BPM and KM overlap. Articles simultaneously focusing on KM and BPM published in the BPM Journal and the Journal of KM were selected based on relevance to the research problem. A content analysis of selected papers was conducted to identify possible intersections between BPM and KM based on suggestions for further research and research gaps identified during the analysis. We identified themes that describe the research focusing on the overlap and connected them with concepts of BPM and KM. The analysis led to developing the framework of BPM and KM overlap and formulation of problems for further research. We found that the overlap is investigated through two main perspectives: knowledge-intensive business processes (kiBPs) and IS/ICT. The kiBPs perspective contains themes such as process-perspective knowledge mapping, KM processes and organizational learning influencing business process improvement, or process modeling influencing KM strategic alignment. The IS/ICT perspective contains themes such as Process KM systems or social BPM systems. The framework of BPM and KM overlap might be beneficial for business professionals as a guideline for selecting best



practices that, once tailored to the organizational context, might increase BPM implementation efficiency and elevate BPM from the “information” level to the “knowledge” level, which will lead to the overall growth of business performance.

**Keywords** – Knowledge Management, Business Process Management, overlap, review, knowledge-intensive business processes

**Paper type** – Academic Research Paper

## 1 Introduction

In the face of new challenges such as the Covid-19 pandemic and global switch to remote working, the role of knowledge management (KM) drastically raises in ensuring the continuation of business processes. However, KM strongly relies on collaboration, which is restricted when employees have to work from home. In this situation, KM and business process management (BPM) become as mutually dependent as never before. Thus, the problem of KM and BPM overlap comes to the front line of the research in both fields since business professionals strive to find how to leverage both disciplines’ efficiency.

Some authors (e.g., Bueren et al., 2005) consider KM to be a toolset that can only be applied to business processes. Simultaneously, other authors (e.g., Seethamraju & Marjanovic, 2009) recognize a vital role of knowledge in BPM. Although researchers attempt to develop models that integrate BPM and KM concepts, as summarized by Ranjbarfard et al. (2013), the area of research in this field remains emerging (Dalmaris et al., 2007; Sary, 2014).

Due to the lack of attention to the topic in the existing literature, defining the scope of possible intersections between BPM and KM could bring an evolution in the research in both areas. The systematic literature review is seen as the most appropriate method to answer the following research questions:

*RQ1. What are the overlapping themes of BPM and KM?*

*RQ2. What are the relations between these themes?*

To answer these research questions, we intend to achieve the following objectives:

- 1) Review existing research on overlaps between BPM and KM.
- 2) Develop a framework of BPM and KM overlap.
- 3) Identify potential research directions in the field of BPM and KM overlap.

The paper is organized as follows: Section 2 provides a brief overview of concepts of BPM and KM and introduces several research gaps in the field of BPM and KM overlap found in literature reviews of both disciplines. Section 3 describes the methodology and algorithm of the systematic literature review. Section 4 characterizes the sample of relevant articles quantitatively and qualitatively. Moreover, it introduces the framework of BPM and KM overlap we developed based on the content analysis of relevant papers and maps directions for future BPM and KM overlap research. Section 5 concludes the paper by introducing the impact and limitations of the research.

## **2 Theoretical Background**

In the theoretical background, we conceptualize business process management (BPM) and knowledge management (KM) with particular attention to their intersections and emphasize the research gaps related to the overlap of BPM and KM specified in the recent literature.

### ***2.1 Business process management***

BPM is an integrated management methodology that includes practices aimed at changing business processes to improve organizational performance. The most frequent understanding of the BPM concept in academic literature is twofold. First, BPM could be described through a set of associated activities forming the BPM lifecycle. Several authors (e.g., Kirchmer, 2017; Dumas et al., 2018; Weske, 2019) agree that the BPM lifecycle includes business process discovery, analysis, and redesign (i.e., improvement). Second, BPM could be perceived as an organizational capability (e.g., Skrinjar & Trkman, 2013; Rosemann & vom Brocke, 2015). Rosemann & vom Brocke (2015) break down the BPM capability into six core elements: Strategic Alignment, Governance, Methods, Information Technology, People, and Culture.

Knowledge of process stakeholders, also referred to as “process knowledge” (e.g., Antunes & Tate, 2019), is considered the main component of the People element of BPM capability (Kokkonen & Bandara, 2015). Dumas et al. (2019) claim that explicit process knowledge resides in organizations’ process models and process descriptions – knowledge objects that play an essential role in BPM lifecycle activities (e.g., process discovery).

Several research gaps are identified in recent literature regarding the overlap of BPM and KM. Badakhshan et al. (2019) suggest assessing the impact of agile BPM on continuous utilization of skills and knowledge of people aimed at continuous value creation. Thenakoon et al. (2018) point out several gaps in BPM training. In particular, what BPM knowledge is required in the training content and which results will BPM training produce. Zemguliene & Valukonis (2018) highlight the importance of future research in integrating external and internal information flows, including knowledge of stakeholders' needs, with BPM systems to support business process improvement initiatives. Roeser & Kern (2015) stress that the People factor of BPM maturity, which includes knowledge as its main component, should be researched more thoroughly in the future.

## **2.2 Knowledge management**

Several authors (e.g., Gold et al., 2001; Chang & Chuang, 2011) perceive knowledge management (KM) as a set of infrastructure and process capabilities that lead to competitive advantage. Infrastructure capabilities include IT, organizational structure, and culture, while various KM processes present process capabilities. Authors consider knowledge acquisition (e.g., He et al., 2013), codification (e.g., Razzag et al., 2019), sharing (e.g., Wang & Wang, 2012), application/utilization (e.g., Lin & Lee, 2005), and protection (e.g., North & Kumta, 2018) as KM processes. Liyanage et al. (2009) unite most KM processes in the knowledge transfer (KT) model and stress that KT allows companies to improve business processes. However, Liyanage et al. (2009) leave the relation between KT and process performance without any examination.

Several research gaps are identified in recent literature regarding the overlap of KM and BPM. Pérez-Salazar et al. (2017) emphasize that the influence of some KM processes (i.e., knowledge creation, storage, and application) on the objectives of supply chain management (i.e., a well-known example of a business process) is under-researched. Martelo-Landroguez & Cepeda-Carrión (2019) highlight the potential of researching the influence of knowledge acquisition and protection on organizational value creation and capture, which are considered the main aims of business process execution (e.g., Dumas et al., 2019). Escrivão & da Silva (2019) suggest considering a process dimension in KM maturity models. Ramy et al. (2015) reveal the research gap in KM application in knowledge-intensive industries, which can also be analyzed via the BPM perspective. Lönnqvist &

Laihonen (2016) also stress the importance of further research in managing knowledge-intensive organizations. The performance of such organizations, by definition, is strongly influenced by KM and BPM.

To sum up, there is a high demand for future research in BPM and KM overlap documented in literature reviews in both disciplines. Researchers agree on the need to integrate BPM and KM maturity models' concepts and see the potential in further research of mutual influence of KM processes and business processes improvement. Moreover, knowledge-intensive organizations are referred to as one of the most perspective objects for research in BPM and KM overlap since both managerial disciplines strongly influence their performance.

### 3 Methodology

By conducting a structured literature review (SLR), we aim to identify concepts in which BPM overlaps with KM and relations between these concepts. This section describes an SLR algorithm to ensure transparency regarding the decisions made during the review process, including literature search, extracting relevant research, and content analysis.

We decided to review scholarly articles from the Business Process Management Journal (BPMJ; ISSN 1463-7154) and the Journal of Knowledge Management (JKM; ISSN 1367-3270). As journals directly targeting BPM and KM communities, they ensure the relevance of the published materials. To cover articles that focus on overlaps between BPM and KM concepts, we have applied several search queries in Scopus and Web of Science (WoS) databases, moving from narrow to broad search definition, as presented in Table 1.

Table 2: Approach to the identification of potentially relevant papers

Nº	Query	Short description	Database	Results
1	TS=("business process management" OR BPM OR BPMS) AND AK=("knowledge" or "knowledge management" or KM or KMS) AND SO=(business process management journal OR journal of knowledge management)	BPM and KM and knowledge in BPMJ and JKM	WoS	7
2	( TITLE-ABS-KEY ( "business process management" OR bpm OR bpms ) AND TITLE-ABS-KEY ( "knowledge management" OR kim OR kms ) AND ISSN ( 1463-	BPM and KM in BPMJ and JKM	Scopus	12

Nº	Query	Short description	Database	Results
	7154 ) OR ISSN ( 1367-3270 ) )			
3	TOPIC: ("knowledge management" or KM or KMS) AND TOPIC: ("business process management" or BPM or BPMS) AND PUBLICATION NAME: ("business process management journal" OR "journal of knowledge management")		WoS	13
4	( TITLE-ABS-KEY ("knowledge management" OR km OR kms ) AND ISSN ( 1463-7154 ) )	KM in BPMJ	Scopus	67
5	( TITLE-ABS-KEY ("business process management" OR bpm OR bpms ) AND ISSN ( 1367-3270 ) )		WoS	34
6	TOPIC: ("knowledge management" or KM or KMS) AND PUBLICATION NAME: ("business process management journal")	BPM in KMJ	Scopus	6
7	TOPIC: ("business process management" or BPM or BPMS) AND PUBLICATION NAME: (journal of knowledge management)		WoS	2

Source: Elaborated by the authors

Figure 1 presents the SLR protocol we used in our research.

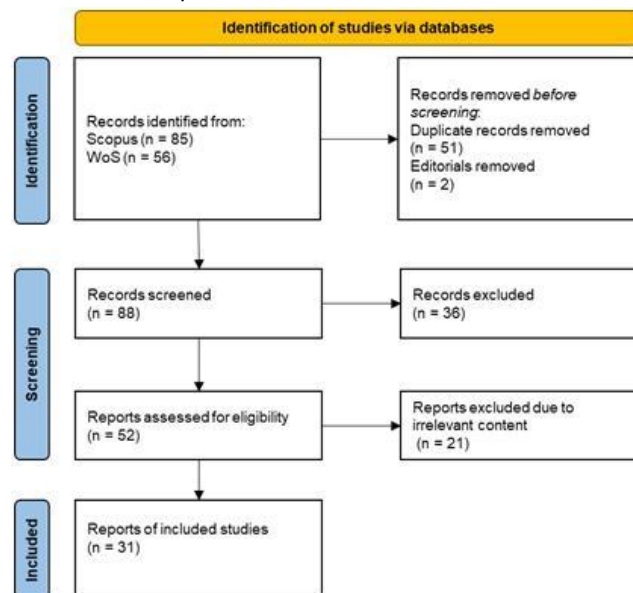


Figure 1: Systematic literature review protocol

Source: Elaborated by the authors based on Page et al. (2021)

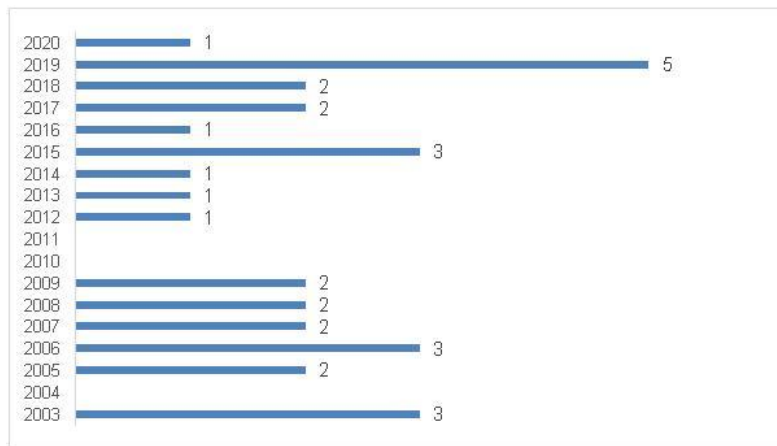
At first, we identified 141 records from Scopus and WoS by applying queries presented in Table 1. After duplicates and editorials were removed, there were 88 papers left to construct an initial sample. Each of these papers was scanned for keywords related to KM (i.e., "knowledge management") and BPM (i.e., "business process" and "process management"). 36 papers were excluded from the sample because they do not contain these keywords in the main text. 52 papers left after scanning were read more carefully, and 21 were classified as irrelevant to the topic after reading. Thus, we concluded the literature search by including in the final sample 31 papers that we considered relevant.

## **4 Findings**

This section characterizes the sample of relevant papers quantitatively by source, year, and method (see sub-section 4.1) and qualitatively by introducing and describing the most common themes referred to in relevant papers (see sub-section 4.2). Then, the framework of BPM and KM overlap is presented in sub-section 4.3, leading to the identification of directions for further research presented in sub-section 4.4.

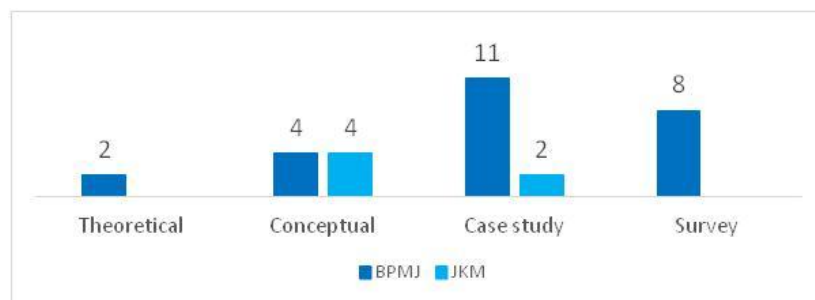
### **4.1 Quantitative results of research**

The final sample of 31 relevant papers includes 25 papers from the Business Process Management Journal (BPMJ) and 6 papers from the Journal of Knowledge Management (JKM). As shown in Figure 2, the interest in BPM and KM overlap first appeared in 2003. Around 2 papers per year were dedicated to the topic from 2003 to 2009. After a decrease in the interest to the topic from 2010 to 2014, the recent research stage in BPM and KM overlap started in 2015. The maximum interest in the topic was registered in 2019 when 5 relevant papers on the topic were published.



*Figure 2: Relevant papers by year*  
*Source: Elaborated by the authors*

Figure 3 shows the distribution of relevant papers by a method. Theoretical papers (i.e., Marjanovic, 2005; Szelagowski & Berniak-Wozny, 2019) critically analyze existing concepts, while conceptual papers (e.g., Capuano et al., 2008; Sarnikar & Deokar, 2017) introduce new ones (without validating them). Case studies (e.g., Stry, 2014; Rengiha et al., 2016) test introduced concepts qualitatively, while surveys (e.g., Aureli et al., 2019; Nguyen & Harrison, 2019) utilize quantitative analysis of data collected via questionnaires.



*Figure 3: Relevant papers by a method*  
*Source: Elaborated by the authors*

As seen from Figure 3, papers from the JKM primarily focus on developing new concepts and sometimes include qualitative validation (i.e., Papavassiliou &

Mentzas, 2003; Stary, 2014). Simultaneously, papers from the BPMJ mainly focus on qualitative and quantitative validation of developed concepts.

#### 4.2 Qualitative results of research analysis

The content analysis allowed us to reveal 9 main themes in the relevant papers: learning, natural integration, business process improvement (BPI), KM processes, KM strategic alignment, process modeling, process-perspective knowledge mapping, IS/ICT, and knowledge-intensive business processes (kiBPs). As seen in Table 2, these themes were appearing in relevant papers with different densities.

Table 3: Themes in sample

Rank	Source (N = 31)	Number of themes (Total = 9)	kiBPs (+/-)	IS/ICT (+/-)
1	Sarnikar & Deokar, 2017	6	+	+
2	Bueren et al., 2005	3	+	-
3	Chión et al., 2019	3	+	-
4	Kalpič & Bernus, 2006	3	+	-
5	Ranjbarfard et al., 2013	3	+	-
6	Seethamraju & Marjanovic, 2009	3	+	-
7	Silva & Rosemann, 2012	3	-	+
8	Al-Sa'di et al., 2017	2	+	-
9	Apostolou & Menstaz, 2003	2	+	-
10	Aureli et al., 2019	2	+	-
11	Chatzoudes et al., 2015	2	+	-
12	Dalmaris et al., 2007	2	+	-
13	Liao & Bernes, 2015	2	+	-
14	Mahoomadzadeh et al., 2019	2	+	-
15	Marjanovic, 2005	2	+	-
16	Papavassilou & Mentzas, 2003	2	+	-
17	Rehman & Iqbal, 2020	2	+	-
18	Szelagowski & Berniak-Wozny, 2019	2	+	-
19	Zhang, 2018	2	+	-
20	Kang et al., 2003	2	+	-
21	Stary, 2014	2	-	+
22	Adamides & Karacapilidis, 2006	2	-	+
23	Lavikka et al., 2015	2	-	-
24	Nguyen & Harrison, 2019	2	-	-
25	Rangiha et al., 2016	1	-	+



<b>Rank</b>	<b>Source (N = 31)</b>	<b>Number of themes (Total = 9)</b>	<b>kiBPs (+/-)</b>	<b>IS/ICT (+/-)</b>
26	Andriani et al., 2019	1	-	-
27	Capuano et al., 2008	1	-	-
28	Dezi et al., 2018	1	-	-
29	Lee et al., 2007	1	-	-
30	Macris et al., 2008	1	-	-
31	Ungan, 2006	1	-	-

*Source: Elaborated by the authors*

In Table 2, the kiBPs theme is distinguished to the separate column since it can be perceived as a perspective through which most of the other themes can be examined. The IS/ICT theme cannot be perceived through the kiBPs perspective and thus distinguished in a separate column.

The term kiBPs is also referred to as dynamic (Szelagowski & Berniak-Wozny, 2019), emergent (e.g., Marjanovic, 2005), semi-structured, ill-structured, and unstructured (e.g., Kalpič & Bernus, 2006) processes. These processes are characterized by high complexity and knowledge intensity (e.g., Aureli et al., 2019). The examples of kiBPs are innovation process (e.g., Al-Sa'di et al., 2017), coordination process (e.g., Marjanovic, 2005), creative problem-solving process (e.g., Aureli et al., 2019), customer relationship management (CRM) process (e.g., Bueren et al., 2005), and knowledge management (e.g., Apostolou & Mentzas, 2003; Rehman & Iqbal, 2020).

Relevant papers that include the IS/ICT theme refer to Process-oriented KM systems (PKMS) and social BPMS (sBPMS). In recent years, several studies (e.g., Kang et al., 2003; Marjanovic, 2005; Mahmoodzadezh et al., 2009; Stary, 2014) focused on the integration of KM systems (KMS) and BPM systems (BPMS). Sarnikar & Deokar (2017) summarized previous findings regarding the integration of BPMS and KMS under the concept of PKMS. Rangiha et al. (2016) define social BPM as "the engagement of relevant stakeholders throughout the BPM lifecycle by utilizing social software features." Once involved in BPM, process stakeholders share process knowledge and collaborate on different BPM lifecycle stages such as process improvement and execution (e.g., Rangiha et al., 2016) and business process modeling (e.g., Adamindes & Karacapidilis, 2006; Silva & Rosemann, 2012). Such involvement is typically conducted via specially set BPMS, which we call social BPMS (sBPMS).

### 4.3 Framework of BPM and KM overlap

Based on the content analysis of the relevant papers, we suggest a framework that can be used to structure current and future research in overlapping themes of BPM and KM. As presented in Figure 4, the framework is constructed using themes revealed during the content analysis. The framework includes two perspectives (i.e., kiBPs, and IS/ICT) and encounters three types of relationships between BPM and KM: BPM influences KM, BPM is influenced by KM, and BPM and KM mutually influence each other.

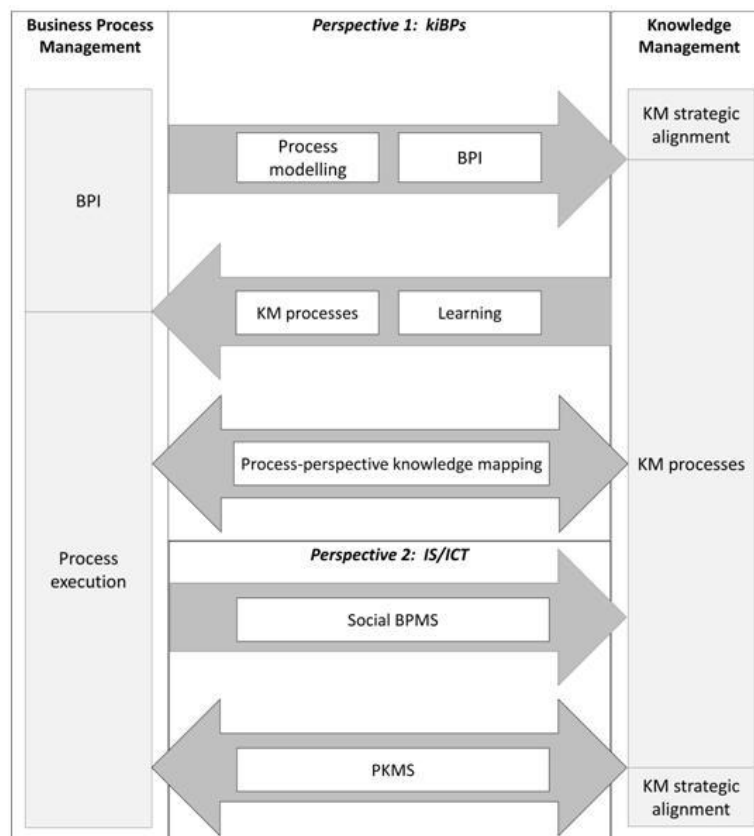


Figure 4: Framework of BPM and KM overlap  
Source: Elaborated by the authors

From the perspective of kiBPs, there are three types of relationships between BPM and KM: BPM influences KM, BPM is influenced by KM, and BPM and KM mutually influence each other.

Lavikka et al. (2015) and Zhang (2018) highlight the positive impact of process modeling on knowledge sharing (i.e., KM process) and thus allow us to conclude that BPM positively influences KM processes. This statement is proved by Dezi et al. (2018) and Lavikka et al. (2015), who discovered an increasing interest in the link between BPM and ambidextrous KM processes, which include exploitation of existing internal knowledge (Lavikka et al., 2015) and exploration of new external knowledge (e.g., Liao & Bernes, 2015; Nguyen & Harrison, 2019). Moreover, some authors (e.g., Kalpič & Bernus, 2006) highlight the facilitating role of BPM concerning externalization and internalization of knowledge – components of the SECI model developed by Nonaka & Takeuchi (1995). BPM also positively influences KM strategic alignment. Andriani et al. (2019) claim that business processes align KM strategy with the enterprise's business strategy.

Chión et al. (2019) stress that KM processes (i.e., knowledge acquisition, knowledge creation, knowledge sharing, and knowledge application) have a positive influence on the effectiveness of the business process improvement (BPI) activities. Several authors (e.g., Dalmaris, 2007; Seethmaraju & Marjanovic, 2009; Ranjbarfard, 2013; Nguyen & Harrison, 2019) provide evidence for the reliability of this relationship. However, the prevailing research trend in this field is to focus explicitly on knowledge sharing, ignoring other KM processes. For instance, the findings of Chión et al. (2019) and Aureli et al. (2019) confirm the significant effect of knowledge sharing on process improvement. Moreover, Mahmoodzadezh et al. (2009) claim that KM is a significant critical success factor for business process outsourcing. In other words, KM processes positively influence process execution.

In recent research, special attention is given to KM support of knowledge-intensive business processes (kiBPs) provided via KM processes such as knowledge sharing, knowledge collection, and knowledge reuse (Marjanovic, 2005; Sarnikar & Deokar, 2017). Another direction of KM support is learning (e.g., Sarnikar & Deokar, 2017; Lavikka et al., 2015), and several models were developed in this regard (e.g., Stary, 2014; Capuano et al., 2008). Several authors (e.g., Sarnikar & Deokar, 2017; Aureli et al., 2019) agree that the amount of KM support should grow with the growth of knowledge-intensiveness of the business processes. In other words, the strength of KM processes on process improvement and execution rises along with the knowledge intensity of the business processes.

This statement is confirmed by Seethmaraju & Marjanovic (2009) and Chi3n et al. (2019), who define business process improvement as a kiBP.

Process-perspective knowledge maps (Kang et al., 2003) integrate knowledge mapping and process modeling. Reflecting on the fact that knowledge is deeply embedded in business processes (e.g., Macris et al., 2008; Ranjbarfad et al., 2013; Szelagowski & Berniak-Wozny, 2019), produced and consumed during the business process execution (Sarnikar & Deokar, 2017), process-perspective knowledge maps deal with the knowledge specific to the particular task of the business process.

Process-perspective knowledge maps raise awareness of KM resources within knowledge workers who execute these processes, which is an essential factor in better utilization of KM resources (Sarnikar & Deokar, 2017). On the one hand, this fact can be interpreted because process-perspective knowledge maps support knowledge application/utilization (i.e., KM process). On the other hand, they increase the efficiency of process execution.

From the IS/ICT perspective, we identified two types of relationships between BPM and KM: BPM influences KM, and BPM and KM mutually influence each other.

Chatzoudes et al. (2015) claim that collaboration enabled by sBPMS positively influences KM. Silva & Rosemann (2012) and Rangiha et al. (2016) especially highlight the role of sBPMS in leveraging knowledge sharing (i.e., KM process).

PKMS simultaneously affect KM and BPM. According to a summary by Sarnikar & Deokar (2017), PKMS support KM processes, including knowledge acquisition, creation/codification, sharing, application/utilization. Moreover, Stary (2014) highlights the role of knowledge repositories, which “allow reconfiguring previously produced [knowledge] and tie [it] to running codification schemes and business processes” and thus stresses the fact that PKMS support another KM process – knowledge protection. Moreover, Sarnikar & Deokar (2017) stress that PKMS allows for incorporating KM processes’ performance measures, ensuring their alignment with objectives of business processes. In other words, PKMS support KM strategic alignment.

As for the influence of PKMS on BPM, Sarnikar & Deokar (2017) claim that PKMS personalize the delivery of knowledge to process and ensure accessibility of knowledge sources, which positively influences process execution.

#### **4.4 Analysis of research gaps**

We clustered suggestions found in the sample to identify existing research gaps and critically evaluated the framework of BPM and KM overlap described in the previous section. Since research on BPM and KM overlaps is fragmented, many authors highlight the need to prove existing overlaps in various settings: (a) for different industries (Al-Sa'di et al., 2017; Dezi et al., 2018; Chi6n et al., 2019; Nguyen & Harrison, 2019; Aureli et al., 2019; Andriani et al., 2019), (b) for different organizational settings (Zhang, 2018), (c) for different processes (Capuano et al., 2008; Ranjbarfard et al., 2013), and (d) for different control variables (Al-Sa'di et al., 2017; Chi6n et al., 2019).

Moreover, we identified several directions for future research that we consider the most perspective in their ability to accelerate the research of BPM and KM overlap in topics such as kiBPs, KM processes, and formalization of KM and BPM overlap.

Talking about future directions in kiBPs, Ranjbarfard et al. (2013) see the need to classify kiBPs. Moreover, Bueren et al. (2005) and Dalmaris et al. (2007) draw attention to the development of kiBPs performance measures. At last, Marjanovic (2005) suggests further investigate different aspects of KM support of kiBPs.

As for KM processes, Seethmaraju & Marjanovic (2009) stress the importance of researching transferring KM processes from one BPI project to another. Lavikka et al. (2015) suggest identifying barriers for exploitative and explorative KM processes and continuing researchings KM processes from the organizational ambidexterity perspective.

At last, Szelagowski & Berniak-Wozny (2019) stress that current BPM maturity models should be adopted to capture aspects of kiBPs management. In other words, the authors suggest formalizing the overlap of BPM and KM in the form of maturity models and encountering structured and knowledge-intensive business processes when estimating organizational maturity in BPM.

Two additional directions for further research were also identified after critical examination of the framework of BPM and KM overlap. First, most of the relevant sources from the researched sample focus on knowledge sharing omitting other KM processes. This fact is also noticed by Lee et al. (2007), Liao & Barnes (2015), and Al-Sa'di et al. (2017). Therefore, studying the influence of knowledge acquisition, knowledge creation, knowledge application, and knowledge protection on the process improvement and linking KM processes with stages of

BPM lifecycle (i.e., process discovery, process analysis, and process enactment) are seen as perspective directions for further research. This research direction is also suggested.

Second, most analyzed sources (e.g., Lavikka et al., 2015; Zhang, 2018) primarily focus on factors that influence knowledge sharing and do not pay any attention to critical success factors of other KM processes. Therefore, studying the influence of various critical success factors, including BPM activities (e.g., process discovery, process modelling) and social BPMS on knowledge acquisition, knowledge creation, knowledge application, and knowledge protection, is considered a direction for further research.

## **5 Conclusion**

By conducting a systematic literature review on the overlap of BPM and KM, we developed the framework for BPM and KM overlap and mapped directions for future research. Although the framework is grounded in theory, we consider explicit focus on scholarly articles from the Business Process Management Journal and the Journal of Knowledge Management the main limitation of our systematic literature review. Although this allowed us to ensure targeted identification of relevant papers, the explicit focus on two journals led to a narrow sample of 31 papers. This data insufficiency led to the high level of abstraction in the framework of BPM and KM overlap. To overcome the limitations mentioned above, in future research, we plan to expand the sample by including other scientific journals, using backward and forward searches, and updating our search queries with keywords revealed in this systematic literature review. This will allow us to extend the framework of BPM and KM overlap and investigate overlapping themes for both disciplines on lower levels of abstraction.

Nevertheless, our paper contributes to BPM and KM fields in two ways. First, the framework might serve as a starting point for researchers interested in investigating the relationship and overlaps of BPM and KM. Second, we identified problems for future research in BPM and KM that could be followed to extend the current body of knowledge in the field. The framework of BPM and KM overlap might also be beneficial for business professionals as a guideline for selecting best practices that, once tailored to the organizational context, might increase BPM implementation efficiency and elevate BPM from the “information” level to

the “knowledge” level, which will lead to the overall growth of business performance.

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## Exploring the Role of Entrepreneurial Capital and Leadership in Innovation Performance in High-Tech SMEs in Argentina

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### Abstract

**Purpose-** This paper explores the relationship between Entrepreneurial capital (EC), Leadership and Innovation performance (IP) in small and medium enterprises (SMEs) of the high-tech sector in Argentina.

**Design/methodology/approach-** For this study survey data were collected in small and medium sized high-tech firms in Argentina using scales previously validated internationally. The data were collected from November 2020 to March 2021 (excluding the analysis of COVID-19 influence, and referring to year 2019) by mailing to the companies' CEOs. The final sample comprises 200 companies from the technology-based sector located in Argentina. Hypothesis were tested using structural equation modelling in ADANCO.

**Originality/value-** There is scarce research carried on how Entrepreneurial capital and leadership influence innovation performance as a key factor for survival in crisis times, for small and medium sized high-tech firms. This study aims to fill the literature gap by exploring the relationship between the Entrepreneurial capital (EC), the CEO leadership and

the Innovation performance of technology-based small and medium enterprises (SMEs) on an emerging economy.

Practical implications- This study brings useful and valuable information to managers of small and medium sized enterprises of the high-tech sector, by identifying the importance of entrepreneurial capital (EC) and leadership impact on innovation performance.

**Keywords** – Intellectual capital – Entrepreneurial capital - Leadership- Innovation Performance – Small and medium sized-firms - SMEs.

**Paper type** - Academic Research Paper

## 1 Introduction

The current changing and uncertain times companies are operating in force them to innovate in order to survive (Nguyen, 2018; North & Varvakis, 2016; Zhang, Zheng, & Ning, 2018). In this context, knowledge is a key resource for firm innovativeness and competitiveness (Davila, Varvakis, & North, 2019).

A widely accepted definition describes innovation as the implementation of new or significantly improved product or service, process, new organizational or marketing method in business practices, workplace organizations or external relations (OECD, 2005).

In order to be more effective in innovation, organizations have to be focused on how they manage intellectual capital (Cabrilo & Dahms, 2018).

*Intellectual capital (IC)* is defined as the sum of all knowledge assets that firms use to attain a competitive advantage and is divided traditionally into three components – human capital (HC), structural capital (SC) and relational capital RC (RC) (Bontis, 1998; Edvinsson & Malone, 1997; Subramaniam & Youndt, 2005). However, deeper understanding of the knowledge-based antecedents of innovation suggest including a novel type of capital, the entrepreneurial capital (EC) (Cabrilo, Kianto, & Bojana, 2018). This capital is defined as a stock of competences and employee's attributes related to identify business opportunities, take risks, be proactive, innovative and make difficult decisions (Cabrilo et al., 2018; Demartini & Paoloni, 2014; Erikson, 2002).

According to some authors, intellectual capital is considered a main driver of innovation in the knowledge based economy (Buenechea-Elberdin, Sáenz, & Kianto, 2018; Cabrilo & Dahms, 2018; Delgado-Verde, Martín-De Castro, & Amores-Salvadó, 2016; Inkinen, 2015; W. Wendra, Sule, Joeliaty, & Azis, 2019).

In this line, due to the fact that entrepreneurial capital is associated with innovation and creativity, it deserves special attention (Crespo, Curado, Oliveira, & Munoz-Pascual, 2021; Demartini & Paoloni, 2014; Paoloni, Coluccia, Fontana, & Solimene, 2020).

In small and medium sized enterprises (SMEs) knowledge management has been a core component to use employees' tacit and explicit knowledge to increase internal business innovation and leverage such in this global competitive business environment (Ajibade, 2016). Although, managers and owners of these type of companies are aware of growth potential, they tend not communicate that strategy to employees (North, Bergstermann, & Hardwig, 2016).

In this regard, the figure of the leader of the company becomes extremely relevant. Leaders able to motivate and encourage other employees can be a great competitive advantage of an enterprise (Hitka et al., 2019).

Furthermore, the leadership of the CEO influences the innovation behaviours of their employees especially in small and medium sized enterprises (SMEs) of high-tech firms (Busola Oluwafemi, Mitchelmore, & Nikolopoulos, 2020).

In the case of small and medium enterprises (SMEs), especially the technology-based firms, the ability to overcome adversity under highly changing and turbulent environments highlights the importance of the capability to innovate in order to develop and maintain competitive advantage (Bueno & Moreno, 2019; North & Varvakis, 2016).

A gap in the literature, regarding the importance of entrepreneurial capital and leadership to boost innovation performance in emerging countries in high-tech firms has motivated this study (Cabrito et al., 2018; Caridi-Zahavi, Carmeli, & Arazy, 2015; Wendra Wendra, Sule, Joeliaty, & Azis, 2019). Consequently, the purpose of this research is to explore how entrepreneurial capital and the CEO leadership influences the innovation performance of high-tech SMEs in Argentina.

## **2 Theoretical Background and hypotheses**

### ***2.1 Leadership and Entrepreneurial capital (EC)***

In order to maintain a competitive advantage in the current turbulent environment, particularly for SMEs of the high-tech sector, leaders are constantly challenged to leverage the intellectual capital of their firms to thrive (Busola Oluwafemi et al., 2020; Makri & Scandura, 2010). The majority of the past studies

consider that IC include human skills, expertise and motivation (human capital); processes, systems, solutions, databases, patents and IPs (structural capital) and the value shown in the network of relationships (relational capital) (Kianto, Ritala, Spender, & Vanhala, 2014). Recently, academic researchers proposed entrepreneurial capital as a novel component of intellectual capital, which is related to entrepreneur behaviour performed by organizational members (Cabrilo et al., 2018; Demartini & Paoloni, 2014; Inkinen, Kianto, Vanhala, & Ritala, 2017; Kianto et al., 2014; W. Wendra et al., 2019). Entrepreneurial capital is defined as a stock of competences and the employees' attributes related to proactive, risky, innovative, and aggressive decision-making (Cabrilo et al., 2018; Demartini & Paoloni, 2014; Erikson, 2002; Firkin, 2003).

Leadership strongly affects intangible assets and effective leaders have awareness regarding the value of their staff for enabling change (Alrowwad, Abualoush, & Masa'deh, 2020; Cortes & Herrmann, 2020). In this regard, leaders have a vital influence on the creativity and innovative behaviour of employees by communicating and encouraging a shared vision (Caridi-Zahavi et al., 2015; Khalili, 2017).

In high-technology industries, CEOs must create a climate that encourages exploration and risk taking, that fosters innovation (Makri & Scandura, 2010). According to previous studies, it would be expected that the effects of leadership would occur through the behaviours of employees (Makri & Scandura, 2010). The CEO leadership shapes an organizational context of openness and work environment in which employees create new opportunities for new knowledge creation and cultivate relational connectivity, which enhance a firm's innovation performance (Caridi-Zahavi et al., 2015). A clear direction demonstrated by the CEO as a vision that encourages and inspires employees can foster new ideas that may lead to innovation. This vision is supported and goes in hand with the CEO leadership behaviours (Caridi-Zahavi et al., 2015). Leadership at the top management positions appears to be an important antecedent of a firm's ability to innovate because the CEO has an important impact on the development of the organizational vision and the strategies to attain that vision (Makri & Scandura, 2010).

In this study, is considered that assuming a direct influence of a CEO's leadership on firm innovation performance may not take into consideration the mechanism that support this process, where leaders create the environment for

entrepreneurial behaviours among organizational members that drives innovation performance of the firm (Caridi-Zahavi et al., 2015).

A clear direction demonstrated by the CEO as a vision that encourages and inspires employees can foster new ideas that may lead to innovation. (Busola Oluwafemi et al., 2020; Caridi-Zahavi et al., 2015).

Following the ideas stated above, the next hypothesis is proposed:

*H1. Leadership (L) influences Entrepreneurial capital (EC) in SMEs of the high-tech sector.*

## **2.2 Entrepreneurial capital (EC) and Innovation**

It is considered that innovation is a vital key to organizations survival on turbulent and changing environments (Dabić, Lažnjak, Smallbone, & Švarc, 2019; North & Varvakis, 2016). Intellectual capital and innovation are intrinsically related, and it is widely accepted that leveraging intellectual capital creates a competitive advantage for driving innovation (Buenechea-Elberdin et al., 2018; Yitmen, 2011). This linkage has been widely analysed by numerous studies (Cabrito et al., 2018; Nguyen, 2018; Omerzel & Jurdanab, 2016; Subramaniam & Youndt, 2005). However, the majority of these studies leave aside the influence of entrepreneurial capital on innovation performance.

It has been found that entrepreneurial capital influences innovation of a firm (Hughes & Morgan, 2007). Furthermore, the technology level of the firm generates mayor differences in the entrepreneurial capital and innovation performance relationship (Buenechea-Elberdin, Sáenz, & Kianto, 2017).

Studies of the intellectual capital and innovation relationship have shown a tendency to investigate the human side of intangibles from a traditional perspective, examining only attributes such as professional qualifications, skills and motivation of employees and more specific attributes that may be relevant in this context were not included (Buenechea-Elberdin et al., 2017). Aspects such as proactive, risky, innovative, and aggressive decision-making must be contemplated (Demartini & Paoloni, 2014). In this matter, as mentioned a novel type of intellectual capital has emerged, the entrepreneurial capital (Cabrito et al., 2018; Demartini & Paoloni, 2014; Inkinen et al., 2017; Kianto et al., 2014; Wendra Wendra et al., 2019).

Innovation is enhanced by entrepreneurial capital because it encourages risk taking and creating new knowledge (Buenechea-Elberdin et al., 2017).



In accordance with was stated, the next hypothesis is proposed:

*H2. Entrepreneurial capital (EC) influences the innovation performance in SMEs of the high-tech sector.*

### **3 Research Method**

#### **3.1 Sample and data collection**

The population considered in this study consists of Argentinian SMEs firms of the high-tech sector. The definition of the Ministry of Productive Development has been used to identify SMEs firms. The target enterprises were selected from Technology Clusters across the country. The data was collected from November 2020 to March 2021, (excluding the analysis of COVID-19 influence, and referring to year 2019) by mailing to the companies' CEOs. A sum of 227 responses were collected, representing a response rate of approximately 10%. After excluding 27 responses with incomplete data or ungagged responses, a sample of 200 where achieved for further analysis. Confidentiality was guaranteed to all participants. The aim was to obtain a representative sample of the composition of Argentinian high-tech SMEs.

#### **3.2 Measures**

For measuring leadership it was use part of the scale of the creative and innovative leadership developed by Khalili (2017), using its second component of encouraging shared vision, composed by eight items and that was built considering different research models for leadership. Components were measured with five-point Likert scales (where 1 = strongly disagree and 5 = strongly agree).

For measuring entrepreneurial capital the scale developed by Kianto and colleagues were used (Inkinen, Kianto, Vanhala, & Ritala, 2014). Components were measured with five-point Likert scales (where 1 = strongly disagree and 5 = strongly agree).

Measures for innovation performance were developed by using the Weerawardena scale (Weerawardena, 2003). Components were measured with five-point Likert scales (where 1 = strongly disagree and 5 = strongly agree).

This study considers firm size and firm age as control variables. Each variable is represented by the logarithm of the number of employees and the logarithm of the number of year operating.

### **3.3 Statistical analysis**

Structural Equation Modelling (SEM) was used to test the hypotheses, which is a family of statistical techniques that has the ability to model latent variables and to test theories (Henseler, Hubona, & Ray, 2016). SEM combines multiple regression concerns and factor analysis in order to estimate a number of dependency relationships and identify the collective strength of multiple variables (Creswell, J. W., & Creswell, 2014). In this research, variance-based partial least squared technique (PLS-SEM) is used due to its predictive capability (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014; Henseler et al., 2016).

The PLS-SEM modelling is carried out by ADANCO Software, and is analysed and interpreted in two stages (Hair et al., 2014; Henseler et al., 2016). First, reliability, convergent validity and discriminant validity of the measurement model is analysed. Second, the structural model is assessed. The Standardized Root Mean Square Residual (SRMR) is examined as model fit criteria. The adjusted-R<sup>2</sup> is analysed, which is the amount of variance of dependent variables explained by the model.

For testing research hypothesis the statistical significance of path between constructs are examined, and bootstrapping procedure is executed to obtain the confidence intervals and statistical significance of the hypothesis

## **4 Results**

In this section, results of the assessment of the measurement model and the structural model are presented to test the developed hypotheses.

### **4.1 Measurement model.**

Evaluating the measurement model is for testing how accurately measured and well represented are the constructs (Hair et al., 2014).

Due to all constructs in the tested model are reflective, individual item reliability, construct reliability, convergent validity, and discriminant validity

should be ascertained (Henseler et al., 2016). The definitions of the scale items can be found in the annex (Table A1).

Three reliability coefficients for latent constructs were assessed: Cronbach's Alpha, composite reliability and rho A. After evaluation, all scores were acceptable and tested above 0.7 (Henseler et al., 2016). (Table 1).

For testing convergent validity, the average variance extracted (AVE) was evaluated for latent variables and it was verified that all scores were above 0.5, showing that the constructs explain more than half of the variance of its indicators (Hair et al., 2014). Also each item has outer loadings above 0.7, supporting a suitable convergent validity (Henseler et al., 2016). (Table 1).

The next step for assessing the measurement model is evaluating the discriminant validity, which represents how constructs are empirically different from each other's (Hair et al., 2014).

Discriminant validity is assessed by the Fornell and Larcker (1981) criterion, by verifying that the square root of AVE of each construct is higher than the construct correlation with each other of the model (Henseler et al., 2016). In addition, descriptive statistics of the constructs are presented. (Table 2).

Table 1– Results of assessment of the measurement model

Construct	Indicator	Loadings	Cronbach's Alpha	Rho A	Composite Reliability	AVE
Entrepreneurial capital	EC2	0.789	0.860	0.871	0.905	0.703
	EC3	0.865				
	EC4	0.851				
	EC6	0.847				
	EC1	Excluded				
	EC5	Excluded				
Innovation Performance	INN1	0.721	0.811	0.815	0.869	0.570
	INN2	0.831				
	INN3	0.743				
	INN4	0.724				
	INN5	0.751				
Leadership	L1	0.830	0.932	0.934	0.944	0.678
	L2	0.874				
	L3	0.822				
	L4	0.817				

L5	0.768
L6	0.880
L7	0.756
L8	0.831

Source: Results of this study

Table 2 – Descriptive statistics and correlations of constructs

Construct	Mean	EC	INN	L	FS	FA
EC. Entrepreneurial capital	3.301	0.703				
INN. Innovation Performance	3.667	0.218	0.571			
L. Leadership	3.980	0.300	0.313	0.678		
FS. Firm Size	40.600	0.014	0.024	0.010	1.000	
FA. Firm Age	16.990	0.007	0.001	0.046	0.124	1.000

\*Square root of AVE in diagonal

Source: Results of this study

#### 4.2 Structural model.

The model used to test the hypotheses (Figure 1), after executing the bootstrapping procedure showed an index of 0.060 SRMR, below the maximum of 0.08 (Henseler et al., 2016).

The results after running the bootstrapping provide evidence that supports the two hypotheses (H1 and H2) (Table 3). Leadership seems to be an antecedent of entrepreneurial capital (H1), with a significant path (0.547,  $p < 0.01$ ). Entrepreneurial capital has a direct influence on innovation performance (H2), with a significant effect (0.452,  $p < 0.01$ ). The model shows a large  $f^2$  (effect sized) for H1 and H2 (Cohen, 2013). Regarding the moderating effects of firms' size and firm age, their paths have no significant influence on the model studied.

Table 3- Tests of Hypotheses

Hypotheses	$\beta$ coef.	p values	f <sup>2</sup>	Result
H1. L -> CE	0.547	0.000	0.428	Accepted
H2. CE -> INN	0.452	0.000	0.257	Accepted
Firm Size-> INN	0.111	0.121	0.014	
Firm Age-> INN	-0.025	0.724	0.001	

Source: Results of this study

The proportion of variability explained by the model is evaluated with the adjusted-R<sup>2</sup> values (Henseler et al., 2016), and is possible to conclude that the model of study explains 29,6% of entrepreneurial capital and 21,7% of innovation performance. (Table 4).

Table 4- Adjusted R<sup>2</sup> values

Construct	Adjusted R <sup>2</sup>
EC. Entrepreneurial capital	0.296
INN. Innovation Performance	0.217

Source: Results of this study

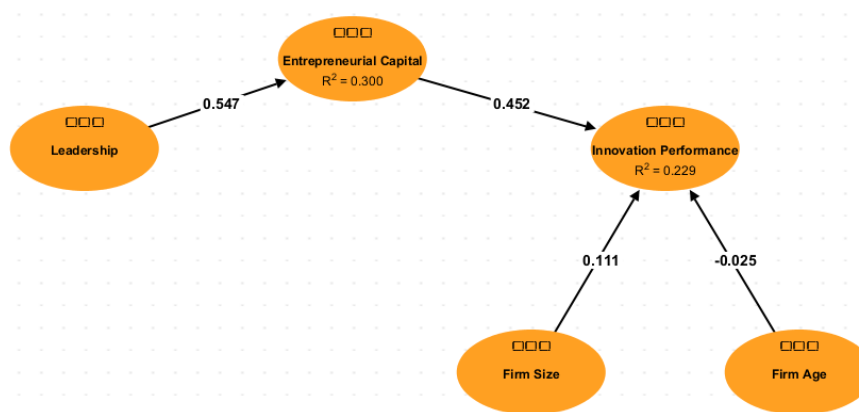


Figure 1. Path Model  
Source: Own elaboration.

## 5 Conclusions

The present study found that leadership is a key source for boosting entrepreneurial capital for high-tech SMEs. This brings valuable information for managers by identifying vital importance of leadership on entrepreneurial capital, being an effective predictor. CEO's influence on developing entrepreneurial capital by encouraging a shared vision and inspiring employees, allows creation of new knowledge and risk taking.

The research provides evidence that entrepreneurial capital has a positively and direct impact on innovation performance. These findings contribute to a better understating on how the entrepreneurial behaviours of employees drive innovation.

In a scenario of uncertainty and crisis, it is vital that the members of an organization create new knowledge and turn it into value for the company in order to maintain a competitive advantage. Mainly for SMEs, which depend on adapting to changes on the environment and innovation to survive, making it particularly important in emerging countries. (North & Varvakis, 2016).

The main contribution of this study is that explores the relationship between entrepreneurial capital , CEOs leadership and the innovation performance of technology-based small and medium enterprises (SMEs) on an emerging economy filling a gap on literature on this matter. Future research could explore this relationship from a different perspective such as a different environmental context, to broaden the research area. In addition, future studies are suggested to explore the interaction between leadership and others components of intellectual capital, to have a more comprehensive understating on this interaction.

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## Appendix

Table A1– Scale Items

Construct	Indicator	Item
Entrepreneurial capital Based on Inkinen,Kianto, Vanhala,&Ritala	CE1	Risk-taking is regarded as a positive personal quality in our company.
	CE2	Our employees take deliberate risks related to new ideas.
	CE3	Our employees are excellent at identifying new business opportunities
	CE4	Our employees show initiative.
	CE5	The operations of our company are defined by independence and freedom in performing duties
	CE6	Our employees have the courage to make bold and difficult decisions.
Innovation Performance Based on Weerawardena	INN1	Compared to our competitors, our company has been successful in creating innovations in Products and services for customers.
	INN2	Compared to our competitors, our company has been successful in creating innovations in Production methods and processes
	INN3	Compared to our competitors, our company has been successful in creating innovations in Management practices
	INN4	Compared to our competitors, our company has been successful in creating innovations in Marketing practices
	INN5	Compared to our competitors, our company has been successful in creating innovations in Business models

Leadership Based on Khalili	L1	Leaders create and express an exciting vision of the future.
	L2	Leaders create and express an exciting vision of the future.
	L3	Leaders make the vision clearly understood by giving examples, telling stories, and using figures of speech and metaphors.
	L4	Leaders have visions/dreams of what can be.
	L5	Leaders have a clear image of the future.
	L6	Leaders express enthusiasm for their vision.
	L7	Leaders are models of what they want others to do.
	L8	Leaders use the vision to give the life and work of the company a sense of meaning and purpose.

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Source: Own elaborate

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## The Role of Intellectual Capital in Universities: a Review of the Literature and a Research Agenda

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### Abstract

In recent years, the concept of Intellectual Capital (IC) has acquired a crucial role in the university context. This because universities are characterized by a high intensity of adoption of intangible resources. Numerous studies have focused on IC performance reporting models, especially in the organizational context. Fewer studies, however, have considered the measurement of IC of universities. This paper aims to analyze the existing literature and identify the main metrics adopted for measuring IC in universities. To achieve this aim, we perform a systematic literature review of a sample of 71 articles and define a taxonomy of indicators of IC. The findings of this study highlight and categorize the main IC metrics and identify future research directions.

**Keywords** - intellectual capital, university, relational capital, structural capital, human capital.

**Paper type** - Academic Research Paper

## 1 Introduction

The relevance of Intellectual Capital (IC) has emerged mainly in the private sector, but, nowadays, there is a growing interest in this topic also in the public sector. The IC is a valuable strategic management asset to gain a competitive advantage. The IC offers managers a better understanding of the internal and external issues that arise in the organization (Tayles, Pike, & Sofian, 2007). In this regard, previous researchers highlighted how IC could help develop a learning culture that transforms traditional organizations into dynamic learning organizations (Ankur & Rajat, 2019; Secundo, Elia, & Passiante, 2010). Among public companies, the role of higher education and research institutions has major relevance for the economy of countries and regions as it has a considerable weight in terms of an educated workforce and greater entrepreneurship within the country. However, the importance of IC in higher education institutions is rarely discussed when evaluating the results in terms of cost and efficiency.

Today, university systems are immersed in an intense transformation process triggered by the need to make universities more flexible, transparent, competitive, and comparable (Sánchez, Elena, & Castrillo, 2009). To meet these challenges, higher education institutions must consciously manage the processes of creating their IC elements and recognize the importance of their role in society and the value they can create. Knowledge resources are the foundation of the core competencies of any organization. Therefore, they play a key strategic role and must be measured in a clear and detailed way using ad hoc metrics. The universities that adopt a strategic approach to manage the intellectual components have the opportunity to improve their reputation. However, to date, no study uniquely identifies and categorise the metrics used to enhance IC in universities.

This paper aims to define a taxonomy of indicators for the measurement and management of IC within universities. This taxonomy stands as a useful tool for developing culture, identifying activities aimed at knowledge management, and providing a useful contribution to the growing demand for transparency. To this end, we carried out a systematic review of the literature about IC in university to better understand the research directions currently explored. In particular, two research questions guided the drafting of this paper, consisting of:

- R1: how have the studies related to IC reporting evolved in the university context?

- R2: what are the main indexes in valuing IC in universities?

In answering these questions, this paper contributes to the research on IC in the university by conducting a systematic review on the topic and discussing the potential support and theoretical and managerial implications of IC reporting in universities. The remainder of the paper is organized as follows. In section 2, we present a brief overview of the topic of IC. The third section presents the methodology adopted to analyse the extant literature. Section 4 discusses the obtained result and, finally, section 5 outlines the gaps, future research avenues, and limitations.

## **2 Theoretical background**

The transition from the industrial society to the information-based, and subsequently, to the knowledge-based has already been anticipated by Drucker in the late 1990s. He stated that the emerging social context would rely on new organizational structures, focusing on knowledge as the main resource. Knowledge, developed in a tacit or explicit form, represents the basic concept of IC. Statistics relating to the most developed countries show a Gross Domestic Product (GDP) made up of about 50% from knowledge-based industries (software, pharmaceutical industry, information technology, education and research). In the United States, over 80% of GDP comes from this production sector and the various Research and Development (R&D) centres of manufacturing industries (Niebel, 2018). The difficulty in defining and understanding the IC scope limits the opportunity to describe it in a single research area. Despite the many attempts of researchers to define IC, there is still no univocal definition of this concept. Stewart (1997) defines IC as an intellectual tool for developing knowledge, information and intellectual property useful for supporting the creation of wealth and social development. Brătianu (2006) considers IC as an element capable of strengthening the intellectual components and transforming them during technological and administrative processes into operational, active and value-adding constructs. Numerous different classifications identify the components of IC (Bontis, 2001). Most of them are very similar in terms of decision-making aspects. Indeed, previous contributions focus on aspects related to the human, organizational (structural or internal) and relational components (Andriessen, 2004; Roos and Piche, 2007). Specifically, IC is

structured in three main components: Human Capital (HC), Relational Capital (RC), and Structural Capital (SC).

HC represents tacit knowledge, skills acquired by employees throughout their entire career, experience and attitude (Fanea-Ivanovici, 2013). SC considers aspects related to the different organizational structures, the patents and trademarks and all the other capabilities that favour the improvement of the productivity of employees (Edvinsson, 1997). Finally, RC incorporates the value generated in the development of relationships between the organization and its stakeholders: suppliers, partners, national bodies, and the business environment (Roos and Piche, 2007).

Given this background, universities and research institutes began to show interest in the management of the IC. Indeed, the implementation of IC reporting models within universities is a useful tool to support the growth and dissemination of knowledge. In dynamic contexts like university ones, the development of these models requires a considerable number of resources to generate organizational benefits. Although previous contributions illustrate methods for the analysis of IC (e.g., Sanchez, 2009; Leitner, 2002), to date there is still no study that reviews the main metrics used for measuring IC of universities. This paper aims to fill this gap by analysing the extant literature and defining a taxonomy of the metrics adopted to measure IC in universities.

### **3 Methodology**

The proposed literature review focuses on analysing the importance of IC within higher education and research institutions as a fundamental tool to generate knowledge. Specifically, the review was performed using a systematic approach adapted by Seuring et al. (2005). The methodology is structured in the following phases:

1. *material collection*: identification of the keywords, definition of the search strings, and selection of the database;
2. *material selection*: definition of exclusion criteria;
3. *descriptive analysis*: examination of the articles according to specific dimensions of analysis to highlight specific characters about the IC in universities;
4. *content analysis*: review the selected sample of papers to identify and group the main metrics adopted to measure IC in universities.

### 3.1 Material collection

This phase involves the search and selection of the articles using a database. We have chosen the Scopus database as it is considered the most reliable and high-quality data source for conducting literature reviews (Ahi and Searcy, 2013; Eskandarpour et al., 2015). The next step deals with the definition of the search string. Table 1 shows the search string and the total number of articles collected (288). In line with Denyer and Tranfield (2009), conference proceedings and book chapters were excluded from the hits to ensure the quality of the analysed papers. Indeed, only peer-reviewed publications were included in the final sample. Furthermore, no filters have been included to reduce the data range considered. The data collection phase was conducted in January 2021.

Table 1 Search string

<i>Search String</i>	<i>Papers</i>
(( ( intellectual AND capital ) OR ( intangible AND ( assets OR resources ) ) ) AND ( university OR higher AND education ) )	288

### 3.2 Material selection

This step is based on the selection of papers according to two exclusion criteria. First, we read the title and abstract of the articles. Indeed, the articles incongruent with the topic under investigation and those more polarized towards a theme and not on the link between IC and universities were excluded. Thus, following the first criterion, 122 documents were excluded from the sample. The second criterion is based on the full-text reading. In the case of unclear abstract, the entire paper was read to better view the aspects covered. Therefore, the systematic literature review was based on a sample consisting of 71 documents, as illustrated in Table 2.

Table 2 Exclusion criteria

<i>Exclusion criteria</i>	<i>Papers excluded (-)</i>
Initial sample retrieved	<b>288</b>
<b>1. Title and abstract reading</b>	-122
<b>2. Full-text reading</b>	- 95
Final sample	<b>71</b>



### **3.3 Descriptive analysis**

Once the collection of the sample was completed, we conducted the descriptive analysis to evaluate the formal aspects of the collected material. More in detail, this analysis allows us to characterize the context and support the results presented in the content analysis. The sample was analysed according to various dimensions listed below:

- distribution of articles per year of publication and number of citations;
- distribution of articles per document type;
- distribution of citations per journal.

#### *Distribution of articles per year of publication and number of citations*

Figure 1 depicts the evolution of articles over time, considering the year of publication. The results show that the 71 articles collected in the previous step were published between 1997 and 2020. The first article on the link between IC and universities in our sample was published in 1997 by Kinsella and McBrierty. Only eight articles were published between 1998 and 2011, and the highest number of articles published on the topic (13) was recorded in 2020. In the last few years, the authors have shown a growing interest in deepening the areas related to IC, thus enriching the academic literature and generating documents useful for defining the context and modelling structures aimed at evaluating IC in universities.

As for the number of citations received, there are four peaks in 2004, 2010, 2015 and 2018. In particular, the most cited article is the one by Leitner (2004) with 88 citations.

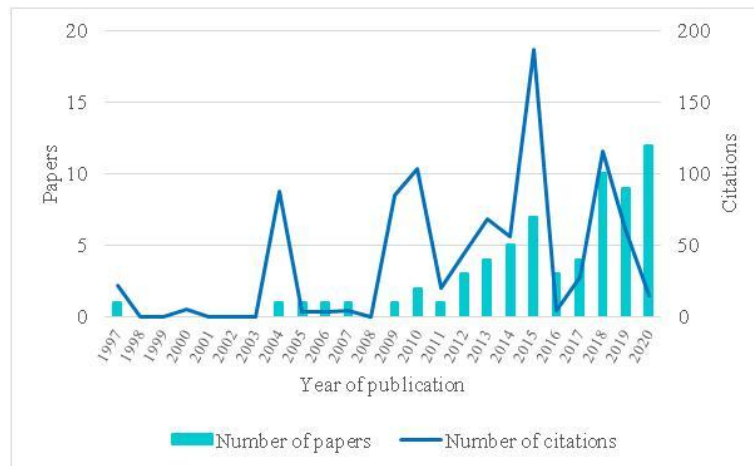


Figure 1 Papers per year of publication and number of citations

### 3.3.1 Distribution of articles per document type

Figure 2 shows the number of publications by document type. Specifically, 97% of the material collected consists of articles (69 papers out of 71), while the remainder consisted of reviews. This trend shows, as anticipated in the previous paragraphs, the scarcity of review papers that summarize the existing literature. In particular, the most recent review dates back to 2018 (Bisogno et al., 2018) and proposes a state of the art of IC in the university. With this aim, this study identifies and characterizes the main metrics adopted by the previous authors in measuring the IC of universities.

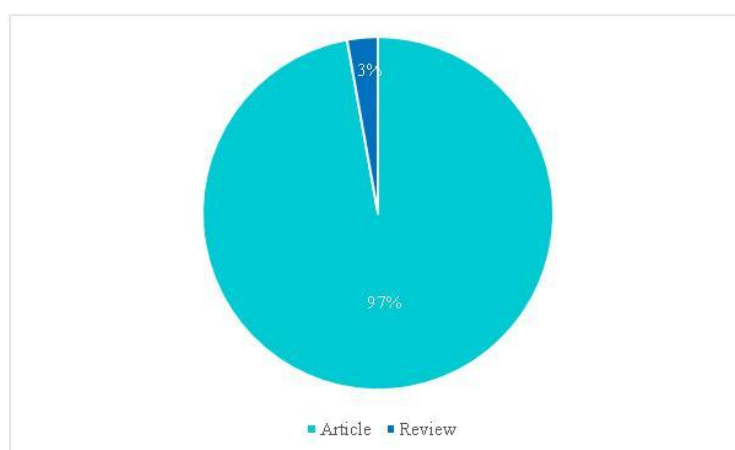


Figure 2 Articles per document type

### 3.3.2 Distribution of articles per journal

Figure 3 presents the distribution of articles by journals. The 71 articles of the sample were published by 51 different journals. This data is very significant since only the *Journal of Intellectual Capital* has published as many as 14 articles, followed by the *International Journal of Learning and Intellectual Capital*, with 3 articles, *Quality and Quantity*, *Studies in Higher Education*, *International Journal of Environmental Science Education*, *Knowledge Management Research*, *Industry and Higher Education* and *Practice* contribute with two articles each. The contribution of other journals is lower than 2%. Figure 3 highlights the heterogeneity of the theme under investigation. In that, the journals embrace different fields from entrepreneurship to the service industry.

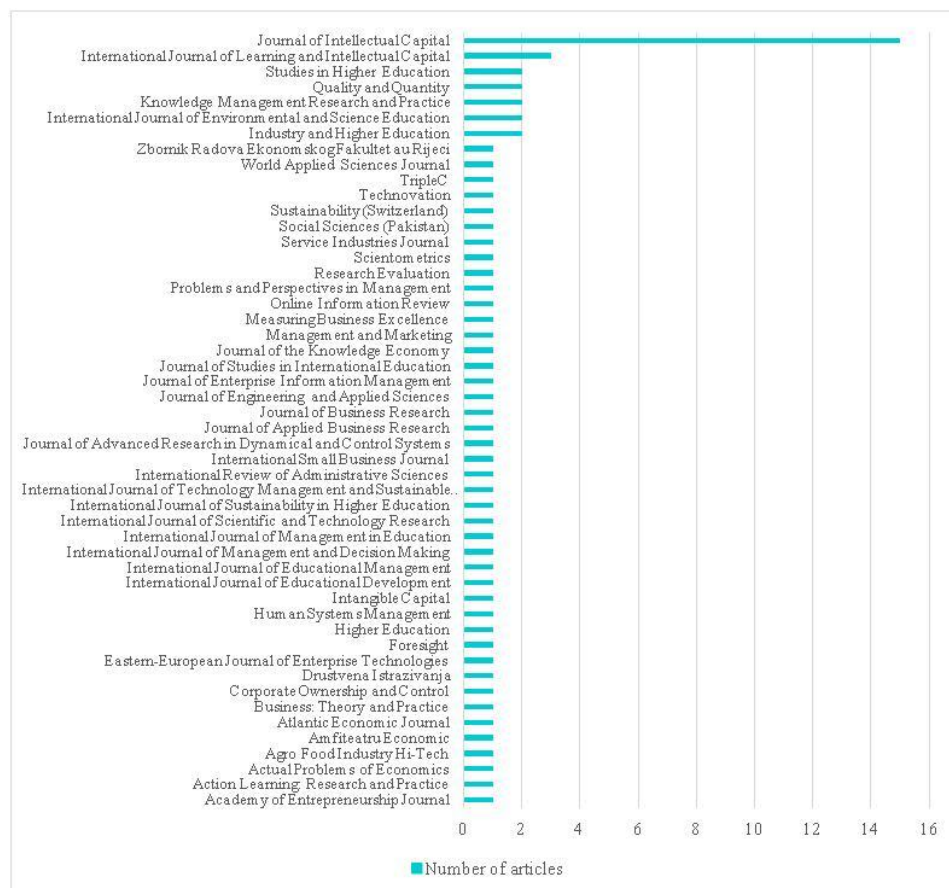


Figure 3 Articles per journal

### **3.4 Content analysis**

The analysis of the selected material allows us to highlight the main metrics adopted to measure IC in the university context. Specifically, we group the metrics according to IC components (HC; SC; RC) and identify performance metrics of universities. The following sections will present in detail the classifications for each IC component and the IC performance.

#### **3.4.1 Human capital**

The HC represents the tacit and individual strategic source that contributes to creating competitive advantage and supporting its sustainability (Carmeli, 2004). Furthermore, the HC is a significant factor determining growth across countries (Ang et al., 2011; Banerjee and Roy, 2014; Barro, 1991; Goldin, 2001). Numerous studies have demonstrated the positive effect of HC on organizational performance (Carmeli, 2004; Hsu, 2008). In the context of universities, Teodorescu (2006) stated that researchers play the most important role in the generation, management and transfer of knowledge within universities and research institutes. Nguyen (2016), in a recent study, went further, proposing policies aimed at the management of human resources based on effective research in universities to motivate institutes to improve their performance in research. Townsend et al. (2015) explored the structural policies needed to promote research efforts. On the contrary, Chang et al. (2015) took a different perspective by advocating a balance between teaching and research to achieve excellence. These studies overlooked the role that the HC plays in stimulating university performance by converting the skills of an institutional researcher into knowledge, motivation into better research and interdisciplinary research on results, thus achieving the goal of excellence. Another set of studies was developed in the context of research universities and their contribution to the knowledge economy concerning developing countries (Altbach, 2013; Postiglione and Arimoto, 2015; Postiglione, 2013; Shin and Lee, 2015). These studies focus on globalization and internationalization through academic productivity, innovation and quality research, but neglect the role of the HC generated in the entire process. Table 3 presents the metrics adopted in measuring HC by the selected articles. These metrics have been divided into three groups: employees features, full-time and part-time employees. The first area includes metrics related to specific characters of university personnel. The second and third group consider

indicators that differentiate employees based on the type of contract with the university.

Table 3 Human capital metrics

	Components	Metrics	References
Human Capital	Employees features	Average years of experience of research staff	Kulikova et al. (2019)
		Average age of staff (professors, researchers, and administrative staff)	Kulikova et al. (2019), Kinsella et al. (1997)
		Academic and teaching staff (ATS) with a master's degree	Pedro et al. (2019), Kulikova et al. (2019)
		Gender of staff (professors, researchers, and administrative staff)	Stukalova et al. (2016)
	Full-time employees	Percentage of teaching, technical and auxiliary staff	Iacoviello et al. (2019)
		Number of administrative staff members	Iacoviello et al. (2019)
		Number of associate professors	Iacoviello et al. (2019), Pedro et al. (2019), Ramírez Y. et al. (2017), Feng et al. (2012), Renzl (2006)
		Number of full professors	Iacoviello et al. (2019), Pedro et al. (2019), Ramírez Y. et al. (2017), Feng et al. (2012), Secundo et al. (2010)
	Part-time employees	Number of part-time research contracts	Ramírez et al. (2017), Secundo et al. (2010)
		Number of teaching assistants	Iacoviello et al. (2019)
		Number of PhD students	Ramírez et al. (2017), Manes Rossi et al. (2018)
		Number of research collaborators	Sánchez et al. (2009)
		Number of researchers involved in the research activities	Sánchez et al. (2009), Secundo et al. (2010)
		Number of research assistants	Sánchez et al. (2009)
		Number of student assistants	Iacoviello et al. (2019), Kulikova et al. (2019), Leitner (2004)

### 3.4.2 Structural capital

The SC can contribute to organizational sustainability practices through the implementation of support and improvement programs, such as structural improvements based on new technologies (databases and forms of intellectual property); knowledge sharing practices; organizational processes and tools that

transform individual knowledge into organizational assets and corporate culture (Tonial et al., 2019). Concerning SC, the importance of creating and managing specific mechanisms of know-how and knowledge flows within ecosystems is essential for developing employees skills (Borin and Donato, 2015). As for the HC, the SC is also classified into sub-categories. Table 4 presents the three different groups of metrics identified. Specifically, the three groups refer to the different investments made by universities, respectively for the staff, technological infrastructures and R&D activities.

Table 4 Structural capital metrics

	Components	Metrics	References
Structural Capital	Employees	Total expenditure on staff in relation to total expenditure	Pedro et al. (2018), Leitner (2004)
		Number of research infrastructures/incubators and laboratories	Stukalova et al. (2016)
		Lump-sum for research (government funding and non-government funding) / total research funding	Sánchez et al. (2009)
		Amount of budget constraints (cost of staff equipment + personnel) / research	Sánchez et al. (2009)
	Technologies	Number of investments in libraries and electronic material	Leitner (2004), Manes Rossi et al. (2018), Feng et al. (2012), Kulikova et al. (2019)
		Total expenditure on IT and communication in relation to total expenditure	Pedro et al. (2018)
		Number of technical services performed and revenues from those services	Gardner. et al. (2010)
		IT and communication spending	Pedro et al. (2019)
		Number of PCs for faculty members	Secundo et al. (2010)
		Number of PCs per staff member	Secundo et al. (2010)
		Number of PCs per student	Secundo et al. (2010)

	IT costs spent on staff	Secundo et al. (2010)
	Fee for leasing of premises and equipment	Leitner (2004)
R&D	Share of the budget related to knowledge transfer by origin	Gardner. et al. (2010)
	Thresholds imposed on fundraising (including the weight of university contributions on the total budget and incentives given to private donors to support research activities)	Sánchez et al. (2009)
	Non-core funding /total budget and budget for research.	Sánchez et al. (2009)
	Non-institutional funds (contract research, etc.)	Secundo et al. (2014), Sánchez et al. (2009)
	R&D expenses	Ramírez et al. (2017), Feng et al. (2012), Gardner. et al. (2010), Kulikova et al. (2019), Sánchez et al. (2009)
	Expenses for advertising and market research	Pedro et al. (2018)
	Total expenditure on scientific journals in relation to total R&D expenditure	Pedro et al. (2018)
	Total funding for third parties (public and private) for R&D in relation to total financing	Pedro et al. (2018)

### 3.4.3 Relational capital

The RC focuses on the relationship between universities and external partners, which has acquired a central role due to the investments made by universities to increase their social capital and the development and dissemination of digital media. These initiatives facilitated the creation of networks between universities, industries and local communities, and university-university. In line with this point of view, we group RC metrics based on two different types of partnership:

academics and industry. Table 5 shows in detail the RC metrics adopted by selected papers. Metrics related to university-university relations focus mainly on international exchanges. The metrics related to the industrial area, on the other hand, refer to collaborations and projects carried out with industries.

Table 5 Relational capital metrics

	Components	Metrics	References
<b>Relational Capital</b>	Academia	Level of internationalization of the teaching staff	Manes Rossi et al. (2018), Leitner (2004), Secundo et al. (2010), Pedro et al. (2019), Kulikova et al. (2019), Ramírez et al. (2017)
		Number of students with international experience (undergraduate, master and doctorate) and on postgraduate programs	Pedro et al. (2019), Secundo et al. (2010)
		Number of faculty members in international conferences	Secundo et al. (2010)
		Number of international conferences visited	Leitner (2004)
		Percentage of international students	Secundo et al. (2010), Kulikova et al. (2019)
		Duration of stay for international researchers from other universities (months)	Leitner (2004)
		Research grants abroad	Leitner (2004)
		Number of international affiliations with education/research institutions	Secundo et al. (2010), Secundo et al. (2014), Kulikova et al. (2019), Stukalova et al. (2016), Pedro et al. (2019)
		Number of agreements signed with foreign educational organizations	Pedro et al. (2019)
		International student mobility level	Kulikova et al. (2019)
		Rate of foreign university students in postgraduate programs	Manes Rossi et al. (2018)
		Number of events to attract foreign students	Kulikova et al. (2019), Manes Rossi et al. (2018)
		Number of European and international collaborative research projects	Kulikova et al. (2019)
		Number of foreign language courses offered	Manes Rossi et al. (2018)
		Number of teachers abroad	Iacoviello et al. (2019), Kulikova et al. (2019)
		Number of courses in English	Iacoviello et al. (2019)
		Number of government institutions involved in research and education	Leitner (2004)



	activities	
Industry	Number of international companies involved in research and education	Secundo et al. (2014)
	Number of students participating in orientation	Secundo et al. (2014)
	Number of internships/stages foreseen for students	Iacoviello et al. (2019)
	Percentage of interns, speakers sent in learning programs	Iacoviello et al. (2019)
	Number of contracts with industry (by sector and by competitive/non-competitive classification)	Ramírez et al. (2017)
	Relations with the company (number of positions held within the management / governance / civic participation / consultancy / accreditation / social or specialist forums for negotiation and / or discussion)	Sánchez et al. (2009)
	Total n. existing contracts / agreements for cooperation / protocols (teaching / research) with public and private, national and international organizations	Pedro et al. (2019)
	The number of university-industry cooperation	Pedro et al. (2019)
	Number of events organized (career days, workshops)	Feng et al. (2012), Iacoviello et al. (2019)

#### 3.4.4 Performance

The measurement of university performance represents a rather complex issue, given its immaterial nature. This is one of the most critical aspects of university management. As knowledge is difficult to measure, researchers sought to identify appropriate metrics and indicators, mostly based on the results of activities generated by knowledge and its dissemination. Indeed, we group indicators according to four different components. The first focuses on the creation of knowledge through the generation and exploitation of patents and licenses. The second considers indicators capable of enhancing the scientific production of universities. The third is linked to the third mission. Finally, the last group considers the didactic scope. Table 6 shows the metrics collected in detail.

Table 6 IC performance metrics

	Components	Metrics	References
<b>Performance</b>	Intellectual property	Number of technology licenses	Feng et al. (2012)
		Income generated from licenses	Leitner (2004), Feng et al. (2012)
		Number of patents developed	Secundo et al. (2010), Ramírez et al. (2017), Feng et al. (2012), Iacoviello et al. (2019), Sánchez et al. (2009), Kulikova et al. (2019), Kinsella et al. (1997), Manes Rossi et al. (2018)
		Number of active patents owned by the university (by sector)	Sánchez et al. (2009)
		Number of patents incorporated in the new products/solutions developed	Secundo et al. (2014)
		Number of national patents obtained	Kulikova et al. (2019)
		Number of patent applications submitted	Secundo et al. (2014), Wu et al. (2012), Chen et al. (2013)
		Number of patent extensions submitted	Secundo et al. (2014)
		Number of licenses/options executed within the year based on know-how only	Gardner. et al. (2010)
		Number of pilot applications developed	Secundo et al. (2010)
	Scientific research	Number of publications of scientific articles in international scientific journals	Kulikova et al. (2019), Secundo et al. (2010)
		Number of scientific/didactic publications	Ramírez et al. (2017), Manes Rossi et al. (2018), Feng et al. (2012), Leitner (2004), Pedro et al. (2019)
		Number of research published by the faculties	Wu et al. (2012), Chen et al. (2013)

	Number of publications in diaries	Renzl (2006), Sánchez et al. (2009)
	Number of publications in newspapers	Renzl (2006), Leitner (2004), Sánchez et al. (2009)
	Total number of citations and publications by discipline/university publications.	Sánchez et al. (2009)
	Number of co-publications per sector	Sánchez et al. (2009)
	Number of books published	Iacoviello et al. (2019)
	Scientific awards	Renzl (2006)
Third mission	Number of people hired by the newly generated company	Secundo et al. (2014)
	Total number of new local partners	Secundo et al. (2014), Kinsella et al. (1997)
	Number of people employed by the interested parties involved	Secundo et al. (2014)
	Number of start-ups implemented	Kulikova et al. (2019), Pedro et Al. (2018), Secundo et al. (2014)
	Number of spin-offs	Secundo et al. (2010), Secundo et al. (2014), Leitner (2004), Manes Rossi et al. (2018)
	Total number of new jobs created	Secundo et al. (2014), Kinsella et al. (1997)
	Number of spin-offs funded by the university and percentage higher than the total number of spin-offs (funded + supported).	Sánchez et al. (2009)
	Number of university-backed spin-offs.	Sánchez et al. (2009)
	Number of spin-offs that have ceased operation	Gardner et al. (2010)
	Number of spin-offs that have carried out a capital increase during the year	Gardner. et al. (2010)
	Number of employees acquired by spin-offs	Leitner (2004)

	Number of research projects in progress	Secundo et al. (2010)
	Number of projects marketed	Kulikova et al. (2019), Manes Rossi et al. (2018)
	Time until the first job	Ramírez et al. (2017)
	Graduates' employment rate	Ramírez et al. (2017)
Didactics	Number of doctoral courses with official mention of quality	Pedro et al. (2019), Ramírez et al. (2017)
	Share of educational programs accredited in national and international agencies	Kulikova et al. (2019)
	Number of new students accepted in the current academic year	Pedro et al. (2019), Secundo et al. (2010)
	Number of student complaints	Pedro et al. (2019), Secundo et al. (2010)
	Number of teaching hours provided	Iacoviello et al. (2019), Secundo et al. (2010)
	Student attendance at lessons (number of hours taught / total number of lesson hours)	Iacoviello et al. (2019), Secundo et al. (2010)
	Number of speeches made per lesson (interactive participation)	Iacoviello et al. (2019)
	Average grades for students enrolled in the exam	Iacoviello et al. (2019)
	Number of hours of thesis supervision provided for students	Iacoviello et al. (2019)
	% Of graduates (undergraduate, master and doctorate)	Iacoviello et al. (2019), Ramírez et al. (2017), Pedro et al. (2019)
	Average time for graduation	Iacoviello et al. (2019), Ramírez et al. (2017)
	Number of participating students out of the total number of students enrolled	Iacoviello et al. (2019), Secundo et al. (2010)
	Number of exams passed / total number of exams /	Iacoviello et al. (2019)
	Number of students attending exam sessions in a	Iacoviello et al. (2019)

year / total number of students enrolled in the course

Number of reports received by students	Iacoviello et al. (2019)
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Number of students who reconfirm their enrolment at the university for the year following the year in which they received orientation activities	Iacoviello et al. (2019)
--	--------------------------

Image/opinion/reputation of higher education institutions (society, media, among others) at regional, national and international level	Pedro et al. (2019)
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Student satisfaction	Pedro et al. (2019), Manes Rossi F. et al. (2018), Secundo et al. (2010)
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Number of seminars organized and attendance	Iacoviello et al. (2019)
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## 4 Discussion

The content analysis has highlighted the main elements that influence the development of the IC components in universities. Metrics were grouped according to IC components and performance. First, the HC indicators assess the organic structure of the university, distinguishing full-time and part-time employees. This distinction makes it possible to assess the degree of turnover and expertise of the university's personnel. Moreover, HC indicators refer to employees' characteristics (e.g., age, gender, year of experience). Second, as for the organizational component, the SC indicators deal with investment aspects for staff and technological infrastructures. In this way, it is possible to highlight the strategy pursued by the universities indirectly. Furthermore, the SC metrics allow the university managers to obtain useful information to support future decisions related to the implementation of structural improvement actions. Third, the RC metrics aim to analyse the degree of internationalization of universities and the link with the local community and industry.

Moreover, the classification identified the performance metrics of the universities. We categorize the metrics into four different areas. The first area shows the aspects related to the codification of knowledge through intellectual property. The main metrics concern the creation, and subsequently, the use of patents and licenses, the result of research actions developed to obtain added value compared to competing universities. These indicators quantify the outputs generated by those activities that mainly use intangible resources complex to measure. The second group of indicators is defined as innovation and codification of knowledge through scientific research. In particular, this classification includes a set of indicators that analyze and show the extent of the work of universities in terms of scientific research. A considerable part of the metrics refers to aspects related purely to the publications. Third, we have grouped performance indicators related to the third mission. This classification introduces metrics such as the number of new partners, spin-offs, and jobs created. These indicators are essential for evaluating the third mission of universities and, therefore the social contribution of the university to the environment in which it operates. Finally, the last category of IC performance indicators refers to didactic. The quality of teaching is assessed through student satisfaction metrics and course enrollment rates.

The conducted analysis reveals the need to integrate quantitative and qualitative indicators to provide a complete set of information about the IC and the methods implemented for its development. The proposed taxonomy represents a first attempt to reorganize the knowledge that emerged from the analysis of the content providing a potential answer to the research question R2. More in detail, 116 indicators have been identified. The trend in recent years is to identify indicators linked above all to didactics performance. In addition, the researchers focused on indicators that assess the incidence of links with international bodies. These trends are not surprising. In that, universities tend to measure the quality of didactics to increase the number of students through improvement actions, events, and investments in digitalization. In this sense, didactics represents the driving force of the overall performance. On the other hand, the need to assess the degree of internationalization is due to the importance that this aspect is acquiring in the university in the last few years. Indeed, a good level of internationalization, in addition to allowing the attraction of students, improves research performance and the capability to obtain funding. Another interesting aspect is related to the third mission of the universities. This

sphere is often neglected in measurement. In this perspective, if it is easy to analyse the graduates hiring rate and the number of spin-offs created, it is difficult to assess the effective continuity of these last, and even more difficult to assess the degree of dissemination of the sustainable culture in the local community. Thus, universities must spread a sustainable culture not only social but also environmental and digital. In this sense, the pandemic has highlighted the importance for universities of being flexible and able to facilitate the transition of the actors involved towards the digital paradigm.

## **5 Conclusions and future research directions**

In recent years, the topic of IC measurement in university contexts has acquired considerable importance. Given the scarce number of reviews in this area, the need to analyze and classify the existing literature arose. This paper attempts to fill this gap by performing a systematic literature review relating to IC management in universities. This review aims to understand the research directions currently being explored. In particular, two research questions were identified. The descriptive analysis allows us to answer question R1, highlighting how the academic literature on IC has evolved. In particular, there is a positive trend in the number of articles published. Besides, the descriptive analysis highlighted that most of the documents are articles. This suggests the call for more review papers focused on the management of IC in universities. Moreover, we were able to observe that studies on IC embrace a wide range of subject areas from technological to humanistic fields. This emphasizes the centrality of IC measurement, as, in recent years, universities have been called to generate performance and activities reporting models with stringent transparency requirements. Subsequently, through a careful analysis of the content, it was possible to reorganize the literature according to the main metrics adopted for IC measurement. The indicators for the three IC components (HC, SC, RC) and performance were thus analysed and described. These indexes were grouped based on specific characteristics to identify a taxonomy of IC metrics. The latter represents an important contribution in answering the research question R2. The taxonomy underlines the wide possibilities of implementing report models within universities and showing the importance of analysing, in detail, the information generated by the indicators. The analysis revealed a predominance of indicators for assessing the performance of universities, especially in the didactic sphere.

This result highlights how teaching is a driving aspect that also influences the performance of other areas such as the third mission. Indeed, the third mission indicators are strongly correlated to the didactics performance, such as the total number of new jobs created and the employment rate of graduates. The area characterized by a smaller number of indicators, on the other hand, is represented by the HC. This could be due to the difficulty of measuring the human component of universities. As for practical implications, the main advantage of implementing an IC evaluation system, based on the metrics included in the taxonomy, is to facilitate accountability towards different stakeholders and monitor intangible inputs and outputs. In that, the taxonomy can serve as a tool for measuring and evaluating IC and its productive use in universities. The categorization represents a global approach, which simultaneously addresses the need for transparent communication to external stakeholders and internal management of resources. Besides, the use of these metrics allows universities to evaluate organizational and research activities. On the other hand, since the objectives defined by the universities are distinct and disparate, it is difficult to create a standard to be applied in all areas. Therefore, we identified the following future research direction:

- recognize innovative methodologies for comparing data at the faculty or university level across different disciplines, such as engineering, medicine and art;
- define novel indicators to evaluate the dissemination of environmental culture provided by universities;
- exploit the taxonomy to implement empirical models to analyse and compare the impact of each component of IC on university performance;
- investigate the methods of acquiring strategic and operational information used to define the mission and strategic objectives of universities;
- deepen the search for indicators used in organizational performance evaluation models of universities;
- analyse how the Industry 4.0 technologies impact on IC of universities;
- investigate the promotion of projects aimed at fostering the sharing of knowledge and the exchange of information between universities.



The main limitation of the study refers to the adopted methodology. Specifically, some relevant articles may be excluded from our sample due to the exclusion criteria, database, and keywords used.

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## The Impact of Intellectual Capital to Financial, Market and Operational Performance

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### Abstract

In the current economic era, named the knowledge economy, it is considered that knowledge is the most critical tool to create products and services. Knowledge transfer forces a focus on the knowledge-based economy, where access to tangible resources alone does not provide a sustainable competitive advantage (Marr & Spender, 2004). There are methods to measure tangible assets in businesses, for instance, financial statements, but sometimes not all intangible assets, as shown in this research. However, managing intangible assets has become crucial in businesses because it supports decision-making, innovation, and formulation of strategies for higher performance (Marr et al., 2004), in today's fast-changing environments that include technological developments (Chen & Zhu, 2004). Therefore, the primary source of value creation reduces tangible assets or structural capital, and intangible assets become a more reliable source (Carson et

al., 2004). Intellectual Capital (IC) is vital because it is a fundamental factor for generating and transferring knowledge, improved productivity and efficiency, and excellent business value.

This research aims to analyze the correlation of IC on business performance. This research answers the question 'do IC in firms spur its performance? The proposed research methodology is an analysis of multiple correlations. In the results, it is provided that the level of relationship between IC and business performance. In this research methodology, we applied a survey to 142 business in the services, commercial and industrial sectors. The survey measured the human, structural, and relational capitals and the financial, market, and operative performance. The results present that IC contributes 30.5% to economic performance, 36.2% to market performance, 46.3% to operational performance and 51% to total performance.

To conclude, it was possible to identify that the IC may have some variations in human, structural and relational means, all influencing business performance. The greater the IC, the greater the effect on performance. However, IC must be correctly identified to create an organisation's operational plan that improves financial, functional, and market performance. Still, developing strategic plans to make a one-of-a-kind company creates a more excellent value in the organisation. IC is not repetitive between organisations, not even in the same sector or specific situation. Still, it can be a great support to create a unique, solid, and irreplaceable company, depending on the organisation. Knowledge management is, therefore, a necessity. The development of organisational knowledge is the task and challenge of current administrators. Thus, this research provides a tool to identify businesses' IC for performance improvement.

**Keywords** – Intellectual Capital, Performance, Intangible Assets, Knowledge Management, Knowledge-Economy.

**Paper Type** - Academic Research Paper

## 1 Introduction

Global economic growth has changed since 1970 with the rapid and dizzying development of technology (Chen & Zhu, 2004). Now, society is distinguished by a constant change based on knowledge (Smart et al., 2003) and knowledge management. Therefore, the organisation focuses on having Intellectual Capital (IC) as a critical organisational asset (Bose & Oh, 2004) fundamental economic resource. Furthermore, the organisations now have a fast pace of work due to global competition. Facing this competition and dynamic environments to gain access to new markets and technologies has led organisations to have diverse talents and use their expertise towards achieving organisational goals (Bhatt, 2002). Therefore, organisations seek to generate a competitive advantage, and for

this, they strive to codify knowledge and develop their structural capital (equipment, programs, databases, organisational structure, patents, trademarks). Additionally, the business environment has changed because consumers are better informed and more demanding.

Furthermore, commercial borders have been fading because of increased collaboration between organisations and expanding the market in a competitive field. This situation forces a focus on a knowledge-based economy, where access to tangible resources alone does not provide a sustainable competitive advantage (Marr & Spender, 2004). Therefore, the primary source of value creation reduces tangible assets or structural capital, and that intangible assets become a more reliable source (Carson et al., 2004). In this sense, generating competitive advantage implies a tremendous challenge for organisations that must codify and externalise the tacit knowledge that exists in the minds of their employees (Bontis et al., 2000). It is also important to mention that effective knowledge management becomes a guide for the business philosophy that influences the strategies undertaken by managers in organisations (Darroch & Mcnaughton, 2002). In other words, a company obtains a competitive and sustainable margin if it knows what it knows, if it knows how to use that knowledge and how quickly it can learn something new (Viedma, 2001).

The knowledge economy from the post-industrial era and immediate communication mean that best practices are distributed in any direction and to anyone. Advances in education such as distance education and knowledge management, the Internet and email, make us think about the distribution of knowledge differently, thereby increasing the organisation's performance, maintaining, and capturing knowledge. There are two types of organisations in the world of knowledge-intensive organisations that produce information products and whose distinctive competence is collecting and transmitting financial information and knowledge-creating organisations dedicated to innovation: creativity and personalised delivery (Civi, 2000). And better defining people's potential abilities (Wiig, 2012).

Drawing collective creativity and employee know-how is emerging as one of the best ways to anticipate customer needs and create new markets (Bukowitz, 1997). Therefore, institutions should prioritise quality thinking, learning, and better use of knowledge (Coulson-thomas, 1997). IC's innovation capacity is enabled, making the difference in businesses and not cash (Bontis & Fitz-enz, 2002). IC's innovation capacity is boosted, making the difference in companies

and not money (Nick Bontis & Fitz-enz, 2002). IC is part of knowledge management (KM), as it is the knowledge created, integrated and shared by the firm (Nonaka & Teece, 2001), which enhances a sustainable performance in firms and creates distinctive competencies (Chaharbaghi & Cripps, 2006). Such competitive advantage is developed by combining resources that are valuable, rare and difficult to be replicated by others (Pike et al., 2005).

Therefore, it is time to carry out a program to obtain the existing knowledge in every organization in an orderly and systematic way. It is also critical to consider employees like partners instead of only a human resource or labour source. Thereby transform employees' experience, expertise, intellect, intuition, and ability into new knowledge available to the organization. Additionally, it is relevant to convert and change that -generally tacit- knowledge into explicit knowledge. The only sustainable advantage is what people know and what they do with such knowledge (Civi, 2000).

It is essential to consider that IC generates considerable competitive advantages for the organisation, so the organisation must identify all those internal elements that help it create value, improve its performance, and achieve its objectives. Of course, the organisation easily remember all those tangible assets that support it in achieving the above. Still, there are also intangible assets that are not always easy to identify in the organisation. In the same way, contribute enormously to achieving the objectives, sometimes in a more significant proportion than tangible assets. It is then necessary for the company to identify its intangible elements to develop them and increase its capacity to respond quickly to changes in the market and achieve and maintain a better position. Acknowledging all the intangible factors generating value allows the firm to develop, store, and make it remain in the organisation, focus on the relevant aspects, and set aside those elements that do not generate value even in the present or future. In addition, this identification will allow partners, workers, clients, and suppliers to obtain greater and greater benefits at different levels: financial, operational, and administrative, then focusing their efforts on those elements that generate value, that covers their needs, and that allows them to achieve goals.



## 2 Literature Review

As traditional production factors, land, labour and capital are no longer considered the most critical resources in the organisation. But businesses manage knowledge, information and experience, to adequately address IC, creating value in the organization since it cannot be transferred (Bontis, 1998). But managing knowledge, information and experience, to adequately manage IC and create value in the organisation since it cannot be transferred (Bontis, 1998). IC is defined as the knowledge that generates high-value assets, which can be considered the difference between the market value and the company's book value (Abeysekera, 2006). The intangibles assets are classifying into three parts: internal structure, external structure, and employee competence. Internal construction consists of patents, research and development models, and computer and administrative systems; outer frame consists of relationships with customers and suppliers, brands; and employee competence consists of individual education, skills, training, values, and experience (Karl Erik Sveiby, 2001).

IC is elusive but provides organisations with a new resource base to compete once discovered and exploited. Thereby generation of intangible assets such as intellectual property is based on people who have an infrastructure that allows them to merge into the company (Bontis, 1998). However, the Balance Sheet does not include current intangible assets that generate value in the organization. On the contrary, a Balance Sheet does not have intangible assets that create value in the organization. This gap is because modern accounting methods do not consider the organisation's employees' knowledge translation of such knowledge, thus creating a knowledge package (Nick Bontis, 1998b; Nick Bontis & Fitz-enz, 2002). This gap is because modern accounting methods do not consider the organisation's employees' knowledge translation of such knowledge, thus creating a knowledge package (Bontis & Fitz-enz, 2002).

There are different definitions of knowledge, and there is still no single and standard definition to define and classify IC (Marr et al., 2004). Nevertheless, several authors have studied and proposed these definitions over time, shown in

Table 7. Definitions of IC.

Author	Year	IC
Hall	(1992)	It can be classified as “active” (example, brand, contracts, database) or “skills” (example Know-how of employees, organisational culture)
Edvinsson & Sullivan,	(1996)	The knowledge that can be turned into value
Brooking	(1996)	It consists of four main components: Market Assets, Human-Centric Asset, Intellectual Property Assets, and Infrastructure Assets.
Sveivy	(1997)	It consists of three categories of intangible assets: internal structure, external structure, and human competence.
Roos et al	(1997)	It is composed of the thinking part, for example, human capital, and the non-thinking part, for example, structural capital
Stewart	(1997)	Intellectual Material that has been formalised, captured, and provides or produces a highly valued asset
Edvinsson y Malone	(1997)	It is the sum of human capital and structural capital. It involves applied experience, organisational technology, client relationships, and professional skills that provide an organisation with a competitive advantage.
Bontis et. al.	(1999)	It is the concept that classifies all intangible assets as well as their interconnections
Lev	(2001)	Origin of future benefits (value) which are generated by innovation, unique organisational designs, or human resource practices
Marr y Schiuma	(2001)	It is composed of knowledge-based assets, distinguished into three organisational actors (relationships, human resources) and infrastructure (virtual and physical)
EUFORUM	(1998)	Intangible assets are not recorded in accounting. Therefore, these are not shown in traditional financial statements. But generate value to the organisation related to human and structural capital; It is also a source of sustainable competitive advantage, fundamentally considering what the company knows and how it uses it. Finally, it is a capacity for constant learning.
Stewart	(1998)	It is the creation of value of intellectual material, knowledge, information, intellectual property, experience
Sanchez	(2008)	They are the intangible assets of the organisation.
Edvinsson & Malone	(1999)	It is the language that marks the organisational activities that generate future-benefits
Bradley	(1997)	It is the ability to transform knowledge and intangible assets that generate wealth in organisations and countries.
Stewart	(1991)	It is everything that cannot be touched, but that generates money for the organisation
Lev	2001	They are intangible resources that generate future financial benefits but do not have a physical or financial body

## 2.1 Intellectual Capital

The IC comprises human, relational and structural components. It stands out that each of the elements will generate competitive advantages over the organisation (Seetharaman, Lock Teng Low, & Saravanan, 2004). Figure 4 shows an alternative to classifying the IC as internal capital, external capital, and human capital (Boedker et al., 2005; Guthrie & Petty, 2000).

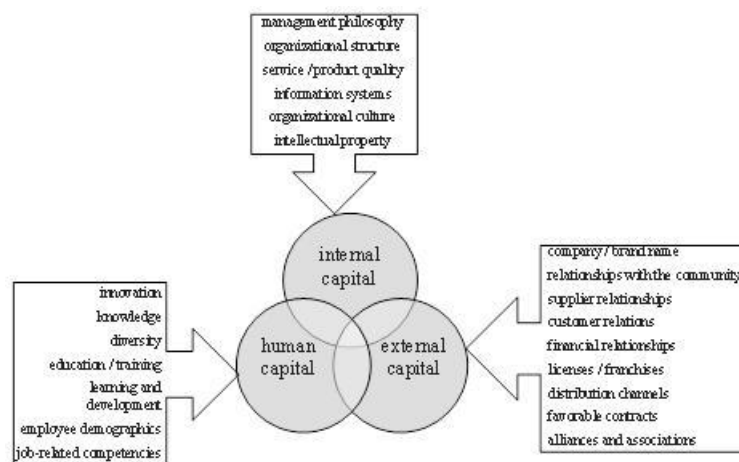


Figure 4. Tripartite model of Intellectual Capital (Boedker et al., 2005).

Three primary IC constructs have been identified human capital, structural capital, and relational capital (Bontis et al., 2000). Three primary IC constructs have been identified human capital, structural capital, and relational capital (Bontis et al., 2000). Next, we will explain the classifications based on the human, relational and structural dimensions.

### 2.1.1 Human Capital

IC includes human capital in which the human intellect stands out, found within employees (Bontis, 1998). The structural capital is integrated by the organisational routines and the client capital in which the market relationships are found. In essence, it is the knowledge rooted in external relations to the organisation. Thus, IC includes human capital in which the human intellect stands out, found within employees (Bontis, 1998). The structural capital is integrated by the organisational routines and the client capital in which the market relationships are found. In essence, it is the knowledge rooted in external relations to the organisation. Thus,

the first element of IC is human capital. Human capital is the individual knowledge stock of an organisation represented by employees. The employees generate IC through their competence, attitude, and intellectual agility. Competencies include skills and education, while perspectives cover the behaviour component of employees' work. Intellectual agility allows changing practices to think of innovative solutions to problems. Therefore, employees are considered the corporation's most crucial asset in a knowledge organization (Seetharaman et al., 2004).

Human capital is the collective capacity of the company to extract the best solutions from the knowledge of its individuals, all of this to improve personal skills or develop new ones (Bontis et al., 2000). Human capital is a source of innovation and strategic renewal, such as brainstorming in a research laboratory, office dreams, old files, process reengineering. It improves personnel skills and develops new leaders; human capital is limited to knowledge, and it is also the most challenging element of IC to codify (Nick Bontis, 1998a). Human capital is the collective capacity of the company to extract the best solutions from the knowledge of its individuals, all of this to improve personal skills or develop new ones (Nick Bontis et al., 2000). Human capital is a source of innovation and strategic renewal, such as brainstorming in a research laboratory, office dreams, old files, process reengineering. It improves personnel skills and develops new leaders; human capital is limited to knowledge, and it is also the most challenging element of IC to codify (Bontis, 1998).

Human capital combines genetic inheritance, education, experience, attitudes about life, and business. Therefore, it is a source of innovation and strategic renewal. Also, it is considered an intangible asset to create unique skills, tacit knowledge and awareness of what the client wants and internal processes. Also, human capital expresses employees' knowledge, talent, and experienced relates to the culture that can be managed if the organisation's members relatively without mobility (Bontis & Fitz-enz, 2002).

### *2.1.2 Structural Capital*

The second IC element is structural capital that includes what is not human from the knowledge warehouse in organisations like databases, flowcharts, process manuals, routines. Such knowledge is not worth more to the company than its value material, which belongs and stays with it when employees go home (Seetharaman et al., 2004). Structural capital is systems and procedures by which

organisations can follow their actions, allowing individuals to try to do things, learn to minimise costs, and maximise utility (Bontis, 1998). For example, structural capital is copyrights, trademarks, patents, internal databases, computer systems and intranet, managing knowledge (Seetharaman et al., 2004).

### *2.1.3 Relational capital*

The third element of IC is relational capital. It is the knowledge rooted in the marketing channels; and customer relationships that an organisation develops through business. It represents the potential that an organisation has due to the intangibles of the companies; generated by the relationship between employee satisfaction, customer satisfaction, customer loyalty and financial performance. It should be mentioned that it is considered the essence of knowledge rooted in external connections to the organisation, measured by the seniority of the staff (Bontis, 1998). (Nick Bontis, 1998a). The companies' external income derived from brands, reputations, strategic alliances, and relationships with clients and suppliers (Seetharaman et al., 2004).

## **3 Methodology**

The proposed research methodology is an analysis of multiple correlations. In the results, it is provided with the level of relationship between IC and business performance. In this research methodology, a survey was applied to 142 commercial, industrial, and service businesses. The survey measured the human, structural, and relational capitals and the financial, market, and operative performance. The research used a quantitative methodology to test the hypotheses. The inference is causal, taking the dependent and independent variables (Bernal, 2010). This research has four hypotheses:

*H1: Intellectual Capital has a positive impact on Financial Performance*

*H2: Intellectual Capital has a positive impact on Market Performance*

*H3: Intellectual Capital has a positive impact on Operational Performance*

*H4: Intellectual Capital has a positive impact on Total Performance*

The research is practice, non-experimental, and transactional to know the variables in the context (Hernández Sampieri et al., 2014), and the sample is non-probabilistic (Bernal, 2010). Finally, to process the data, the software SPSS was applied.

#### 4 Results

The questionnaire about IC and its relationship with organisational performance was applied through the Survey Monkey platform, with 141 responses for data collection. The detail of the sample is shown

Table 8.

Table 8. Sample details.

Variable	Item	%
Position	General manager	59%
Working time in the company	0-5 years working	81%
Gender	Men	56%
Scholarship	Graduate	83%
Business area	Manufacturing industry	82%
Size of the company	Big company	78%
Age of the company	More than 11 years	75%
Origin of capital	Foreign capital	66%

Cronbach's Alpha values were more significant than 0.8, demonstrating the validity of the model. Table 9 presents these values.

Table 9. Cronbach's Alpha analysis.

Variables	Cronbach's Alpha
Human capital	.885
Structural capital	.945
Relational capital	.942
IC	.969
Financial performance	.861
Market performance	.888
Operations performance	.914

In terms of hypothesis one: *IC affects financial performance*. Based on the regression analysis of the model presented in

Table 10, the variable that best explains financial performance is the relational capital and the human capital, with an R-squared of 30.5%.

Table 10. Summary of the model.

Model	R	R square	R square adjusted	Standard error estimation	Durbin-Watson
1	.523 <sup>a</sup>	.274	.269	.43342	
2	.562 <sup>b</sup>	.316	.305	.42234	1.910

a. Predictors: (Constant), relational capital

b. Predictors: (Constant), relational capital, human capital

c. Dependent variable: finance performance

In regards to hypothesis 2, stating: *the IC affects the market performance*. Table 11 shows that the variable that best explains market performance is the relational capital, and the human capital, with an R-squared of 36.20%.

Table 11. Summary of the model.

Model	R	R square	R square adjusted	Standard error estimation	Durbin-Watson
1	.606 <sup>a</sup>	.367	.362	.41918	
2	.660 <sup>b</sup>	.436	.428	.39709	1.843

a. Predictors: (Constant), human capital

b. Predictors: (Constant), structural capital,

c. Dependent variable: Market performance

Hypothesis three, defined as *IC, affects operational performance*. According to Table 12, the variable that best explains financial performance is the relational capital, and the human capital, with an R-squared of 46.3%.

Table 12. Summary of the model.

Model	R	R square	R square adjusted	Standard error estimation	Durbin-Watson
1	.640 <sup>a</sup>	.409	.405	.45109	
2	.686 <sup>b</sup>	.471	.463	.42830	2.131

a. Predictors: (Constant), Relational capital

b. Predictors: (Constant), Relational capital, human capital

c. Dependent variable: Operational performance

The model in Table 13 demonstrates that the variables that best explain financial performance are relational capital and human capital, with an R-squared of 51%; relating to hypothesis four, *IC affects total performance*.

Table 13. Summary of the model.

Model	R	R square	R square adjusted	Standard error estimation	Durbin-Watson
1	.717 <sup>a</sup>	.513	.510	.33666	2.093

a. Predictors: (Constant), IC

b. Dependent variable: Total performance

Finally, the results show that IC impact 30.5% on financial performance, 36.2% on market performance, 46.3% on operational performance and 51% on total performance.

## 5 Conclusions

In this new global competition world, characterized by rapid technological developments, more demanding customers and fast-growing information, businesses need to focus on Intellectual Capital (IC) as the most critical organizational asset. This world context is called the knowledge-based economy, where intangible assets, like knowledge, are the most reliable source. Therefore, firms need to revamp their IC, classified by Boedker (2005) as internal, external, and human capital. Furthermore, businesses need to externalize their employees' knowledge and improve their learning processes. This situation demands new ways of treat knowledge and defines peoples abilities. In this sense, there are two types of organisations, knowledge-intensive (with distinctive competence in collecting and transmitting financial information) and knowledge-creating.

Nowadays, the importance of intellectual capital lies in generating and transferring knowledge as essential factors to improve the productivity and efficiency of the organization and generate more excellent value. IC is considered an intangible asset due to its lack of physical evidence. However, despite this lack of tangibility, it represents 80% of its value for organisations since it is the main innovation, creativity, and competitive advantage in companies. Therefore, this research aimed to analyze the correlation between intellectual capital and business performance. The regression analysis showed that the IC contributes 30.5% to financial performance, 36.2% to market performance, 46.3% to operational performance and 51% to total performance. The hypothesis



confirmed that the higher IC, the better the performance in organizations. Since the IC contributes 51% to absolute performance, the higher the IC level, the more significant the IC impact on performance.

Thus, firms can diagnose their IC, which may possess but not correctly identified and managed to improve. So, organisations can directly improve their financial, market, operating and overall performance. It has been mentioned that IC is the most crucial resource for the organisation, thereby managing knowledge, information, and experience. But, is intangible is not transferable. Therefore, the benefits are unique and specific to each organisation, allowing competitive advantage and market differentiation. So, organisation, when discover and exploit IC, can improve performance, strategies, and overall results.

In conclusion, the identification of IC is possible. However, there may be variations between human capital, structural capital and relational capital. Still, all of them influence business performance. It is affirmed that it has a greater effect on the organisation's performance at a higher level of IC. Still, it must be correctly identified to create an organisation's work plan, which can improve financial, operational, and market performance, enabling strategic projects to make a one-of-a-kind company, thereby creating an excellent value in the organisation. IC is unique in each organization, and it does not matter if it is from the same corporate group, from the same sector or located in the same city. It then depends on the organisation, so knowledge management is necessary—the task of current administrators in the development of organisational learning. We proposed this research as a tool to identify the organisation's IC and thus improve their performance goals.

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## Why Mind Maps Are so Poor: Analysing the Drawbacks of Generalisation

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### Abstract

Nowadays information flow overload is typical for our daily life. Search for a tool to visualize complex information and big data has led to the emergence of new areas of research related to visualization (infographics, cognitive graphics, virtual reality, computer graphics, etc.) The main aim of these new types of graphical presentations of information is to compress and to simplify the information.

From the well-known practically used types of diagrams, mind maps were selected as the most common, convenient, and simple method for the proper representation and design of professional knowledge, business ideas, projects, functions, or any other complex conceptual structures. Mind maps reflect hierarchical relationships among the concepts associated with the central key concept and radially presented around it; and allow the analyst to reflect in details the features and patterns of the domain with their specific relationships.

The paper describes a classification of main errors and mistakes of mind-mapping analysts. There is a vast amount of research about the effectiveness of mind mapping as a learning tool. On the one hand, mind maps are used to generate, visualize, structure, and classify ideas, on the other hand, to facilitate (accelerate) research, group projects, and case

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studies, problem solving, “brainstorming” or decision-making, as well as in various documents development.

The analysis summarizes 10 years of pedagogical and practical experience of the authors in the development of business models based on mind maps.

The paper is focused on the new typology of the main mistakes in mind-mapping, based on the analysis of more than 750 mind maps of both senior students of St. Petersburg State University and students of Executive MBA programs. Errors revealed include significant errors in development, in particular, semantic errors, including errors of understanding and fragmentation.

In general, errors analysed in the paper are caused by lack of skills in systemic and structural analysis in terms of concepts categorization and generalization.

**Keywords** – mind-maps, visual-analytical thinking, visual models, knowledge management, knowledge structuring.

**Paper type** – Academic Research Paper

## 1 Introduction

Since ancient times, visualization has been considered as a powerful tool of cognition. Nowadays information flow overload is typical for our daily life. It becomes more and more important to find a tool to visualize complex information and big data. This has led to the emergence of new areas of research related to visualization (infographics, cognitive graphics, virtual reality, computer graphics, etc.) (Al-Fedaghi & Makdessi, 2020; Matrix & Hodson, 2014; Cairo, 2013; Raputo, 2011). The main aim of these new types of graphical presentation of information is to make complex concepts simple and visually friendly for perception and learning; in fact, they serve to compress and simplify the information.

## 2 Mind maps development

From the well-known practically used types of diagrams, mind maps were selected as the most common, convenient, and simple method for the proper representation and design of professional knowledge, business ideas, projects, functions, or any other complex conceptual structures (Davies, 2011). Mind maps reflect hierarchical relationships among the concepts associated with the central key concept and radially presented around it; and allow the analyst to reflect in details the features and patterns of the domain with their specific relationships

(Beel & Langer, 2011; Chernigovskaya et al, 2005; Buzan&Buzan, 1996). Buzan formulated the idea of mind maps in the 1970s as a compact means of organizing abstracts, he later deepened and enhanced this idea, which was later brought to software implementation and was widely used in various fields of education, research and business (Buzan, 2018).

The paper describes a classification of main errors and mistakes of analysts of mind mapping as there is mostly research about the effectiveness of mind mapping as a learning tool (Wan Jusoh & Ahmad, 2016; Rosciano, 2015; Chei Chang, 2008). On the one hand, mind maps are used to generate, visualize, structure, and classify ideas, on the other hand, to facilitate (accelerate) research (Kernan et al, 2018; Crowe & Sheppard, 2012), problem solving or decision-making (Koznov et al, 2011; Roem, 2009; Hverle, 2009; Lim & Klein, 2006), as well as in various documents development (Margulies & Valenza, 2005).

Mind maps can be used in teaching both to explain and to check the material learned. In this case, the structure of the mind map serves as a criterion for understanding the studied subject. Mind maps can be useful for group projects, case studies, etc. Due to the simplified and clear representation of ideas in a graphical form, mind maps are sometimes used to activate “brainstorming”, when solving organizational problems and carrying out planning (Koznov et al, 2011; Lim & Klein, 2006). Mind mapping allows thinkers and analysts a visual-verbal way to delineate the moment of reflection and to capture that moment in order to preserve its structure. This way mind mapping practices deep thinking, which leads to easier self-regulation.

The idea of mind maps (according to Buzan) is to use and combine the functions of logical and imaginative thinking to achieve holistic and visual representation of the concept under consideration. In fact, this is actually a transition from sequential (text) presentation to parallel (network). Buzan declared three rules for mind maps – use different fonts (decreasing from the center), different colors and graphics in order to increase clarity. This method is proposed as a compact tool for organizing abstracts and has begun to be used as a powerful tool of thinking when doing research, innovation, business ideas, political discussions, and pedagogy.

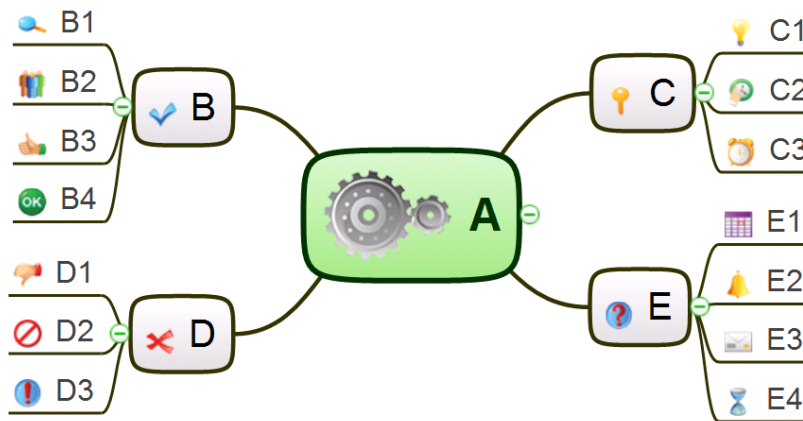


Figure 1. Example of an abstract mind map

The rules for the mind map development according to Buzan are presented below in Figure 1:

- a) the main concept is presented in the central image (A);
- b) basic concepts and / or processes related to the main one diverge from the central image with the help of branches, which are called keywords and images (B, C, D, E);
- c) branches form a coherent hierarchical structure.

Summarizing the experience of mind maps developing and analysts training, there is an opportunity to formulate a number of heuristic rules that facilitate mind maps construction:

*Rules to promote depth of understanding*

- a) Rule of Systems Thinking: "Try to use all the elements, not selected fragments".
- b) Rule of Good Generalization – the rule of homogeneity of the presented concept. The concepts at one level of the hierarchy should be of the same nature and associated with the "ancestor" concept by one type of relationship.

These two rules require significant cognitive effort and systems-analytical thinking skills.

*Rules to increase visibility*

- a) Buzan's Rules – about the use of color, pictures and font reduction when moving away from the center (Buzan 2018; Buzan&Buzan, 1996).
- b) Occam's Razor Rules: "You should not multiply entities unnecessarily".



- c) "Don't use serif fonts". For example, Times New Roman.
- d) "The mind map node must contain nominative phrases, no more than three words." For example, "railroad" or "input financial flows".

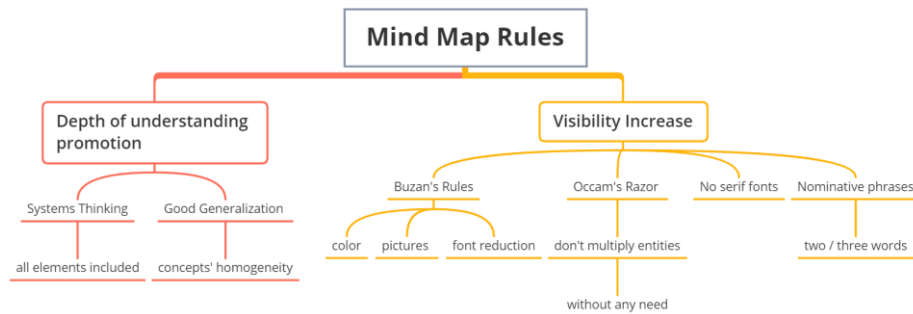


Figure 2. Example of a mind map reflecting major mind maps development rules

### 3 Ability to generalize as a cognitive issue

Generalization is a fundamental task that is solved by every cognitive system in essentially every domain. The task of the analyst in developing a mind map is to cope with the problem of materializing and generalizing their own representations, their adequate and unambiguous representation in the map. It is important for the user to read and interpret the map correctly, even in case when it causes cognitive dissonance.

There are two strategies for developing mind maps – deductive (top-down) and inductive (bottom-up). The first is associated with analysis and decomposition, the second – with the synthesis and construction of concepts.

A serious methodological problem is associated with the choice of the criteria of generality: decomposition or synthesis criterion.

For a deductive strategy, the central concept is broken down sequentially at each level according to the selected criterion or feature. For example, when building a map of modern software, you can use the operating system criterion (Windows or Mac OS) at the first level, or you can use the manufacturer's country. Accordingly, the maps will be different. Then the first rule of good decomposition can be proposed: "The principle of decomposition should be clear and transparent".

You can also choose different features for the inductive strategy. Thus, a set of concepts (Paris, Rome, Tokyo, Moscow, St. Petersburg, Mumbay) can be categorized using ten grouping options depending on the selected attributes. For example, the partition  $X = \{(Paris, Moscow, Petersburg, Rome), (Tokyo, Mumbay)\}$  corresponds to the division according to the clear criterion "Europe – Asia", and the partition  $Y = \{(Paris, Rome, Petersburg), (Moscow, Delhi, Bombay)\}$  – not really clear. In this case, the division Y corresponds to the division according to the principle of "the greatest collections of world art."

Another problem is related to the systems thinking of the analyst, which allows to highlight the concepts of one level of abstraction. This characteristic is associated with the analyst's individual cognitive style, an individually unique way of processing information about the world around: individual differences in the perception, structuring, analysis, assessment and categorization of what is happening (Kholodnaya, 2002). It reflects the specifics of each person's experience and serve as an individual way to adjust the course of cognitive processes.

Cognitive styles – as a broader concept – characterize individual unique ways of studying reality (Kholodnaya, 2002). Four groups of cognitive styles and the corresponding levels of style behavior are identified: styles of information coding, styles of information processing (cognitive styles), styles of thinking and epistemological styles.

Cognitive styles have individual variability. They are related to the success of performing any activity and are not limited to knowledge, skills and abilities of a person. Cognitive styles characterize the specifics of the mindset of a particular person and the distinctive features of the intellectual behavior, and each cognitive style is responsible for a certain aspect of the decision-making process. Thus, cognitive styles are responsible for the construction of a realistic (objective) mental "picture of the world" and the regulation of the process of cognitive reflection.

Individual cognitive style is a subsystem of an individual activity, reflecting its gnostic components – methods of receiving and processing information, which are developed based on the individual specifics of the organization of cognitive processes, affecting all levels of the mental hierarchy.

Cognitive style is especially important when using mind maps to design ontologies. In this case, a number of systemic restrictions should be imposed on

the process of forming concepts of a lower level of the hierarchy, the major of which is the rule of good generalization.

#### **4 Drawbacks of generalization**

The paper proposes the new typology of the main mistakes in mind-mapping based on the analysis of more than 750 mind maps of both senior students of St. Petersburg State University and students of Executive MBA programs.

The main difficulty in mind map development is the systemic development of the first level concepts that describe the central idea. A clear and understandable mind map can be drawn by an expert. Newbies often end up with confusing and indistinctly organized maps due to breaking the homogeneity rule. This rule is at the heart of any taxonomy, since the division into classes usually occurs according to ONE characteristic.

This means that concepts of the same level require belonging to the same level of generalization. The concept of "generalization level" requires understanding of the methods of system analysis (class-subclass-element of the class) and deep knowledge of the features of the mind maps.

So, when decomposing the concept of FRUIT, one of the correct series of concepts of the first level will be: "apples, pears, tangerines". All of these objects belong to the same granularity or generalization level. And the row "apples, pears, citrus fruits" will be wrong. "Citrus" represents higher level of generalization.

Elements of one level of generalization are associated with a higher concept by one type of relationship, they are homogeneous, i.e. all signs or attributes of a concept, or all of its components, or associations. So, in Figure 3, the objects of the lower level are not homogeneous. The object "pockets" does not extend a number of presented attributes (such as manufacturer, price, and weight). It is related to the central concept of the "backpack" by the "part – whole" relationship.

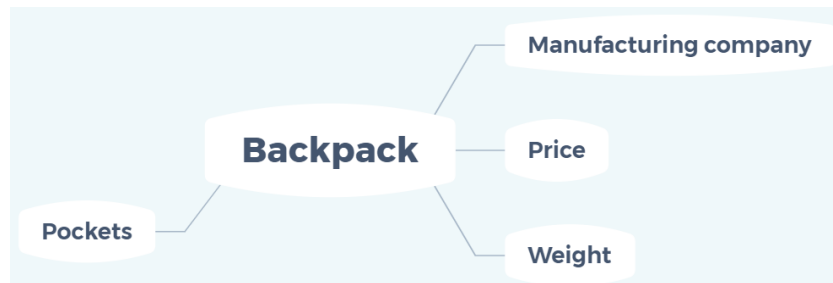


Figure 3. An example of homogeneous mistake breaking the rule of good generalization

Errors revealed are presented in figure 4 and include significant errors in development, in particular, semantic errors, including errors of understanding (there is no understanding of how the knowledge domain works, hence inadequate categories, incorrect attribution to categories) and fragmentation (the map reflects only part of the problem). These errors also include errors in the systematization of elements of the knowledge domain. Often this is an excessive fragmentation of concepts and excessive details as a result of violation of the Occam's Razor rule.



Figure 4. Typology of mistakes in mind maps development

The most "complex" and difficult to correct error of heterogeneity of concepts of the same level can also be classified as systemic (see Rule B of section 2). The mistake occurs when making the first two system errors and a lack of map design.

In general, such errors are caused by the lack of skills in systemic and structural analysis, in terms of categorizing and generalizing concepts. In addition to the lack of skills, these errors can be explained by the characteristics of the analyst's cognitive style (Kholodnaya, 2002; Santos et al, 2010; Cuneo et al 2018). In particular, there is a characteristic "ability to generalize", which cannot be

corrected either by training or experience. The analysis of design errors is diagnostic, that is, the map exposes knowledge gaps and peculiarities of individual thinking.

## **5 Conclusions**

Visualizations allow you to get to a higher level of conceptual generalization of large and very large amounts of data, to facilitate communication gaps between different groups of researchers and experts, between students and teachers.

Aiming at the development of simple concepts that are complex but visually friendly for perception and learning mind maps serve as a powerful tool of cognition that helps to visualize, retain and compress the information needed.

The paper discusses the basic principles of the formation of mind maps and analyzes the typical mistakes of analysts. For the first time, a classification of main errors and mistakes is proposed taking into account syntactic, semantic and pragmatic aspects. The analysis of the most common errors associated with the violation of the rules of good generalization and reasonable minimalism is given.

In general, errors analysed in the paper are caused by lack of skills in systemic and structural analysis in terms of concepts categorization and generalization. Besides, these errors can be explained by the characteristics of the analyst's cognitive style. In particular, there is a special generalization ability, which cannot be corrected either by training or experience. Analysis of design errors is a diagnostic tool, that is, the map exposes knowledge gaps and thinking patterns of its author.

The paper may be of interest to both intelligent systems' developers and knowledge analysts as well as to management and knowledge management practitioners; it summarizes ten years of experience in teaching and training visual-analytical thinking skills as part of Bachelor, Master and Executive MBA Programs and corporate trainings.

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## **Agglomeration, Vertical Disintegration and Specialization in the Knowledge Intensive Business Services: Empirical Evidence on the Italian Provinces**

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### **Abstract**

This paper accounts for the determinants of sectoral specialization in knowledge intensive business services (KIBS), measured by the KIBs location quotient across the Italian provinces (NUTS3), using ISTAT province level panel data from 2012 to 2017. The aim is to see whether increases in agglomeration of activities measured by urbanisation economies and vertical linkages, controlling for knowledge base and absorptive capacity of provinces, push firms to specialize in Knowledge Intensive Business Services (KIBS). More in detail the impact of agglomeration economies, Hirschman linkages between KIBS and their manufacturing users, and innovation activities will be identified by such variables (i.e. localization and urbanization economies; intermediate demand of KIBs services, a proxy for input-output linkages; information and communication technology, public expenditures in research and development). Spatial models, SAR, but especially an IV- that allow us to take into account the endogeneity problem related to some variables



like population density and Intermediate demand –are employed in order to get spatial effects in explaining province specialization in KIBS.

The results show evidence that urbanization economies and input-output linkages, positively affect specialization in KIBS between the provinces.

**Keywords:** Agglomeration Economies; Regional specialization Knowledge Intensive Business Services; Technological Innovation; Spatial Models;

**Paper type** – Academic Research Paper

## 1 Introduction

The theoretical and empirical analysis about Knowledge Intensive Business Services (KIBS) represents an innovative portion of the research activity of the last 15 years because previous attention was especially devoted to the manufacturing services.

KIBS have become of particular importance because they provide knowledge-intensive intermediate inputs to private and public organizations and represent a guarantee of competitiveness in the knowledge-based economy. Moreover, they are characterized by specific production and innovation processes, which require close interaction with their clients and have the potential to spur innovation in other economic sectors (Di Giacinto et al., 2020). An increase in the demand of KIBS services by most firms both in Italy and around the world has developed during the last years.

The researchers have been interested in several dimensions and relationship. Some works investigated on the impact of BS (business services) on growth rate of employment, valued added and productivity (Francois, 1990; Kox and Rubalcaba, 2007a, 2007b). Other studies have considered the innovation behaviour and the differences between KIBS and manufacturing, considering several independent variables such as R&D expenditure, R&D cooperation, external sourcing activities and so on (Teixeira and Santos, 2016). Further studies support the evidence on the relationship between KIBs innovation and economic growth especially in the manufacturing sector also considering the effect on productivity (Griliches, 1995, 1998; Loof and Heshmati, 2001; Crepon et al., 1998; Klomp and van Leeuwen, 1999; Evangelista, 1999; Krempet al., 2004). Cainelli et al. (2006) following the literature related to Schumpeter (1934; 1942) and to

Schmooklerian theories (1962; 1966) explore the two-way dynamic link between innovation and economic performance.

Besides, the effect of an increase in urban population and in vertical disintegration on business services specialization of territories has been investigated more recently with respect to the EU regions (Meliciani and Savona, 2015; Gallego and Maroto, 2015), and also with reference to the geographic localization and productivity of KIBS firms in Italy focusing on Local Labour systems (Di Giacinto et al. 2020) and on specific metropolitan areas (Antonietti and Cainelli, 2016).

In line with this literature, this study accounts for the determinants of specialization in knowledge-intensive business services, measured by the relative share of employment in KIBS across the Italian provinces, using ISTAT NUTS3 level panel data from 2012 to 2017.

In our analysis the impact of agglomeration economies, and Hirschman linkages between KIBS and their manufacturing users, and innovation activities will be considered. Each one of these determinants will be identified by variables like localization and urbanization economies; input-output linkages; information and communication technology, public expenditures in research and development, which will be the main proxies adopted in our empirical analysis.

The idea is to see whether increases in agglomeration and vertical disintegration, in addition to knowledge base and absorptive capacity of the provinces (controlling for the presence of these factors in neighbouring provinces), push firms to specialize in KIBS. Spatial models, SAR, but especially an IV- that allow us to take into account the endogeneity problem related to some variables like population density and Intermediate demand –are employed in order to get spatial effects in explaining province specialization in KIBS.

The paper contribution to the literature on the agglomeration economies with regards to KIBS localisation in Italy is twofold. First of all, we focus on exploring the province dimension and, secondly, we disentangle the subsector dimensions. To our knowledge there are no papers that investigated this topic considering all the Italian Provinces allowing the reader to capture the differences among them. In addition, given that among KIBS there are Technological Knowledge Intensive Business Services (T-KIBS)-related to scientific and technological knowledge such as R&D services, engineering services, computer services - and Professional Knowledge Intensive Business Services (P-KIBS), who are more traditional professional services legal accountancy, and many management consultancy and

marketing services, our analysis also will try to consider sub sectors of KIBS services capturing their heterogeneous patterns.

More in detail this analysis tries to answer the following questions. Are the urban spatial structure and the KIBS location related? Considering eight KIBS sectors: is there a relationship between their activities and localization economies? What are the other determinants of specialization in KIBS and how these determinants affect each one of eight sector of specialization?

The results obtained considering the KIBS and each 2-digit subsector, show evidence that localization and urbanization economies and input-output linkages positively affect specialization in KIBS in the provinces.

This paper is organized as follows: the next section presents the review of the literature on agglomeration, vertical disintegration and productivity. Section 3 describes the most important variables employed in the analysis. Section 4 shows the estimation strategy and the results are discussed in Section 5.

## **2 Review of the Literature on Agglomeration, Vertical Disintegration and Productivity**

The issue of agglomeration economies has been crucial in the analysis of the localisation of KIBs. KIBS are sensitive to spatial agglomerations, which are crucial for their success and competitiveness (Audretsch, 1998; Scott, 1988). KIBS benefit from proximity to sources of information (Porter, 1990) and to knowledge spillovers (Henderson, 2000; Krugman, 1991). They get access to a labour force with good competences and skills (Coffey and Shearmur, 1997) and major expertise. Besides, they localize in high-density areas near customers, which favour firms' access to the market to undertake the necessary exchanges (Duranton and Puga, 2002, 2005; Krugman, 1991; Puga, 1998).

A large evidence has put forward that business services (BS) in general tend to cluster in dense urban areas which exhibit a strong functional specialisation in knowledge-intensive and high skilled activities. Hence, urbanization externalities favor regional specialisation in KIBs as these mainly serve other high skilled and knowledge-intensive services, also concentrated in large urban areas. The Hirschman forward linkages between BS and their manufacturing user sectors and an innovation- prone regional environment are important factors of location of BS. For example, Guerrieri and Meliciani (2005) discovered that a number of knowledge-intensive manufacturing activities like office and computing

machinery, professional goods, electrical apparatus and radio, television and communication equipment, and chemicals and drugs businesses are the main demanding economic agents of advanced services.

Accordingly, regional specialization in KIBS is expected to be positively and considerably supported by: the regional urbanization state, KIBS immediacy to knowledge spill-overs, KIBS availability of a highly skilled labour force, KIBS closeness to key customers.

In 2008 Antonietti and Cainelli have first underlined the importance of agglomeration externalities in affecting the choice to relocate knowledge-intensive activities as geographic proximity, knowledge spill-overs and closer interaction among agents make it easier for firms to manage complex interactions and to increase their competitiveness. Meliciani and Savona (2015) and Gallego and Maroto (2015) wrote seminal papers on the spatial analysis of clustering of KIBs in Nuts-2 regions. Employing a Spatial Durbin Model, Meliciani and Savona (2015) showed that urbanisation economies, the spatial structure of intermediate sectoral linkages and Information and Communication Technologies, are important factors in determining the specialisation in BS. Gallego and Maroto (2015), adopting spatial autoregressive models also analyse how agglomeration economies affect KIBS localization strategies. They find that KIBS also benefit from knowledge spill-overs and availability of a highly skilled labour force.

Kekezi and Klaesson (2020) show that the distance decay of spillovers is fast. Only local concentrations of KIBS seem to be important. Over longer distances, they rather observe negative outcomes for trademarking, indicating possible spatial competition effects.

Zhang (2020) show that unlike manufacturing and traditional services, KIBS are characterized by relying heavily on highly skilled employment, intense interaction with clients, and professional knowledge. Hence, approaching to an appropriate labour force, reducing the cost related to transport and transaction, and rising knowledge flows are the main characteristics through which agglomeration economies fund to KIBS performance.

Antonioli, Berardino and Onesti (2020) using the Word Input–Output Database on EMU19 countries concluded that disparities are growing in the composition of national productive structure and they are even more pronounced when we consider intersectoral dynamics, confirming the Krugman position about the increasing specialisation among EMU countries. The core countries (central EMU)

show a higher level of KIBS integration in manufacturing than peripheral ones (southern and eastern EMU).

Di Giacinto, Micucci and Tosoni (2020) present evidence of a positive and significant urban productivity premium in KIBS sector, which is more recognizable compared with the generality of non- knowledge-intensive services activities and also a bit larger compared with the average premium estimated for the remaining part of knowledge-intensive services.

Serrano (2019) shows that (a) there is a relationship between urban spatial structure and KIBS location; (b) KIBS localise in a polycentric form in search of urbanization economies; but (c) particular KIBS are very concentrated in just a few subcenters, looking for localization economies; (d) proximity to the core and agglomeration economies are a factor in the location of KIBS.

Quite a large evidence has emerged lately concerning the agglomeration, productivity and vertical disintegration of KIBs. However, the topic of agglomeration economy of KIBS sector still needs further research. In this paper we fill a research gap by investigating not only KIBS, but also its 2-digits subsectors, as analysing the localization patterns of KIBS, one should draw attention to the technological base of the different KIBS categories as localization factors do not seem to influence the localization strategies of the different KIBS subsectors alike given that among KIBS there are Technological Knowledge Intensive Business Services (T-KIBS)-related to scientific and technological knowledge such as R&D services, engineering services, computer services-and Professional Knowledge Intensive Business Services (P-KIBS) who are more traditional professional services legal accountancy, and many management consultancy and marketing services Also conducting the analysis for Italy at Province level gives a different perspective to the subject as usually the study has been conducted for Italy based on NUTs2 regions (Meliciani and Savona, 2015), LLMA (Di Giacinto et al., 2020), or municipalities units (Antonietti, R. and Cainelli, G., 2016).

### **3 Data**

The data used in the analysis are taken from ISTAT and cover information for 110 spatial units at NUTS-3 level (provinces) for the period 2012-2017. So, the total number of observation is 660. The classification of KIBS used throughout the analysis relates to the ATECO 2007 classification (see Table A1 in Appendix for

additional details), which is of common use in Italy. The aim is to cover the broad spectrum of KIBS, but also to make the sample as accurate as possible. The reader will identify hereinafter how this differentiation supports the analysis of the results. Table 1 shows the variables used in the analysis.

### **3.1 Dependent variable**

We compute the regional specialization in KIBS for any of the Italian NUTS-3 regions (provinces) that are included in the analysis. We apply the location quotient (LQ). The ratios indicate whether or not a certain province economy has a greater share of KIBS activity than expected when compared with a reference area. We compute the measure of employees in the KIBS sector using the ISTAT database that provides information on the number of persons employed in each KIBS sector and also on the total employment (TEMP) at both province and at national levels. Data for the employees in KIBS cover the total number of persons who work in KIBS firms while the data on total employment account for the number of employed people, be they either employees (working by agreement for another resident unit and receiving remuneration) or self-employed (owners of unincorporated enterprises).

The ratio below is applied (1):

$$LQ_{pt} = (\text{number of employment in } kibs_{pt} / \text{total employment}) / \text{number of employment in } kibs / \text{total employment} \quad (1)$$

where p and t are the province and the time, respectively. An LQ ratio of employment in KIBS and in each KIBS sub-sector are built. An LQ ratio equal to 1 means that the NUTS-3 region under consideration has the same percentage of employment in KIBS as does the total Italian reference area. LQ ratios that are below or above 1 indicate that the regional employment in KIBS is, respectively, less or greater than expected in comparison with the reference area.

The location quotient measuring specialization in KIBS at the province level has been used to map Italy in terms of KIBS specialization in 2017 (Figure 1). It shows KIBS specialization as the whole sector and also by each 2-digits subsectors (62, 63, 69, 70, 72, 73). The maps visually help bringing to light the presence of an agglomeration pattern in the province distribution of KIBS specialization.

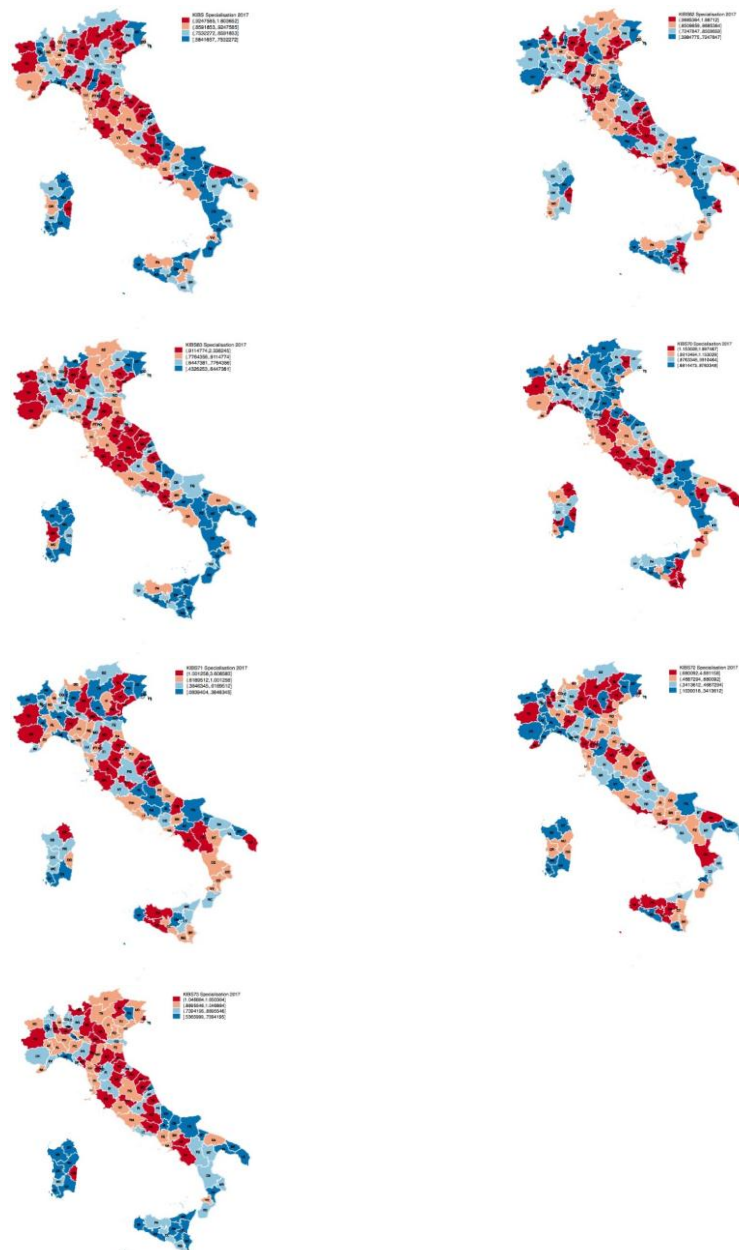


Figure 1. Specialization in KIBS in Italy by Provinces, location quotient (LQ) levels, 2017:total KIBS and 62, 63, 70, 72, 73.  
Source: ISTAT database.

The most specialized provinces in KIBS are those including large urban areas. In particular, the most specialized ones include the “capoluoghi di provincia” (Figure. 1). Moreover, the evidence suggests the existence of a higher clustering in the northern and central Italian regions. In this respect, not only the “capoluogo di provincia” but also other smaller provinces (Rovigo, Treviso, Pisa to mention some) are among the top specialized provinces and they are all clustered within the northern part of Italy. On the other hand, at the bottom of the ranking, there is a predominance of provinces from the Southern Italy. Looking at the subsectors the spread in agglomeration of KIBs between North and South is especially evident in the subsectors 62 (Software production, computer consulting and related activities) and 63 (information activities and other information services). This is also proved by Meliciani and Savona (2015) where they found the evidence of a North-South divide in the specialization of business services.

Also, it is noteworthy to see that in the South Italy there are 2 subsectors that have higher specialization compared to other subsectors: 71 (Activities of architectural and engineering studies; tests and technical analysis) and 72 (Scientific research and development).

The map of subsector 63 is the closest to the spread of specialization of KIBS as whole sector. The highest value of LQ in subsector 62 is 1.89 in Potenza province that are located in the Southern Italian region of Basilicata. And the lowest values (0.4) is in Ogliastra in the eastern part of Sardinia. For subsector 63 it is 2.33 in Siena, central part of Italy in Tuscany region, and 0.43 in Vibo Valentia, Calabria region of southern Italy, respectively. After analysing in the same way the rest of the provinces, it is worth to note that it also proves a North-South divide in KIBS specialization in Italy.

Table 1. Variables of Interest

Variables	Description	Computation	Sources	Years
LQKIBS (KIBS SHARE INDICATO R)	Province specialisatio n in KIBS	(Province Number of employees in KIBs/ province total number of employees)/(Italian Number of employees in KIBs/ Italian total number of employees)	ISTAT	2012-17
PDENSITY	Population density. Proxy of agglomerati	Population/ surface (in sq KM; province level)	ISTAT	2012-17



	on Economies			
CAP	"Capoluogo di provincia" Proxy of urbanisation economies.	Dummy indicator, which takes the value of 1 when the observation refers to a province which is "capoluogo di provincia"; and 0 otherwise		<b>2012-17</b>
IDEMAND	Intermediate demand. Proxy of demand spillovers from intersectoral linkages	Weighted share of employment in manufacturing industries that are high users of KIBS over total employment $IDEMAND = \sum_{s=1}^M W_j E_{ist} / \sum_{s=1}^N E_{ist}$ <p>NOTE : i is province, s the sector, t the time, M the number of above average KIBS users manufacturing sectors, N the total number of sectors, E the employment, W the weight given by the average share of KIBS in total industry output as computed from ISTAT symmetric Input Output tables in 2015</p>	<b>ISTAT</b>	<b>2012-17</b>
R&DEXP	Proxy of knowledge spillovers	domestic in-house R&D expenditures in the NUTS-2 region current values (thousands of euro), over regional GDP. (regional level)	<b>ISTAT</b>	<b>2012-17</b>
ICT	Proxy for ICT: Enterprises with Broad Band.	Percentage of Enterprises with Broad Band (regional Level)	<b>ISTAT</b>	<b>2012-17</b>
TRT	Proxy of Travel effort to reach a region	The index is obtained starting from the calculations made on travel times, expressed in minutes, from the centroid of each municipality to the three closest infrastructures for each of the four categories considered. The categories of infrastructures considered are: i) ports; ii) airports; iii) railway stations; iv) motorway toll booths. For the processing of travel times, a commercial road graph was used which takes into account the real road speeds (therefore also the morphology of the territory) in ideal conditions, i.e. in the absence of traffic- Provinces level	<b>ISTAT</b>	<b>2013</b>
MARCHIS HARE	Proxy for innovation: share of brands over	Brand/population (province level)	<b>Ufficio Italiano Brevetti e Marchi</b>	<b>2012-2017</b>

	population at province level			
LATITUDE AND LONGITUDE	Distance-employed to compute the distance matrix.	Latitude: angular distance of a point from the equator Longitude: the angular distance of a point from an arbitrary reference meridian along the same parallel of the place.	<b>ISTAT</b>	<b>2012-2017</b>
<b>Instruments</b>				
RSE	a proxy for regional scale economies	the ratio between employment and number of firms) –provinces level	<b>ISTAT</b>	<b>2012-2017</b>
SUPERFICIE		and the total land area –provinces level	<b>ISTAT</b>	<b>2012-2017</b>

### 3.2 Independent variables

We introduce a set of determinants, which typically influence the regional specialization in KIBS. These determinants are identified as follows: urbanization, knowledge spillovers, ICT, intermediate demand, R&D expenditure built as indicated in table 2 where the source and the time span is indicated.

KIBS are supposed to group in regions with huge urban areas. The urbanization factor is approached by accounting for a population density indicator following Ciccone (2002), which specifies the share of population over the regional area (in square kilometres). KIBS are also said to cluster in order to benefit from knowledge spillovers. Accordingly, the knowledge spillovers factor is approached by the share of total R&D expenditure over the gross domestic product (GDP) of regions. The regional setting of ICT is another key attribute that influences KIBS agglomeration within a particular area. We use this determinant by considering the percentage of enterprises with a website at regional level.

Moreover, the localization of KIBS is thought to be influenced by the closeness to their clients as it facilitates the transfer of tacit knowledge. Following Meliciani and Savona (2015) we considered the intermediate demand for KIBS (IDEMAND)

that is proxied by the weighted share of employment in manufacturing enterprises that are intensive clients of KIBS over total employment. Intensive clients are identified using the Istat symmetric Input Output tables in 2015. In particular, in order to compute this indicator, we use a vector which value indicate the use of services on output for manufacturing sectors that are above average KIBS users and, for each Provinces and year, we multiply it by the total employment in each respective manufacturing sector. Then, we divide this number by the Province's i total employment in year t.

$$IDEMAND = \sum_{s=1}^M W_j E_{pst} / \sum_{s=1}^N E_{pst} \quad (2)$$

In equation 2 above p is the province, s the sector, t the time, M the number of above average KIBS users manufacturing sectors, N the total number of sectors, E the employment, W the weight given by the average share of KIBS in total industry output as computed from ISTAT symmetric Input Output tables in 2015. A higher value of this indicator suggests a higher provinces employment in manufacturing sectors that are intensive users of KIBS with respect to total province employment for each year.

Finally, a control variable (CAP) is also constructed, by means of a dummy indicator, which takes the value of 1 when the observation refers to a province which is "Capoluogo di provincia"; and 0 otherwise. This variable is expected to be positively related to the dependent variable.

R&DEXP over the GDP and the percentage of enterprises with the broadband a proxy of Information and Communication Technology (ICT)

#### 4 Empirical Strategy

Given the existence of spatial correlation in the dependent variable, in order to perform our analysis, we employ spatial lag or spatial autoregressive (SAR) model (Anselin, 1988) and perform also the IV spatial estimation. These model includes amongst the regressors also the spatial lagged dependent variable<sup>1</sup>. In this context, the models can be represented as variants of the following equation:

$$LQKIBS_{pt}^{SP} = a_p + \rho WLQKIBS_{ptSP} + B_1 IDEMAND_{pt} + B_2 PDENSITY_{pt} + B_3 TRT_{pt} + B_4 R\&DEXP_{rt} + B_5 CAP_{pt} + B_7 ICT_{rt} + MARCHISHARE_{pt} + e_t \quad (3)$$

<sup>1</sup> Robust Lagrange multiplier tests clearly discriminate where the spatial process is allocated, as a spatial lag of the endogenous variation (See Table A2 in Appendix for additional details).

Where in  $\rho \text{WLQKIBS}_i^{\text{SP}} = W$  is the non-negative spatial weights matrix with zeros on the diagonal that formalizes the provinces network structure;  $\rho \text{WLQKIBS}$  is the spatial lagged LQ ratio of KIBS (Total and for each sector separately);  $\rho$  is the SLM parameter.

The variable for province  $p$  and region  $r$  are taken as follows:

- LQKIBS represents the dependent variable indicating the specialization in KIBS, above discussed. We want to point on the use of all the KIBS subsector (62; 63; 70; 71; 72; 73) and specialization (SP) discussed in the above section;
- IDEMAND - represents the share of share of employment in manufacturing sectors that are more intensive of KIBS;
- PDENSITY proxy of agglomeration Economies is the share of population over the province area;
- is the share of Brand over population;
- TRT represents the accessibility index;
- R&DEXP is the R&D expenditure over the GDP;
- ICT is a proxy of Information Technology and it is given by the percentage of firm that have the broad band;
- CAPITAL that is a dummy for regions where capital cities (Capoluoghi di provincia) are located;
- MARCHISHARE that represent the share of brand over population
- $e_{it}$  represent an error term assumed to be independently and identically distributed with a mean of zero and a variance of  $\sigma^2$ .

Moreover, the potential endogeneity of some variables (e.g. IDEMAND and PDENSITY)<sup>1</sup> promotes the risk that OLS estimates are upward biased. In order to test the existence of endogeneity in the model, the Hausman (1978) specification test is used that allows one to choose between the OLS estimation and an alternative two-stage least-squares (2SLS) estimation using instrumental variables.<sup>2</sup>

*1 The Population density is strongly influenced by the geophysical characteristics of the reference area, which may or may not include non-habitable areas (high mountain areas, water surfaces) and by the different settlement contexts of urban and rural areas.*

*The Intermediate demand might be affected by the problem of reverse causality.*

*2 The Hausman test is based on the idea that the covariance of an efficient estimator and its difference with respect to an inefficient estimator is zero. The statistic, under the null hypothesis of endogeneity of the regressors, is asymptotically distributed as a  $\chi^2$  with as many degrees of freedom as non-exogenous regressors are present in the specification. In the present case, the null hypothesis cannot be rejected.*

Given that in order to implement the instrumental variables estimation and following other papers on regional specialization, two instruments are employed: the proxy for regional scale economies (the ratio between employment and number of firms) (that is, Paluziè et al., 2001), and the total land area of the region (that is, Artis et al., 2009; Brulhart and Mathys, 2008; Ciccone, 2002).

The analysis uses these two instruments to enable the performing of over-identification tests as well, which indicate that endogeneity is a problem. This paper therefore deals with this issue by performing 2SLS estimations (F-statistic of first-stage estimation is higher than 10, being instruments used in 2SLS commonly valid).

## 5 Results and Conclusions

The results, presented in table 2 and 3, are consistent along the two models (SAR and 2SLS) model considered<sup>1</sup>. The positive coefficient of the spatial lag confirms the descriptive picture provided by the Moran scatter plot (See Figure A1 and A2 in Appendix) and establishes the spatial dependence in KIBS specialisation. Looking at the agglomeration variables, the population density show mixed results positive in some subsectors; as to the negative or not significant signs obtained it is not surprising and seems to be in line with the pattern of the last years according to which the higher is the population density, the less the level of specialization in some specific KIBS that are more likely to be in places where the agglomeration economies are decreasing (i.e congestion effects)-see Gallego and Maroto, 2015. As to the dummy for provinces with capital cities this is highly correlated with the total KIBS specialization, confirming that urbanisation externalities are key determinants of regional specialisation in KIBS and also in most of the subsectors. and the tendency to agglomerate toward the top of the urban hierarchy. In addition, this highlight a specific role played by urban centres as attractors of these services.

Moreover, our findings related to IDEMAND from manufacturing industries also represents a major determinant of KIBS specialisation across regions.

These results, as in Melicaini and Savona (2013) differ from those by Shearmur and Doloreux (2008), who observe that in Canada KIBS serving a manufacturing may not automatically leave urban areas and consider to be adjacent to their

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<sup>1</sup> Sargan statistics for mutual consistency of the available instruments are made on, and the test rejects the null hypothesis of correlation between the instruments and the error.

markets. The different results may depend on differences in the unit of the analysis (European NUTS2 regions vs smaller regions in Canada) or by differences in the period considered (Shearmur and Doloreux find strong concentration of KIBS in 2001 but also notice that over the period 1991–2001 KIBS developed quicker in municipalities with good access to manufacturers and that this may be indicative of a rising local synergy).

This is an important result because it implies that urbanisation externalities are counter-balanced by the effect of centrifugal forces leading KIBS to locate outside urban areas; on the other hand, it shows that the location of KIBS also depends on previous regional sectoral specialisation.

As to the TRT, the coefficient is positive and significant overall and for some subsector, this means that the lower is the accessibility the greater is KIBS' need for co-localization. Differently by the literature (Antonietti and Cainelli, 2008; Meliciani and Savona, 2009, Gallego and Maroto 2015) ICT, here proxied by the Broadband diffusion across firms, does not show interesting results. As in Meliciani and Savona (2015) that found a relationship between patents over population across regions and BS specialisation, here the level of MARCHISHARE is a key determinant and has a large impact on KIBS specialisation. Also, the innovation environment and knowledge infrastructure of the region, proxied by R&D expenditure, has a positive and significant impact on overall KIBS specialisation (Table 2), anyway the result is not consistent along the two models, but the coefficient is positive (even if not significant) as to most of the sectors considered.

Table 2: Spatial Lag Model

VARIABLES	LQ_KIBS	LQ_KIBS6 2	LQ_KIBS6 3	LQ_KIBS70	LQ_KIBS7 1	LQ_KIBS72	LQ_KIBS 73
	All KIBS	Software production, computer consulting and related activities	Information activities and other information services	Business management and advisory management activities	Activities of architectural and engineering studies; tests and technical analysis	Scientific research and development	Advertising and market research

LQKIBS NEIGHBOUR PROV.	0.685*** (0.229)	1.380*** (0.264)	1.456*** (0.133)	1.517*** (0.283)	0.886*** (0.205)	1.022*** (0.196)	1.431*** (0.131)
PDENSITY	0.0122 (0.0184)	0.00346 (0.0351)	0.0205 (0.0331)	-0.112*** (0.0238)	0.0806 (0.0887)	0.319*** (0.0623)	0.0521** (0.0229)
IDEMAND	0.184*** (0.0103)	0.149*** (0.0242)	0.344*** (0.0150)	-0.0634*** (0.0112)	0.570*** (0.0653)	0.624*** (0.0447)	0.219*** (0.0144)
CAP	0.159*** (0.0324)	0.150** (0.0623)	0.185*** (0.0584)	0.119*** (0.0422)	0.485*** (0.158)	0.194* (0.111)	0.0658 (0.0405)
TRT	0.158*** (0.0535)	0.0894 (0.102)	0.252*** (0.0962)	-0.0410 (0.0693)	0.201 (0.258)	0.405** (0.181)	0.125* (0.0665)
BROADBAN D	- 0.000117 (0.00082 4)	-1.45e-05 (0.00208)	0.000180 (0.00116)	-0.000882 (0.000892)	-0.00189 (0.00575)	0.00351 (0.00390)	-0.000553 (0.00121)
R&D	2.832** -1.362	-1.611 -3.194	1.680 -1.968	1.428 -1.489	4.823 -8.680	-4.835 -5.908	3.530* -1.961
MARCHISHA RE	72.50*** (16.63)	106.4*** (37.48)	71.55*** (25.44)	-6.226 (19.29)	244.3** (99.51)	260.4*** (68.47)	74.84*** (23.02)
Constant	-0.722** (0.287)	-0.353 (0.555)	-0.969* (0.503)	0.746** (0.364)	-1.109 -1.422	-3.502*** -1.002	-0.678* (0.360)
Observations	660	660	660	660	660	660	660
Method	SPA_LAG	SPA_LAG	SPA_LAG	SPA_LAG	SPA_LAG	SPA_LAG	SPA_LAG

Standard errors are in parenthesis. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level; Standard errors in bracke

Table 3: Spatial Lag IV Model

VARIABLES	LQ_KIBS	LQ_KIBS6 2	LQ_KIBS6 3	LQ_KIBS70	LQ_KIBS7 1	LQ_KIBS72	LQ_KIBS 73
	All KIBS	Software productio n, computer consultin g and related activities	Informati on activities and other informati on services	Business manageme nt and advisory manageme nt activities	Activities of architectur al and engineerin g studies; tests and technical analysis	Scientific research and developme nt	Advertisin g and market research

LQKIBS NEIGHBOUR PROV.	1.429*** (0.453)	1.840** (0.890)	1.869*** (0.304)	1.849*** (0.487)	1.218*** (0.383)	1.099*** (0.364)	1.399*** (0.183)
PDENSITY	0.0652* (0.0356)	0.0563 (0.0701)	0.0437 (0.0520)	-0.0410 (0.0536)	-0.0467 (0.155)	0.126 (0.138)	0.110*** (0.0402)
IDEMAND	0.192*** (0.0570)	0.138 (0.107)	0.150* (0.0795)	0.0486 (0.0831)	0.516** (0.236)	0.501** (0.222)	0.244*** (0.0626)
CAP	0.149*** (0.0365)	0.135** (0.0682)	0.116** (0.0521)	0.135** (0.0555)	0.481*** (0.151)	0.195 (0.132)	0.0607 (0.0410)
TRT	0.233*** (0.0736)	0.158 (0.142)	0.235** (0.107)	0.119 (0.110)	-0.0578 (0.315)	0.0462 (0.278)	0.228*** (0.0838)
BROADBAN D	- 0.000169 (0.00088 0)	-0.000279 (0.00215)	-0.000463 (0.00147)	-0.000182 (0.00104)	-0.00235 (0.00600)	0.00319 (0.00396)	-0.000449 (0.00128)
R&D	1.672 -1.572	-2.337 -3.652	4.972** -2.393	0.937 -1.715	3.340 -9.558	-2.349 -6.841	3.252 -2.131
MARCHISHA RE	69.12*** (21.68)	100.3** (46.67)	155.0*** (34.32)	-35.78 (31.13)	283.2** (113.2)	318.5*** (91.58)	64.42** (27.31)
Constant	-1.205*** (0.441)	-0.827 (0.838)	-1.160* (0.640)	-0.201 (0.657)	0.641 -1.900	-1.209 -1.627	-1.358*** (0.504)
Observations	660	660	660	660	660	660	660
Method	SPA_IV	SPA_IV	SPA_IV	SPA_IV	SPA_IV	SPA_IV	SPA_IV
Sargan	✓	✓	✓	✓	✓	✓	✓

Standard errors are in parenthesis. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \*

Significant at the 10 percent level; Standard errors in brackets.

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## Appendix: Additional Tables and Figures

Table A.1 KIBS by ATECO 2007 classification

J62	Software production, computer consulting and related activities
J63	Information activities and other information services
M70	Business management and advisory management activities
M71	Activities of architectural and engineering studies; tests and technical analysis
M72	Scientific research and development
M73	Advertising and market research

Table A.2 Diagnostics

Test	Statistic	p-value
<b>Spatial error:</b>		
Moran's I	2.990	0.003
Lagrange multiplier	2.499	0.114
Robust Lagrange multiplier	10.542	0.001
<b>Spatial lag:</b>		
Lagrange multiplier	34.496	0.000
Robust Lagrange multiplier	42.538	0.000

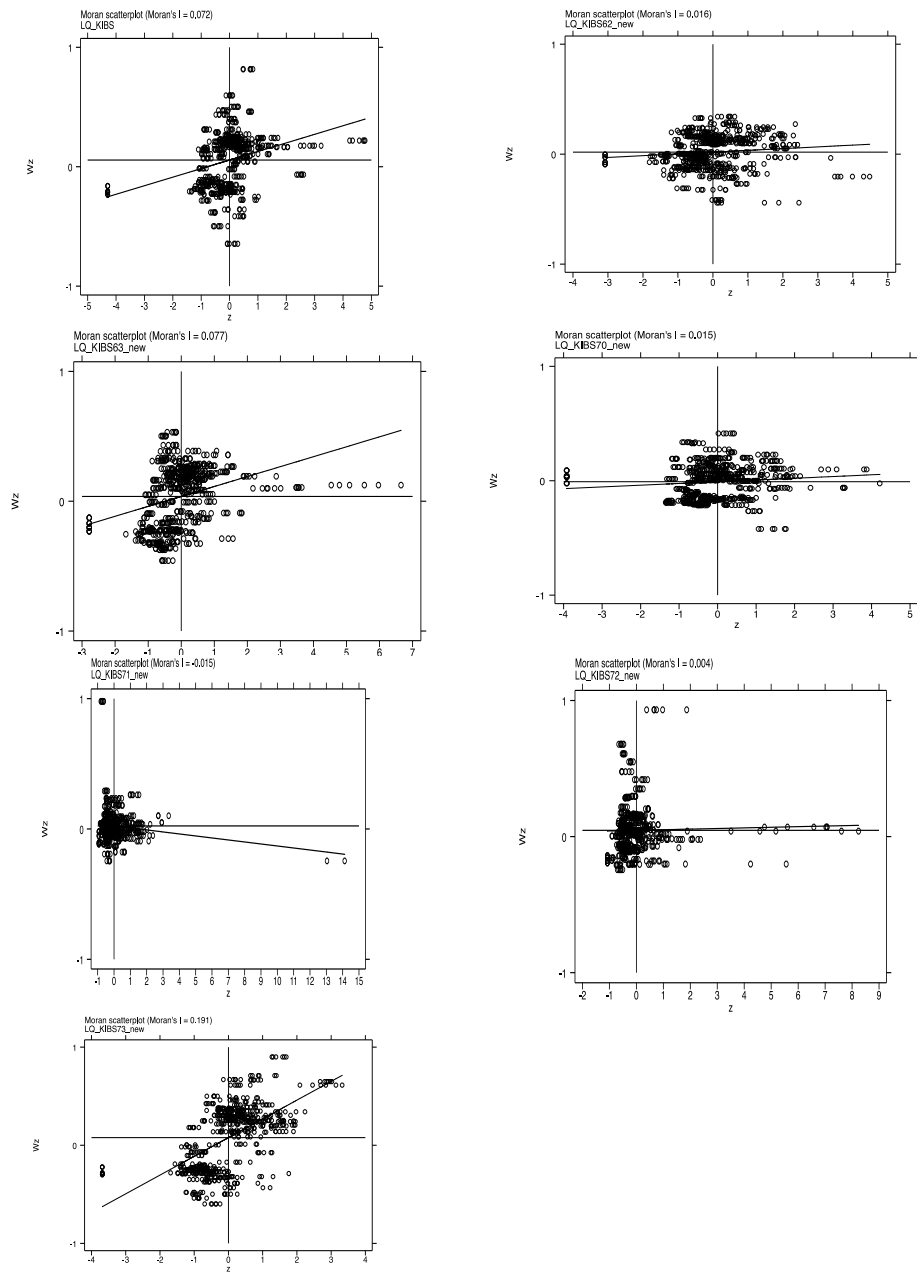


Figure A1. Moran scatterplot for KIBS specialization in Italy by Province—localization quotient between 2012 and 2017: total KIBS and 62, 63, 70, 71, 72, 73.-  
Source: ISTAT database.

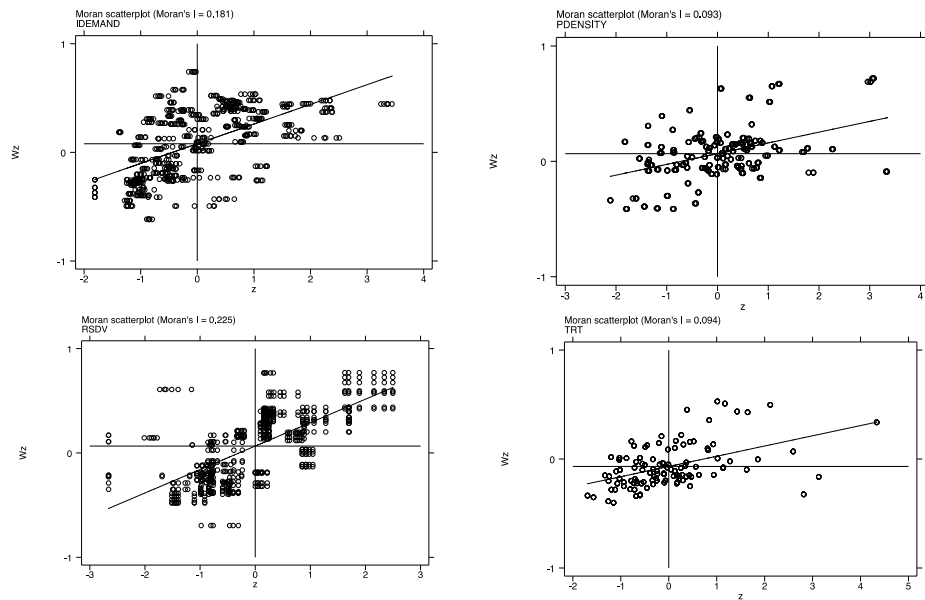


Figure A2. Moran's scatterplot –independent variables (PDENSITY, IDEMAND, TRT, R&D)-  
Source: ISTAT database.

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## **Complementor Relationship Management for Data-Driven B2B Platforms: Towards a Holistic Approach**

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### **Abstract**

In the so-called ecosystem economy, new platform-based business models evolve rapidly based on the prospects of digital technology. Especially in the B2B context, data-driven platforms are highly relevant. Thus far, little research has been conducted on the supply side of data-driven platforms and especially on service providers, the so-called complementors. Therefore, this paper offers insights into the various facets of complementor relationship management (CoRM). The paper aims to develop a framework for the management of complementors of data-driven B2B platforms. For empirical evidence, we draw on 14 semi-structured expert interviews with platform managers and complementors. The findings outline two big areas of CoRM and discuss distinct characteristics of partner management and technology management. For partner management the differentiation into open and closed platform needs to be taken into account for complementor relationship management. Moreover, our study reveals the key factors of technology management which lead from platform infrastructure to digital applications like digital twins or predictive maintenance.

**Keywords** – Entrepreneurship; New Technologies; Digital Platforms; Data Management, Complementors

**Paper type** – Academic Research Paper

## 1 Introduction

According to a study by the International Data Corporation (IDC), the annual amount of data produced worldwide is expected to increase to 177 Zettabytes by 2025. If all this data were to be stored on DVDs and lined up one after the other, it would be possible to circumnavigate the earth 222 times (Reinsel, Gantz & Rydning, 2018). Hence, innovative business models for data-driven platforms evolve rapidly, disrupt traditional industries and face new opportunities due to changing market constellations and increasingly complex value creation processes (Adner & Kapoor, 2010; Adner, 2017; Jacobides, Cennamo & Gawer, 2018; Reuver, Sorensen & Basole, 2018; Jacobides, 2019). In particular, the shift from classical pipeline businesses to innovative co-evolving platform ecosystems has fundamentally transformed industry architectures (Eisenmann, Parker & Van Alstyne, 2007; Van Alstyne, Parker & Choudary, 2016; Rietveld & Schilling, 2020).

A digital platform is a business model that uses technology to connect people, organizations, and resources in an interactive ecosystem with the potential for a nonlinear increase in utility and value (Parker, Van Alstyne & Choudary, 2016; Hein et al., 2019a). While digital C2C or B2C platforms are already well established, the landscape for data-driven B2B platforms is still relatively undefined and lots of platforms are competing for dominance. The core function of a data-driven platform is to offer an open infrastructure to collect, exchange, analyse, use and evaluate data. Besides the platform provider, service providers on the supply side of the digital platform, the so-called complementors, play an important role in the process of value creation (McIntyre & Srinivasan, 2017). Only based on collaboration with those entrepreneurs the necessary knowledge for platform value creation is available (Parker, Van Alstyne & Choudary, 2016).

Thus far, little research has been conducted on complementor relationship management (CoRM) in the context of data-driven B2B platforms. Prior research analyses CoRM from a platform provider's perspective on the one hand (Buchholz, de Bie & Kochendörfer, 2021a) and from a complementor's perspective on the other hand (Buchholz, de Bie & Kochendörfer, 2021b), both with focus on a management not on a technology perspective.

Based on those findings, this paper develops a holistic framework on the different facets of CoRM. Besides the two mentioned perspectives of platform provider and complementor we thirdly add the technology perspective. Hence, this paper will give answers to the following research questions:

*RQ1: Which are the main fields of complementor relationship management for data-driven B2B platforms from a partner management perspective?*

*RQ2: Which are the main fields of complementor relationship management for data-driven B2B platforms from a technology management perspective?*

The paper is organized as follows: The second chapter provides the description of our research design. In chapter three, we present the findings on CoRM regarding the two mentioned perspectives. Finally, the closing chapter summarizes the findings and points out some limitations and possible avenues for future research.

## **2 Research design**

Empirical exploration can be used for research on hitherto neglected phenomena, causal relationships and patterns by depicting and analysing qualitative data. Since all of these criteria and conditions are met for this research field, the study follows Eisenhardt (1989) and Yin (2014) by applying a qualitative research approach to an in-depth investigation of CoRM in terms of data-driven B2B platforms. By relying on semi-structured interviews with open-ended questions, we ensured that all of the perspectives and assessments expressed by the interviewees were captured. We undertook a dyadic research by considering both platform providers and complementors. A within-case analysis was conducted first, followed by a cross-case analysis using replication logic to find commonalities among platform provider and complementor cases (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Hannah & Eisenhardt, 2018).

Interview partners were mainly extracted from press releases and through network research on social media (LinkedIn and Xing). The explorative case-study approach comprises eight interviews with platform providers as well as six interviews with complementors. All expert interviews took place between November 2020 and April 2021. Due to the coronavirus pandemic, we conducted all interviews either by telephone or video conference. The interviews lasted between 22 and 43 minutes and were audio-recorded and afterwards transcribed with the prior consent of the interviewees. A brief overview of the cases is presented in Table 1. In addition to this primary source, we also considered secondary data such as reports, press releases, and newspaper articles to increase the overall reliability and validity of the database via triangulation (Eisenhardt, 1989; Miles & Huberman, 1994).



Table 1: Data sample

ID	Platform/Company	Position	Perspective	Duration
P1	Software-as-a-Service (SaaS) platform for document management	Platform portfolio manager	Platform provider	43 min.
P2	Industry IoT platform of an industrial manufacturing company	Head of digital enterprise and digital services	Platform provider	29 min.
P3	Industry-and-mobility data platform from the public sector	Head of department	Platform provider	28 min.
P4	Industry 4.0 platform of an agricultural machinery manufacturer	Head of digital transformation	Platform provider	33 min.
P5	Industry IoT platform of an industrial manufacturing company	Process manager of commercials	Platform provider	30 min.
P6	Strategy-and-management consulting company	Managing director, project lead	Platform provider	36 min.
P7	Automated infrastructure-inspection platform	Managing director	Platform provider	31 min.
P8	Data-driven B2B platform for farming	Partnership manager	Platform provider	22 min.
C1	Industrial-services provider for B2B platforms	Partnership manager	Complementor	29 min.
C2	Data-and-analytics services provider for B2B platforms	Key account manager	Complementor	44 min.
C3	Technology services provider for B2B platforms	Senior innovation manager	Complementor	37 min.
C4	Infrastructure service provider for IoT platforms	Business architect	Complementor	29 min.
C5	Digital-applications provider for farming platform	Managing director	Complementor	19 min.
C6	Data-science and software-development provider for platforms	Founder	Complementor	17 min.

### 3 Fields of Complementor Relationship Management

#### 3.1 Data-driven B2B platforms and their participants

*Data-driven platforms* generate, collect, share, and monetise information generated by machines or by users and offer an infrastructure for exchange,

analysis and evaluation by focusing on data (Bundesverband der Deutschen Industrie e.V., 2020). Often, companies lack reasonable methods to strategically exploit the significant new value of the amount of data generated by the Internet of Things (IoT). A promising way to put IoT data to work is to offer data on digital platforms to third parties. With the help of sensors and application programming interfaces (APIs), physical objects become smart devices and can independently trigger activities in processes without human intervention (Deichmann et al., 2016; Davenport & Redman, 2020). In an industrial B2B context this type of platform is named Industrial IoT (IIoT) platform. Within a digital platform, different roles should be mentioned (see Figure 1) (Hein et al., 2019b; Hagiu & Altman, 2017; Lusch & Nambisan, 2015).

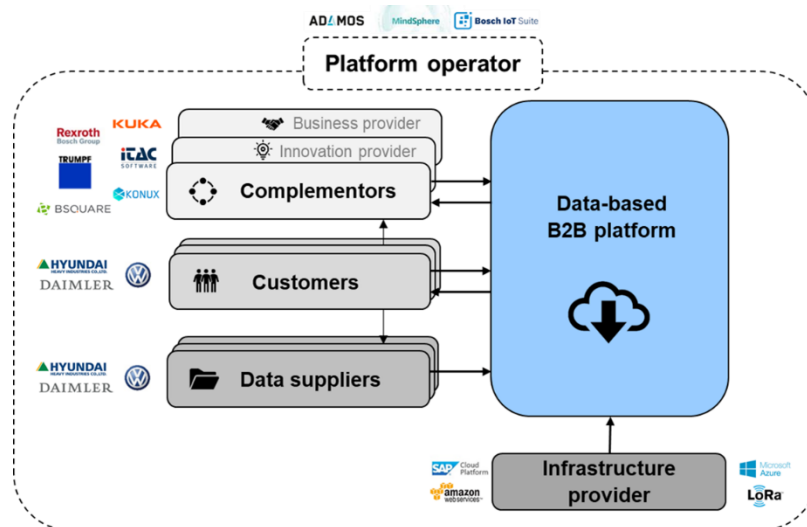


Figure 1: Actors involved in data-driven B2B platforms

(1) The *platform provider* (platform operator, platform shaper, intermediary) creates the basis for the exchange. The provider's role is to orchestrate the interactions between a network of businesses, people and assets that the provider does not necessarily control or own with the purpose of enabling the exchange of value between participants. The provider contributes the technological architecture and ensures the development of the platform's new business model. In addition, the provider must decide which actors are allowed to enter the platform and should be neutral regarding access rights. The provider also defines standards, interfaces, and the rules of interactions (e.g., data privacy policies or

payment terms). Thus, the provider determines the level of openness and the governance criteria to be met for using the platform (Abdelkafi et al., 2019; Schrieck et al., 2017; Tiwana, 2014).

(2) As the proprietary platform itself exhibits elementary or generic functionalities, platform providers depend on complementary services (e.g., software products) offered by third-party service providers, the so-called *complementors* (Baldwin & Woodard, 2008; Gawer & Cusumano, 2008; Hein et al., 2019a). Complementors develop and offer optionally usable complementary products and services for data collection, migration, cleansing, analysis, and processing, e.g., through big data and artificial intelligence tools, which create added value for the user (Hein et al., 2019a; Kansu & Parker, 2018; Davenport & Redman, 2020). The existence of numerous complementors increases the attractiveness of the platform for customers. Apple's Appstore can be seen as a good example for the B2C area.

(3) Complementors differ from *infrastructure providers*, who offer generic underlying technologies such as cloud computing or connectivity (Adner, 2017; Buchholz et al., 2021a; Russo & Wang, 2020). In the case of an open-services platform, infrastructure providers (such as Microsoft and Amazon) are also interested in becoming partners to gain access to the customer data the platform provider owns. They thus also benefit from the services offered and the information accumulated through the platform.

(4) Finally, on the demand side, platform users (*customers*) have to be defined. They transfer their processes onto the platform and are also an important data source for the platform (*data suppliers*). Their willingness to share individual data is a crucial component of the benefits that service providers can derive by using this platform (Kansu & Parker, 2018).

CoRM has to deal with two fields (see Figure 2). First, activities around the complementors themselves have to be managed (*partner management*). Second, topics relating to the technologies used play a major role in CoRM contexts (*technology management*).

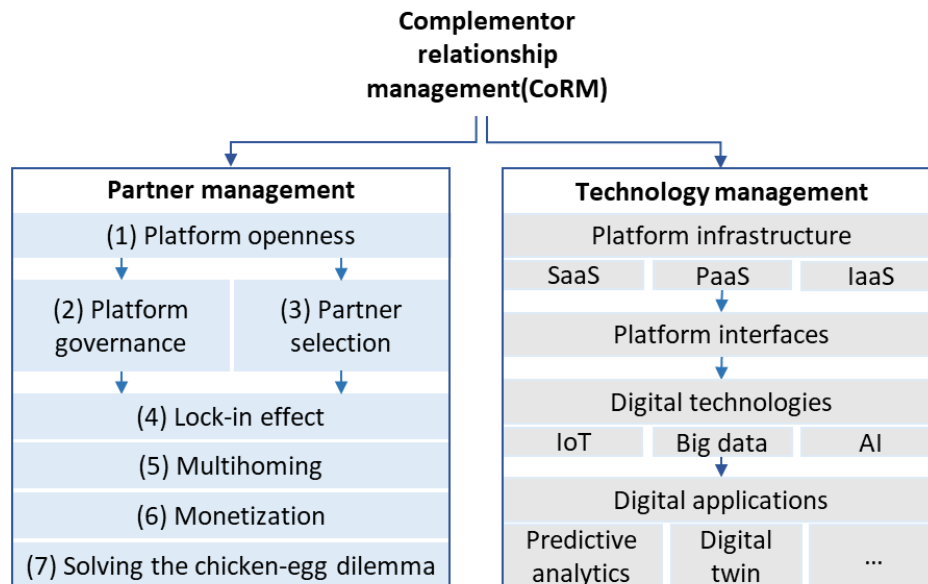


Figure 2: Conceptual framework for complementor relationship management (CoRM)

### 3.2 Partner management

#### 3.2.1 Platform openness

Platform openness has a major influence on the other fields of CoRM - especially on platform governance and partner selection - and is thus mentioned first. The degree of openness describes how a complementor's entry into and use of the platform is regulated. Two possibilities can be distinguished: open and closed platforms. In the case of *open platforms*, no restrictions or limitations exclude certain user groups. Complementors can thus use the offered IT infrastructure on an open platform, for example, to test a new application (Boudreau, 2010). *Closed platforms*, on the other hand, have certain requirements or use monitoring and quality-assurance processes that complementors have to pass through before they can operate on the platform (Van Alstyne et al., 2009). In our case study analysis, we have investigated four open platforms (cases P 2,3,7,8) and three closed platforms (cases P 1,4,5).

A platform must find a degree of platform openness that, on the one hand, attracts complementors while, on the other hand, ensuring that the platform stays permanently under control (Schrieck et al., 2019). The expert interviews confirm

that there is a dependency between the orchestration task of the platform provider and the openness of the platform. The hypothesis is that platforms, as markets, regulate themselves and therefore should be open. Based on this hypothesis, orchestration by platform providers is not necessary because providers who offer services that customers need will be used while those who do not offer the right services will remain unconsidered (Morgan, 2019). The more open a platform is, the lower the requirements are for a strong CoRM (e.g., social platforms). On the other hand, it can also make sense to have stronger restrictions concerning the access of complementors (e.g. P1). If access is restricted for customers, more rigorous selection criteria for complementors are also needed. Finally, a platform must find the appropriate degree of platform openness. On the one hand, it should attract complementors; on the other hand, it should ensure that the platform permanently stays in control (Schrieck et al., 2019).

### *3.2.2 Platform governance*

Platform governance defines the rules and regulations that platform providers need to balance in relation to their own and other participants interests, such as complementors and customers (Marheine, 2020; Shestakofsky & Kelkar, 2020). *Platform-governance mechanisms* help to regulate the transactions between complementors and customers on a digital platform (Lusch & Nambisan 2015; Reuver et al. 2018). The platform provider must achieve a healthy balance between its defined governance rules and the interests of the platform complementors. The platform might also be a competitor for complementors who enter complementary markets with similar services (Ghazawneh & Henfridsson, 2013; Marheine, 2020; Yoo et al., 2020; Zhu, 2019). An unfair distribution of values or a lack of technological necessities - such as appropriate interfaces (APIs) or flexible monetisation methods - can lead not only to the loss of complementors but also to the failure of the entire platform business (Ghazawneh & Henfridsson, 2010; Shestakofsky & Kelkar, 2020). Facilitating the entry of multiple complementors to a platform can be beneficial, but there are some limits. However, platform providers must carefully manage the number of service providers on their platform, as complementors also consider too much competition among complements to be unattractive (Jacobides et al., 2006; Yoffie & Kwak, 2006). Restrictions concerning interfaces provide a particular governance mechanism with which to monitor the entry of complementors on a platform

(Tiwana et al., 2010; Hein et al., 2019a). Platforms have to balance between retaining control on the one hand and fostering third-party innovation on the other hand (Case P7).

The method of *performance management* based on key performance indicators (KPIs) is more beneficial for closed platforms than for open platforms. This is because these platforms choose their complementors more actively and have fewer of them and because the performance of these complementors directly reflects the performance of the platforms. For open platforms, basic data security is an important requirement for applications, but no concrete control measures are relevant (cases P 2, 7, 8 and C1). Closed platforms achieve reliability and quality through control mechanisms and selection criteria. This quality assurance also includes ensuring that there are not too many overlapping offers on the platform (cases P1 and P4). However, platform business is not primarily based on control; it is based more on influence and reciprocity, which involve orchestrating resources rather than owning them (Parker et al., 2016).

### 3.2.3 Partner selection

Concerning partner selection, we found the two directions complementor selection and platform selection. Within the field of *complementor selection*, differences between open and closed platforms could be identified in particular. In case of an open platform, there is often no specific selection process. Those platforms do not choose in detail which service providers are granted access. For closed platforms, predefined services that they want to offer or the prescription of certain technologies might be criteria for complementor selection (Van Angeren et al., 2013). Cases P1 and P4 have specific selection criteria that are applied before a new complementor is included in the platform business. It is certainly beneficial to achieve an overall strategic fit between the platform provider and the complementor and to attract high-quality complements to the platform. Nevertheless, the platform provider must make complex strategic choices in managing the overall value of the platform and how that value can be influenced through the selective promotion of complements (Rietveld et al., 2019).

Complementors are often entrepreneurial start-up companies; therefore, it is difficult to evaluate their service capabilities in advance. The platform provider needs to identify the best-fitting complementors, and, in the best-case scenario, they become leaders in their field. A possible solution to this challenge involves the use of contests organised by platforms; these put the risk back onto the

service providers (Kansu & Parker, 2018). In addition, platform providers can reward successful complements, bring attention to underappreciated complements and influence consumers' perceptions of complementary services (Rietveld et al., 2019). Such incentives can be used to induce and reward the loyalty of preferred service providers (cases P6 and C1).

In addition, the platform selection process has been identified as relevant from the complementor's perspective. *Platform selection* - the procedure used for selecting platforms on which a complementor plans to become active - differs between some cases considered. If complementors follow a multi-homing strategy, an active market scan is mandatory (Case C1). The complementor in Case C2 receives requests from platform operators and is also actively searching for platform operators. Finally, in Case C3, the complementor is involved from the beginning in developing the platform by offering consulting activities and industry networking. However, we found that there are different ways in which complementors choose and become active on platforms.

#### 3.2.4 Lock-in effects

The importance of balancing the interests of different participants on a platform has already been described. This balance plays a central role when considering the phenomena of lock-in effects and multi-homing. *Lock-in effects* keep participants on the platform due to its inherent attractiveness. This leads to increasing switching costs and costs for operating on multiple platforms simultaneously, which makes it difficult for the complementors to change from one platform to another (Kude & Dibbern, 2009; Tiwana, 2014). The higher the asset specificity and the related investment requirements, the higher the dependence between partners and the lock-in effect. A platform's high asset specificity therefore increases the complementors' costs for adopting, operating and maintaining affiliation with a certain platform (Dellermann, 2016). For open platforms, e.g., P 2, 7 and 8, the lock-in effect is not necessarily problematic for the complementor. The experts point out the quality of their technological offerings, the benefits in efficiency and the win-win situation for the participants.

Moreover, an interesting result was obtained regarding the lock-in effect from the complementor perspective. In the literature, the lock-in effect is encountered almost exclusively in a negative context for the complementor. However, the expert interviews with complementors reveal that it can also be the other way round: namely, that the platform may become dependent on the complementor

(Case C3). Based on these findings, the definition of the lock-in effect presented in the theory section must be adapted to the extent that the risk of the lock-in effect exists both for complementors and for the platform provider.

### 3.2.5 Multi-homing

In contrast to the lock-in effect, multi-homing is an adequate complementor strategy. *Multi-homing* means that complementors offer their applications on different platforms (Cusumano et al., 2019). From a platform perspective, this is a risk because complementors may leave the platform when they are more satisfied with another platform. If we look at both phenomena from the perspective of the complementor, it becomes clear that lock-in effects are negative and multi-homing is positive. Offering the complementor's services on multiple platforms opens up access to a larger number of potential customers, reduces the risk and, in terms of economies of scale, boosts profits (Aydin et al., 2019; Lang et al., 2020). The experts consider multi-homing to be the most effective strategy for complementors in general and especially for start-ups. In contrast, the platform provider considers multi-homing to be a danger because knowledge, insights and services may be transferred to another platform, which in turn reduces the exclusivity of the operator's platform (Mukhopadhyay & Bouwman, 2019). The experts indicated that it is important to balance participation in different platforms with the costs of integration (via interfaces) and maintenance of services on the platform. The results also show that multi-homing requires more open platforms and fewer closed platform structures (Case P6).

### 3.2.6 Monetisation

Since the focus of a digital platform is more on cooperation and less on competition between the actors, a fair monetisation concept is essential for the complementary services offered. *Monetisation* concerns how complementors are charged for membership on a digital platform. A platform can operate with a *transaction-based model*, in which complementors are charged only if their services have been sold (de Panafieu and Breitenstein, 2018). Another option is a *membership-based model* in which the complementor has to pay a fee to be listed on the platform. The transaction-based model minimises entry barriers for complementors and therefore often leads to a higher user base. The membership-based model, on the other hand, guarantees a steady stream of revenue even if a complementor does not sell any services within a given period.



In addition, mixed models can be found which include a basic fee plus additional payment based, for instance, on the amount of data traffic or the number of connected APIs (Hodapp et al., 2019).

The question concerning monetisation also reveals differences between closed and open platforms. For example, a prerequisite for using a closed platform is often a subscription to the platform provider's basic product. Only then can the additional services of the complementors be booked. In the case of an open platform, there is no obligation to first subscribe to the platform providers' product (cases P 2,3,7 and 8). In case of an open platform, individual contracts are concluded between the complementors and customers, so there is no contractual relationship between the platform provider and the user groups on the demand and supply sides (cases P2 and P3). However, the opposite is true for closed platforms (P1 and P4), as the platform provider is then responsible for money flow between the users on the platform.

### *3.2.7 Solving the chicken-egg-dilemma*

The attractiveness of a platform increases with the number of users on both sides. Thus, the demand-side benefits from a larger offering of products or services. On the other hand, complementors benefit from a higher number of potential customers (Cennamo & Santalo, 2013; Ott et al., 2018). Without participants, the basic business model - which is to connect providers and customers and facilitate exchange among them - will not be successful (Hein et al., 2019a; Tiwana, 2014). This leads to the following question: How does a platform provider attract those from the supplier side to a platform without the presence of a demand side, and vice versa? This challenge is called the *chicken-egg-dilemma*.

The chicken-egg-dilemma also differs between open and closed platforms. In cases P1 and P4, they supplemented their existing product by offering a platform in addition. Here it is evident that a customer base already existed before the platform started. However, the situation is different for open platforms P2 and P3. In these cases, the chicken-egg dilemma has to be solved to attract users to the platform. Approaches to counteract this problem include reduction of entry barriers, establishment of incentives, use of licensing strategies, use of exclusive contracts, and subsidisation of one side of the market (Reuver et al., 2018; Veisdal, 2020).

From the complementors' perspective, the chicken-egg dilemma is mainly relevant to start-ups, e.g., Case C1. Expert C1 confirms the issue discussed in the literature concerning the unattractiveness of platforms which involve too many complementors while the user is not sufficiently represented. Due to their business models and positions in the market, the chicken-egg dilemma is hardly relevant to companies C2, C3 and C6.

### **3.3 Technology management**

#### **3.3.1 Platform infrastructure**

Besides the management of the platform partner, technology is another field CoRM has to deal with. The platform infrastructure and interfaces, the ground-laying digital technologies and the specific complementary services need to be managed. Concerning the platform infrastructure *cloud computing* is a central component of digital platforms. At its core, computing resources are provided via the internet which companies can use individually. These resources include servers, databases, software and applications. The use of cloud computing offers numerous advantages for companies: Pay-per-use models, low maintenance efforts, high computing power, access independent of time and location are a few of them (Lindner et al., 2020; Gupta et al., 2019). The development of cloud solutions instead of inhouse-on-premise solutions is a highly topical issue. In a study by the International Data Cooperation (IDC) from 2019, 70% of the CIOs stated that they would implement "agile connectivity" via API by 2021 to enable interfaces to cloud providers, start-ups and other providers (Eriksdotter, 2019). Three different service models for cloud computing are possible:

*Infrastructure as a Service (IaaS)* is the virtual provision of data centres, virtual networks, storage and servers. The design of the platform in terms of software or the operating system is entirely in the hands of the user (Shahzadi et al., 2017). This provides the user with high flexibility and scalability (Castro-Leon & Harmon, 2016). The three largest providers (by turnover) in this area are Amazon with Amazon Web Services (AWS), Microsoft with Microsoft Azure and Alibaba with the Alibaba cloud. *Platform as a Service (PaaS)* also offers other cloud-based services in addition to the fundamental structures covered by IaaS (Case P2). Here, the service provider also manages the operating system, the middleware and the runtime of the platform (Hentschel & Leyh, 2018). PaaS is an environment that extends IaaS with structures that allow developers to program, test, run and

update their applications (Giannoutakis et al., 2020; Shahzadi et al., 2017). *Software as a Service (SaaS)* represents the third level of the three cloud computing service models. In addition, the SaaS model provides applications, programs and web tools. Thus, this cloud computing service model includes not only the provision and maintenance of IT-hardware components (Case P1). The service provider is also responsible for administration, maintenance and updates (Castro-Leon & Harmon, 2016). SaaS is aimed less at IT architects and software developers. The majority of the target group addressed by SaaS are end users who use the applications for operational business (Lindner et al., 2020).

### *3.3.2 Platform interfaces*

One important entry barrier that also has an impact on the quality of complementary services is the definition of standardised interfaces. These describe the extent to which the interface between the complementary service and the platform is stable, formalised, and well documented (Dellermann, 2016). Such clarity and transparency offer technological stability to the complementors and hence reduce technological uncertainty (Tiwana, 2015; Kansu & Parker, 2018). An important issue in that context is the integration of the different legacy systems of the players involved. This integration is highly relevant for implementing a successful platform. Without it, both internal and external players cannot access the same database to drive insights and develop products and services (Kansu & Parker, 2018). However, standards can also encourage competition within complementary activities.

*Application Programming Interface (API)* is the interface that enables communication and exchange of data between programs, applications, organizations and things. In the context of data-driven platforms, they play an outstanding role regarding the standardised connection of users to the platform (Iyengar et al., 2017). Cases P2 and P8 are offering standardised interfaces to make connection easier for participants. On the one hand, APIs enable to build a digital ecosystem with the help of partners (complementors and customers) and secure and standardise the connectivity between these entities (Pettey, 2017). On the other hand, they enable the monetisation of data by providing the interface between different entities in the digital ecosystem (Collins & Sisk, 2015).

### 3.3.3 Digital technologies

The digital technologies Internet of Things (IoT), Big data and Artificial intelligence (AI) are the main technologies that are relevant in the context of data-driven platforms.

The *Internet of Things (IoT)* is a network of internet-connected devices equipped with sensors and APIs that can recognize each other and can collect and exchange data by connecting to the internet. Physical objects include machines, vehicles, smart devices, cameras, and sensors among others (Walsh, 2020; Ng & Wakenshaw, 2017). The data generated by the IoT network is the basis for data-driven platforms (Deichmann et al., 2016; Ben-Daya et al., 2019). In pipeline business a machine is basically bound to a location and can therefore only provide its benefit in this local environment. The IoT connects the machine with the internet through sensors and actuators. This allows that a digital image of a machine or the machine operation can be followed regardless of its location (cases P 2, 5 and C1). A data-driven platform collects and analyses the recorded sensor data and the functionality of the machine can be maintained and optimized by using the analysis results (Deichmann et al., 2016).

As the term data-driven already suggest, big data is the basis component for data-driven platforms. In 2001, Doug Laney, an analyst at Gartner Inc., introduced a definition that was used and expanded in the following years to define the term *Big data*. "Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation" (Laney, 2001). Concerning the data structure, it can be distinguished between unstructured, semi-structured and structured data. Especially for unstructured data, big data analytics is offering new opportunities in order to utilize this data strategically for business management purposes within the company (Sedkaoui & Khelfaoui, 2020; Wamba et al., 2017; Gandomi & Haider, 2015). For risk management platforms in procurement this is an important business case.

*Artificial intelligence (AI)* is the ability of a machine to perform cognitive functions associated with human minds by perceiving its environment. This includes data acquisition, interpretation, reasoning on the knowledge, or processing the information, derived from this data for problem solving, and even exercising creativity (European Commission, 2019).

Although the term artificial intelligence has only become widely known in recent years, it was used by researchers already in the 1950s to distinguish it from natural intelligence (Dignum, 2019). A multitude of technologies nowadays is assigned to AI, e.g. machine learning, deep learning, natural language processing or neural networks. In a platform context, AI supports automating business processes, gaining insight through data analysis and engaging with customers and employees (Davenport & Ronanki, 2018). Also the fields of application for AI are extremely diverse. This technology for instance is used in healthcare, traffic safety, manufacturing, consumer electronics, the financial sector or especially currently in the fight against the COVID-19 pandemic (Vaishya et al., 2020). A key component of AI technology in business contexts is extracting patterns from a large amount of data, which can then be used for running a data-driven platform. Based on AI technology, Case P1 is analysing big amounts of documents, e.g., invoices or contracts, to achieve a higher process efficiency.

#### 3.3.4 Digital applications

Predictive analytics and the Digital Twin are among others two important applications on data-driven platforms. *Predictive analytics* helps a company to take an action before a certain outcome of a situation is to be expected. Case P4, e.g., is offering decision support in drilling for farmers. Besides the known concept of predictive maintenance, there are other use cases that utilize predictive technology, such as predictive procurement or predictive production planning (Ogunleye, 2014). Predictive maintenance applied the idea to the maintenance of a machine, which means recognizing the need for maintenance or the threat of downtimes in advance (Wennker, 2020). The ability to strategically plan countermeasures into the production process is a particularly important advantage of predictive maintenance. The failure of one machine or sub-machine can lead to further downtimes in the production process and thus cause high costs. Moreover, the possible procurement of the required spare parts can lead to extended downtimes (cases P 2, 4 and 5). For example, machine defects can be detected via sensors that record a certain level of vibration. Connected to a data-driven platform, the data can then be analysed in real time and, depending on the results, countermeasures can be initiated. In this way, it is possible to identify sources of error that a human being might not even have noticed and downtimes are reduced (Foltyn, 2020). Furthermore, the data can be used by other machine users to optimise their machine usage. Predictive maintenance is a specific data

application of AI that is of central importance, especially when considering data-driven platforms. In open platform ecosystems, such specific applications are often provided by complementors.

A *digital twin* digitally replicates a physical machine, object or process and thus represents the digital counterpart to the physical object (Geisselbauer et al., 2020). The main benefit is, that not only the company itself can use the replica, but also suppliers, customers and other parties involved. Data-driven platforms provide the simulation of future scenarios, deviations, or improvements of the physical object. Thus, processes of the entire life cycle of a plant can be transparently displayed, from the planning phase to the operating phase to maintenance measures (cases P 2, 5 and 7). In addition, networking with other machines, objects and systems included in the value creation process enables a more holistic control of the entire value creation process (Kaufmann & Servatius, 2020; Ivanov & Dolgui, 2020; Ding et al., 2019).

Furthermore, digital twins can be used before the machine even physically exists. Error avoidance as well as optimisations in advance, before the physical image is realized, can thus be achieved by simulations (Haselbauer et al., 2018; Klostermeier et al., 2018). The digital replica of production sites, warehouses, transport routes, capacities and material flows could lead to an enormous increase in transparency and acceleration of processes through decentralized control (Dittmann, 2020). Platform users can use a digital twin alongside their supply chain, especially to monitor the material flows. Based on a cloud solution, data generated at various points in the material flow is collected and finally analysed. The analysis is carried out by using AI algorithms to make predictions about upcoming bottlenecks. On this basis, countermeasures can thereby automatically be initiated to avert the impending risk (Geisselbauer et al., 2020).

#### **4 Conclusions**

Based on a literature study, we have developed a framework for CoRM. In the scope of our first research question, we have described how partner management looks for data-driven B2B platforms. The interviews reveal that it is necessary to distinguish between closed and open platforms when answering this question. On the one hand, for closed platforms, the strategic fit between platform and complementor is highly important. They use specific requirement catalogues for desired use-cases. On the other hand, open platforms typically have no selection

process for complementors. Furthermore, closed platforms are often founded by incumbent firms and offer a central service for an industry (e.g., a data platform for agricultural companies). Thus, they have an exact consideration of the services they need to have from complementors, whereas open platforms only define basic requirements (e.g., data security and data privacy). However, both types try to lower barriers of entry to overcome the chicken-egg-dilemma. Concerning monetisation, subscription models are preferred within closed platforms, whereas open platforms more often use transaction-based models. CoRM must find a balance between intended lock-in effects to bind attractive complementors and the phenomenon of multi-homing, where complementors try to participate on many platforms.

Moreover, we found some important aspects regarding technology management on data-driven B2B platforms. The platform infrastructure is mostly provided by tech giants like AWS or Microsoft Azure. To enable communication and an easy exchange of data standardised interfaces (APIs) are important, especially for open platforms. The main digital technologies used by data-driven B2B platforms are IoT, Big data and AI. Among others predictive analytics and digital twins are often used digital applications.

Although digital platforms are a popular topic in the management literature and practical business applications, little research has been conducted on the supply side of data-driven B2B platforms. Our findings give insights into the management of platform service providers for data-driven B2B platforms: the so-called complementors. Our research contributes to the theory in three ways (Makadok et al. 2018). First, we have combined findings on digital platforms with findings on the management of complementors, which is only analysed in a very rudimentary way in the literature. Second, our work focuses on a specific type of digital platform, the data-driven B2B platform, for which little research currently exists. Third, we have for the first time conducted a dyadic analysis in combining first the two perspectives of the platform provider and the complementor and second partner with technology perspective in a holistic approach on CoRM.

For practitioners, we found several benefits of partnerships with complementors. First, services can be provided at much lower cost and with less effort through a platform instead of building new offerings from the bottom up. Second, there are possibilities of owning as well as sharing large amounts of customer data. Access to aggregated customer data can be a key success factor for innovation and business providers. The data can be used as input to improve

existing services and to develop new applications. However, platform providers must manage how complementors can access the platform to offer them incentives for further business potential. Thus, data sharing offers new options for value creation for all platform stakeholders. For the success of a data-driven B2B platform, it is important to have strong partnerships with several complementors and to select the right service providers for the platform. Close partnerships with complementors can also speed up the innovation process. Product and service innovation can be outsourced to the service providers. Complementors also benefit from a partnership with the digital platform. Digital platforms help them scale products and services into the market much faster with the support of the platform provider's brand value.

Nevertheless, some risks appear when one works predominantly with complementors, which are often start-ups. Start-up service providers tend to be smaller companies that have higher financial risk. Partnering with poorly performing start-ups may cause a lower quality service for customers. To be successful in the long term, platform providers must establish a working CoRM system that helps to identify the best partners. The main functions of CoRM range from simple applications, such as a support system for inquiries, to more complex applications, such as platform governance, performance tracking or fraud identification (Meffert and Swaminathan, 2017).

Because of the novelty and high relevance of data-driven B2B platforms, we have followed an exploratory research design with expert interviews combined with literature research. Although we have had the opportunity to address 14 cases out of a vast landscape of data-driven B2B platforms and complementors, our generalised assumptions are not necessarily representative. Thus, the validity of the data is limited by the relatively small number of cases. In addition, concerning the validity and quality of the data, general limitations of the expert interviews must be identified. Our exploratory study is to be seen as a starting point for CoRM for data-driven B2B platforms.

This study provides initial insights into the subject area of CoRM. Conducting further case studies in this field (potentially with a greater focus on the technology of data-driven B2B platforms) and offering deeper insights into concrete methods of CoRM would complement this study. The inclusion of customers' perspectives into the analysis could also help us gain a deeper understanding of platform relationships. Complementors are often start-ups; thus, literature in the field of entrepreneurship is also a possible area of analysis.



The focus of our study is the data-driven B2B platform. A comparison of our findings with B2C platforms, on the one hand, and transaction platforms, on the other hand, might comprise an interesting additional field of research. Finally, the relationships between complementors, which might be cooperative and competitive, are also worth considering in the future. All in all, we are convinced that the topic offers high potential for future research.

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## **Nudges and Healthy Food Consumer Choices in Diverse Environments: Extant Knowledge and Research Directions**

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### **Abstract**

The increasing rates of diet-related health problems remain a significant social issue of today, and even more in the incidence of the Covid-19 pandemic. However, even when the pandemic subsides, it is still vital to maintain healthier lifestyles, particularly concerning the choice of healthy food. Despite people's inherent consciousness of the positive impacts of healthier food choices, there is still a need to stimulate further and encourage consumers to manifest the desired behaviour. Over the past years, evidence is growing on the use of "nudges" – a concept in the framework of nudge theory in behavioural economics, aiming to induce behavioural changes among people and consequently counter diverse social issues. Nevertheless, as the concept is still in its infancy, a paucity of knowledge remains as to the types of nudges empirically examined in the foodservice sector, their efficacy in in-



store and online retail environments, and the subsisting concerns needed resolves in future research initiatives. In response to this, a comprehensive literature review was conducted. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, about 80 journal articles published from 2014-2021 in the Scopus and Web of Science databases were reviewed. The selection covers research papers that experimentally assessed the nudge as behavioural intervention in the healthy food choice. Key findings reveal many nudges tested in the existing literature and have proven their effectiveness in healthy consumer choices. Nevertheless, specific population characteristics may influence the effectiveness of the intervention. For instance, verbal prompts, internal commitment devices, and nudges with hedonic attributes eliciting entertainment and enjoyment seem more promising for children than adults. Meanwhile, descriptions (nutrition labelling), placement (proximity/visibility), and visual enhancement nudges work effectively on the adult population in real-world or lab-based experimental setups. The review findings likewise recognize the scarcity of knowledge on the use and effectiveness of nudge interventions in virtual environments. Hence, with the increasing relevance of off-site shopping, the examination of nudges towards healthier food choices among consumers is a promising research direction. Extant studies have suggested further investigation of healthy food nudging interventions in diverse environments (i.e., low-income countries and vulnerable population groups) to offer more conclusive and complement extant findings. Indeed, the problems associated with a healthy diet affect the health of society and, consequently, economic performance. Nudge interventions are simple, effective, and low-cost tools that can have a very invasive positive effect on consumers within healthier consumer choices. Acquiring comprehensive knowledge would be relevant to various online and offline enterprises in promoting healthier food choices among consumers and together support public policies to mitigate health-related issues in societies around the globe.

**Keywords** – Behavioural Economics, Consumer Choice, Food Choice, Healthy Eating, Nudges

**Paper type** – Academic Research Paper

## 1 Introduction

According to World Health Organization (2021), 39% of adults and more than 340 million children and adolescents are overweight or obese in 2016. As the risk of diseases directly relates to obesity, this aggravates today's health and social issues. Encouraging people to make healthy food choices plays a vital role in ameliorating obesity and other weight-related issues (Hussain et al., 2020). The Covid19 pandemic makes this issue even worse; hence, accruing the seriousness of promoting a healthy diet. The World Health Organization (2020) advised some policy interventions that governments around the globe can adopt in promoting

a healthy diet. These include creating awareness in consumers, supporting a point-of-sale information, encouraging children to acquire and maintain a healthy diet through different means through education, school programs, and interventions.

Nevertheless, Kroese et al. (2016) argue that changing behavioural patterns can transpire by using unobtrusive strategies (i.e., environmental adjustments) while retaining autonomy on consumer decisions. Specifically, in eating behaviour, one aspect of the consumer decision process is primarily guided by cognitive biases and simple cues in the environment. Therefore, understanding the underlying behavioural mechanisms and the influence of environmental cues can offer a rationale for policymakers to design behaviourally informed policies and consequently address health-related problems.

A nudge is an emerging form of behavioural intervention that enfolds any aspect of the choice architecture. Its basic principles brace on changing an individual's behaviour by making it predictable, retaining freedom of choice while voiding economic incentives (Thaler & Sunstein, 2008). Its growing application attributes to the ease of its implementation and cost-effectiveness. Its usage is apparent in diverse disciplines, specifically as solutions to health, environmental, pension savings, and even problems in everyday life. However, a crucial debate remains as regards to its transparency, efficacy, and persistence effects (Marchiori et al., 2017).

The diffusion of technology in everyday life and the booming movement towards online shopping accordingly increases the relevance of "digital nudging." One example of its application is enriching user interface design elements to influence users' choices in the digital environment. Moreover, it raises pressing questions about the applicability, translatability, and efficacy of nudges from the physical to virtual environments. Hence, owing to the growing evidence on the effectiveness and the low-cost nature of nudge interventions in the diverse milieu, this paper comprehensively reviews the existing interventions that influence consumers' choice towards healthier food in offline and online environments. As to the authors' best knowledge, no thorough inventory of nudges and collation of its efficacy in physical and online environments exist in the retail and foodservice sector. Also, extant empirical initiatives have suggested examining the combined effects of nudges; nevertheless, knowledge-base on which types of nudges to combine or applied that may offer higher efficacy on specific environments is still scarce. Hence, the study aims to secure the knowledge on

the existing interventions in the framework of nudge theory in behavioural economics empirically examined in a healthy food choice context. Under this core aim, we proposed the following research questions:

- What are the types of nudges empirically examined in physical and virtual settings?
- Which scenario and health-related concern that "nudges" addressed?
- How effective are the nudges in directing the desired behavioural outcome?
- What are the key issues and future research directions that the extant literature proposes?

Nudge interventions are simple, effective, and low-cost means that can have a very invasive positive effect on consumers within healthier consumer choices. Acquiring comprehensive knowledge would be of relevance to various online and offline enterprises in promoting healthier food choices among consumers and together support public policies in the pursuit to mitigate health-related issues in societies around the globe.

## 2 Methodology

The systematic literature review process anchors on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Page et al., 2021). Figure 1 reflects the PRISMA flow diagram, which outlines the sequential actions undertaken to identify, screen, and include research articles in this review. Apropos to the thematic focus of this review paper, the researchers have chosen a set of relevant keywords before the search query in the scientific databases. By reflecting on the researchers' present knowledge and exploratory perusal of some research articles utilizing nudges as a behavioural intervention in the food and health-related fields, it shows that "nudge," "choice architecture," "behavioural economics," and "nudge theory" are commonly cited keywords. Subsequently, we set up a structured search query by infusing logical operators "OR" and "AND" along with the initial keywords identified (*search string: "nudge" OR "choice architecture" OR "behavioural economics" OR "behavioural economics" OR "nudge theory" AND "food"*). We launched the query in the worlds' leading scientific databases, namely the Web of Science and Scopus database. Besides, Zhu & Liu (2020) knowledge domains for meta-analysis and bibliometric studies due to the availability, quality, and extensive coverage of academic research papers. The

search query resulted to:  $n^{WOS} = 12,994$  and  $n^{Scopus} = 35,238$  scholarly papers. We further filtered the result and excluded scholarly works published before 2004, articles not published in journals, articles not in the economics, health, or non-food domains. In so doing, it substantially reduced academic articles to 719 ( $n^{WOS} = 319$  and  $n^{Scopus} = 400$ ). Then, we excluded 57 duplicated records leaving 662 articles in the screening stage.

The screening of the research articles followed specific inclusion criteria to ensure that the identified articles align with the core objective of this paper. These include: 1) a discourse on "nudges" as behavioural intervention; 2) an experimental (field/laboratory/online) assessment on the efficacy of nudge intervention; 3) nudge application towards the choice of healthy food. The evaluation focused on the titles and abstracts of the selected articles and was performed manually among the researchers. This procedure further discarded 562 articles, hence, sought 100 papers for retrieval. Nevertheless, 7 of the papers were inaccessible, leaving 93 of them for full reading and analysis. We extracted data on the following: the year of publication, source reference, country of origin, underlying health/food-related concern of the study, type of nudge intervention, type of respondents (study subjects), type of experimental scenario/setup, and the nudge efficacy in general. However, while still bearing in mind the screening criteria, 13 more papers were not within the scope, hence excluded. In total, 80 research articles were thoroughly reviewed and scrutinized for any issues or concerns which may need to be addressed in future research. The extracted data were manually encoded in Microsoft Excel, and the descriptive analysis for some metadata was performed using IBM SPSS Statistics version 23.

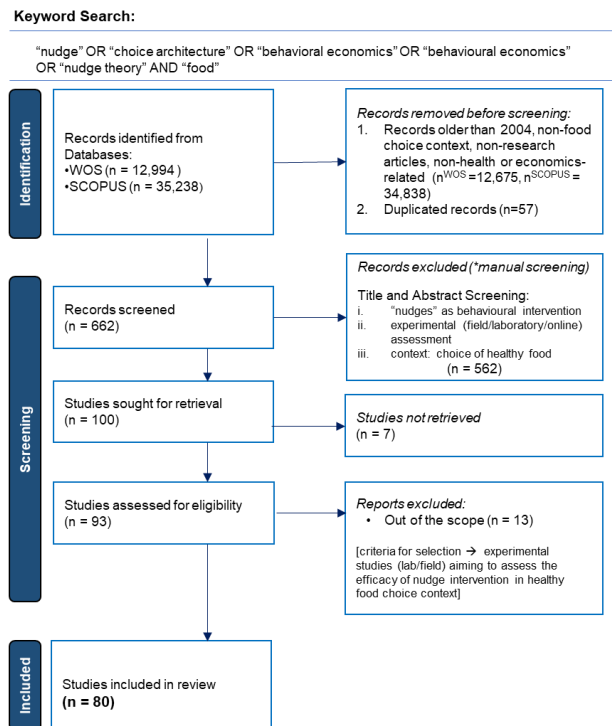


Figure 5. Systematic literature review process adopting PRISMA Guidelines

### 3 Results and Discussion

#### 3.1 Basic profile of articles

The study comprehensively reviewed 80 research articles after passing through the prescribed eligibility and screening criteria. The majority were published from 2018-2020 in top-tier international journals such as *Appetite*, *Public Health Nutrition*, *Journal of Behavioural Nutrition and Physical Activity*, *BMC Public Health*, and so forth. The analysis also reveals that the scholarly works pervade cross-cutting research disciplines, ranging from nutrition and dietetics, health, business economics, behavioural sciences, etc. However, the studies mainly originate and concentrate on the world's most advanced economies, such as the United States, Canada, Netherlands, France, Italy, England, and Australia. Table 1 shows the basic profile of the reviewed articles.

### 3.2 Types of nudges in the food choice context

A crucial inquiry of this review paper is to specify the different type nudges with empirical support in the physical and virtual environments. The findings reveal the diverse forms of nudges examined in the existing literature. Hence, we categorized and described nine major nudge categories with examples (Table 2). Prompts, descriptions, presentation, and placement nudges are predominantly investigated. These nudges seem to encase information and perceptibility cues that enhance the salience of targeted products and consequently stir people to enact a desired behaviour. It also observed that scholarly works combined different types of nudges and examined their effects on the choice and consumption of healthy food in natural/field settings. Meanwhile, the impact of nudge interventions is commonly observed among the adult population targeting diverse diet-related issues. Studies also considered the children and adolescent groups in promoting healthy diet suchlike increasing fruit and vegetable consumption in school canteens and cafeterias. The importance of imbuing a healthy diet in the early life stages could establish the foundation for a healthier lifestyle and can promote overall health during adolescence and adulthood.

Table 14. Descriptive analysis of the selected and reviewed research papers (n=80)

Year of Publication	n	Journal	n
2014	3	Appetite	17
2015	7	Public Health Nutrition	7
		International Journal of Behavioural Nutrition and Physical	
2016	3	Activity	5
2017	8	Nutrients	5
2018	17	BMC Public Health	4
2019	21	American Journal of Clinical Nutrition	3
2020	18	Journal of Economic Behaviour & Organization	3
2021	3	American Journal of Agricultural Economics	2
		Others	36
Country of Origin	n	Research Area (Field)*	n
USA	40	Nutrition Dietetics	42
Netherlands	11	Business Economics	20
England	8	Behavioural Sciences	19
France	8	Public, Environmental, Occupational Health	18
Canada	7	Psychology	8
Italy	7	Physiology	5
Denmark	4	Agriculture	4

Australia	3	Food Science Technology	4
Switzerland	3	Health Care Sciences Services	2
Others	11	Others	42

\* articles fall on multiples research fields; n – number of articles

### 3.3 Nudges and Targeted Health-Related Concern

Conversing about a "healthy diet" is notably a broad subject matter. Besides, ascertaining a healthy versus unhealthy diet can be challenging due to individual-level and context-specific differences. Therefore, we refer to the World Health Organization (2020) as it delineates the basic principles of a "healthy diet" into several facets, including i) balanced energy intake with energy expenditure (calories), ii) consumption of fruits, vegetables, legumes & whole grains, and iii) limiting sugar, salt, and fat intake. In light of these, the in-depth review reveals that 25 papers confer the improvement of diet in general, while 55 studies address a specific aspect of a healthy diet. At the fore tackles the surplus calorie intake from out-of-home consumption and discretionary food (snacks) (n=26). Another pertinent area of concern focuses on the inadequate consumption of fruits, vegetables, and fibre-rich food (n=22). The interventions considerably targeted the children population as fruit and vegetable consumption seems lower than the defined standards (Bucher et al., 2014; dos Santos et al., 2020; Mariel Marcano-Olivier et al., 2019; Mistura et al., 2019). Meanwhile, only a few studies (n=7) have explicitly applied nudges to counter excess salt, fat, and sugar intake.

Table 2. Categorization of nudges and examples

Category	Description/examples	n
Prompts	Verbal/written persuasive reminders, social norms, commitment devices & signages	26
Descriptive	Product labelling (nutritional labels)	21
Presentation	Changing how targeted products appear (packaging, different shape of food, portion size, printed plates, other artworks, and visuals)	18
Placement	Placing target products based on proximity or product visibility and other location and positioning parameters	17
Availability	Increasing availability and variety of products. It also captures financial/cash-back incentives.	10
Contrast	Changing visual brightness/contrast, frames or boxing on menu items, arrows to increase the salience of target products	11
Default	Pre-set options for decision-makers	10
Semiotics	The use of icons, marking of traffic lights, emoticons, naming logos, other marks	5

\*n – number of articles

### 3.4 Scenario Specification and Experimental Set-up

The analysis bares many studies assessing the efficacy of nudges abetting the choice and consumption of individuals towards the targeted food items in the dining points in the school environment (Figure 2). Additionally, the nudges are also applied to in-store food retail settings, encompassing conventional supermarkets, grocery, and convenience stores. Most of the investigations are orchestrated in the field (real-life) setting, permitting data extraction of naturally elucidated behaviour from the study participants. The natural setup is advantageous as it suffices and enriches the external validity of the research results. Nevertheless, en masse with all other field experimental setups, it is clear that confounding factors are hard to control and may influence the experimental outcomes. Also, the studies suffer some practical issues, including intricacy in measuring outcome variables, sample representation issues, Hawthorne effect, and other logistical issues. Notably, only a few papers have applied and experimented with nudges in online or virtual environments, despite the progressing online presence among retailers in the foodservice sector.

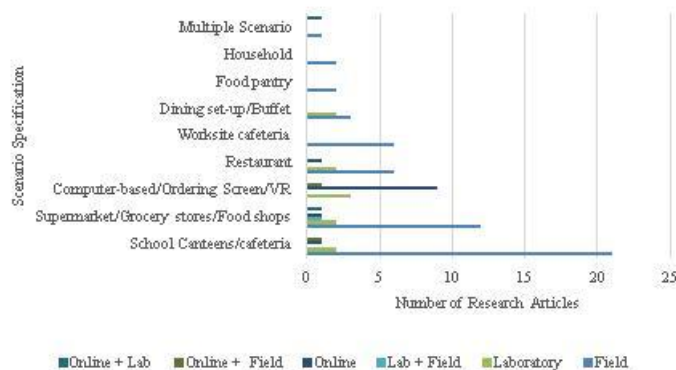


Figure 6. Number of articles based on scenario and type of setup

### 3.5 Efficacy of Nudge Interventions

Further analysis detects the prevalence of empirical results in support of the efficacy of nudges in directing consumers to choose healthier food alternatives, may it be in the context of out-of-home food consumption or purchases in retail food outlets (Table 3). Descriptions (labelling) and verbal/written prompts are just some of the nudges frequently demonstrating significant effects on behavioural



outcomes in both laboratory and field environments. For instance, Cioffi et al. (2015) findings indicate an increase in sales of low-fat and low-calorie foods in the university setting, following the use of descriptions such as calorie and nutrition labels. Dallas et al. (2019) also found that labels with calorie information effect when placed to the right of food, but they have a significant effect when placed to the left. Many other studies conform to the efficacy of descriptive nudges in improving diet in general (Byrd et al., 2018; Colson & Grebitus, 2017; Gustafson & Prate, 2019).

Nevertheless, Castellari et al. (2018) assert that nutritional information may not work if not linked with other interventions. In the online environment, the usage of descriptive nudge is also evident; however, a few recent studies documented the affirmative impact of the nudges in the online setting across all reviewed papers. To cite a few, the online-based study of Gustafson & Zeballos (2019) indicates that participants without access to calorie summation significantly underestimated the number of calories they order. Another is pre-filling a shopping cart with healthy foods, which has led individuals to make healthier food choices (Coffino et al., 2020).

In general, one can apply nudges to different population groups (i.e., children, adolescents, adults, and elderly); however, we noticed some patterns in how the studies design and impose the nudges. Notably in children population groups, nudges confirming its effect somehow hold hedonic attributes, enabling targeted food items to be more salient and appealing for them (Hubbard et al., 2015; Kleef et al., 2014; M Marcano-Olivier et al., 2019; Mistura et al., 2019). The work of dos Santos et al. (2018, 2020) even argues the significant effect of the conventional labelling approach among children despite evident efficacy among adults. The setup of Cravener et al. (2015), which presented vegetables in boxes with cartoon characters, contained stickers, which could then be exchanged for prizes, have all been shown to stir healthy food choices among children. Commitment devices Samek (2019) and conditional incentives (List & Samek, 2015) equally aid children in stirring their choices towards the targeted food products. Furthermore, the work of Olstad et al. (2014) and Thunstrom (2019) recognizes the heterogeneity in the effectiveness of behavioural economic interventions (i.e., nudges) due to complex and context-specific issues. For instance, the level of efficacy of labelling as used by some studies is contingent on placement (Dallas et al., 2019; Manipa et al., 2020), order of information (Gustafson & Prate, 2019), type of information (Sogari, Li, Lefebvre, Menozzi, Pellegrini, Cirelli, Gómez, et al., 2019), or presence

of information trade-off (Gustafson & Zeballos, 2019). Meanwhile, individual-level characteristics viz restrained vs. unrestrained eater (Tonkin et al., 2019), dining frequency (PolICASTRO et al., 2017), indulgent vs. health-conscious (OTTO et al., 2020), low vs. high cognitive load (CARROLL et al., 2018), socioeconomic class (NAGATOMO et al., 2019), and gender (MOHR et al., 2019) found to matter as well for other types of nudges.

The use and simultaneous deployment of two or more nudge interventions bring forth better behavioural outcomes. The evidence from the work of Vermote et al. (2020) which probe the effect of food label in combination with semiotics and social norm nudges has significantly directed behaviours towards purchasing fresh fruits. The empirical work of Hoenink et al. (2020) also endorses some synergetic effects of nudges in combination with traditional interventions (i.e., pricing), resulting in to increase in healthy food purchases. Another remark from (Caspi et al., 2019; Castellari et al., 2018) emphasizes the need to integrate behavioural interventions as findings refute behavioural effects when an intervention is singled out (e.g., solely increasing food availability). Following this integrative approach allowed the nudges to exhibit some persistence effects lasting 11 to 12 weeks (Velema et al., 2018; Vermote et al., 2020). Bearing this may address the shortcomings acknowledged from the existing studies ascertaining a nudge effect yet only examined in a limited period.

Table 3. Consolidated assessment of nudges from the reviewed articles

Author, Year	Intervention								Consolidated Findings
	DC	DF	PL	AV	CN	PR	SM	PM	
Bucher et al., 2014				\					Supported
Kleef et al., 2014						\			Supported
Olstad et al., 2014	\			\					Supported
Cioffi et al., 2015	\								Supported
Cravener et al., 2015						\			Supported
Downs et al., 2015	\								Supported
Hubbard et al., 2015				\		\	\	\	Supported
List & Samek, 2015								\	Supported
van Kleef et al., 2015								\	Supported
Kral et al., 2016				\					Supported
Kroeze et al., 2016			\						Supported
Miller et al., 2016						\		\	Supported
An & Sturm, 2017				\					Supported
Colson & Grebitus, 2017	\								Supported

Hou, 2017			\				\	Supported
Leak et al., 2017		\		\		\		Supported
N. L. W. Wilson et al., 2017								Supported
Policastro et al., 2017							\	Supported
Sihvonen & Luomala, 2017							\	Supported
Anzman-Frasca et al., 2018						\		Supported
Byrd et al., 2018	\							Supported
Carroll et al., 2018		\		\				Supported
Grutzmacher et al., 2018							\	Supported
Kurz, 2018			\					Supported
Labbe et al., 2018				\		\		Supported
Mazza et al., 2018	\			\	\		\	Supported
Petit et al., 2018						\		Supported
Radnitz et al., 2018		\						Supported
Robinson & Kersbergen, 2018						\		Supported
Van Gestel et al., 2018			\					Supported
van Kleef et al., 2018		\						Supported
Velema et al., 2018	\	\	\	\		\	\	Supported
Walmsley et al., 2018			\					Supported
Bergeron et al., 2019		\						Supported
Caspi et al., 2019			\		\	\		Supported
Chapman et al., 2019	\		\	\	\		\	Supported
Cheung et al., 2019			\			\	\	Supported
Dallas et al., 2019	\							Supported
Gustafson & Prate, 2019	\							Supported
Gustafson & Zeballos, 2019	\							Supported
Marcano-Olivier et al., 2019	\		\			\		Supported
Mohr et al., 2019					\		\	Supported
Moran et al., 2019		\						Supported
Nagatomo et al., 2019				\				Supported
Reijnen et al., 2019			\					Supported
Sadoff & Samek, 2019	\	\		\			\	Supported
Samek, 2019							\	Supported
Saulais et al., 2019					\			Supported
Sim & Cheon, 2019							\	Supported
Sogari et al., 2019							\	Supported
Thunström, 2019	\							Supported

Tonkin et al., 2019	\					Supported
Allan & Powell, 2020					\	Supported
Boehm et al., 2020	\	\	\			Supported
Cawley et al., 2020	\					Supported
Coffino et al., 2020	\					Supported
Dai et al., 2020			\			Supported
De Marchi et al., 2020					\	Supported
Gustafson & Zeballos, 2020	\					Supported
Hoening et al., 2020		\	\			Supported
Huitink et al., 2020	\				\	Supported
Knowles et al., 2020		\		\		Supported
Lai et al., 2020					\	Supported
Lange et al., 2020				\	\	Supported
Manippa et al., 2020	\					Supported
Montagni et al., 2020	\					Supported
Otto et al., 2020					\	Supported
Ozturk et al., 2020	\			\		Supported
Vermote et al., 2020	\				\	Supported
Blom et al., 2021			\			Supported
Davidson et al., 2021	\			\		Supported
A. L. Wilson et al., 2015					\	Not supported
Zandstra et al., 2017					\	Not supported
Castellari et al., 2018	\					Not supported
dos Santos et al., 2018			\			Not supported
Pechey & Marteau, 2018		\				Not supported
Mistura et al., 2019	\					Not supported
Wyse et al., 2019	\					Not supported
dos Santos et al., 2020			\			Not supported
Bauer et al., 2021	\			\	\	Not supported

**DC- Descriptives** (menu wording, labeling); **DF- Defaults** (standard menu); **PL - Placement** (eye level, top of menu, repositioning, cue, timing); **AV - Availability** (quantity, price, discounts, product variety); **CN - Contrast** (boxing on menu, visual brightness/contrast, frames); **PR - Presentation** (visual attractiveness, themes); **SM - Semiotics**, logos, emoticons; **PM - Prompts** (verbal/written - social norms, slogans, messages, posters)

#### 4 Extant Research Concerns and Future Research Directions

The analysis of the literature acknowledges some of the concerns noted in previous research. Based on them, the following research directions are proposed:

- i. *Sample size and generalizability.* Several researchers cautioned on generalizing their findings. One reason is the inadequate sample size; hence, they suggested that the replication of the experiments should involve a sample size adequate to represent a specific population. Also, the population under investigation stems mainly from advanced economies. It is worthwhile to examine the interventions in the less developed world as context-specific elements (i.e., culture, socio-demographic characteristics, diet composition, food neophobia, etc) may bias the efficacy of nudge interventions. At the same time, further research can clearly define target groups (i.e., specific age categories or socioeconomic class) and find a suitable nudge intervention for them.
- ii. *Long-term studies and persistent effects.* Researchers cannot detect the long-term effectiveness of nudges due to a shortage of time and resources. Some studies also acknowledged one-shot observation of behaviour, limiting the observance of continuance behaviour when the treatment period stopped. Hence, it is suggested to conduct experiments for extended periods and evaluate nudges' long-term effects. Another concern applies to the adoption of nudge intervention by the food service management after the experimental period. Although the nudge effect was observed in the field, it was not confirmed if the management of foodservice outlets continued to apply the nudge interventions. Hence, ascertaining its lasting effects cannot be verified.
- iii. *Addressing experimental setup issues.* Some experiments were unable to mimic real-life environments and could not capture actual consumption behaviour among study participants. For instance, the setup solely draws out hypothetical choices. A disregard for product prices and brands eventuates, and participants did not manifest actual purchase towards the targeted products. In enhancing the external validity of investigations, the examination should be under cognitive strain and the absence of price advantages. Recording the actual consumption of the targeted product can also show meaningful

findings as the impact of healthy diet proceeds from actual consumption rather than food choice. It is also necessary to analyse the compensatory behaviour of consumers. Meanwhile, *it is appropriate to ensure a holistic approach in linking the physiological impacts of labelling, testing different types of discounts, separating individual interventions, and exploring the nature of nudge and how it works regarding healthy food and how it works when it comes to unhealthy food.* Other measures to evaluate the effects of nudges may focus on using an index (e.g., Healthy Eating Index) or nutritional values. For descriptive (educational) nudges, it is important to find out what type and how much information work concerning healthy food consumption.

- iv. *Individual-level characteristics, perceptual and cognitive biases.* Findings reveal that although nudges can prompt a behavioural change in general, the effects vary depending on individual-level characteristics such as dietary habits, personality, gender, etc. Meanwhile, individuals react differently to various stimuli in the environment. Hence, it is crucial to consider individual-level characteristics, including perceptual and cognitive biases of the population and their impact on decisions.
- v. *Confounding factors in real-world environments.* Although research experiments implemented in natural (field) environments may demonstrate higher external validity, it cannot be ignored that exposure to confounding factors is higher. Hence, future research must take extra precautions to control these factors and be highly considered during the experimental setup to minimize the possible spillover effects.
- vi. *Replication of studies in other (virtual) settings.* The literature analysis indicates many studies utilizing nudges in the physical environment. However, with the increasing online presence and digital transformation in the retail and foodservice sector, it is equally necessary to assess the efficacy of nudges in the online world. Stakeholders in the academia, the public, and private sector must address healthy diet in multiple channels in the light of technological and social changes.
- vii. *Combined effects of nudge interventions.* Scholars argue that combining different types of nudges can result in better behavioural outcomes.

Given this, future research initiatives can go through the same and validate extant findings. It is also interesting to isolate the level of influence of each nudge within the amalgamated intervention.

## 5 Conclusions

The comprehensive review reveals that several types of nudges have been studied in the existing literature, specifically in the context of retail and catering services. These include verbal/written challenges, descriptive, presentations, location, availability, contrast, background, and semiotics. Interventions focus primarily on aspects of a healthy diet, such as balancing calorie intake and increasing fruit and vegetable consumption. Previous empirical work offers positive and significant support for incentives to encourage healthy food choices in the physical (field) area through online environments. This suggests that small changes in the environment have appealed to consumers and triggered shifts in behaviour while maintaining autonomy over their decisions. However, further research is still needed to increase the generalizability of the findings for the theory of consumer behaviour, to address existing problems with experimental settings and confusing factors, and to verify the lasting effects of plucking in both physical and virtual environments in the retail and foodservice sector.

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## Knowledge Factors Influencing IS Investment Decision-Making

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### Abstract

Knowledge plays a crucial role in enhancing the quality of information system (IS) investment decisions. This study aims to explain which and how knowledge-related factors contribute to strategic alignment in IS investment decision-making. We conducted a narrative literature review of 32 papers and applied image theory to develop a conceptual model. Our results show that business understanding and shared domain knowledge are central to aligning strategic IS investment decisions. In addition, other factors enhance IS alignment, namely IT knowledge, education, awareness of impacts, system requirements, intangible benefits, IT governance, knowledge of justification methods, and metacognitive experience. Scientists might use this study to operationalize quantitative research about real decision-making, while practitioners might improve their decision process and seek suitable training thanks to this study.



**Keywords** – Knowledge, IS investment decision-making, IS alignment, IS adoption, Image theory

**Paper type** – Academic Research Paper

## 1 Introduction

Investment decisions about IS/ICT assets, human resources, and IS capabilities (further IS investments) can substantially affect firm performance (Schryen, 2013). IS investments may increase the strategic IS alignment in an organization. Also, IS alignment (Chan and Reich, 2007) and IS investments (Sabherwal and Jeyaraj, 2015) positively affect firm performance. However, successful IS alignment remains a significant challenge. The KPMG's CIO survey (2018) found that 55% of companies are moderately or worse effective in "aligning IT and business strategy," and 68% are moderately or less effective in "relying upon an overall digital vision to guide decisions" (KPMG, 2018, p. 20). Similarly, Deloitte's global CIO survey (2018) indicates that IT business alignment is uncommon: "only 52 percent of baseline organizations have a technology investment decision-making process jointly owned by IT and the business, and only 35 percent have a clear process for prioritizing IT investments" (Deloitte 2018, p. 25). This could indicate existence of a research-practice gap.

Misaligned IS investments could be prevented during the decision-making process. According to Salge et al. (2015), two types of IS investment decisions occur during an IS investment process: (1) a budgetary decision (e.g., Kobelsky et al. (2008)) about the overall IS investment budget (allocation stage); (2) the IS solution decision (adoption stage). We focus only on decision-making in the adoption stage, which reaches from investment problem recognition to authorization (or rejection) of an IS investment project (Mintzberg et al., 1976; Malichová and Miciak, 2018). If the resultant IS solution supports the business strategy, goals, and needs, it is deemed strategically aligned (Luftman et al., 1999)

Understanding factors contributing to alignment during the IS investment decision-making process might prevent IS misalignment, failed IS implementations, and wasting resources (Tamm et al., 2014; Gerow et al., 2015). Moreover, recent literature (Baker and Singh, 2019) encourages studying IS misalignment on the process level, improving the decision-making practice in

organizations. Therefore, it appears beneficial to show which factors could improve IS alignment practices.

Knowledge management (KM) could affect the success of IS/ICT projects (Reich et al., 2014) which is increased by the high competencies of users (Djanegara et al., 2018). Also, KM could provide recommendations for IS investment decisions from the planning stage to the implementation stage (Djanegara et al., 2018). However, we have limited evidence of how specific factors related to knowledge can affect the IS investment decisions and thus increase IS alignment. Therefore, this paper will present a conceptual model of knowledge-related factors influencing IS investment decision-making.

This paper proceeds as follows. First, it introduces the theoretical background of IS alignment and decision-making. Second, the methodology describes our conceptual approach and protocol for narrative literature review. In the results, we present ten factors related to knowledge and may enhance strategic alignment of IS investment during decision-making. Then, we map the factors to a decision-making process framework, the image theory, and draw explanations for the importance of knowledge during the process. Lastly, we discuss the conceptual model, state limitations, suggest implications for scientists and practitioners, and conclude.

## **2 Theoretical background**

The following sections present the background of our research that builds on several fields of literature, namely IS alignment, IS investment decision-making, strategic decision-making, and naturalistic decision-making.

### **2.1 Information system alignment**

Strategic IS alignment can be defined as *"the degree of fit and integration among business strategy, IT strategy, business infrastructure, and IT infrastructure"* (Chan and Reich, 2007, p. 300) or as *"applying IT in an appropriate and timely way, in harmony with business strategies, goals and needs"* (Luftman et al., 1999, p. 3).

Henderson and Venkatraman (1999) recognize six types of IS alignment: intellectual alignment (between business strategy and IT strategy), operational alignment (between business infrastructure and IT infrastructure), and four cross-domain types. Two of the *cross-domain alignment* types address the relationship between business strategy and IT infrastructure, including IS investments. In the

strategy execution type, the business strategy is already formulated by business management and is implemented by the IT management as infrastructure and processes inside the current business structure. The technology transformation type involves the formulation of an IT strategy (Henderson and Venkatraman, 1999). These two types shed light on the process and multivariate relationships in IS alignment (Henderson and Venkatraman, 1993). However, cross-domain alignment seems understudied compared to other types of alignment (Gerow et al., 2015). Thus, when discussing alignment factors in this paper, we mostly draw on literature about IS alignment on the intellectual level and argue that these factors might be significant on the cross-domain level.

Few studies focus purely on alignment in IS investment decision-making, and their focus is limited in detail. Negoita et al. (2013) focused on the IT role in an organization, the ownership structure, responsibility, and the motivation behind the drive towards strategic alignment. They argue that IS alignment is achieved through converging cycles of strategic decision-making. Alsudiri et al. (2012) investigated communication, project manager leadership competence, and the commitment and involvement of stakeholders. Kajalo et al. (2007) analyzed drivers, such as awareness of IS decisions' impact, the efficacy of IS management, systematic decision-making process, and business development orientation of IS management. They divided the approaches to IS alignment into four categories: ad-hoc, business-driven, consensual, and technology-driven (Kajalo et al., 2007).

## ***2.2 IS investment decision-making process***

This paper concentrates on the decision-making about IS adoption which represents a managerial process focusing on which IS to adopt (Salge et al., 2015). The object of the decision is a project proposal, which is developed, evaluated, and approved or rejected (Irani and Love, 2002).

A large proportion of IS investment literature perceives decision-making only as a selection from alternative solutions and their evaluation or justification (e. g., Ballantine and Stray, 1998; Gunasekaran et al., 2006; Karadag et al., 2009). However, decision-making is a broader concept starting significantly earlier with recognition and formulation of an investment problem. Misaligned decisions might not always be caused by selecting an inaccurate alternative but by solving an inappropriate problem. Thus, more comprehensive IS decision-making process models are based on Simon's (1960) trichotomy of intelligence, design, and

choice (Boonstra, 2003; Xue et al., 2008), which he describes as “finding occasions for making a decision; finding possible courses of action; and choosing among courses of action” (Simon, 1960, p. 1). Later, Mintzberg (1976) refined this conceptualization into six stages (in Figure 1 as rectangles) grouped by three phases (as bidirectional arrows). In the intelligence (identification) phase, (1) management *recognizes* a stimulus and (2) *diagnoses* the information about the situation. In the design (development) phase, (3) actors *develop* a solution or *search* for ready-made solutions. Then, in the choice (selection) phase, the developed or found alternatives are (4) *screened*, (5) *evaluated*, and the optimal solution is (6) *authorized*. Screening reduces the number of alternatives to a few feasible ones, which are then evaluated. Evaluation has three possible forms – judgement, bargaining, or analysis. They correspond with an intuitive, political, or rational form of the process (as in Tamm et al., 2014). After evaluation, the selected alternative is passed to authorization (Mintzberg et al., 1976). Altogether, the process of decision-making about IS adoption commences with investment problem recognition and finishes with investment project authorization. Nevertheless, its stages can repeat or be omitted (Mintzberg et al., 1976; Boonstra, 2003) during different types of IS decision-making processes (Sabherwal and King, 1995).

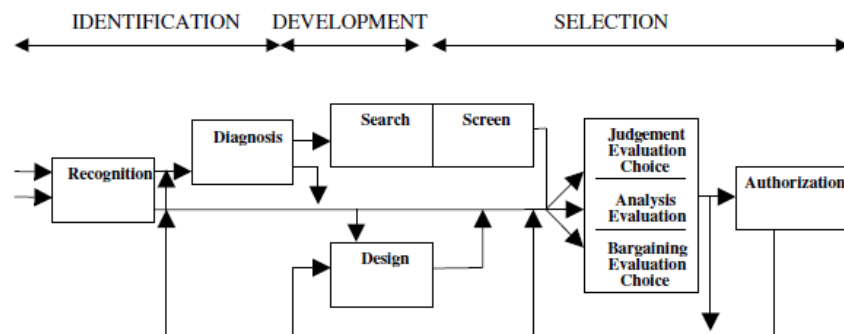


Figure 1: General model of a decision-making process  
Source: Mintzberg et al. (1976), adapted by Boonstra (2003)

Other conceptualizations closer to the IS decision-making mention refer partially to the development and selection phase as *justification* (AbuKhousa and Al-Qirim, 2012). During justification, managers set criteria for selection among the alternatives, evaluate the alternatives according to the criteria, and decide about

the outcome (Karhade et al., 2009) or defer its realization (Irani and Love, 2002), and set its priority (AbuKhousa and Al-Qirim, 2012) based on the investment portfolio. Other decision-process conceptualizations include more stages. For instance, Götze et al. (2008) mention developing a capital investment strategy, and Panagiotou (2008) includes setting organizational goals and objectives before problem recognition. These stages constraint and form the subsequent IS adoption decision-making, but they each present another decision-making process. Implementation, testing, and ex-ante evaluation can occur after investment authorization (Götze et al., 2008; AbuKhousa and Al-Qirim, 2012; Salge et al., 2015). These may provide input and constraints for later IS adoption decision-makings. However, stages before problem recognition and after solution authorization lie outside the scope of this paper.

### **2.3 Factors influencing decision-making**

Factors that influence strategic organizational decision-making and IS investment decision-making consist of antecedents, mediators, and moderators of the process on its way to a strategically aligned outcome. Tamm et al. (2014) present a comprehensive framework that divides the factors into six levels based on their origin. First is the *external environment*, which can be characterized by uncertainty (Atuahene-Gima and Li, 2004), resource munificence (Sabherwal and King, 1995; Baum and Wally, 2003), or competition (Demirhan, 2005; Xin and Choudhary, 2018). Second, *organizational characteristics* relate to structure (Baum and Wally, 2003; Shepherd and Rudd, 2014), culture (Kanungo et al., 2001), and formalization (Papadakis et al., 1998; Ranganathan and Sethi, 2002). Third, the characteristics of the *decision-making team* include tenure (Papadakis and Barwise, 2002; Goll and Rasheed, 2005), cognitive diversity (Sherer, 2004; Olson et al., 2007), or communication (Ravichandran and Liu, 2011). Fourth, *individual decision-maker* characteristics relate to her cognitive style (Hough and Ogilvie, 2005), risk propensity, and IT knowledge (Li, 2009). Fifth, *decision-matter* characteristics refer to the object and attributes of the decision, such as impact (Kotani and Iijima, 2008; Xue et al., 2008), time pressure (Papadakis et al., 1998), or uncertainty (Hickson et al., 2001; Kotani and Iijima, 2008). Sixth, and the closest to the decision, are the informational factors, labeled as *justification criteria*. These include system requirements (Rantapuska and Ihanainen, 2008; Irani et al., 2014), financial (Love and Irani, 2001; Demirhan, 2005), non-financial (Irani and Love,

2002; Gunasekaran et al., 2006), tangible (Malichová and Miciak, 2018) and intangible (Ryan et al., 2002; Ryan and Gates, 2004) costs, risks, and benefits. As a result, each factor induces different effects on decision-making regarding rationality, speed, comprehensiveness, quality, politics, or intuition (Tamm et al., 2014), and possibly IS alignment.

#### **2.4 Image theory perspective**

We needed a suitable descriptive decision-making theory for creating a conceptual model of knowledge factors influencing IS decision-making that explains the behavior of actors in an organizational environment. Therefore, the theory needed to address individual and group decision-making levels and include decision stages of justification, problem recognition, and diagnosis. Previous decision-making research has taken either an attribute-based (factor-based) approach or a stage-based (process-based) approach (Xue et al., 2008). However, this study attempts to connect both approaches with the framework by linking factors to activities of the process. Finally, we needed a theory not predicated on economic rationality because real IS investment decision-making is not always rational.

*Naturalistic decision-making* (NDM) is a discipline that opposes rational and normative theories of decision-making. Instead, NDM focuses on how experts make decisions in the natural environment, facing ill-structured problems, time pressure, and conflicting goals (Zsombok and Klein, 1997). Models of NDM assert that decision-makers rely on their experience and rarely generate and compare sets of alternatives (Klein, 2008). The most prominent NDM model is the Recognition-primed decision (RPD) model (Klein et al., 1986). Other NDM models feature Rasmussen's Decision ladder (Rasmussen, 1976), Skill/Rule/Knowledge model (Rasmussen, 1983), Cognitive Model for Situation Assessment (Noble et al., 1989), Story model (Pennington and Hastie, 1993), and Image theory (Beach and Mitchell, 1987). Naturalistic decision-making also relates to macrocognitions, such as sensemaking (Weick, 1995).

The most suitable NDM model for our research is the *image theory* (Beach and Mitchell, 1987). It is a descriptive theory of decision-making that posits that decisions result from beliefs, goals, plans, and decision characteristics. Unlike the Decision ladder or RPD, it involves evaluation of alternatives and comparison to strategy; and is not as detailed as sensemaking.

This theory applies to individual and organizational decision-making (Beach, 1993, 1990) and has already been used to explain strategic misalignment (Stephenson, 2012; Penney et al., 2019). The version of the theory for individuals presents four knowledge structures labeled as images: the value, trajectory, strategic, and projection image (Klein et al., 1993). The value image represents the decision-maker's values, beliefs, and principles. The trajectory image comprises her goals, which can be specific or abstract. Then, each goal relates to one or more strategic images with plans for attaining the goals. Finally, the projection image contains anticipated events and states for adoption or rejection of a candidate plan (Beach and Mitchell, 1987). When describing organizational decision-making, the value, trajectory, and strategic image are referenced as the organization's culture, vision, and strategy (Beach and Connolly, 2005). Culture presents the principles, norms, values, ethics, and beliefs that members of the organization hold in common to some extent (Klein et al., 1993). Culture specifies guidelines and imperatives for members' behavior and expectations, power distribution, and success criteria (Beach and Connolly, 2005; Miner, 2005). Vision consists of organizational goals and timeframe, while strategy outlines how these goals shall be reached (Beach and Connolly, 2005). The greater the similarity between individual value image and organizational culture image, the more the members agree upon appropriate goals and plans. Knowledge of organizational images forms parts of individual images contributing to the organizational decision-making process. Indeed, from the perspective of image theory, it is not the organization that makes a decision but the individual, who either acts as an agent or whose decision is combined with others' through negotiation (Beach and Connolly, 2005; Miner, 2005).

According to image theory, the process of individual adoption decision-making (depicted in Figure 2), also called *decision framing* (Klein et al., 1993), starts with recognizing a stimulus situation. This situation is framed using previous knowledge and experience (Zsombok et al., 1992), followed by evaluating potential plans in two stages. First, they are compared to the value, trajectory, and strategic images, and incompatible plans are rejected or modified. Second, the most "profitable" of the plans is selected (Beach and Mitchell, 1987). Lastly, the plan is compared to the status-quo (Penney et al., 2019). This description of the decision process corresponds to the above conceptualization of IS investment decision-making because it captures recognizing an investment problem,

appraisal of alternatives (as compatibility to images and to each other), and go/no-go decision (as comparison to status-quo).

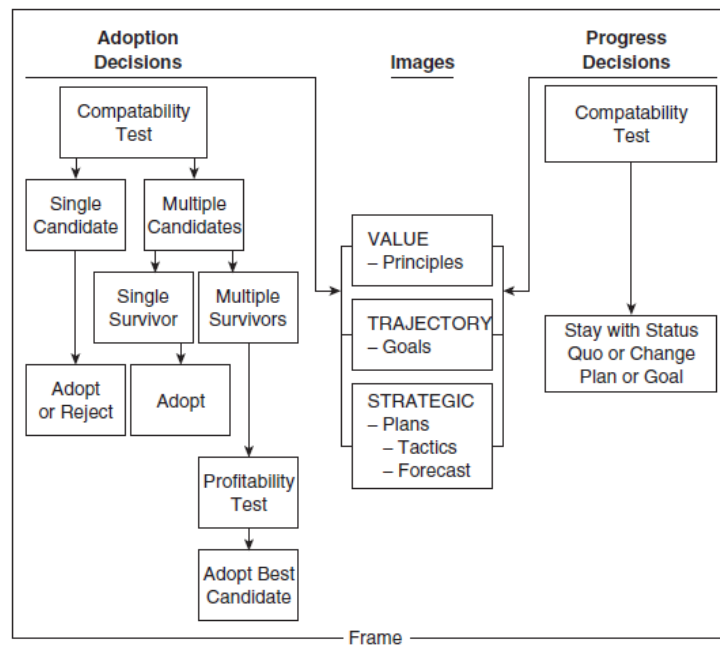


Figure 2: Decision-making according to image theory  
Source: Beach and Connolly (2005)

The image theory is suitable for our purpose for several reasons. First, it links factors, mostly as constituents of images, to actions in the decision-making process, e. g., by comparing a plan to images (Beach and Mitchell, 1987). Second, strategic alignment can be regarded as high accordance between individual and organizational images, i. e., shared knowledge (Chan et al., 2006). As image theory hypothesizes, "the greater the agreement among the members about the culture, the more agreement there will be among them about what constitutes appropriate goals and plans for the organization" (Beach and Connolly, 2005). Third, images are knowledge structures by definition, and knowledge is brought to framing a problem (Zsombok et al., 1992). The role of knowledge factors, such as education or IT knowledge, may then consist in more realistic shaping of the decision-maker's images, framing of the stimulus situation, and creating a proper projection image of IS impacts. Thus, with more realistic knowledge and expectations, the probability of selecting an aligned IS rises.



On the other hand, several limitations of image theory persist. The theory mainly focuses on decision-making on the individual level, and parallels with organizational decision-making have not been thoroughly tested (Beach and Connolly, 2005). Some of these parallels, namely between the organization's vision and the individual's trajectory image, suggest different underlying processes guiding decision-making in each case. Moreover, interactions between images of individuals within organizations and between organizations have also received little attention. Insufficient treatment of group processes and sociological phenomena in decision-making, such as groupthink, organizational politics, or imperfect communication, present an ample source of critique of the theory (Miner, 2005). Original focus on individual decision-making also subjects the theory to neglecting environmental factors (Vlek, 1987).

Another source of critique focuses on empirical tests of the theory. Authors themselves admit that research about the theory should move from laboratory studies to a more ecologically valid decision-making environment in organizations (Beach and Connolly, 2005). Further, empirical tests focus pervasively on compatibility tests, profitability tests, and progress decisions but do not address the nature of images due to a lack of satisfactory research techniques (Beach, 1998). Indeed, this theme does not seem to be resolved even today, when the authors call for the development of instruments that would measure the value, trajectory, and strategic images (Penney et al., 2019). Inability to adequately specify the concept of the image has led one of the authors to replace it with a concept of narrative, forming a new Theory of Narrative Thought (Beach et al., 2016).

### **3 Methodology**

We conducted a narrative literature review of 32 papers. The selected sample of papers represents a subset taken from a systematic literature review regarding factors influencing IS investment decision-making and IS alignment. We combined "information system investment" with the following keywords in citation registers Scopus, Web of Science, and Google Scholar:

- expenditure
- decision
- factors
- appraisal

- justification methods
- decision strategic (mis)alignment

We also conducted a backward search to reach primary sources of knowledge factors mentioned in the papers' literature reviews. The content of the papers was inductively coded and thematically analyzed to determine knowledge-related factors. Only the factors which relate to knowledge and impact IS alignment or decision quality were selected. To develop a conceptual model, we interpreted the literature from the perspective of image theory. The model was developed by one researcher and revised for accuracy by other authors.

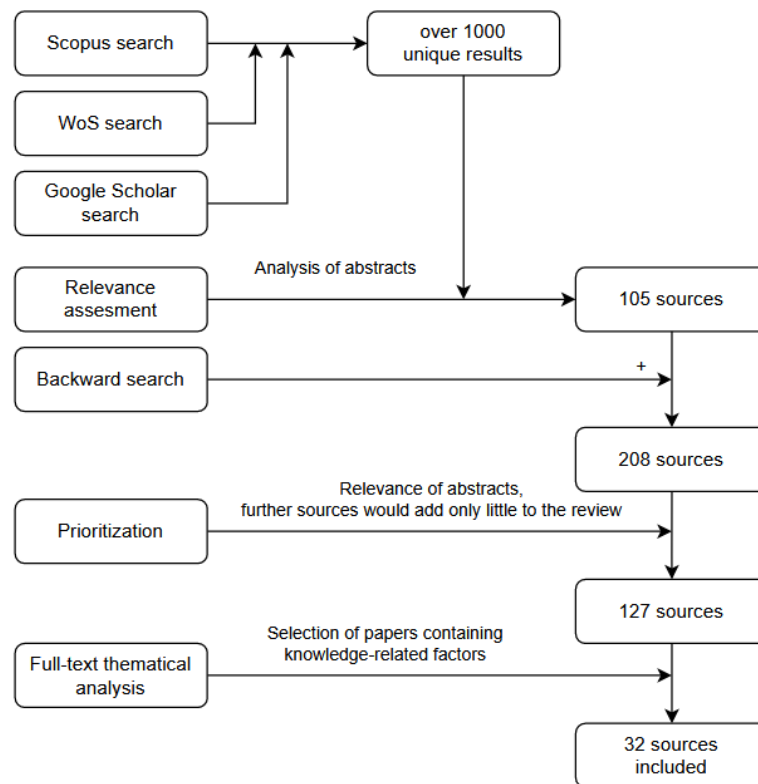


Figure 3: Literature search strategy  
Source: authors

## 4 Results

In this section, we present ten knowledge-related factors linked to IS investment decision-making. Then, we apply image theory to develop a conceptual model, linking the factors to decision stages.

### 4.1 Knowledge-related factors

We identified ten knowledge-related factors which influence strategic managerial decision-making, IS investment decision-making, or IS alignment.

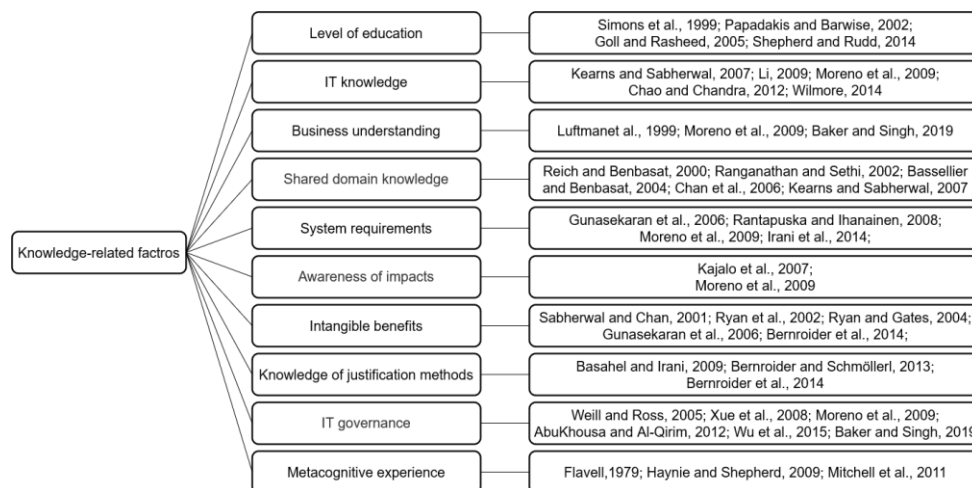


Figure 4: Identified factors  
Source: authors

The finished *Level of education* of the top management team increases the rationality and comprehensiveness of strategic decision-making, particularly during the situation analysis, generation and evaluation of alternatives, and integration of the decision with the firm strategy (Papadakis and Barwise, 2002; Goll and Rasheed, 2005). Moreover, diversity in team education is associated with higher levels of decision-making comprehensiveness (Simons et al., 1999). Besides, individual level of education, for example, the education of a CEO, has been found to increase financial reporting information in decision-making, but no other aspect (Papadakis and Barwise, 2002; Shepherd and Rudd, 2014).

*IT knowledge* of top management does not necessarily mean technical knowledge. Instead, it presents the familiarity with the value and potential of IT

(Kearns and Sabherwal, 2007), awareness of IT trends, opportunities, and risks (Wilmore, 2014), understanding of IT's contributions, and ability to define IT needs (Moreno et al., 2009). However, Wilmore (2014) views the prior experience as a necessary precondition of IT knowledge. IT knowledge enhances IS alignment through increasing organizational active IT investment attitude (Li, 2009; Moreno et al., 2009), top manager's participation in IT planning (including IS investment decision-making), an IT manager's participation in business planning (Kearns and Sabherwal, 2007). In small firms, the owner's IT knowledge enhances IS alignment directly (Chao and Chandra, 2012).

*Business understanding* is the "level of business knowledge of the executives, managers and employees of the IT area" (Moreno et al., 2009, p. 46). IS alignment increases when IT managers and employees understand their business, business environment (Luftman et al., 1999), and business strategy (Baker and Singh, 2019). Therefore, IT governance's proper allocation of decision rights is essential, as employees at lower organizational hierarchy levels might have less understanding of the business strategy (Baker and Singh, 2019).

*Shared domain knowledge* labels IT and business knowledge which is mutually understood and exchanged among business and IT managers (Ranganathan and Sethi, 2002). It includes participating in the others' key processes and respecting each other's contributions and challenges (Reich and Benbasat, 2000). Thus, shared domain knowledge comprises the aforementioned dimensions of business and IT knowledge and mutual exchange (Kearns and Sabherwal, 2007). This factor has been emphasized for its positive impact on IS alignment (Reich and Benbasat, 2000; Bassellier and Benbasat, 2004; Chan et al., 2006) and increasing rationality of IS investment decision-making (Ranganathan and Sethi, 2002). In particular, shared domain knowledge contributes to short-term IS alignment through frequent communication of business and IT managers, and enhances long-term alignment directly (Reich and Benbasat, 2000).

*System requirements.* Investment appraisal and justification criteria largely consist of requirements on the adopted IS. Technical requirements comprise functional features, compatibility, reliability, implementation (Rantapuska and Ihanainen, 2008), ease of customization and implementation time (Irani et al., 2014). Then, organizations need to assess the technological fit of the evaluated IS with the current IS infrastructure (Irani et al., 2014) and necessary further changes. Finally, security requirements include security policy, accountability, and documentation (Gunasekaran et al., 2006). Sufficient business and IT knowledge is

necessary to appropriately define these requirements (Moreno et al., 2009) and select a solution that aligns with the business strategy (Chao and Chandra, 2012).

*Awareness of impacts.* Investment justification criteria usually include costs, benefits, and risks. Awareness of the impact and risks, such as dependency on providers or security threats, was identified as a driver of IS alignment (Kajalo et al., 2007). Therefore, the IT knowledge of business managers and employees is crucial because they can be more aware of the risks of IS decisions (Kajalo et al., 2007) and understand their contributions (Moreno et al., 2009).

*Intangible benefits* are often overlooked by decision-makers (Bernroider et al., 2014), but they are valuable as they further impact tangible and financial firm performance (Gunasekaran et al., 2006). Some intangible benefits might present enhanced training or support of knowledge creation and sharing (Ryan et al., 2002; Ryan and Gates, 2004). An example of a system with significant intangible benefits is KM systems, which pertain to decision support systems. Therefore, their adoption would be strategically aligned for any strategic type by Miles and Snow (1978) (Sabherwal and Chan, 2001).

*Knowledge of justification methods*, such as the Balanced Scorecard or Utility Ranking method, enhances IS investment decision-making effectiveness (in terms of benefits, satisfaction, confidence, and easiness) (Bernroider et al., 2014). However, it is crucial not only to know but also to apply justification methods for a decision to be more effective (Bernroider and Schmöllerl, 2013; Bernroider et al., 2014). Mainly, strategic justification methods can be applied to assure IS alignment (see Basahel and Irani, 2009).

*IT governance* is a set of structures, processes, rules, rights, and responsibilities that shall ensure the alignment between IS and business goals, and the execution of IT strategy (Weill and Ross, 2005; Xue et al., 2008; Wu et al., 2015). IT governance shapes the IS investment decision-making process, prescribes its format, and allocates decision rights (AbuKhoussa and Al-Qirim, 2012) concerning actors' business, IT, and specialist knowledge (Xue et al., 2008; Baker and Singh, 2019). This way, IT governance determines who participates in decision-making and which rules they should follow, including the justification methods to be used. Well-implemented IT governance decreases the pursuit of goals different from the organizational ones during decision-making (Weill and Ross, 2005). Explicit IT governance also implies higher organization's formalization, including formal plans and planning processes, which then achieves higher levels of IS alignment (Moreno et al., 2009).

*Metacognitive experience* denotes individual reflection about one's thinking (Flavell, 1979; Mitchell et al., 2011). Metacognitive experience suggests that previous experience can evoke the belief that one knows what to do best in the current situation (Haynie and Shepherd, 2009). Higher metacognitive experience mitigates inconsistency in strategic decisions, which is considered one of the thinking errors (Mitchell et al., 2011).

#### **4.2 Conceptual model**

In terms of image theory, IS investment decision-making represents an adoption decision about adopting a new plan (a constituent of the organization's strategy image) because the decision's object is a project proposal (Irani and Love, 2002). During this process, the decision-maker first recognizes or identifies a stimulus situation. Then, she frames the situation (Zsombok et al., 1992), for which she uses *metacognitive experience* (Mitchell et al., 2011), i. e. her previous experience with similar situations, in image theory, also called repertory of problem solutions (Zsombok et al., 1992). A compatibility test follows, in which she screens the options (potential plans) to see whether they meet her standards (Beach and Connolly, 2005). This is done by comparing options, together with their projection images (expected outcomes), to her images and organizational images (Beach and Mitchell, 1987; Beach and Connolly, 2005). Several knowledge-related factors play a significant role in constituting or influencing these images.

The value image comprises decision-makers' values, beliefs, and "self-evident truths" (Beach and Connolly, 2005). First, some of these beliefs and the completeness of the value image are formed by *education* because it teaches norms (e. g., principles of working with information, ethical behavior, and normative management theories). Second, *IT knowledge* creates beliefs about whether an organization needs IT, how IS should function, and what constitutes proper *system requirements* (Moreno et al., 2009). The culture image presents the principles, norms, and values (Beach and Connolly, 2005). *IT governance* constitutes its part as it defines norms, rules, and responsibilities regarding IT management (Weill and Ross, 2005). Thus, IT governance pertains to the culture image as it shapes the decision process, prescribes criteria (standards) for compatibility tests and justification methods for profitability tests (Bernroider and Schmöllerl, 2013). The trajectory image refers to individual goals, such as getting a job promotion, while organizational vision typically determines profitability or

maximization of shareholder value as its goals. Strategic image and strategy then present the plans and tactics that the decision-maker and organization adopted for achieving their goals (Beach and Mitchell, 1987; Beach and Connolly, 2005).

Image theory posits that a higher degree of similarity between organisation members' beliefs, values, goals, and plans (therefore, according to individual and organizational images) enhances a newly adopted plan (Beach and Connolly, 2005). *Business understanding* may increase one's identification with the organization's culture, vision, and strategy (Luftman et al., 1999; Baker and Singh, 2019), thus enhancing decision-makers' capability to compare a new plan to these images. Similarly, *shared domain knowledge* increases the accordance between beliefs (i. e., value images) of decision-makers regarding business and IT principles (Reich and Benbasat, 2000; Ranganathan and Sethi, 2002). Therefore, *business understanding* and *shared domain knowledge* may enhance IS alignment by connecting organizational and individual images.

The last image is the projected image of a potential plan consisting of expected events and states after the plan's adoption (Beach and Mitchell, 1987). *Awareness of IS investment's* impacts costs, tangible and *intangible benefits*, and risks might enhance the projected image's realistic creation, and drive IS alignment (Kajalo et al., 2007). *System requirements* represent the functionality and attribute one expects from the IS (Gunasekaran et al., 2006; Rantapuska and Ihanainen, 2008; Irani et al., 2014), by which they constitute the projected image. As previously mentioned, *IT knowledge* improves *awareness of impacts* and appropriate formulation of *system requirements* (Chao and Chandra, 2012; Moreno et al., 2009) and supports realistic construction of the projected image.

If a potential plan and his projected image violate the other images to an extent (exceed the rejection threshold), this plan is screened out. If not, it proceeds to the profitability test (Beach, 1998). In this step, the decision-maker compares the plans to each other to determines the most profitable solution. She uses a choice strategy (Beach and Connolly, 2005) by selecting from the *justification methods she knows* to enhance the decision effectivity (Bernroider and Schmöllerl, 2013; Bernroider et al., 2014).

After the best option has been selected and evaluated as more desirable than the status-quo (Penney et al., 2019), its implementation might bring *intangible benefits*. These may improve knowledge creation and sharing (Ryan et al., 2002; Ryan and Gates, 2004), complementing the individual value image (e. g., by creating new beliefs about IS benefits, risks, or functioning) and form contextual

memory useful for framing subsequent decisions. The individual knowledge also augments by adopting the plan into the strategic image (Beach and Connolly, 2005).

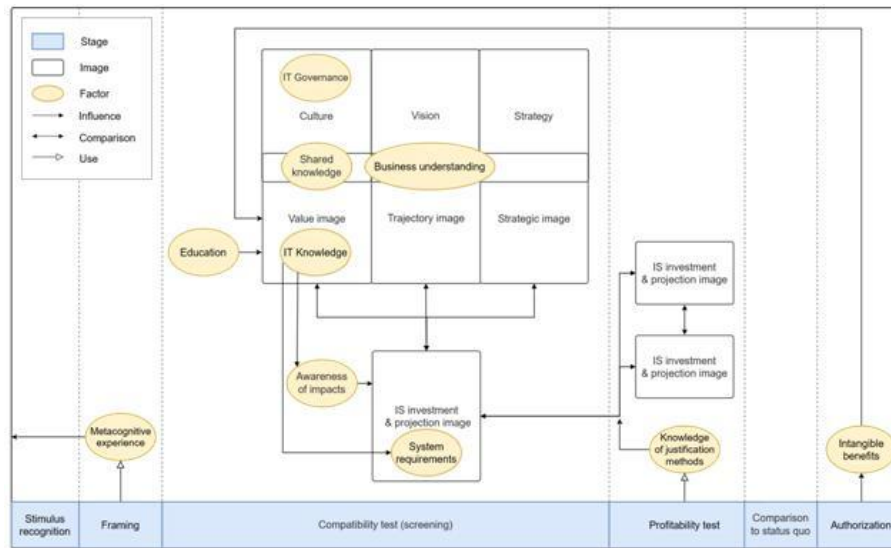


Figure 5: Conceptual model  
Source: authors

To summarize, our conceptual model shows that shared domain knowledge and business understanding are central to making strategically aligned IS investment decisions because they support the decision-maker in identifying herself with organizational values, goals, and plans. Besides, education, IT knowledge, and proper IT governance contribute to more realistic shaping of individual and organizational beliefs and expectations, while knowledge of justification methods enhances effective IS selection. Nevertheless, the whole process depends on how the initial stimulus situation is framed by previous metacognitive experience and contextual knowledge, which is, in turn, enhanced after the decision authorization by the solved situation and intangible benefits of the newly adopted IS.

## 5 Discussion

In our conceptual model, knowledge is proposed only to have a positive relationship to IS decision alignment. However, IT knowledge might, for instance, contribute to managers' overconfidence bias in decision-making (Vetter et al.,



2011) and thus, cause suboptimal decision outcomes. Similarly, the model could be enriched by other perspectives, such as unlearning or organizational learning. Especially in the case of a double loop learning mechanism (Argyris, 1982), knowledge gained after IS authorization could improve IT governance and, therefore, the rules of subsequent IS decisions. Double-loop learning is also consistent with image theory's emphasis on problem framing (Argyris, 1991).

In comparison to previous research on IS investment decision-making, this paper is unique because it combines a stage-based and attribute-based approach to examining the decision process. To achieve this, we have demonstrated another possible application of image theory. This study has implications for scientists to help them focus on investigating how knowledge and other factors can affect IS investment decision-making and strategic IS alignment. Also, our research could guide them in the operationalization of quantitative investigations. Practitioners could use the results of our paper to improve their investment decision-making process by knowingly integrating specific KM processes into decision-making. Finally, the results of this paper might contribute to the design of IS-related training or university courses.

This study is subject to several limitations. First, by choosing the narrative literature review method, we might have omitted some important studies dealing with the role of knowledge in IS investment decision-making. Second, no model or discipline could describe the decision-making process entirely (Gore et al., 2006). Image theory leaves interactions between actors unexplained and could omit other organizational aspects – aside from culture, vision, and strategy – such as power centralization in the organizational structure. Third, this study derives the quality of an IS decision from its alignment with business strategy. A longitudinal approach to studying IS investment decision-making together with decision impacts would bring more accuracy to understanding the whole IS investment process.

In continuation to this research, we gather qualitative empirical data through interviews, document analysis, and observations to explain misaligned IS investment decisions. Future empirical research of the concepts of image theory, especially the creation of, changes to, and constituents of images, would also contribute to a reliable explanation of (mis)aligned strategic decision-making in organizations. On the other hand, since image theory is no longer developed by its author (Beach et al., 2016), future research could suggest more appropriate frameworks to explain misalignment in organizations.

## 6 Conclusion

Knowledge plays a vital role in enhancing business performance through the alignment of IS investments. This study presents a conceptual model of knowledge-related factors and their influences on IS investment decision-making process grounded in the image theory. It emphasizes the importance of investigating the IS decision-making process not only as a selection process but also together with problem framing. Our conceptual model shows that shared domain knowledge and business understanding are central to strategically aligned IS investment decisions. They support the decision-maker in identifying herself with organizational values, goals, and plans. Besides, education, IT knowledge, and proper IT governance contribute to more realistic shaping of individual and organizational beliefs and expectations, while knowledge of justification methods enhances effective IS selection. Nevertheless, the whole process depends on how the initial stimulus situation is framed by previous metacognitive experience. Therefore, appropriate fostering of the identified knowledge-related factors shall contribute to the alignment of IS investment decisions.

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# Intellectual Capital Management, Technology and Innovation: a Systematic Literature Review

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## Abstract

In a time when society is confronted with global concerns that have the potential to fundamentally transform the economy, the underlying social structures, work, education and science, the digital technologies particularly, and technology in general play a unique role in the development of remedies, in building up economic and social resilience, and in facilitating exchanges between individuals, organisations, communities and governments. As the intellectual capital (IC) is the prominent source of organisational knowledge and the foundation of innovation, it is important to assess the research concerning the relationships between IC, technology and innovation, in order to unveil the established interdependencies. The present study attempts to systematically review the literature dedicated to the aforementioned relationship, aiming to reveal its extent, focus, gaps and trends, for the benefit of future research.

**Keywords** – Intellectual Capital Management, Technology, Innovation, Systematic Literature Review.

**Paper type** – Academic Research Paper

## 1 Introduction

Both economy and society are subject to ongoing and deep-changing, technology-based transformation. The advanced economies already harvest the fruits of their innovation strategies focused on the Industry 4.0 technologies - Big Data analytics, cloud computing, IoT, 3D printing, advanced robotics - (Rupp et al., 2021), and envision the “super-smart” Society 5.0 (Fukuda, 2020).

Meanwhile, in the context of tackling the Covid19 pandemic and its effects, information and communication technology (ICT) has become irreplaceable by enabling and supporting the management of the crisis and the aftermath,

ensuring access to data and information, storage, processing and communication infrastructure, services (e.g. e-healthcare, e-commerce, e-finance, e-government, e-learning, entertainment), communication, teleworking, etc. At the same time, increased reliance on ICT must be associated with embedded trust and security solutions, in order to avoid unwanted consequences like privacy violations, disinformation, fraud, burnout, information overload and digital divide (related to wealth, age, gender) (OECD 2019, 2020).

In the digital economy the word “technology” - referring generally nowadays to ICT enabled equipment - is never missing from both scientific and popular literature, while being positively associated in many cases with organizational innovation - when used purposefully for management processes - (Kianto et al., 2017; Cabrilo et al., 2020), performance (Coombs and Bierly, 2006; Steinfield et al., 2010; Andreeva and Kianto, 2012; Khan et al., 2019; Palazzi et al., 2020) and growth (Porter and Heppelmann, 2014). However, these findings are not always in line with other sources (Aramburu et al., 2015; Usai et al., 2021), who sometimes nuance such a conclusion by underlining that IT capital supports firm performance only in coordination with other intellectual capital (IC) components, and its value depreciates quickly because of fast technological changes and large diffusion (Bharadwaj, 1999; Huang and Liu, 2005). Orlando et al. (2020) while testing the relation between intellectual property and digital technologies concluded that they are marginally useful for IC creation and the curvilinear function indicates that beyond a certain level, undifferentiated use of such technologies can hinder value creation.

Nevertheless, as noted by Palazzi et al. (2020), today's economy relies on knowledge and knowledge assets are supplied by the IC components. Technological capability is seen as a significant constituent of a firm's knowledge base (Renko et al, 2009) and IT has a paramount role in enabling knowledge sharing processes (Mazzuchelli et al., 2021) and R&D (Nakahara, 2001).

However, according to Orlando et al. (2020), the relationship ‘IC-digital technologies’ has been scarcely studied. On the other hand, though the literature on IC and innovation appears to thrive, a 2017 structured literature review conducted by Buenechea-Elberdin rendered some conflicting findings. Overall, the research on the role of technology and its relationship with IC management and innovation in achieving organizational growth and renewal did not necessarily seem to be abundant and well structured. Furthermore, despite the decades-long existence of the intellectual capital research field, it has not been

possible to find in the academic literature a structured overview of these topics of interest. As a first attempt to search for literature concerning the association of specific concepts e.g. "intellectual capital", "technological orientation" or "technological capability" and "innovation performance" yielded no or too few results, it has been decided to keep the search terms general, as it already became apparent that the body of work regarding the relationships between these concepts is not as extensive as initially assumed.

This study set out therefore to attain a structured review of the literature concerning the association of IC, technology and innovation. Encountering a research gap, it seems worthwhile to systematically study the dedicated literature, to reveal its extent, to classify its focus and findings, and to bring out the research trends.

In order to scrutinize and analyse the accumulation of papers that cover the subjects, with the view to reveal the literature's interest, gaps and streams, the following research questions have been formulated:

RQ1: What has been the focus and the framework of scientific literature on the relationship 'intellectual capital management-technology-innovation'?

RQ2: What are the trends in the study of the relationship 'intellectual capital management- technology-innovation'?

The paper follows the structure already established in the academic literature, by presenting a review of the concepts (part 2), explaining the research method (part 3), providing the findings and discussing them (part 4), and attaining some conclusions (part 5).

## **2 Theoretical framework**

### ***2.1 Intellectual capital management***

Though the concept of IC was introduced by Galbraith in 1969 (Bellucci et al., 2020), there is still no wide agreement on either its definition, or its components (Choong, 2008). There is however an understanding that IC is grounded on knowledge resources that have the potential to be transformed into value (Buenechea-Elberdin et al., 2018). According to Santos-Rodrigues et al. (2011) IC management aims to harness the value of knowledge. Kianto et al. (2010) conveyed the view that the essential difference between knowledge management (KM) and IC is that KM is concerned with the management of information and

knowledge at tactical and operational level, while IC management is concentrated at strategic level and comprises a variety of intangibles.

Knowledge and information have a strategic importance for organizations (Bratianu and Orzea, 2010; Paoloni et al., 2020) and knowledge is the fundament of value creation (Nielsen, 2019). The reiteration of the tacit and explicit (codified) knowledge processes ensures organizational innovation, where enterprises create and share knowledge that is afterwards embedded into new products and technologies (Nonaka, 2007). Heffner and Sharif (2008) have proposed that knowledge creation and technological innovation are the outcome of fusion processes between knowledge, technologies and various organizational resources. Knowledge is found in different forms and in various organizational areas.

The tacit knowledge flow is associated with the human capital (HC). „Human capital is important because it is a source of innovation and strategic renewal“ (Bontis, 1998, p.65). Knowledge is transformed into structural capital through organizational routines, that serve efficiency and innovativeness, while information is codified into structural, explicit knowledge. Building on the model introduced by Edvinsson and Malone (1997), IC came to be traditionally seen as comprising human capital (HC), structural capital (SC) and relational capital (RC). Information and networking systems pertain to SC (Petty and Guthrie, 2000).

Kianto (2007) proposed another IC component, namely the renewal capital. Furthermore, Inkinen et al. (2017) put forward a model of IC structure which comprises seven dimensions, by adding trust capital and entrepreneurial capital to the four categories mentioned before, and by splitting the relational capital into internal and external. These resources allow a company to build new knowledge and skills, to achieve competitive advantage and to innovate, and thus to renew its knowledge resources (Inkinen et al., 2017; Kianto et al., 2010). According to Martin-de-Castro et al. (2013), SC is organizational knowledge expressed through intellectual property rights, R&D, databases, structures, processes, and systems.

Some authors argued that valorization of intellectual and information processes is the basis of profit in the new economy, i.e. through R&D and technological innovation (Quinn et al., 1996), and the use of advanced ICT can increase the value of IC (Murray et al., 2016). In the digital economy, technological competence and network competence positively influence innovation success, and both are linked to organizational technological strategy (Ritter and

Gemünden, 2004). But the impact of IC on organizational performance can be different in advanced versus emergent economies, affected by brain drain, underdevelopment of intangibles and (IC) management (Kianto et al., 2018).

## **2.2. Technological capability, technological orientation and technological intensity**

Having its roots in strategic management, technological orientation (TO) refers to an organization's propensity to acquire and employ advanced technologies to sustain innovation (Gatignon and Xuereb, 1997). Halac (2015) has proposed a TO multidimensional construct, which comprises top management capability, technological capability, commitment to learning and commitment to change.

The technological capability (TC) concept has appeared within the dynamic capabilities framework, concerned with competence renewal to adapt to a changing environment, where competition is fierce, especially in the high-technology sectors (Teece et al., 1997). TC is viewed by Campos et al. (2020) as innovative technologies prowess, consisting in acquiring, adapting and perfecting such technologies for organizational needs. Tzokas et al. (2015) describe TC as the faculty to carry out the required organizational technical functions that lead to effectiveness and efficiency, but also allows the development of new products and processes. Developing TC is linked with exploratory and exploitative learning and relies on absorptive capacity (AC) (op.cit.).

Understanding technology and its use is paramount for accomplishing organizational digital transformation (Siachou et al., 2021). However, this transformation does not happen in isolation, it is influenced by the levels of absorptive capacity and partnership interdependencies (op.cit.). AC of technology in this context defines an organization's ability to take in knowledge assets and to valorize them as dynamic capabilities (op.cit.). AC associated with TC relying on advanced technologies impacts new product development (Tzokas et al., 2015; Wua et al., 2019).

Companies with higher technology intensity are better placed to innovate (Kianto et al., 2017). Technology intensity has been defined within the ISIC rev.3 framework to differentiate between four levels of technological utilization in manufacturing industries, namely high, medium-high, medium-low and low (OECD, 2011). Smart technologies can support not only the operational management (e.g. transport and distribution, quality checks, etc.), but also

strategic tasks, like resource planning, staff selection, etc. (Gerst, 2019). Technological transformation inside an organization is usually linked to enhanced IC components i.e. structural and human (Brynjolfsson & Hitt, 2000, 2002).

### **2.3 Innovation**

Innovation is essential nowadays for a company's success and IC is a key driver of innovation (Buenechea-Elberdin et al., 2017a). Innovation has been defined as the "organizational capacity to achieve renewal in products, services, processes, strategies, management activities, etc.", which should permeate the entire organization (Nisula and Kianto, 2013, p.61). According to Gatignon et al. (2002) innovation can be understood within a structural framework that includes four dimensions, namely product complexity, innovation locus (core vs. peripheral), innovation type (generational vs. architectural, i.e. changes in subsystems or linkages between them) and innovation characteristics (incremental vs. radical, and new acquisition of competence vs. enhancing/destroying competence).

Subramanian and Youndt (2005) noted that business associated innovation has been studied from various perspectives, such as organizational knowledge, knowledge management, knowledge creation, and they reiterated the link between IC and innovation. It has been established that IC components have different impact on the types of innovative capabilities, depending on how they are combined. The innovation capability has been defined as the ability to convert knowledge and ideas into new products and processes (Lawson & Samson, 2001).

In what concerns the management of innovation, literature looks at the innovation degrees (incremental or radical), innovation types (product or process) and innovation sources (generation or adoption) (Dost et al., 2016). More recently attention was drawn to the concept of open innovation, which is understood in opposition with the closed model, as inbound and outbound knowledge flows, to stimulate the internal innovation and to secure markets for its external use (Chesbrough et al., 2006).

As Van de Ven (1986) stressed, the management of innovation is complex, as it has to organize and direct relationships between new ideas, multiple stakeholders, numerous and intricate transactions, while institutional leadership should ensure organizational strategies, culture, structure and systems that sustain innovation. While incremental innovation improves and exploits existing technology, radical innovation is disruptive, by questioning existing knowledge

and aiming for new solutions (Subramanian and Youndt, 2005). Product innovation is significantly linked to R&D in technological-intensive industries, while process innovation is more important for other sectors (Hervas-Oliver et al., 2021).

According to Verbano and Crema (2016), innovation performance is dependent, apart from the technical resources, on their management inside the company, and larger firms are favored, while small and medium size enterprises (SME) have to be more agile and to develop their IC to innovate, as they have limited resources compared to bigger companies.

Empirical research has returned mixed results on the relationship between technology and innovation (Kohli and Melville, 2018). While IT use was not found to have a significant effect on innovation processes and performance, data indicated that this association is positively influenced by higher technological orientation (Haug et al., 2021). Carmona-Lavado et al. (2013) on the other hand have found that IC components - particularly HC - influence innovation performance in technical knowledge-intensive business services (t-KIBS), namely in the software and R&D industries. Unlike professional KIBS (p-KIBS) which offer consultancy i.e. in legal, accountancy or advertising field, and which are themselves users of technology, t-KIBS are more innovative in the IT industry (op.cit.). At the same time, the effect of renewal capital and entrepreneurial capital on innovation is related to the technology level (Buenechea-Elberdin et al., 2017b). Technological diversification strongly impacts innovative capability (Quintana-Garcia and Benavides-Velasco, 2008).

### **3 Research method**

Following recommendations made by Tranfield et al. (2003), Massaro et al. (2016) in respect of so called systematic or structured literature reviews, a literature review protocol has been established, with the goal to search for the relevant literature according to defined criteria. Selected works have been collected for further analysis and data has been extracted in accordance with a structured framework, as to allow examination. The insights achieved after analysis grounded the answers to the research questions stated in the introductory part of this paper.

For this study the review protocol comprised the following inclusion/exclusion criteria:



- papers regarding the relationship between IC-technology-innovation;
- work based on thorough empirical research that concerns management and business, with the view to provide objective, reliable and generalizable results, useful for both practitioners and academia;
- articles published in academic journals, that have been subject to peer-review, to ensure accurate and valuable insights;
- studies written in English, which is deemed the language employed by academia (Bunechea-Elberdin, 2017);
- research contained in databases accessible online, published until 01 June 2021.

In the first phase, the established databases for academic purposes Scopus and Web of Science (Core Collection) have been interrogated, by using the search terms "intellectual capital\* AND innovation\* AND technology\*", the volume of returned results being comparable, 249 vs. 227 respectively, and therefore ensuring cross-checking. The search included title/abstract/key words/article and has been refined for the categories: management, business, economics, social sciences multidisciplinary, computer science. A keyword search on Scopus, using the predefined terms "intellectual capital", and its components "human capital", "social capital", "relational capital", "organizational capital", as well as "knowledge management", "technology", "innovation" led to further narrowing the results to 178 entries.

In the second phase, abstracts of the identified articles have been checked individually, and 38 articles have been retained from the Web of Science (WoS) collection, and 32 from Scopus, for further full text examination. 17 documents have been encountered in both lists. In the third phase, the scrutiny has extended to sources identified in the references of selected works. In the final phase, a total number of 35 documents have been included in the list of studies to be analysed for the systematic review.

From this sample data for analysis has been extracted according to the following framework: publication year, author(s) name, article title, journal of publication, citations, author(s) country, sample country, industry, technology type, firm type, method, sample size, findings (Appendix Table 1).

## 4 Findings and discussion

### 4.1 Descriptive analysis of results

#### *Author(s) and Sample Location*

As indicated by the data, Spain is the country with the greatest number of published articles - namely 9 - on the relationship between 'IC-technology-innovation'. Second is Italy with 8 articles. In the third position is China (including Taiwan) with 5 papers. Finland, Canada and Pakistan are in the fourth position, with 3 articles each, then come USA, UK and Jordan with 2 articles each. Countries where IC first gained prominence are represented with one article each - Sweden and Denmark -, as do the newcomers Russia, Kenya, Tunisia, Colombia, Brazil, Oman, Mexico and Indonesia.

It can be concluded that the topic that makes this paper's object has been mostly researched in Europe (19 articles) and Asia (10 articles), while North America and Africa were responsible for two articles each.



Figure.1 Author(s) location.

In the vast majority of cases, researchers investigate local and regional companies. As a consequence, the same positions in top 3 based on sample location are occupied by the same three countries: Spain, Italy and China. The research focus on the local business could be due to a better knowledge of the local business environment, facilitated access to databases within local projects, and also the location of the co-authors.

### *International cooperation*

One third of the selected articles (12) have been co-authored by researchers from different countries. It can be noted that Spain is again a front runner, with 5 articles on this topic written in international co-authorship, then comes Finland. While Italy is constantly classified among the top countries in the IC discipline research, Italian researchers are represented here only with local groups of authors.

### *Specialized authors*

Spain is on top position once more in respect of authors that specialize on topics related to IC, innovation and technology, with two researchers that have jointly written 3 articles on the subject, namely Miriam Delgado-Verde and Gregorio Martín-de Castro (2011, 2013, 2016).

### *Citations*

Table 1 shows the articles with more than 50 citations (WoS/Scopus/combined).

Table 1. Most cited articles.

Year	Author(s)	Title	Citations	
			Wos	Scopus
2009	Renko, M., Carsrud, A., Brännback, M.	The Effect of a Market Orientation, Entrepreneurial Orientation, and Technological Capability on Innovativeness: A study of Young Biotechnology Ventures in the United States and in Scandinavia.	121	147
2005	Huang C.J., Liu C.J.	Exploration for the relationship between innovation, IT and performance.	-	125
2015	Tzokas, N., Ah Kim Y., Akbar H., Al-Dajanid, H.	Absorptive capacity and performance: The role of customer relationship and technological capabilities in high-tech SMEs.	92	113

2016	Delgado-Verde M., Martín-de Castro G., Amores-Salvado J.	Intellectual capital and radical innovation: Exploring the quadratic effects in technology-based manufacturing firms.	48	56
2016	Murray A., Papa A., Cuzzo B., Russo G.	Evaluating the innovation of the Internet of Things. Empirical evidence from the intellectual capital assessment.	35	42
2013	Martin-de Castro, G., Delgado-Verde, M., Amores-Salvado, J., Navas-Lopez, J.E.	Linking human, technological, and relational assets to technological innovation: exploring a new approach.	34	40
2016	Verbano C., Crema M.	Linking technology innovation strategy, intellectual capital and technology innovation performance in manufacturing SMEs.	31	40

#### *Journal of Publication*

As expected and confirmed by the analysis, articles on this topic are published not only in mainstream journals dedicated to the field of intellectual capital, but also in journals that focus on innovation and technology.

#### *Industry and Technology Type*

The selected articles cover a range of economic sectors, manufacturing and services being investigated the most. A couple of articles are dedicated to FinTech and biotechnology respectively, and one to pharma industry and agriculture each. As anticipated, the overarching technology researched is ICT, even in those cases where the generic term “technology” is used, without further specification. The intended use of the term becomes apparent only after studying the constructs utilized, when content is available. In few cases the actual technology concerned by the study is described. In only two cases the subject of research are specifically the digital technologies associated with Industry 4.0 (i.e. 3D printing, Big Data, cloud computing, robotics), and both of them have been published this year.

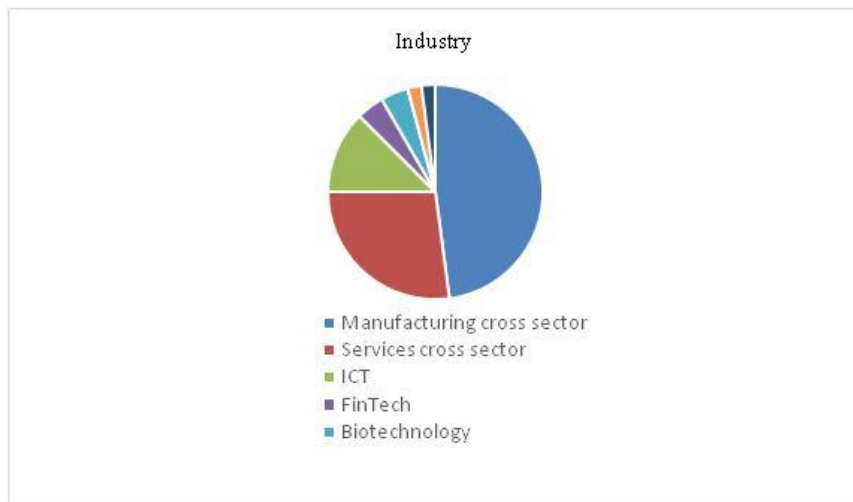


Figure 2. Industry sector.

#### *Firm Size and Sample Size*

The distribution of data shows that various firm types (SME, large, combination) have been investigated almost equally, with SMEs being slightly favoured. The sample size ranges from one firm (case study), to vast regional (EU) data sets.

#### *Method*

Quantitative methods have been preferred by researchers, which indicates an inclination towards achieving objective and generalizable results. While a variety of methods have been utilized, there is nevertheless a preference for the structural equation modelling, as shown in Figure 3. Qualitative methods encountered more often were case studies and interviews. A combination of quantitative and qualitative methods was used in 6 cases.

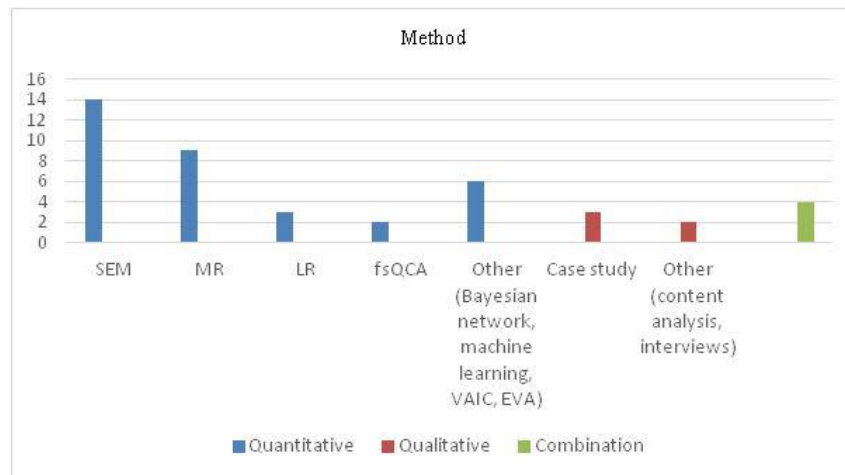


Figure 3. Method employed.

## 4.2 Research findings

With the view to answer the first research question (RQ1), concerning the focus and framework of scientific literature on the relationship ‘intellectual capital management-technology-innovation’ we could distinguish between four main streams of research:

### 4.2.1 Technology and IC management to leverage knowledge for innovation

Kipkirong Tarus and Kiptanui Sitienei (2015) larger firms are better placed in harnessing structural capital through ICT systems and increase innovativeness, unlike SMEs, which have to remain nimble to substitute for the lack of extensive resources (Verbano and Crema, 2016). A proper IT infrastructure supports better synergy between business functions and improved management processes Torre et al. (2020). ICT enables IC development e.g. by providing HC with advanced training and education capabilities, collaborative tools, networking opportunities for exchanging knowledge (Steinfeld et al., 2010). However, as stressed by Cabrilo et al. (2020), having the technological capability is not sufficient and what is important is how organizations utilize it to manage IC and create value. In addition, an appropriate IT system can be a remedy to fragmentation of knowledge, especially in the case of geographically dispersed teams (Mazzucchelli et al., 2021). Also, according to Andersson et al. (2021), harnessing the potential of advanced technologies is dependent on the organizational absorptive capacity.

#### *4.2.2. Technological capital as dynamic capability*

While referencing Gatignon and Xuereb (1997), who grounded the technological orientation as a strategic dimension leveraged to achieve innovation, Renko et al. (2009) focused their work on the technological capability, described as an organizational pledge to expand its IP and R&D, pertaining to a firm's knowledge base. Other authors defined TC as organizational endeavours to master innovative technologies (Campos et al., 2020; Wang et al., 2020).

#### *4.2.3 Technological capital to sustain innovation*

As Martin-de Castro et al. (2013) indicated, the technological capital comprises the blended organizational knowledge such as R&D and IP, connected to the activities and functions of the operational technical system, aimed at generating new products and services. Technological knowledge affects the innovation capabilities (Galeitzke et al. 2017). According to Najar et al. (2020) advanced technological capital supports open innovation (OI) by integrating external knowledge, and OI is grounded on ICT platforms that enable communication and knowledge exchange. Unlike incremental innovations, radical ones require changes in a company's technological trajectory and associated competencies (Delgado-Verde et al., (2011). However, as underlined by Delgado-Verde et al. (2016), excessive investments in technological capital are not reflected in radical innovation performance.

#### *4.2.4 Technological capital and organizational performance*

Mahmood and Mubarik (2020) stated that technological absorptive capacity (TAC) allows companies to adapt and grow within a dynamic industry context, and IC is paramount in stimulating TAC and innovation. OI enables organizations to enhance technological competences by assimilating external technologies and technological knowledge. TO positively affects performance (Masa'deh et al., 2018; Khan et al., 2019; Andersson et al., 2021) and the interaction between HC and SC is required in order to leverage innovative technologies (Cavicchi and Vagnoni, 2018). New technologies offer the tools for improved performance, enhanced knowledge management and are essential in generating value (Torre et al., 2020).

Technology intensity (TI) augments the positive effect of HC efficiency on firm performance (Palazzi et al., 2020). Buenechea-Elberdin et al. (2018), Martín-de

Castro et al. (2013) established that TI mediates the relationship between IC and business performance, as well as innovation.

The positive effect of technology is not undisputed, though. According to Usai et al. (2021), Orlando et al. (2021) digital technologies increase firm efficiency, but they can negatively affect HC and RC, through reduced interactions and standardised learning. Nevertheless, it has been also found that digital technologies such as 3D printing, robotics, and Big Data analysis are valuable for innovation up to a certain extent.

#### **4.3 Emergent research trends**

This section aims to provide the answer to the second research question (RQ2).

As Martin-de-Castro et al. (2019) have noted, despite the fact that the study of IC has approached maturity, this discipline still has an interdisciplinary nature, and its findings are not unified and undisputable. The cited authors have also stated that, since the inception of this research field, several phases corresponding to specific periods could be distinguished, namely conceptualization and business focus (1990-1999), measurement and management models, including IC component research (2000-2009) and IC as a practice (2010-2016). In this respect, taking into consideration the evolution of ICT, which is either the principle or the enabling technology studied in relation to IC, it can be concluded that the literature reviewed for our topic corresponds to the third phase.

Looking at the analytical data briefly presented in the previous section, while taking into consideration the current global economic and social setting, it can be envisaged that the research could be heading towards the study of IC, technology and innovation in various industrial settings, especially since some currently relevant ones are under-researched e.g. healthcare, pharma and green IC. Furthermore, the effect of technology advancement e.g. robotics and AI on HC, knowledge generation and innovation is still to be undertaken. The relationship between IC and innovative business models that rely on new technologies is another avenue for investigation. Finally, studies that employ new research methods that rely themselves on advanced technologies e.g. machine learning, vast data sets are expected to increase in numbers.



## 5 Conclusions

When attempting to draw some preliminary conclusions for this study, what could firstly be stressed is the need to build a more in-depth conceptual framework underlying the research on the relationship 'IC-technology-innovation', which should also be better embedded in practice, with the aim to understand how organisations actually use technology in developing IC for operational and strategic purposes. As various investigations have brought out conflicting findings, researchers should consider the fitness of the frameworks and the methodologies used, as well as the specificities of the local business context and the proper understanding of the technology concerned.

Despite the fact that many digital technologies and other ICT enabled technologies originated or are extensively employed in North America, it appears that the focus on the relationship with IC is mainly an endeavour of European and Asian researchers, therefore a large geographical area is not covered by the current research. At the same time, certain economic sectors have scarcely made the object of IC research in the proposed paradigm, e.g., healthcare, pharma, agriculture, fintech etc. Most studies have focused on general purpose ICT applications, while technologies pertaining to the Industry 4.0 framework have just started to be considered by researchers.

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## **Situation Awareness and Governed Trust in Partner Networks: A Hierarchical Conceptual Model**

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### **Abstract**

This research was motivated by numerous challenges of collaboration in loosely connected partnership networks and strived to propose suggestions, applicable especially for critical cross-border infrastructures. Such need was induced by the necessity of secure and uninterrupted character of their services, significant of even dangerous impacts of possible malfunctions and inherent presence of nationally specific differences. As a possible solution, we propose a conceptual model of a governing framework for such types of industrial partnerships, considering several types of their structural and behavioural aspects. In the organizational context, situation awareness was included as a physical function in the second level of the Work domain analysis framework (WDA) in a form of a qualitative knowledge-based model. Its layered structure allows interconnection of situation awareness with principles of organizational performance, cybersecurity and trust, as well as the synthesis of related joint metrics. Toward the collaborating partners, there are two main outputs from WDA framework, performance and availability. Based on the continuously shared set of momentary values of these indicators, governing level of partnering network can efficiently plan further joint steps and develop or optimize own collaborative procedures.



Methodologically the presented solution combines WDA with traditional methods and tools of system thinking into the resultant Causal loop diagram, characterizing dynamics of mutual trust among collaborating partners. This diagram can be either analysed directly or conveniently adjusted for specific cases. Its individual or team analyses can provide a useful insight into the dynamic aspects and consequences of efficient extra-organizational collaboration. Besides the optimization of joint performance, such a complex knowledge-based model can also decrease the overall vulnerability and help organizations to safely recover from undesirable effects of fast global dynamics, including, e.g., the total impacts of the ongoing pandemics.

**Keywords** – Situation awareness, Partner network, Trust, Mental model, Governance

**Paper type** – Academic Research Paper

## 1 Introduction

At first sight, the concept of situation awareness (SA) seems to be straightforward. However, a deeper consideration enlightens the complexity and wide spatio-temporal context of this phenomenon. Its main characteristics, applicable to individuals, teams or organizations, can be summarized as follows:

- The primary role of situation awareness is the support of the right decisions. From the organizational point of view, well-developed SA is useful especially for planning and fulfilment of SMART objectives on the level of executive management,
- Managerial decisions usually combine the truth-preserving deductive, i.e., knowledge-based and inductive, i.e., data-driven inference. Consequently, SA requires a firm base of valid, relevant and diversified knowledge, extended with secured, correct, reliable and consistent data.
- Real-world problems are holistic and multidimensional with numerous subjective factors, represented with nonlinear utility functions. Also, causality and a wide range of internal dynamism, are fundamental challenges, accompanying the decision making processes.

### 1.1 Situation awareness

As the overall unifying paradigm, this research adopted principles of the Maslow's hierarchy of needs (Bridgman *et al.*, 2018; Maslow, 1943), applied to the corporate environment. In such context, the crucial prerequisite for any type of

cooperation is functional organizational metabolism, representing the conversion of industrial inputs into expected outputs and expressed, e.g., in terms of productivity or, in a broader context, performance. This vital transformation is located on the ground level of the hierarchy, as it is shown in the left part of Figure 1. For effective and repeatable production, an organisation must feel secure in all its value-creating phases. This essential requirement concerns both its internal processes and external inputs, influenced by the market or environmental changes, governmental regulations or interaction with collaborating subjects. While at the first and partially also at the second level of Maslow hierarchy the organisation is mainly concerned with its own needs, all subsequent levels also assume different types of social bindings. Nevertheless, this research dealt mainly with the third level, because the performance management, widely explained in the literature (Davies, 2016; Lee and Snyder, 2017), was out of its scope. The same purposely done omission holds also the cybersecurity domain, research and scientific analysis of which is presented in (Edgar and Manz, 2017; Metcalf and Spring, 2021). Our approach, directly applicable also in WDA hierarchy, was presented in (Voracek *et al.*, 2020). Concerning the upper two levels of Maslow's pyramid it is evident that they can be added to this framework later. Both research and practice (Kenrick *et al.*, 2010; Krech *et al.*, 1962; Maslow, 1942; Uchejeso, 2019) distinctly indicate that for a standard-functioning organisation, the level of fulfilment of its own needs increases over time and its composition and scope changes.

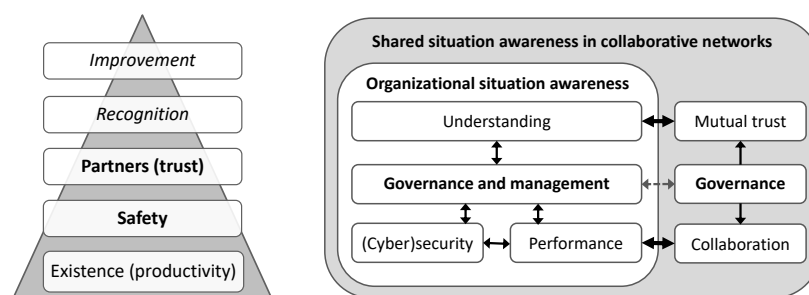


Figure 1 Maslow hierarchy and situation awareness in a wider context

## 1.2 Modelling of situation awareness

There are numerous models of individual situation awareness, derived from the seminal paper (Endsley, 1995). This model distinguishes three generic SA phases,

perception, comprehension and projection, forming the desired decisions and actions, as it is schematically shown in Figure 2.

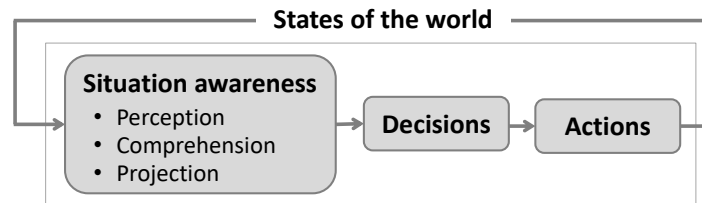


Figure 2 Simplified Endsley's model of situation awareness

Many consecutive modifications of this originally air-traffic model were introduced to fit better to more complex and technically oriented SA models, useful for phased processing of multi-input semi-autonomous systems, typical for the Internet of things, Industry 4.0 or cybersecurity. Their characteristic representative is the Observe-Orient-Decide-Act (OODA) model, informally introduced by Boyd and further developed by (Luzwick, 2000; Lytvyn *et al.*, 2020). Extended models of individual SA can also be used for work in teams (Endsley and Jones, 2001).

### 1.3 Shared situation awareness

The stronger the scope and responsibility, the higher need for well-formalized situation awareness. This evident fact also concerns the presented case of network collaboration. As the network usually represents rather governing than managing superstructure, its role typically insists on overall coordination and harmonization, and not in the generation of core performance. Thus, the challenging situations arise when cooperating organizations need to share their specific states of SA. This is impossible in terms of the model itself because its individual architectures and parameterizations are unique and contain mainly private, formally and semantically specific information. Inspirative characteristics of distributed SA were presented in (Salmon *et al.*, 2017) and applicable shared mental models of secured situation awareness were proposed in (Gawron, 2019; Noran and Bernus, 2018).

Networking matters can be solved based on the Resource dependence theory (RDT) presented in (Hillman *et al.*, 2009; Loasby, 1979; Pfeffer and Salancik, 2003). The RDT states that an organisation can be in a specific way dependent on

resources that it does not own in sufficient quantities. Thus, it must rely on resources of another organisations, especially in critical situations. Hence, shared resources can become a tool of particular power in such communities. This theory was further developed into general models of collaboration, where the Resource Dependence Institutional Cooperation (RDIC) model described in (Hoefsmit *et al.*, 2013; de Rijk *et al.*, 2007) was adopted for this research. Figure 3 shows that it also preserves all three stages of the individual SA model, where perception and comprehension are located at level 3 and level 2 is a result of their projection.

Instead of complex metrics, the status of external collaboration is expressed just with two descriptors, the real ability to cooperate and the corresponding willingness. The former represents the level of ready to share capabilities and resources, the latter indicates the real motivation to cooperate, resulting from the trust. When analysing this pair of determinants in terms of bilateral relations, the following four possible combinations emerge:

- Correspondence in ability and willingness: efficient collaboration with added synergy,
- Correspondence in ability, differences in willingness: quantitative, mainly administratively additive form of cooperation,
- Differences in ability, correspondence in willingness: societal effort to cooperate without explicit commercial interests,
- Differences in ability and willingness: random, inconsistent collaboration with non-deterministic added value.

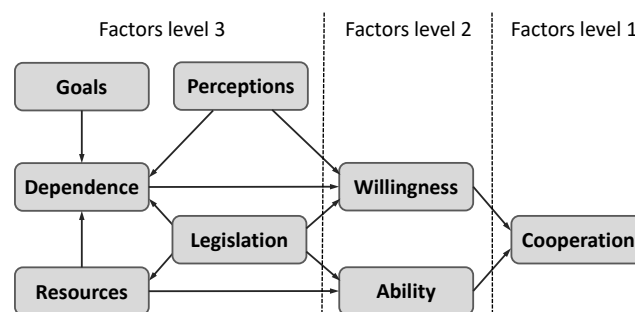


Figure 3 Schematic representation of RDIC model

The generic RDIC model for collaborating organizations must be appropriately implemented. Practically this means, that the metrics, continuously provided outside, must be centralised, regularly processed and results used for future

optimization of network performance. Similarly, the applicable model of such agile network governance must respect the local habits, actual means and capabilities. According to the literature focusing on governance (Laimer, 2016; Provan and Kenis, 2008; Raab *et al.*, 2015), there are three following concepts of network governing structures, illustrated also in Figure 4:

- Organizationally arranged and administratively linked partners share the common governance, executed by individual management structures. This option is suitable for tight global organisations or supply chains. In case of loosely coupled units, the centralized way of policymaking violates the assumption of individual independence.
- Consortium represents a federative form of governance and preserves individual levels of management. The main weakness of consortium is the identification of the most convenient way of federalized decision-making.
- Coalitional structure does not have an explicit level of governance; however, partners are informally coordinated at their own governance and management levels. While this arrangement maximises autonomy and ensures information sharing, it may have problems with implementation of common decisions.

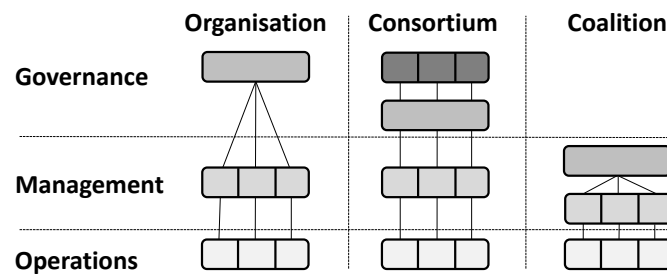


Figure 4 Different structures of network governance

#### 1.4 Understanding and trust

The willingness to collaborate is the key enabler, determining the real scope of shared services or resources, provided by an organization to its partners. To explicitly analyse and share this crucial soft category with partners, its transparent quantification is unavoidable. Thus, we propose to express the willingness with

the two explicitly defined indicators, mutual (terminological) understanding and trust.

## **2 Terminological unification and reduction**

The notion of mutual understanding expresses the fact that the cooperating organisations understand each other both syntactically and semantically. Syntax refers to the set of related terminology, semantics concerns the overall meaning of particular concepts. Standardization of both communication aspects mitigates linguistic and cultural differences and minimisation of shared dictionary properly structures and simplifies the collaboration. This process results in the following four combination of communication compatibility, which must be early recognized, managed and optimised:

- Consensus, when syntax and semantics are understood similarly,
- Correspondence, resulting in the commonly understood meaning, expressed with different terminology. This is an acceptable and usual situation, because the definition of common descriptors for joint concepts is a technical matter,
- Conflict means that involved parties are used to present different topics in the same words. This risky situation usually requires thorough redefinition of the ambiguous concepts,
- Contrast indicates that the members of the working group cannot agree either on common issues or terminology, which usually indicates an inappropriate composition of the working group or incorrectly designed structure of the set of the modelled concepts, pairing them with inappropriate descriptors.

Another effect of the unification phase is the possible reduction of total number of shared concepts and terms. The irrelevant items can be removed, and the close ones merged. This is usually realized by the numeric clustering of initial sets of concepts (semantics) and constructs (terms), after which the resultant sets are personally analysed. The Repertory grid (Kelly, 1991; Ryle, 1975; Stewart *et al.*, 1990) can be used for these purposes.

## **3 Trust**

Trust is defined as the will to accept potential risks based on the positive expectations, intentions or behaviour of another entity (Cui *et al.*, 2018).

According to (Thanetsunthorn and Wuthisatian, 2020), trust is recognised as one of the most significant determinants of both organisational development and success. Nevertheless, increased performance, productivity, creativity, innovativeness, inner satisfaction, motivation or the willingness to share knowledge are the positive consequences of trust within an organisation (Pirson and Malhotra, 2011). From the static point of view and primarily at the individual level, it is challenging to quantify trust because of its hardly distinguishable causes and effects. Hence, this is the specificity of trust, compared, e.g., to the quality, which is also intangible but can be straightforwardly expressed as a degree of non-compliance with the explicitly given standards. Therefore, it is better to analyse trust dynamically, because in such case it evolves within interconnected feedback loops, where the role of initial causal relations is important mainly at the beginning of analysis. Trust T is frequently characterized by the Trust equation (TE) (Maister *et al.*, 2001) as follows:

$$T = (C * R * I) / O, \quad \text{where:}$$

C is Credibility, which represents the joint level of past perceived trustworthiness and expertise,

R is Reliability and can be measured as a level of fulfilment of past commitments,

I is Intimacy as a metric of ability to preserve secret or sensitive information,

O is Self-orientation, i.e., level of preferring personal benefits over the team ones.

Although trust among organisations is based on similar principles; the structure of operands in TE must be derived directly from organisational processes. A number of specifically targeted publications are devoted to this matter, analysing the possibilities and tools of forming and evaluating trust in specialised organisational structures (Aydogan *et al.*, 2014; Radomska *et al.*, 2019; Ward *et al.*, 2014). Interesting are also conclusions from the extensive review of methods and tools for trust modelling, presented in (Cho *et al.*, 2015). It states that trust is determined with close synergy between corporate governance and management, whereby the implemented strategies clearly respect the mission, values and general goals. Furthermore, trust needs to be continually evaluated, primarily through simple, unambiguous, easily understandable and transferable metrics. In addition, adequate and explicit resources should be dedicated for trust-building

initiatives and should be carried out on an ongoing, regular and personal basis. Finally, the following dimensions of composite trust were presented:

- Communication trust, in our case referring to the overall quality of network services, including, e.g., their stability, availability, timeliness, reliability, scalability, effectiveness, maintainability or bandwidth,
- Information trust, expressing the level of information sharing and its quantitative and qualitative aspects, concerning the intrinsic (accuracy), contextual (relevance), representational (interpretability) and accessibility (security) characteristics. This dimension correlates with the intimacy component of the trust equation (TE),
- Social trust: indicates the trust between individuals in virtual networks, measured with selected indicators of their interactions. This metrics concern practically all internal, performance related processes and any form of business-oriented digital networking (supply chains, critical infrastructures, global businesses) and it is close to TE reliability component,
- Cognitive trust, acquired from any kind of cognitive processes, established among partners, such as the internal learning and growth processes or personal development of network collaboration. The cognitive component of composite trust is vaguely related to credibility and self-orientation elements of TE.

Dimensions of trust can naturally evolve within the organizational structure and over time. Such levels of maturity, applicable gradually on teams, organizations and the whole network, can be characterized as follows:

- Basic maturity, implemented at the level of organizational management and including regular monitoring and control of trust reflecting metrics, derived either from the overall performance or from its specific BSC-like sectors (operations, learning and growth, customers, finances),
- Intermediate maturity, implemented at the level of organizational governance, expecting definition of trust-driving values, policies and strategies, compliant with adopted industrial standards,
- Advanced maturity, implemented at the level of network governance and assuring harmonization and optimization of all aspects of single trust dimensions.



## **2.1 Work domain analysis**

The above-presented structural elements can be further refined and integrated into the hierarchical structure of the Work domain analysis (WDA) framework, presented and applied in (Burns *et al.*, 2009; Lintern and Naikar, 2000; Wang *et al.*, 2017). WDA is the first stage of Cognitive work analysis framework (Rasmussen, 1985; Vicente, 1999), capable to modelling structure, behaviour, strategies, social interactions and competencies of complex socio-technical systems. As an architectural diagram, it deals entirely with structural elements, disregarding their specific functionality. It is the bidirectional means-end type of abstraction-decomposing architecture with two physical and three domain layers, ordered in a vertical direction. Sometimes, WDA diagram is structured also in the horizontal direction, showing different levels of decomposition, from whole to parts.

Inner nodes of vertical layers represent structural function or constraint as follows:

- Domain purpose: the main focus of the analysed system,
- Domain values and priority metrics: the key qualitative and quantitative descriptors of system purpose, either collected from lower layers or passed there from the upper level,
- Domain functions: general functions, synthesizing the system purpose based on outputs from physical functions or adjusting these functions,
- Physical functions: specific capabilities, generated or requested by underlying social or technical systems,
- Physical resources or constraints: different types of system inputs and outputs.

## **3 Methods**

The main methodological goal of this research was to review, systemize and merge the extensive and thematically heterogeneous resources to address the following topics:

- Weak situation awareness of loosely collaborating organizations,
- Lack of simplistic formalization and standardization of their daily interactions,
- Absence of common cohesive structural elements, that would guarantee an appropriate level of governance for the whole network.

Results of literature review and personal interviews indicated that the routine processing of organisational knowledge as well as sharing it with partners is not a common practice. Valuable information and practical experience were found also in extensive deliverables of EU projects, concerning mainly infrastructural resilience and containing results of workshops with stakeholders (DARWIN, 2018; IMPROVER, 2018; RESILENS, 2015; SMR, 2018). Furthermore, these resources also state that there are multiple reasons for such a closedness, from mutual procedural incompatibility to unsolved political, economic, social, technological, legislative and ecological (PESTLE) differences.

Consequently, the identification of appropriate ways of creating and developing a suitable coordination platform is crucial for harmonising synergies across the network. We propose to eliminate these bottlenecks through the following qualitative outputs:

- Structural standardization of situation awareness of single partners in the form of WDA framework, as a specification of RDIC model,
- Identification and dynamic formalization of shared trust as the key prerequisite for efficient collaboration in partner networks, using the Causal loop diagram.

Such qualitative models established the initial common understanding of the researched problem, which will be further specified and quantified. The complex networking problems, characterized as functionally and managerially independent, geographically distributed, intrinsically complex and evolving over time, are typically analysed using the System of systems framework (Cantot and Luzeaux, 2013; Kopetz *et al.*, 2016; Lane and Epstein, 2013; Nielsen and Nielsen, 2013; Thacker *et al.*, 2017; Yang *et al.*, 2009).

We, however, adopted the more aggregate System dynamic (SD) approach, especially because of its relative simplicity and possibility of straightforward computational implementation. The system dynamic approach for the compact study of complex socio-technical systems was introduced in (Forrester, 1961). This powerful framework helps to approximately evaluate the multidimensional time-varying problems involving delays, feedbacks and nonlinearities (Meadows and Wright, 2015). It combines three main modelling methods, Causal loop diagrams (CLD), System sequence diagrams (SSD) and Stock and flow diagrams (SFD), based on which it is possible to create high-quality models of the real-world problems (Sterman, 2014). Although system dynamics methodology is used mainly in the areas of economic and social sciences, it also has numerous

successful applications in natural or technical sciences. Qualitative SD models, usually in the form of CLDs, can efficiently support individual or team decisions, safely train decision-makers or validate dynamic hypotheses, concerning the temporal evolution of selected variables. Quantitative instances of SD diagrams, SFDs, generate numerical predictions, analyse internal sensitivity, evaluate and compare different external scenarios or parametrically optimize initial configurations (Morecroft, 2015; Warren, 2008).

#### **4 Results and discussion**

Besides the problem systemization, presented in the introductory part, we also designed two qualitative models, illustrating the inclusion of a knowledge-based model of situation awareness into the abstract architectural WDA hierarchy, presented in Table 1. For representational clarity, the tabular format was used instead of the more usual graphical scheme. Thus, 42 links between the adjacent layers were omitted. This model follows the proposed duality of purposes and maintains both aspects of performance/availability and trust/willingness. It starts from the physical objects, providing a secure bidirectional interface for raw data and information, altogether with the necessary drivers and enablers of performance. At the physical functional level, belonging inputs and outputs are transactionally processed in accordance with the prescribed objectives. Moreover, this level also technically implements the knowledge-based model of situation awareness, proposed as a CLD diagram in this research. Its requirements are defined and adjusted in the upper parts of the WDA model. Domain functions synthesize domain values, constrains and have a character of configurable services. Standard performance is incorporated with nontrivial functionality of organizational learning and marketing. Furthermore, this level functionally establishes principles of trusted networking. Both sets of activities are supported with organizational managerial frameworks and adopted decision making procedures. Domain purposes are monitored or controlled through a usually extensive set of concrete values, collectively derived from/or affecting domain functions.

The final presented result, dynamic model of shared trust among collaborating partners, is composed of the seven mutually interconnected and internally structured subsystems, shown in Figure 5.

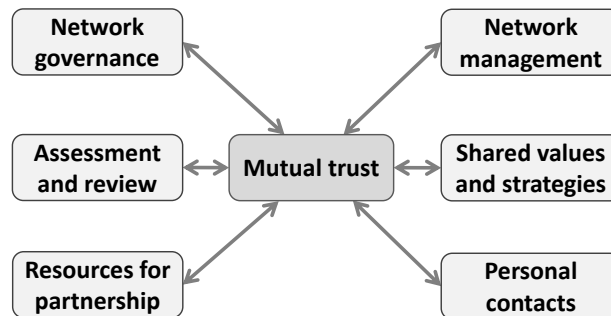


Figure 5 Subsectors of Causal loop diagram, representing mutual trust in networks

Implementation CLD thus contains 45 variables interconnected with 220 oriented and polarized edges, which form 32600 loops with the length varying from 2 to 25 edges. Such a complex chart cannot be presented as a whole, and its analyses require specialized tools. On the other hand, such purposely introduced redundancy stimulates analytical thinking and encourages team discussions. For example, the ordered horizontal histogram of the variables, appearing simultaneously in different subsystems is in Figure 6. Trust, as the key concept, is a natural part of all sectors. Similarly, the following three busy variables, Governance, Agility and Knowledge sharing, illustrate the most desirable initiatives.

Table 1 Work domain analysis of situation awareness and trust in partner networks

Domain purpose	<ul style="list-style-type: none"> <li>▫ Efficient collaboration with partners</li> <li>▫ Maximization of own performance</li> </ul>
Domain values	<ul style="list-style-type: none"> <li>▫ Dynamics, complexity, sensitivity, regulations</li> <li>▫ Level of sharing and collaboration</li> <li>▫ Predictions and projections</li> <li>▫ Risks, (cyber)security, resilience</li> <li>▫ Internal and networking workload</li> <li>▫ Trust, understanding, transparency</li> <li>▫ Performance</li> </ul>
Domain functions	<ul style="list-style-type: none"> <li>▫ Selection and analysis of relevant information and knowledge</li> <li>▫ Decision-making and execution of decisions (management)</li> <li>▫ Organizational learning and marketing</li> <li>▫ Networking</li> </ul>
Physical functions	<ul style="list-style-type: none"> <li>▫ Automated knowledge modelling across physical objects</li> <li>▫ Data and information distribution and batch processing</li> <li>▫ Operations and financing</li> </ul>

Physical objects	<ul style="list-style-type: none"> <li>▫ Cybersecurity</li> <li>▫ Data, information, and knowledge resources</li> <li>▫ Organizational, information and communications systems</li> <li>▫ Human performance drivers (knowledge, skills, experience)</li> <li>▫ Non-human performance enablers (infrastructure, resources)</li> </ul>
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Finally, the first two levels of an unrolled set of the *Mutual trust* related loops are proposed in Figure 7. For technical reasons, the right part (causes) and left part (uses) were captured separately and thus the notation of variables in parentheses (.), meaning their second and further occurrence in the diagram, was evaluated independently on both sides of the diagram. Even such a limited cut-out shows many short and so temporally fast trust-related loops, demonstrating the dynamic fragility of this concept. Change of any of the closely neighbouring variables can affect the mutual trust and invoke the domino effect. Beyond the trust itself, also other, topologically closely variables are interrelated (parenthesised) which increases the overall trust volatility, too.

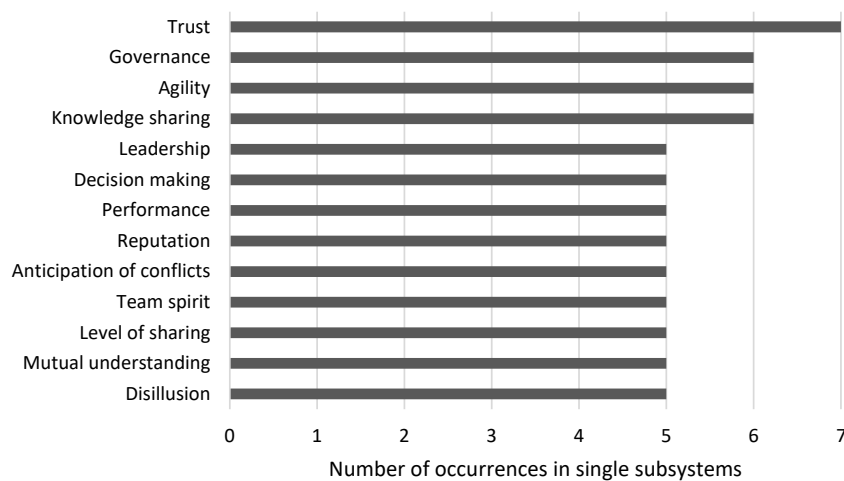


Figure 6 The most frequently occurring variables in single modelled sectors

To illustrate the overall complexity, randomly selected loop of the most frequent length 16 looks as follows and its starting and ending sequences can be found in Figure 7:

*Trust* → *Organisational learning* → *Shared values* → *Shared knowledge* → *Effectiveness of network monitoring* → *Mutual understanding* → *Networking strategy* → *Mutual social cohesion* → *Disappointment* → *Mutual commitment* →

*Agility → Network governance → Access to and sharing of information → Local performance → Shared accountability → Organizational flexibility → Trust*

## 5 Conclusions

Digital communication, process automation, purposely established coalitions of business partners or shared resources and services are sample challenging characteristics of the contemporary world. Besides their indisputable benefits, there are also related bottlenecks that must be minimised. This research reflected the need for comprehensive and coherent orientation in a rapidly changing environment by means of a flexible, transparent and shareable model of situation awareness.

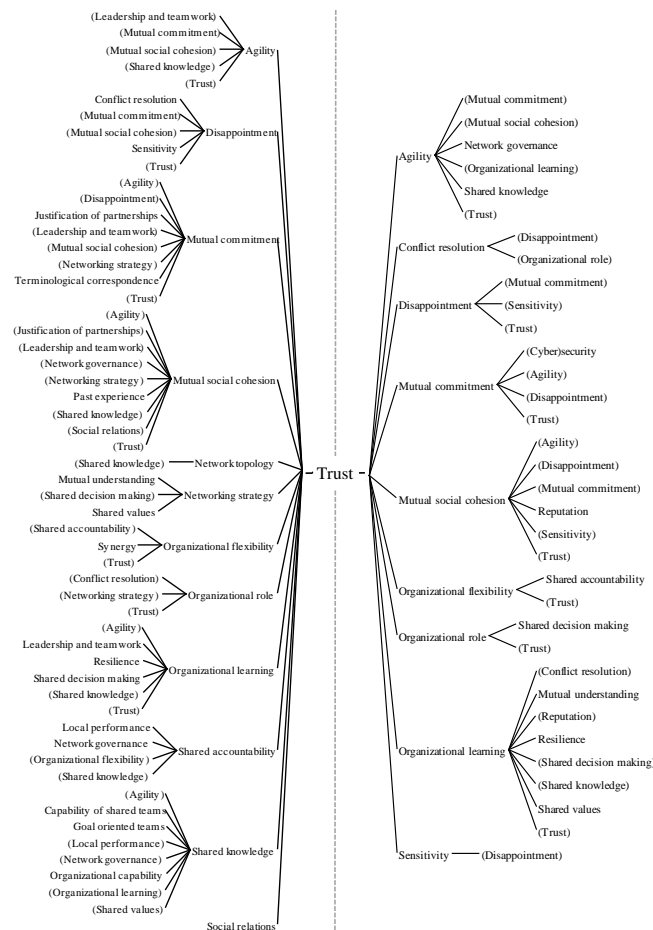


Figure 7 Partially unrolled loop of dynamic model of SA for variable Trust

The proposed conceptual solution uses the hierarchical structure of Works domain analysis as the unifying framework, within which all the key functionalities can be efficiently displaced and mutually interconnected. Such approach allows to combine highly specialized and continuously developing knowledge-intensive technologies with more or less traditional ways of business administration. Besides, this paper also distinguishes between internal and external utilization of situation awareness. The former uses any kind of perceived and contextually interpreted information for maximization of own performance, while the latter indicates the institutional availability and willingness towards the collaborators. In such case, we argue that explicit networks of repeatably interacting firms must have their own governing structure, flexible enough to maintain the desired level of cohesion and simultaneously be able to preserve the desirable level of partners' autonomy. The importance of mutual understanding of the shared terminology was discussed, too.

Thus, the presented solution systemizes and integrates a wide range of topics, substantial for loosely associated organizations. The main emphasis was given on a credible model of situation awareness interlinked with standard management and governance frameworks. Such architecture makes the vertical communication better structured, more deterministic and trustworthy. As a result, external readiness indicators of involved organizations are uniformly quantified and easy to understand. Moreover, for the governance on this extra-organizational level, a thorough trust-based dynamic model for continuous harmonization of overall interoperability was developed. It incorporates details of all presented aspects of situation awareness, divided into seven subsectors. Interactive analysis of its behaviour can identify the main sources of collaboration dynamics and determine their sensitivity and robustness with respect to external scenarios.

The originally set goals were fulfilled and viable solutions for existing gaps suggested. However, there are research limitations that need to be addressed in future research. They concern mainly general structure of suggested results, which requires further specifications. Also, the currently indirect influence of users' feedback needs to be concretized with the real data and expertise from industrial partners, namely operators of critical infrastructures. As the extension of this work, a closer mapping between strategic management platform Balanced Scorecard and governance framework COBIT (Control Objectives for Information and Related Technologies, (Information Systems Audit and Control Association, 2019) will be studied, as well as the inclusion of an explicit capability and maturity

improvement model to SA WDA architecture. Finally, the resultant model will be implemented in the executable form of a Stock and flow diagram and applied to a practical case.

We believe that the proposed hierarchical, systemic representation of common transnational, cross-sectoral and intercultural aspects of collaboration among numerous partnering organizations, presented in the context of their regular business, could support involved managers and governors in searching for appropriate internal and external policies. The innovativeness of the proposed concept lies in the fact that it tightly connects performance with trust in a structured and quantifiable manner, which can be appropriately integrated into existing administrative and decision-making processes. Chosen system dynamic way of implementation supports this approach with an intrinsically understandable representation of the modelled processes, user-friendliness, interactivity and support of teamwork. It is a natural reflection of the current digital practice where technical solutions with high degree of independence are increasingly introduced into regular managerial processes.

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## The Role of Patent Organization for the Successful Implementation of Patent Strategy

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### Abstract

With the purpose of verifying the existence of different profiles of firms based on the level of sophistication of their PM core processes, and testing the impact of the interplay between PM supporting dimensions, namely patent strategy and organization for patenting, on the level of sophistication of PM core processes, we collected data from 82 patent management professionals. This data is analyzed with factor analysis, cluster analysis, and regression analysis. The results show that patent strategy positively and significantly impacts patent management sophistication, and that the patent organization positively moderates this relationship.

**Keywords** – Patent management, Patent strategy, Patent Organization

**Paper type** – Academic Research Paper

## 1 Introduction

Firms increasingly realize that patents should not be considered an administrative and legal burden, but rather as (costly) assets that can bring economic and competitive advantage if properly managed (Ernst and Fischer, 2014). With this background, a stream of literature has developed around the concept of patent management that, according to Agostini et al. (2019), Moehrle et al. (2017) and others, is a macro-process consisting of several processes supported by the characteristics of the patent organization (e.g. Granstrand, 2000) and strategy (e.g. Somaya, 2012). More recently, there has been a further development of the literature on the patent management process, which has adopted a broad perspective and presented frameworks meant to organize the different patent management activities. In particular, authors (e.g. Agostini et al., 2019; Moehrle et al., 2017) have converged towards the view of patent management as composed of core processes (i.e. patent generation, portfolio management, intelligence, exploitation and enforcement) and supporting dimensions (strategy and organization for patenting), which has contributed to shed more light on the conceptualization of patent management. However, to the best of our knowledge, no previous study has looked into the interrelationship among these processes and dimensions with an overarching perspective, instead of on specific matters (e.g. Holgersson et al., 2018; Teece, 2018). This issue is particularly relevant, because poor patent management processes/activities, rather than the size of patent portfolio, seem to reduce the value derived from patents (Somaya, 2012). In this situation, patent strategy, which “reflects a coordinated effort for developing, managing and using patents to accomplish company's goals” (Gilardoni, 2007, p. 1), sets the conditions for core processes to work well. Furthermore, the objectives of patent management should be coherent with the organizational choices, as recently outlined by Gassmann et al. (2021) who sustain that “successful patent management in a company is rooted choosing the right organizational form” because “the best strategy is good-for-nothing if it is not consistently implemented. This requires suitable structures and processes within the company.”

As patent strategy now is a much more complex matter, with lots of different interdependent activities, we hypothesize that a well-functioning internal patent organization is critical for the patent strategy to be translated into successful patent-related activities.

Based on these premises, the purpose of this article is twofold: the former, more explorative, is to verify the existence of different profiles of firms based on the level of sophistication of their PM core processes; the latter, more structured, is to test the impact of the interplay between PM supporting dimensions, namely patent strategy and organization for patenting, on the level of sophistication of PM core processes.

The remainder of the article is structured as follows: firstly, we set the theoretical background leading to our hypotheses; secondly, we explain the methodology; thirdly, we present the results of the empirical analyses; and fourth, we discuss results in light of extant literature before deriving the theoretical and practical implications.

## **2 Theoretical background and hypotheses**

### ***2.1 The patent management process***

Our starting point is a view of patent management as a complex process going beyond the binary decision of whether to apply for a specific patent or not. The complexity relates to several dimensions, among which a few refer to the multitude of use cases and motives for patenting (Holgersson, 2013; Somaya, 2012), as enforcing the rights against potential infringers is the formal and legal use of patents, but also signalling and licensing (Chirico et al., 2020; De Rassenfosse et al., 2016) and improving freedom to operate (Holgersson & Wallin, 2017). Moreover, patent management includes the analysis of and interaction with multiple external actors, and their supply and/or demand of patents; for example, patent data can provide valuable insights in the R&D directions of others (Ernst, 2003). Furthermore, patent management must continuously reconsider the patent portfolio (Bader et al., 2012).

These are some important dimensions that patent management must embrace. Previous research has already identified a number of core processes covering these dimensions (Agostini et al., 2019; Moehrle et al., 2017; Somaya, 2012). For example, Somaya (2012) identified the generation, licensing, and enforcement of patent rights. This conceptualization of the core processes of patent management was later expanded by Agostini et al. (2019) to include patent generation, freedom to operate, patent portfolio management, patent exploitation and enforcement, and patent intelligence. In this paper, we build upon Agostini et al.'s

review of patent management measures along the lines of these core processes, which will be further developed in the methods chapter.

We expect to find variation across firms in terms of how sophisticated their patent management processes are, and expect that more sophisticated firms typically are more advanced across all core processes of patent management. Thus we formulate the following first hypothesis:

*H1: Firms can be clustered based on their level of sophistication of the PM processes.*

## **2.2 The patent management process**

Our main interest is to investigate the impact of patent strategy and patent organization on patent management processes. In other words, do patent strategy and organization matter for the sophistication of patent management?

Research on intellectual property (IP) management increasingly argues for a strategic perspective of IP and patents (Reitzig, 2007; Somaya, 2012; Teece, 2018). Both research and practice of patenting have raised concerns about the overly operational, rather than strategic, focus of patenting, where a budget is provided to a patent unit, and patenting decisions follow in line with the budget—too often disconnected from the business model and corporate strategy of the firm. While this message, arguing for a more strategic perspective, resonates well with us, there is still a gap in the literature in terms of showing that a patent strategy actually matters for the patent management process.

Nevertheless, much previous research in the more general strategy domain tells us that strategy helps us to choose a specific path, and align decisions accordingly (Rumelt, 2012). This may be especially important for patenting, since patenting decisions are long-lasting and therefore need to be aligned with each other and with the long-term direction of the firm (Wustmans et al., 2019). Following this argument, we formulate the following hypothesis:

*H2: Patent strategy has a positive impact on the level of sophistication of PM processes.*

Not only strategy matters, however, but also organization and the culture of the organization. A famous saying attributed to Peter Drucker is that “culture eats strategy for breakfast”. The meaning of this message is not that strategy is of no importance. On the contrary, strategy is important, but without the right culture of the organization—a culture that represents the strategy—the strategy will



never be successfully implemented in decisions throughout the organization (Deshpandé and Farley, 2004). Thus, the organization and its culture often moderates the impact from strategy on a firm's processes and performance (e.g. Nandakumar et al., 2010). Consequently, we formulate the following final hypothesis for how patent organization impacts patent management processes:

*H3: Organization for patenting positively moderates the relationship between patent strategy and the level of sophistication of PM processes.*

### **3 Methodology**

#### **3.1 Sample**

Considered the research aim, we adopted a purposive sampling technique to identify potential respondents to our survey. We targeted 927 professionals (e.g. patent managers, intellectual property managers, patent engineers, patent analysts) who hold a formal role within the patent management area in companies in Central European countries (i.e. Germany, Austria, Switzerland, Belgium, Hungary, and Poland). The questionnaire, sent via SurveyMonkey, included an explanation of the research purpose, the items measuring activities and organizational aspects operationalised as detailed in the subsequent paragraph.

In the end, we collected 103 completed questionnaires, which corresponds to a response rate of 11.1%. Of these firms, 82 provided their details (it was optional), which allowed us to retrieve information of their patent portfolio, which is useful for our analysis.

#### **3.2 Measures**

To operationalise our variables, we relied on measurement scales for PM processes and supporting dimensions developed by Agostini et al. (2019) who identify five PM processes: Patent generation (GEN) includes activities mean to find out what has already been patented, i.e. state of the art analysis (G\_SOA) and to decide the jurisdictions the firm wants its patent protection, i.e. patent geographical scope (G\_GEO); Freedom to operate (FTO) refers to the understanding of whether the characteristics of the object of the patent could infringe valid intellectual property rights of others, i.e. freedom to operate (F\_FTO)

and the ability to take actions to hinder other firms from holding patents in the field of interest, i.e. securing freedom to operate (F\_SEC); Patent portfolio management (PORTF\_MNG) refers to the activities related to routinely reviewing the firm's patent portfolio to discover whether its patents are still providing value to the firm (P\_REN); Patent exploitation and enforcement (EXPL\_ENF) encompasses activities related to whether and how the firm can exploiting its patents outside its boundaries to reap monetary or non-monetary benefits, as searching for other firms potentially interested in using patented technologies, i.e. proactive licensing (E\_LIC), voluntarily disclosing information on technologies and patents to make third parties get to know the firm, i.e. signalling effect (E\_SIGN), and searching for other firms' infringements and enforce the patents when needed (i.e. enforcement (E\_ENF); Patent intelligence (INTELL) comprises the activities to the firm's competitive and technological landscape using information about third parties' patents, as monitoring existing or emerging patents regularly, i.e. patent watch (I\_WTC), and analysing third party patents, i.e. patent landscape (I\_LSD).

To operationalise organization and strategy, we also referred to the measures developed and tested by Agostini et al. (2019). Organization for patenting (ORG) refers to the organizational arrangements related to the management of patents and includes activities as the provision of incentives for employees active in patent activity, i.e. patent rewarding (O\_REW), the existence and activity of a patent committee with responsibilities over patenting activities, i.e. patent committee (O\_COM), the level of commitment and involvement of top managers in patent-related issues, i.e. top management involvement (O\_TOP), the presence of a spread culture about patents, i.e. patent culture (O\_CUL). Patent strategy (STRAT) reflects the ability to see patenting as a strategic source of value and competitive advantage and, thus, align it with the overall business strategy.

All variables are measured on a 5-point Likert scale; Table 1 shows the details of the measurement items of all variables.

In the t-test and regression analysis, we used also the firm patent portfolio size (N\_PAT) that we retrieved in the patent platform Derwent Innovation.

### **3.3 Statistical procedure**

We relied on a confirmatory factor analysis (CFA), to check validity and reliability of our measures, a cluster analysis, complemented by a t-test, to

identify clusters of firms with a different level of sophistication of PM processes, and a regression analysis to assess the relationship between organization and strategy and the level of sophistication of PM processes.

For the CFA, we conducted a principal component analysis with promax using the software SPSS. All items were significantly related to their underlying constructs, providing support for convergent validity, and most factor loadings greater than 0.7 (see Table 1). We further assessed discriminant validity by examining Cronbach's  $\alpha$ , which showed alphas definitely higher than the threshold of 0.60 (Nunnally, 1978).

For the cluster analysis, we used SPSS applying a K-means method. Based on the research purpose, PM processes were the clustering variables. After the identification of clusters, we carried out a t-test with the software Stata to check if those clusters of firms showed significant difference in terms of organization for patenting, patent strategy and patent portfolio size.

To support these results still further, we performed a regression analysis to test the impact of the interplay of patent strategy and organization for patenting on the level of sophistication of PM processes. Here, the constructs related to activities were aggregated into the macro-variables associated to PM processes and supporting dimensions by calculating the mean value, following previous studies (e.g. Furlan and Vinelli, 2018).

To test the moderation, we carried out a two-group analysis based on the level of organization for patenting. We included in the "High/Low ORG" group firms with levels of organization for patenting higher/lower than the mean of the sample respectively. Afterwards, we carried out a Chow test (Chow, 1960) to assess the statistical difference between the regression coefficients associated to the independent variable, i.e. strategy for patenting.

Table 1: Results of the confirmatory factor analysis

	Construct	Id	Items	Factor loading	Cronbach's alpha
GENERATION	State-of-the-art analysis	While carrying out an R&D/innovation project in our company, we (1=strongly disagree; 5=strongly agree):			0.694
		G_SOA_1	Identify and store all information that might be relevant to a patent's claims of novelty/patentability	0.651	
		G_SOA_2	Gain insights into what has been patented in a certain technological	0.877	

FREEDOM TO OPERATE			field				
		G_SOA_3	Use public and private databases to check relevant existing patents/prior art in the technological field	0.824			
	Geographical scope	While carrying out an R&D/innovation project in our company, we (1=strongly disagree; 5=strongly agree):				0.813	
		G_GEO_1	Examine carefully in which countries we want to file each patent	0.855			
		G_GEO_2	Carefully analyze the specific rules/procedures/fees of each jurisdiction	0.757			
		G_GEO_3	Consider current and future market needs in different countries	0.826			
		G_GEO_4	Follow specific criteria (e.g. location of manufacturing facilities, target market, core countries, cost of filing/renewal, activities of competitors) to select in which countries to file patents	0.750			
		Freedom to operate analysis	While carrying out an R&D/innovation project in our company, we (1=strongly disagree; 5=strongly agree):				0.845
			F_FTO_1	Analyse the most critical in force patents (all independent claim) with technical staff for the most critical cases	0.836		
			F_FTO_2	Check the probability of litigation	0.841		
			F_FTO_3	Use databases to check the evolution of a other firms' pending patents	0.880		
			F_FTO_4	Formulate a formal opinion on the freedom to operate of the freezed concept	0.743		
		Securing freedom to operate	Please, indicate your level of agreement (1=strongly disagree; 5=strongly agree) with the following sentences regarding managers in your company in the last years:				0.733
			F_SEC_1	File patent application to defensively prevent other firms' grant of exclusive rights over markets and technologies	0.804		
			F_SEC_2	Use offensive patenting to exclude competitors from using a technology	0.856		
			F_SEC_3	Consider developing a thicket of patents surrounding the single invention	0.728		
M	Patent renewal	Please rate your level of agreement or disagreement with these statements regarding patent renewal in your company:					

EXPLOITATION AND ENFORCEMENT		P_REN_1	We follow specific criteria (e.g. location of manufacturing facilities, target market, core countries, cost of filing/renewal, activities of competitors) to select in which countries maintaining patents	0.748	0.814	
		P_REN_2	We regularly check whether expected future benefits of a patent exceed the cost of renewal in a particular country before renewing it	0.749		
		P_REN_4	We regularly review patent portfolio to consider which patents to maintain	0.810		
		P_REN_5	We consider the technological impact of patents when making patent renewal decisions	0.774		
		P_REN_6	We regularly assess how to use patents in our portfolio (e.g. to support an existing technology, to prevent a competitor to use that technology, to sell the patents)	0.726		
		Signalling effect	Please, rate your level of agreement or disagreement with the following statements regarding patent exploitation in your company:			
	E_SIG_1		We use patents to attract debt capital, such as bank loans	0.875	0.812	
	E_SIG_2		We use patents to attract equity capital, such as venture capital	0.870		
	E_SIG_3		We use patents to set better conditions in merger and acquisition operations	0.823		
		Enforcement	Please, rate your level of agreement or disagreement with the following statements regarding enforcement in your company:			
	E_ENF_1		We regularly look for infringers	0.747	0.638	
	E_ENF_2		We focus our monitoring on patents with broad claims	0.779		
	E_ENF_3		We pursue patent enforcement in case of infringement	0.734		
		Proactive licensing	Please rate your level of agreement or disagreement with these statements regarding patent portfolio in your company:			
	E_LIC_1		We check potential for out-licensing into other markets or technology areas	0.864	0.941	
	E_LIC_2		We check potential for out-licensing within our own markets or technology areas (short-term ROI)	0.828		

INTELLIGENCE		E_LIC_3	We assess the patents that are suitable to be externally out-licensed	0.861		
		E_LIC_4	We put a lot of commitment in licensing out	0.792		
		E_LIC_5	We give a high-priority to non-core patents during out-licensing decisions	0.662		
		E_LIC_6	We actively search overseas alliances for out-licensing	0.909		
		E_LIC_7	We search similar technologies (e.g. through the analysis of citations) to find firms potentially interested in licensing our technologies	0.911		
		E_LIC_8	We actively search other industries for out-licensing	0.881		
		Patent watching	Please rate your level of agreement or disagreement with these statements regarding patent monitoring in your company:			
			I_WTC_1	We regularly monitor granted patents and/or newly issued patents as well as possibly pending patent applications	0.852	0.857
			I_WTC_2	We regularly build a picture of external patent activity around a particular technology	0.877	
			I_WTC_3	We regularly build a picture of external patent activity around a particular competitor	0.912	
		Patent landscape depth	Please, indicate your level of agreement (1=strongly disagree; 5=strongly agree) with the following sentences regarding information sharing along the supply chain in the last years:			
			I_LSD_1	We use multiple indicators (e.g. citations, number of inventions, geographical scope) to analyze patent data	0.810	0.863
			I_LSD_2	We compute/calculate indicators with the aim of analyzing patent data along different dimensions (e.g. temporal, technical, geographical)	0.836	
			I_LSD_3	We create patent maps that allow complex patent information to be understood easily	0.869	
	I_LSD_4	We create patent networks that visualize complex technological relationships	0.851			
5	Patent	Please rate your level of agreement or disagreement with these statements				

ORGANIZATION FOR PATENTING	strategy and alignment	regarding the patent strategy in your company:			
		S_STRAT_1	We have a clear plan for patenting	0.852	0.867
		S_STRAT_2	We see patenting as a corporate strategic decision	0.877	
		S_STRAT_3	We build our patent portfolio based on how patents can help our company to gain and sustain competitive advantage	0.912	
		S_STRAT_4	Our company looks at the corporate vision and objectives to determine what the company wants to accomplish with patent management	0.810	
		S_STRAT_5	Our company decides how to organize patent management based on the overall strategy of the firm	0.836	
		S_STRAT_6	Looking at the actual and expected future position of the firm, our company sets the activities, decisions and outcomes of patent strategy	0.851	
	Patent culture	O_CUL_1	Patenting is a common concern for all employees	0.675	0.890
		O_CUL_2	We emphasize education and training for managers, engineers, and researchers to improve their knowledge and skills in patent management	0.876	
		O_CUL_3	We foster behavioral attitudes and norms regarding patenting	0.872	
		O_CUL_4	We make efforts to spread the patent culture at all levels	0.836	
		O_CUL_5	Patenting is embedded in our company's day-to-day operations and procedures	0.742	
	Patent committee	O_COM_1	Technology staff submits invention disclosures to the patent committee for evaluation	0.853	0.715
		O_COM_2	The committee encourages the staff to submit disclosure forms	0.880	
		O_COM_3	The committee meets regularly	0.628	
	Patent rewarding	O_REW_1	We have incentives (monetary or nonmonetary) for idea generation	0.813	0.760
		O_REW_2	We have incentives (monetary or nonmonetary) for employees notifying patentable discoveries	0.797	

		O_REW_3	We have incentives (monetary or nonmonetary) for employees who file a patent application	0.746	
		O_REW_4	We have incentives (monetary or nonmonetary) for employees who obtain a granted patent	0.812	
	Top management involvement	O_TOP_1	Top management is actively involved in patent strategy definition	0.812	0.736
		O_TOP_2	We develop a common language to share issues regarding patent management with top management	0.693	
		O_TOP_3	Top management is regularly informed on ongoing activities related to patenting	0.819	

## 4 Results

### 4.1 Results of the cluster and t-test analysis

The cluster analysis distinguishes two clusters of firms with different levels of sophistication of PM processes: Cluster 1, including 19 firms, has a lower level of sophistication of PM processes (the “low” cluster) with respect to Cluster 2, counting 59 firms (the “high” cluster).

As Table 2 exhibits, the only two activities that seem not to be significantly different between the two clusters are signalling effect and proactive licensing. Actually, these two activities register lower values with respect to the others and these lower values are similar in the two clusters. Overall, activities directed towards third parties, which go beyond the monitoring of third parties patent activities, seem to be less implemented.

Table 2: Clustering variables – Descriptives and ANOVA

Variable	Mean	Cluster 1 ( <i>Low</i> )		Cluster 2 ( <i>High</i> )		ANOVA
		Mean	Std deviation	Mean	Std deviation	
G_SOA	4.19	3.68	0.684	4.36	0.464	***
G_GEO	3.98	3.49	0.856	4.18	0.545	***
F_FTO	3.73	2.75	0.920	4.10	0.531	***
F_SEC	3.82	3.10	0.916	4.07	0.547	***
P_REN	3.96	3.32	0.761	4.19	0.415	***
E_SIG	2.61	2.54	0.982	2.64	0.951	n.s.



E_ENF	3.39	2.79	0.432	3.59	0.537	***
E_LIC	2.57	2.44	1.163	2.62	0.894	n.s.
I_LSD	2.96	2.04	0.689	3.27	0.768	***
I_WTC	3.70	2.58	0.837	4.09	0.661	***

Note: \*\*\* means that the test is significant at  $p < 1\%$  level; n.s. = not significant.

The t-test reveals that the “high” cluster registers also significantly higher levels of patent strategy and organization for patenting than the “low” cluster, as Table 3 exhibits.

Table 3: Patent strategy and organization for patenting – Descriptives and t-test

Variable	Mean	Cluster 1 (Low)		Cluster 2 (High)		T-test
		Mean	Std. dev.	Mean	Std. dev.	
STRAT	3.83	3.31	0.684	4.01	0.536	***
O_REW	3.22	3.07	0.959	3.88	0.892	**
O_COM	3.73	2.81	1.451	3.33	1.374	**
O_TOP	3.56	3.55	0.713	3.81	0.666	**
O_CUL	3.31	3.07	0.791	3.73	0.757	***

Note: \*\*\* means that the test is significant at  $p < 1\%$  level; \*\* significant at  $p < 5\%$  level.

#### 4.2 Results of the regression analysis

While the evidence already speaks in favor of H2 and H3, we employed regression analyses to formally test H2 and H3. As Table 4 exhibits, we included in Model 1 only patent strategy, in Model 2 only organization for patenting and in Model 3 both supporting dimensions as independent variables, beyond patent portfolio size as the control variable. Model 1 is able to explain a higher percentage of the response variable variation than Model 2; moreover, when adding both patent strategy and organization for patenting as independent variables, patent strategy remains highly significant, whereas organization for patenting does not; this holds true independently of the PM process used as a dependent variable. All these evidences support that patent strategy is the strongest predictor.

If we look at Model 4 and Model 5 in Table 4, we can notice that the magnitude of regression coefficient and the associated level of significance in the “High ORG” group are higher than in the “Low ORG” group. This evidence remains stable for all PM processes used as dependent variables, a part from the patent generation process that is significant at 1% level in both groups, which means independently of the level of sophistication of the activities in the

organization for patenting dimension. The Chow test, differently from all of the other PM processes, is not significant for the patent generation process.

Table 4: Results of the regression analysis

Dependent variable: Patent generation						
	Model 1	Model 2	Model 3	Model 4 (High ORG)	Model 5 (Low ORG)	Chow test
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	
STRAT	0.474*** (0.000)		0.461*** (0.000)	0.448*** (0.000)	0.465*** (0.002)	$p=0.942$
ORG		0.215** (0.028)	0.031 (0.737)			
N_PAT	0.009 (0.221)	0.001 (0.127)	0.008 (0.256)	0.009 (0.293)	0.008 (0.544)	
R <sup>2</sup>	0.32	0.11	0.33	0.33	0.25	
Adj. R <sup>2</sup>	0.31	0.09	0.30	0.30	0.21	
Obs.	82	82	82	43	39	
Dependent variable: Freedom to operate						
	Model 1	Model 2	Model 3	Model 4 (High ORG)	Model 5 (Low ORG)	Chow test
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	
STRAT	0.612*** (0.000)		0.668*** (0.000)	0.813*** (0.000)	0.418** (0.012)	$p=0.041^{**}$
ORG		0.128 (0.310)	-0.138 (0.234)			
N_PAT	-0.002 (0.770)	0.001 (0.593)	-0.000 (0.948)	0.004 (0.802)	0.000 (0.775)	
R <sup>2</sup>	0.30	0.02	0.31	0.45	0.15	
Adj. R <sup>2</sup>	0.28	0.003	0.28	0.42	0.11	
Obs.	82	82	82	43	39	
Dependent variable: Patent portfolio management						
	Model 1	Model 2	Model 3	Model 4 (High ORG)	Model 5 (Low ORG)	Chow test
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	
STRAT	0.606***		0.517***	0.734***	0.379***	$p=0.043^{**}$

	(0.000)		(0.000)	(0.000)	(0.001)	
ORG		0.424*** (0.000)	0.218** (0.021)			
N_PAT	0.000 (0.190)	0.001 (0.182)	0.006 (0.376)	0.000 (0.406)	0.001 (0.173)	
R <sup>2</sup>	0.41	0.24	0.45	0.42	0.34	
Adj. R <sup>2</sup>	0.40	0.22	0.43	0.39	0.31	
Obs.	82	82	82	43	39	
<b>Dependent variable: Patent exploitation and enforcement</b>						
	Model 1	Model 2	Model 3	Model 4 (High ORG)	Model 5 (Low ORG)	Chow test
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	
STRAT	0.380*** (0.000)		0.331*** (0.001)	0.392*** (0.003)	0.334** (0.024)	$p=0.035^{**}$
ORG		0.252*** (0.009)	0.120 (0.218)			
N_PAT	0.005 (0.000)	0.007 (0.412)	0.003 (0.648)	0.008 (0.404)	0.000 (0.963)	
R <sup>2</sup>	0.21	0.11	0.23	0.25	0.13	
Adj. R <sup>2</sup>	0.19	0.09	0.19	0.21	0.08	
Obs.	82	82	82	43	39	
<b>Dependent variable: Patent intelligence</b>						
	Model 1	Model 2	Model 3	Model 4 (High ORG)	Model 5 (Low ORG)	Chow test
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	
STRAT	0.596*** (0.000)		0.561*** (0.000)	0.642*** (0.000)	0.380** (0.018)	$p=0.028^{**}$
ORG		0.308** (0.015)	0.085 (0.482)			
N_PAT	0.001 (0.139)	0.001 (0.102)	0.001 (0.187)	0.001 (0.533)	0.001 (0.153)	
R <sup>2</sup>	0.31	0.13	0.32	0.32	0.21	
Adj. R <sup>2</sup>	0.30	0.11	0.29	0.28	0.18	
Obs.	82	82	82	43	39	

Note: \*\*\* means that the test is significant at  $p < 1\%$  level; \*\* significant at  $p < 5\%$  level; \* significant at  $p < 10\%$  level

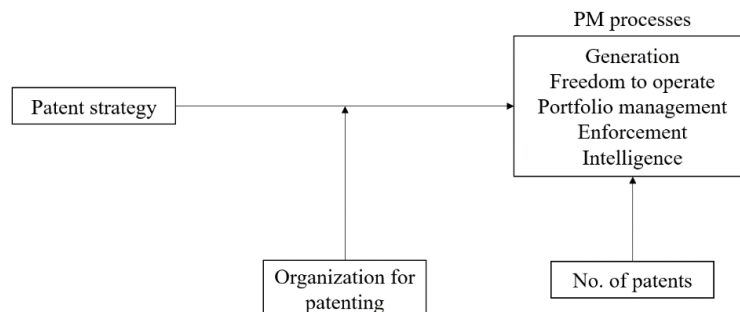


Figure 2: The final model

## 5 Discussion and conclusions

Results of this study show that two different profiles of firms exist based on the level of sophistication of their PM core processes, that patent strategy positively and significantly impacts patent management sophistication, and that the patent organization positively moderates this relationship. In other words, a patent strategy, supported by a well-developed patent organization and culture, will positively influence the processes of managing a firm's patent portfolio.

This is, to our knowledge, the first time quantitative empirical evidence is provided that supports the notion that it is important to take a strategic perspective of patent management. Considering how widespread this message has been in both research and practice during recent years (Holgersson et al., 2018; Reitzig, 2007; Teece, 2018), our results might not be surprising. But they are nevertheless important. There is now evidence that patent strategy—including the alignment with firm strategy—positively impacts patent management processes.

Maybe more interestingly, our results highlight the moderating—rather than direct—impact of patent organization on patent management processes. Thus, the patent organization and its culture is what translates the patent strategy into successful patent management processes. The organization plays an important role, but only when there is a strategic direction to act upon. This goes in line with previous research on the interaction between strategy, organization, and performance more generally (e.g. Nandakumar et al., 2010), but our results are to our knowledge the first to show this type of interaction in the area of patent management.

Our study is not without limitations, and these limitations also motivate additional research in this area. First, we have not been able to test the direction

of causality by means of the dataset used in this paper. While we have good reasons to hypothesize that the direction goes from patent strategy to patent management processes, there could be mechanisms by which sophisticated management processes, supported by organization, result in strategy. Future quantitative and qualitative studies may explore this question further.

Second, with our dataset we are not able to investigate how strategy's and organization's impact the sophistication of patent management processes have long-term positive impact on the general firm performance. This relates to an ongoing larger discussion about the long-term effects and value of patents (e.g. Gambardella et al., 2017).

Third, our empirical data covered a number of European countries. While patenting becomes increasingly internationalized and converged in terms of various national and technological preferences (e.g., Granstrand and Holgersson, 2014), there are still national differences. These difference include to what extent patenting is seen as strategic, with quality focus, and operational, with quantity focus (Ibid.; Hu et al., 2017). Hence, it is possible that our results would differ in countries where the IP system and IP competence are still emerging. Consequently, follow-up studies with a different geographical focus would be valuable.

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## **Fostering the Building of New Capacities in Responsible Research and Innovation through Co-Creation**

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### **Abstract**

Responsible Research and Innovation (RRI) aims to involve stakeholders and society actively in innovation processes, making them more responsible and collaboratively while tackling pressing societal challenges. Facing difficulties in translating this concept from theory into practice, co-creation has been identified as a potential approach to operationalize RRI involving organizations into concrete initiatives. As a non-linear process, it involves multiple stakeholders in an iterative, collaborative development procedure of products, services, policies, or systems intended to obtain a satisfying solution for all involved actors. This contribution investigates co-creation applied and assessed in a learning-by-doing process to explore the dynamics and results of knowledge exchange and capacity building. Knowledge is gained from the H2020 project SISCODE, which examines the operationalization of RRI through co-creation in concrete contexts with real-life experimentations. With the setup of an experiential learning process, ten pilot experimentations using co-creation to tackle various societal challenges across Europe were conducted.

To monitor and assess the direct results, mid-term outcomes, and the potential of long-term impact, an assessment framework was developed as part of the project. It consists of monitoring practices and tools that focus on collaborative data collection to foster self-reflection and track changes over time.

The dimensions investigated aimed at obtaining a perspective of capacities built and learning processes triggered as indirect results of the process to sustain co-creation and Responsible Innovation in the long term beyond the single initiative.

The capacities developed as a result range from soft skills (like empathy) to the capability of systemic thinking and the application of co-design tools. Activating a broader reflection,



it is finally discussed the roles of prototypes as boundary objects for learning processes, the need to create a safe and encouraging space as a learning environment and long-term strategies for in-depth change.

**Keywords** – Responsible Research and Innovation, co-creation, capacity building, organizational learning

**Paper type** – Academic Research Paper

## 1 Introduction

Responsible Research and Innovation (RRI) has emerged in recent years to involve society in innovation processes. The EU showed a clear interest towards more responsible innovation practices while pointing at the urgency to effectively involve citizens and stakeholders in the co-creation of solutions for pressing societal challenges. However, this translation from theory into practice to implement RRI and embed it into contextual practices, specifically into organizational practices, is a significant and well-known challenge.

Co-creation as a practice was pinpointed as a driver for empirical and experimental approaches stressing its practical orientation and its nonlinear process, leading to increased versatility in adapting to different and changing contexts (Payne et al., 2008).

Furthermore, a central focus of co-creation transforms the passive user's figure into an active agent in the development process. A noticeable trend within society shows how users are becoming co-creators of the products and services addressed to them (Sanders, 2005). As a result, their value is commonly decided and developed among service providers, stakeholders, and end-users (Saarijärvi, 2012).

These characteristics of co-creation make it a promising approach to the claim of RRI to change the way innovative initiatives evolve and which actors are engaged in their development (Bajmócy & Pataki, 2019).

The application of co-creation within the field of RRI aims to create co-produced solutions in collaboration with all involved actors to include a variety of perspectives from the very beginning of the development process and assess its impact from early stages. These processes and activities require adopting novel practices that often require an in-depth shift within organizations to effectively practice and embed co-creation (Hansen et al., 2020).

Specific novel capacities can be a trigger for organizational change and enhance the available capacity of an organization to innovate, leading to competitive advantages on the market (Nguyen and Huber, 2019). However, there is still a lack of documentation on how these capacities are built and embedded within an organization concretely.

## **2 Background**

### ***2.1 Responsible Research and Innovation and co-creation***

RRI as an approach to include society in innovation was introduced as a top-down concept even though it promotes a bottom-up approach (Zwart et al., 2014). However, the trend towards more responsible innovation practices points out the urgency to effectively involve citizens and stakeholders in the co-creation of products, services, and policies providing concrete directions for applying the principles of RRI. Many have been attempting to show the benefits and relevance derived from applying co-creation, aiming to open up the practice to broader audiences, making research and innovation more accessible, responsible, and inclusive. Nevertheless, mainly because of its nature perceived as abstract and research-oriented, and hence difficult to be operationalized, there are still limitations in its diffusion and uptake in actual settings (Von Schomberg, 2013). To embed the principle in real-life settings is fundamental to establish it as a common practice and promote approaches for its implementation, such as co-creation. The embedment ensures that RRI is not considered a temporary concept but fully adopted to innovate responsibly beyond the single initiative. Capacity building and learning processes have positively impacted an organizations' capability to innovate and perform successfully (Liao et al., 2008; Argote, 2012). Moreover, RRI has been directly connected to RRI by Egeland and colleagues (2019), describing the performance of Responsible Innovation as a learning process for the organization practicing it.

### ***2.2 Organizational capacity building***

The integration of co-creation as an approach towards more Responsible Innovation additionally implies introducing new practices and ways of working in relation to co-creation within organizations. Studies on organizational learning

and capacity building within organizations have significantly increased in the last decades providing various definitions of the terms and different approaches to the topic (Schulz, 2002; Kaplan, 2010) and pointing out the complexity and extensiveness of the processes (Cornforth & Mordaunt, 2011).

Some specificities and concepts of capacity building investigated are detailed in the following that functioned as a base for the study presented here.

The advantages of building capacities through learning-by-doing processes within organizations were pointed out by various scholars (Brix, 2019; Mullen et al., 2015) that often did not only include the organization itself but its environment, actors, and stakeholders, enhancing learning through interaction (Engstrom & Kakela, 2019).

Linden and colleagues (2019) argue that effective and long-term learning processes within organizations do not take place in a closed environment but require the involvement of other actors and stakeholders to connect strategic and operational aspects. Furthermore, processes of organizational learning can increase the overall innovation capacity of an organization even leading to advantages on the open market in comparison to competitors (Argote, 2013; Liao et al., 2008).

In line with the principles of RRI and co-creation, working across boundaries and disciplines has proven to encourage innovation and change. On the other hand, it also leads to frequent difficulties due to the mismatch between the desire to innovate and how it relates to the knowledge of the stakeholders engaged in the process, which can be varied and often domain-specific. A challenge that can act both as a source and barrier to innovation (Brown and Duguid 2001).

### ***2.3 Co-creation in RRI as a versatile approach for organizational capacity building***

In co-creation ecosystems, this variety of perspectives comes with a multiplicity of expertise and knowledge able to sustain and encourage innovation. From a managing knowledge standpoint, a relationship among actors that goes beyond sharing domain-specific knowledge and reaches out to be able to assess their mutual knowledge (Cramton 2001) supports innovation by setting the conditions for better grasping challenges and possibilities, sharing meanings and knowledge transfer, even across domains (Carlile 2004).

Co-creation has particular attributes and aspects like collaboration, discussion, and communication that make it a promising approach that may trigger organizational capacity building.

Constant **communication and exchange** are a core aspect of co-creation and fostering activities with these features among the members can support uptake and learning. In this regard, Morland and colleagues (2019) have pointed out the importance of communication, discussion, and shared sensemaking within multi-cycles of learning for long-term learning within organizations.

Closely related to sharing and communication, the **collaborative** features enhancing this communication are another aspect worth mentioning.

It regards not only activities within the single organization but the cooperation of various actors in ecosystems and environments that proved to improve uptake through direct experiences and interaction with the surrounding context (Argote, 2012).

Furthermore, the **practice-based** and hands-on mentality of co-creation provides **tangible examples** and inherits the potential of learning-by-doing. Concrete initiatives and prototypes can work as **boundary objects** (Star & Griesemer 1989) able to favor exchange and understanding, as well as overcoming the stickiness due to knowledge situated or siloed in specific domains (Tyre & von Hippel, 1997; von Hippel, 1994). Rhinow and colleagues (2012) discuss the impact of prototypes at both the level of the design teams involved in developing the solutions and then the broader level of organization, potentially impacting its flows and structures.

## ***2.4 Monitoring and assessing impact and capacity building***

One of the main challenges in investigating co-creation and capacity building, not only within an RRI context, is the difficulty to monitor and assess outputs, outcomes, and impacts (Saarjärvi et al., 2013; Hailey et al., 2005).

Hailey and colleagues (2005) defined capacity building as an intangible, highly complex, and variable process developing over longer periods that make its monitoring and assessment difficult and labor-intensive. The issues for the assessment of RRI are similar dealing with its intangibility and not measurable key dimensions that require its operationalization before it can be measured (Van de Poel, 2020, p. 348).

On the other hand, assessment is crucial to prove and communicate impact and to learn from conducted experimentations extracting best practices and drivers of both capacity building and RRI to prove impact, improve performances, and foster future initiatives (Peter et al., 2018; Hailey et al., 2005; Van de Poel, 2020).

The fact that assessment is often perceived as a valuing and imposed activity with few involvement of the experimentations themselves. This negative perception and the need to make assessment more inclusive led to the emergence of self-assessment actively involving actors in evaluation activities. These dynamics were observed both in studies on capacity building and RRI (Hailey et al., 2005; Ravn et al., 2019).

Another relevant topic is the data gathered through such evaluation practices. Dealing with often relatively small-scale experiments and applying assessment not only as a purely evaluating but at the same time self-reflective activity, data gathered is often purely qualitative and needs to be carefully elaborated to ensure its accuracy and substance (Van de Poel, 2020; Carmines & Zeller, 1979) resulting in a non-straightforward and often iterative and collaborative process of assessment that needs to be individually adapted.

### **3 Capacity building in RRI contexts through co-creation**

#### **3.1 The SISCODE project**

SISCODE (Society in Innovation and Science through CO-DEsign - [siscodeproject.eu](http://siscodeproject.eu)) was a three-year project under the Horizon2020 program and ran from 2018 to 2021.

It involved 17 partners from academia and research institutes, networks of co-creation laboratories, and their members from various sectors.

It investigated the application of co-creation, its methodologies, and tools to operationalize RRI and build innovation capacities.

The researchers conducted extensive desk research and field research to analyze the current landscape of co-creation and Responsible Innovation (RI) and explore existing cases. Furthermore, ten real-life experimentations were carried out within SISCODE to investigate the dynamics and effects of co-creation applied following the same framework in different contexts across Europe.

A focus was set on the broader transformations in terms of novel practices, capacities, and capabilities developed in the organization and the surrounding ecosystem due to the application of co-creation and the interaction between citizens, stakeholders, and policymakers.

### ***3.2 Co-creation to build novel capacities in an RRI context***

For 21 months, ten co-creation labs across Europe identified locally relevant societal challenges. The labs carrying out the experimentation are part of three European networks: The FabLab network, the European Network of Living Labs (ENoLL), and the European Network of Science Centers and Museums (ECSITE). All networks functioned as project partners as well and provided direct support and networking opportunities.

The labs tackled the chosen local challenges by co-creating specific solutions involving actors and stakeholders in a previously defined co-creation journey consisting of four phases (Fig 01). It derives from the experiential learning cycle defined by Kolb, combining it with the phases of the Design Thinking process (Kolb, 1984; Parnes 1967).

This pre-defined process serves as a framework complemented by a set of tools and constant support from the partners of the project and exchange- and peer-to-peer learning sessions among the labs. The framework functioned as a general guide to give continuity to the various and fundamentally different experimentations providing the possibility to assess and evaluate them to some extent.

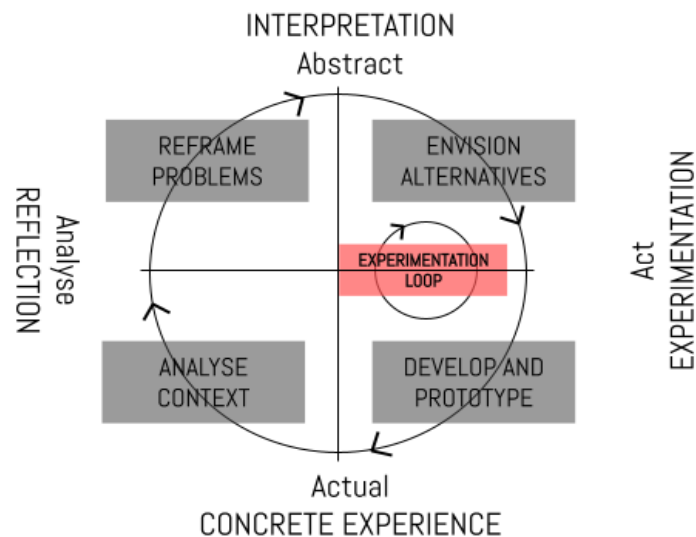


Fig 01 - SISCODE's learning framework

### 3.3 Methodology

The set-up and development of an assessment framework aimed at monitoring and assessing the results of the single pilots and encouraging reflection on the conducted experimentation on a broader level. It was designed to monitor and assess mainly the direct and indirect effects of the pilot experimentation and anticipate potential long-term impact reaching beyond the duration of the project and, therefore, the monitoring period itself.

The framework investigated three different levels and typologies of results (Fig 02):

- **Outputs**  
Direct results in terms of prototypes in the shape of products or services.
- **Outcomes**  
The changes triggered by the applied methodology in a learning-by-doing process and the prototype itself considering the longer-term and indirect outcomes as the uptake of new knowledge and learning processes triggered.
- **Impact**  
Impact refers to long-term changes like a shift in organizational culture or processes of decision making.

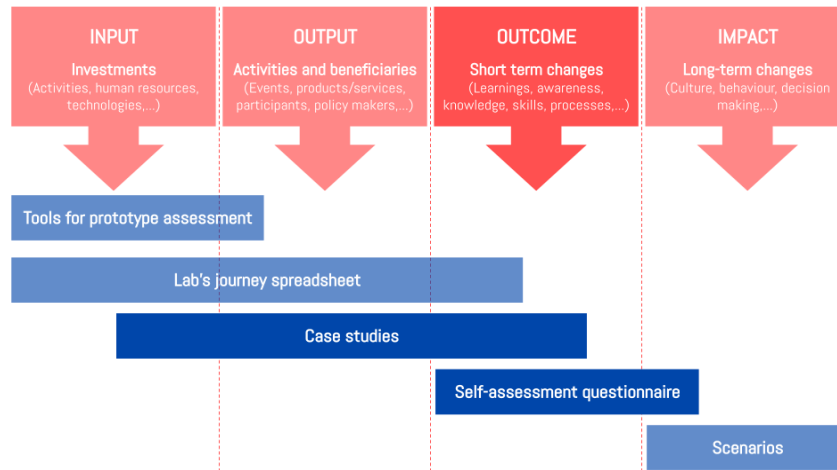


Fig 02 - Rationale of the SISCODE assessment framework

A set of tools specifically developed for the project investigated the different dimensions:

- **A monitoring spreadsheet** collecting quantitative data and documenting all the single activities conducted as well as the stakeholders and citizens involved.
- **A self-assessment questionnaire** submitted three times throughout the experimentation to identify and track changes related to organizational practices and routines.
- **Case studies** created by the labs document the investigation of each pilot in detail. The case studies documented the entire were written following the conclusion of the experimentation and also included a reflection on a broader impact of the project on the organization.
- **Video scenarios** produced by each of the labs to both provide a synthesis of the developed prototype and a future outlook, taking possibilities for scaling or replication into account.

The focus of this contribution lies mainly on the results of the self-assessment questionnaire and the analysis of the pilots as case studies shaping the mid-term outcomes in terms of triggered learning processes, knowledge uptake, and organizational change in terms of novel capacities and practices.

The data collected through the various tools during the experimentation provided holistic knowledge of the overall process, as well as of the manifold interdependencies across the different dimensions and factors analyzed relying



on a qualitative approach. Notes and insights were extracted from the data gathered, which were clustered and interconnected to identify recurring themes and patterns (Fig 03).

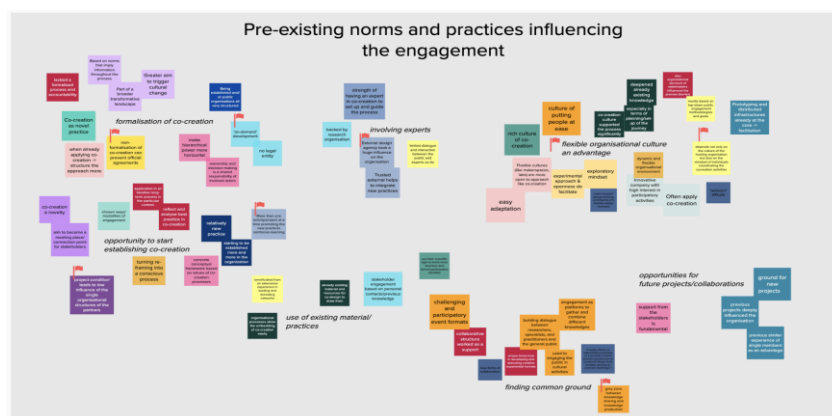


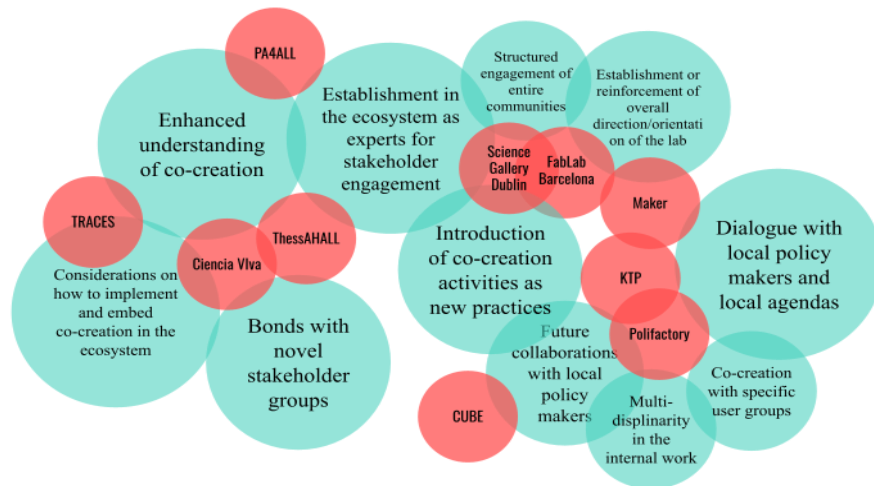
Fig 03 - Clusterization and elaboration of insights

The practices described and the examples derived from the experimentation show specific and context-related dynamics and specific features, also outlining typical traces and underlying concepts interconnecting the diverse cases. The descriptions of concrete examples connect to organizational practices to trace back to evidence and dynamics of capacity building and transformations. Especially the multiple conductions of the self-assessment over a longer timespan allowed a reflection on the multi-level impacts and general considerations on the assessment framework and its potential for adaptation for other RRI initiatives.

### 3.4 Results and evidence of capacity building

Especially the self-assessment questionnaire triggered reflections of newly developed capacities, occurred knowledge exchange, and related ongoing transformations of the organization. SISCODE investigated these capacities and practices mainly in relation to co-creation and stakeholder engagement as the main topics of the project. The findings gathered are mainly associated with acknowledging that real change takes an amount of time beyond the time frame of a project. However, there is first evidence on the embedding of novel organizational capacities and resulting in ongoing transformations. The figure

below reports the ten labs and the associated concrete practices that were newly adopted or significantly improved throughout the project (Fig 03).



*Fig 03 - Novel practices adopted during SISCODE*

The practices and capacities developed can be directly related to the experimentation conducted within SISCODE and its core themes. In fact, most capacities built can be related directly to the topics of stakeholder engagement and the capability to plan and conduct co-creation activities.

However, communicating the project's main topics and describing these capacities also triggered a broader reflection on changes and transformations activated in the organizations beyond the single initiative. Further considerations regarded the long-term impact that the exposure to co-creation methods and tools may have.

As a result of the data evaluation, a series of specific capacities were identified that were built or significantly improved throughout the experimentation. The main capacities as direct outputs are described in the following grouped by clusters:

- **Soft skills for communication and mediation**

The involvement of multiple and various stakeholders and users and the collaborative development of solutions led to the building and improvement of soft skills like empathy, capacity for mediation and negotiation, and flexibility in a learning-by-doing process on the field. These capacities can be traced back to the interaction with varied groups with different backgrounds, interests, and

motivations, which worked together towards a common solution. It is worth to be mentioned that this aspect was pointed out particularly in experimentations dealing with vulnerable groups like children or users with health conditions.

- **Systemic and holistic thinking and planning**

Adopting a broader view and taking all different points of view and involved actors into consideration triggered the improved ability to manage complexity. It also nurtured capacities related to systemic thinking and holistic planning of processes and activities considering broader and long-term effects into consideration. This was often practiced by using specific tools from the design field like stakeholder maps, system maps, or customer journeys to visualize and collaboratively plan and reason on procedures and solutions.

- **Flexibility and adaptation to the context**

The non-linear and iterative structure of the co-creation process enhanced flexibility and capacity to adapt and react to the ongoing and often unexpected changes and development throughout the process. Openness, the consideration of alternative pathways, and the adaptation of activities and tools to the specific context were pointed out in relation to this group of capabilities.

### ***3.5 Findings and reflections***

One of the main results from the observation and assessment of the experimentation concerning novel capacities is the role of concrete initiatives and of the resulting **prototypes as boundary objects**. The latter demonstrated to trigger learning-by-doing processes and make practices of co-creation tangible, facilitating their adoption. The process of designing prototypes through a participatory approach can incentivize communications and exchanges within and through the organizations involved. In addition, the existence of a concrete object of discussion facilitated the comprehension and also the conception of the new methods. This triggered moments of sharing and discussion within the organization shedding light on conflicts with existing practices and creating a space for experimentation and facilitation of integration.

Another aspect concerning the building of novel capacities within a project framework is the **function of a terminable activity as a safe space** for the experimentation and subsequent adoption of novel practices – as a safer space than a direct implementation. The opportunity to apply a new and disruptive practice in a temporary context like a project withholds the possibility to end its

utilization together with the single initiative. The protected space that this condition creates appears to facilitate the introduction through a terminable space of experimentation that can be ended in case of failure without any further implications or drawbacks for the organization.

Another insight from the evaluation which particularly emerged from the self-reflection of the labs is the significant amount of **time required to achieve an in-depth change** within an organization. The importance of the aspect of time has pointed out especially the necessity to expose organizations and their members to co-design and its practices over a more extended amount of time, not only considering the single project as a self-contained and closed space for capacity building but as part of a broader, extensive learning process that necessarily goes beyond the single initiative to generate real impact.

The collaborative aspects of the experimentation did not only lead to the capacity to adopt other points of view and develop empathy but it also fostered familiarity with other fields and their expertise. Working in a multi-disciplinary environment with actors from varied background, first-hand knowledge from experts was shared and also transferred directly within the working group.

#### **4 Conclusions**

The experimentation conducted within SISCODE stressed the difficulty of assessing both RRI initiatives and the capacities built as a result.

One of the main findings of the research conducted is the need to develop a universal assessment framework for RRI initiatives to reduce the significant amount of time spent to develop and set up the evaluation activities in order to make them more sustainable. Such a framework would need to provide a set of indicators and tools to be adapted to the single initiative. A one-size-fits-all framework would be too reductive considering the high context-dependency and particularity of each experimentation, but a general framework with adaptable elements could be one approach towards common indicators and facilitation of evaluation. This could also withhold the potential to compare different initiatives at least to some extent.

Even though there is evidence of long-term changes and permanent embedment of new practices within the organization, future assessment, and research on how the capacities developed and spread across organizations over

time could be conducted, taking other initiatives in the field of RRI and co-creation into consideration.

One aspect to be taken into consideration is that the study experimented in FabLabs, Living Labs and Science Centers and Museums that by nature are innovation-friendly environments and future studies could extend this approach to less favorable organizations and settings exploring effects and results.

A limitation of the study so far is its recent conclusion not yet analyzing factual long-term changes beyond the conclusion of the project to investigate their spread in the organization tracing novel practices and capacities back to the experimentation and investigating influence and correlations with other, similar initiatives conducted in the organization.

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## University Patents: an Asset to Communicate

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### Abstract

The transfer of knowledge between universities and businesses has attracted the attention of many stakeholders. This process of knowledge transfer poses several challenges for universities such as the difficulties and barriers to the commercialization of patents. These assets need to be enhanced and communicated to third-parties to increase their impacts outside the university. In order to promote and increase the valorisation of university patents, in recent years new platforms have been activated, as well as the number of dedicated initiatives (e.g. the innovation fairs) has significantly increased. The technology transfer offices (TTOs) manage the patent portfolio of the universities and they face some challenges such as an effective transfer of knowledge to third parties, a proactive commercialization of university patents, and a promotion of these assets aimed at maximizing their impact. TTOs and inventors communicate patent information to third parties through short presentations/pitches and marketing sheets. The characteristics and attributes of patents can act as useful signals to reduce information asymmetries towards third parties. This qualitative research offers an analysis of the main characteristics and attributes of patents that influence investment or acquisition decisions by third parties. Interviews were carried out with several entrepreneurs and investors with specific experience in the field of university patents, and revealed key information on the main



characteristics and attributes of the patents that are of prime importance to them. These parameters could help TTOs, inventors and universities to implement their communication strategies and to improve their presentations/pitches or marketing sheets with the categories of characteristics/attributes that emerge from this research. This study could have interesting implications for some stakeholders such as universities, TTOs, inventors, innovation managers, platform managers, policy-makers, governments and public agencies.

**Keywords** – Knowledge transfer, Patents, Universities, Technology transfer offices, Innovation.

**Paper type** – Academic Research Paper

## 1 Introduction

Over the years, the transfer of knowledge and innovation between universities and businesses has attracted the attention of many stakeholders (Kang, 2016), as well as it has become increasingly relevant for its significant contribution to global development (de Almeida et al., 2019; Ferreira et al., 2019; Hooi and Wang, 2020; Kaiser et al., 2009; Venkitachalam and Ambrosini, 2017). At the same time, knowledge transfer represents a crucial activity to foster the competitiveness of firms (Teixeira et al., 2019).

Daniel and Alves (2020, p. 278) underline that “Universities are regarding their third mission as an important challenge in the current era of knowledge-based economy” and they explore both the main challenges in University-Industry Technology Transfer process and the key drivers for the successful licensing of university inventions.

The technology transfer process poses some major challenges for universities, the main one being the commercialization of research results (Daniel and Alves, 2020). In particular, some studies have focused on patents and the related difficulties or barriers to their commercialization (Hermans and Castiaux, 2017; Valkokari et al., 2012).

Patents are strategic knowledge assets (Bontis, 2001; Marr et al., 2002) and they represent a key component of the intellectual capital’ structural dimension exploited by technological spin-offs to innovate their business models (Elia et al., 2017). In this vein, Elia et al. (2017) highlighted that these companies leveraged their patents to move towards a revenue model innovation.

Several scholars explored the value of patents (e.g. Grimaldi and Cricelli, 2020), being a significant element in influencing the performance of companies and their innovation results (Agostini et al., 2016; Zakery and Afrazeh, 2017), and their role in university–industry knowledge transfer (e.g. Crespi et al., 2010).

Patents can be considered as outputs of university technology transfer that need to be enhanced and communicated to third-parties to increase their impacts outside the university (Troise et al., 2019; Troise, 2020).

The management of patents (as well as other industrial proprieties) is one of the main activities of the technology transfer offices (TTOs hereafter) of universities (Netval, 2016, 2018). These offices increase the patenting activities of their universities and promote their links with industry (Cartaxo and Godinho, 2017; Coupé, 2003; Siegel et al., 2003; Thursby and Thursby, 2002).

In recent years, the total number of patents in the portfolio owned by Italian universities has been steadily growing. Based on the latest reports (see among other Netval report, 2018), which show the trend of patents for each year, about 4,000 patents are held in portfolios by Italian universities.

The TTOs manage the patent portfolio of the universities and they are continually called upon to face some challenges such as an effective transfer of knowledge to third parties, a proactive commercialization of university patents, and a promotion – as well as communication – of these assets aimed at maximizing their impact.

In order to promote and increase the valorisation of university patents, in recent years new platforms and tools have been activated, as well as the number of dedicated initiatives – such as innovation fairs – has significantly increased. An example of a new web platform is “Knowledge Share”, an online portal launched in 2019 by Netval, MiSE-UIBM and Polytechnic of Turin. Among the main innovation fairs, “Tech Share Day” and “Innovagorà” are two important examples.

The platforms act as intermediaries between the universities and the main stakeholders of the ecosystem, while the innovation fairs are useful opportunities for meeting and promotion activities. The purpose of participating in both platforms and fairs is to get in touch with third parties interested in investing or acquiring the outputs of technology transfer such as patents and academic spin-offs.

On these occasions, TTOs and inventors communicate patent information to third parties through short presentations/pitches and marketing sheets. The

characteristics and attributes of patents can act as useful signals to reduce information asymmetries towards third parties.

TTOs and inventors can increase third-party knowledge and interest in a given invention through specific presentations of patents characteristics in order to positively influence their subsequent acquisition and/or collaboration decisions.

Given the growing attention towards university patents in recent years, it is particularly interesting and useful to understand what are the factors that can lead to their success, that is, to attract the attention of third parties and induce them to invest financial resources.

This research offers an analysis of the main attributes and characteristics of patents that influence investment or acquisition decisions by third parties. The latter pay particular attention to certain parameters and use specific types of information to improve their knowledge of patents and their value.

Our main research question is: What types of patent characteristics and attributes influence third party investment or acquisition decisions and interests?

## **2 Background**

Patents are a typical signal used in the literature to represent the quality of the firm (Conti et al., 2013; Hottenrott et al., 2016; Mason and Stark, 2004) and useful for the latter to attract financing or obtain loans (Fischer and Ringler, 2014; Gredel et al., 2012). Among the main investment criteria of various types of investors, the ownership of patents is a recurrent parameter that influence their decision-making process. Patents are mainly used as signals in the investment decisions of two main types of investors analyzed in the literature, namely Venture Capitalists (VCs) (Baum and Silverman, 2004; Hsu and Ziedonis, 2013) and Business Angels (Bas) (Audretsch et al., 2012; Maxwell et al., 2011).

Despite many studies examined the signalling role played by patents for third parties, these types of studies focus on patents related to the companies that own the rights (i.e. whether or not the presence of patents can influence the decision-making process of third parties), while an aspect neglected in the current literature seems to be that relating to patents as elements not necessarily linked to a company. In fact, patents can be owned both by inventors who are not part of companies, and by universities that become owners following the transfer of the relative rights by the inventors (i.e. the ownership of these patents can be transferred by the inventors to the university). Currently, little is known about the

effects of the specific characteristics and attributes of patents on third parties such as investors and companies. The lack of knowledge of these effects is even more evident in the field of technology transfer and especially in that of patents owned by universities. These assets make up the patent portfolio of universities and are often not linked to a company.

The characteristics of patents could play a key role in influencing investment or acquisition decisions by third-parties. The information provided by TTOs and inventors may increase the latter's knowledge about the value of the patents and induce them to commit financial resources.

In the current scenario characterized by considerable efforts by universities and governments to promote innovations and patents born within universities, the understanding of what are the characteristics that can favour the sale of these assets and support their adequate valorisation assumes a great relevance.

Based on the above, this study aims to explore the characteristics of patents useful to act as quality signals to third parties.

### **3 Method**

In order to add new knowledge in this research field and identify which characteristics and attributes of patents serve as signals for third parties, interviews were carried out with some entrepreneurs and investors with specific experience in the field of innovation and intellectual property. In particular, the interviews were carried out with entrepreneurs and investors who already had experience with the specific type of patents of Italian universities (i.e. the group of experts interviewed is made up of individuals who have invested in this type of asset or have acquired patents from universities).

For this study, an inductive qualitative research design is used (Eisenhardt, 1989; Eisenhardt and Graebner, 2007) and the main source of information is represented by open and in-depth interviews with 22 experts.

The interviews focused on open questions related to what are the main characteristics and attributes that a patent must possess in order to be of interest to the interviewee, or to increase their knowledge and therefore useful both to limit information asymmetries and to positively influence their acquisition (licensing or purchase) or investment process.

## 4 Results and conclusions

Interviews with experts revealed key information on the main characteristics and attributes of the patents that are of prime importance to them. These parameters can be summarized as follows: applications; international extension; multi-sectoriality; exploitation; innovation development stage; inventor team; time to market; advantages; economic value.

These characteristics are relevant to third parties and can be considered useful signals for them. Therefore, TTOs and inventors should pay special attention to them as well as include these information in their patents' presentations.

Hopefully, this study will have interesting implications for universities, TTOs, inventors, innovation managers, platform managers, policy-makers, governments and public agencies, and other players of the entrepreneurial ecosystem.

It is critical today to know which patent characteristics drive third party investment/acquisition decisions. Knowing them will help inventors, TTOs and universities to implement their valorisation strategies and design the communication activities. In particular, in recent years, TTOs are increasingly involved in the promotion of patents held by universities and proactively participate in innovation fairs, in specific meetings with investors (e.g. "Borsa della Ricerca") and in implementing dedicated platforms with marketing sheets (e.g. Knowledge-Share). Based on the results of this study, universities and their TTOs can define and implement their communications strategies (Ferrara and Troise, 2018; Troise et al., 2019) as well as improve their presentations/pitches or marketing sheets with the categories of characteristics and attributes that emerge from this research.

The implementation of active policies for the enhancement of existing patent assets is a recurring problem within Universities (Cesaroni and Gambardella, 2001). The commercialisation of patents requires searching for investors and interested firms (Daniel and Alves, 2020). Hence, these patent characteristics can be a key factor in the successful transfer of the patent from universities to third parties. TTOs have different commercialisation strategies for their university outputs (Dias and Porto, 2018), therefore our research could be particularly important for universities in defining these strategies with the aim of increasing their valorisation and communication capacity.

This research could be particularly topical and interesting considering the entry of new actions into the ecosystem such as crowdfunding, and in particular equity

crowdfunding (Troise et al., 2020; Troise and Tani, 2021), which involve a crowd of investors who decide to finance certain initiatives and/or products based on some parameters that are relevant to them.

A possible promising future research in this field could be to investigate how the use of knowledge visualization (Troise, 2021) can increase the knowledge of third parties and influence their investment/acquisition decision making. The use of visualization tools could allow universities to increase their performance related to technology transfer activities, in particular those related to the transfer of patent knowledge from universities to external actors.

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## **SMILE: towards an Automated Methodology for Systematic Literature Reviews**

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### **Abstract**

**Purpose** – The main contribution of this paper is the development of a methodology for conducting a systematic literature review implemented in a software named SMILE. The methodology and the SMILE tool are applied, as an example, to the field of human resource management in the context of Industry 4.0 or HR4.0.

**Methods** – After analysing characteristics of main approaches for systematic literature review (SLRs), we highlighted limitations of methods and tools currently used to support

researchers in SLRs and defined an original methodology for automating the SLR phases. The methodology, that can overcome limitations of other methods, has been implemented in a digital tool, SMILE. To validate the correctness of the methodology and test the robustness of SMILE, a SLR has been carried out to the case of HR4.0 and main results have been reported.

**Findings** – First, a methodology of automatic extraction of the most relevant contributions in the literature is presented. The methodology regards the implementation of Latent Dirichlet Allocation (LDA) as an unsupervised method of topic modelling that enables the identification of relevant topics from a collection of contributions selected from scientific literature. Second, SMILE, a digital tool for conducting systematic literature reviews, has been implemented in the form of a decision support system (DSS). SMILE supports the proposed methodology and is based on machine learning (ML) for natural language processing (NLP) and text analytics technique.

**Originality/value** – Compared to the previous review contributions, in this paper the authors propose an automatic methodology for the optimal choice of parameters used by Latent Dirichlet Allocation, such as the optimal number of topics calculated through iterative runs to perform best results in terms of words coherence in topics. SMILE reduces the effort of researchers by the implementation of an interactive procedure that allows the supervision of all the fundamental phases envisaged by the SLR.

**Keywords** – Systematic Literature Review, Research tool, Scientific Knowledge Management, Knowledge extraction, Knowledge visualization

**Paper type** – Academic Research Paper

## 1 Introduction

Literature reviews are an established research method able to advance knowledge in a scientific domain by organizing available knowledge. Several types of reviews exist, different from each other depending on the methodology required by the purpose of the review, for example using a typical purpose approach, research questions or basing the approach on examples of contribution (Snyder, 2019).

Due to the pace of scientific research in the organizational and managerial fields, the need to use a systemic approach to rationalize the growing body knowledge is increasingly pressing (Donthu et al., 2020). The high volume of scientific production, the emergence of interdisciplinary approaches and the high fragmentation of research contributions make systematic literature review an increasingly relevant research method (Snyder, 2019).

While a literature review qualitatively reports evidence on a specific topic using subjective methods to interpret studies, systematic literature reviews (SLRs) provide a broader overview of primary research on a specific question that identifies, selects, synthesizes and evaluates all the high-quality research evidence relevant to that question (Williams et al., 2020). Furthermore, traditional reviews do not follow rigid rules on the selection of contributions and consequently the choice of studies is very likely to be guided by the subjectivity of the author (Hodgkinson and Ford, 2014). Systematic methods offer the possibility to provide a clear picture of a knowledge domain and, because of the objective and repeatable method used, allows other scholars to confirm, challenge or expand the findings.

However systematic reviews can be burdensome. The number of articles to be analyzed can be of several hundred, to ensure high quality in the review process it is necessary to analyze all selected contributions which makes it difficult and time-consuming even for an experienced researcher (Carver et al., 2013).

Tools to facilitate the work of researchers have been developed, in particular, several automated methods have been implemented that can classify many documents in a given topic (Blei et al., 2003; Alghamdi and Alfalqi, 2013; Osborne et al., 2019).

There are currently complementary limitations when studying the state of the art of a specific topic: SLRs are very onerous in terms of the time required for domain experts to perform manual tasks; automated techniques hide some crucial phases from researchers, such as conceptual analysis in which human experience is fundamental.

This work aims to answer the following research questions:

*RQ1: Which phases characterize the process of SLRs according to a knowledge management perspective?*

*RQ2: What phases and how does the tool support the researcher in the execution of SLRs?*

With this aim, the paper presents a new tool (named SMILE) for conducting systematic reviews, which reduces the effort of researchers by the implementation of an interactive procedure that allows the supervision of all the fundamental phases envisaged by the SLR. SMILE can support also non-technical researchers in carrying out a systematic literature review thanks to the automatic selection of optimal parameters of the model such as number of topics (k) and showing in near real time the new results. Furthermore, the tool allows the choice of the

algorithm that best classifies the contributions and discovers research topics starting from the initial set of keywords.

In order to test the proposed tool a literature review on human resources management in the context of Industry 4.0 has been conducted.

## **2 Theoretical Background**

### ***2.1 Knowledge-based perspective in scientific research communities***

Knowledge is widely recognized as the most strategic asset in any organization (Kuo et al., 2019). This is particularly true for research (or epistemic) communities where knowledge resides and articulation and knowledge creation can take place (Haas, 1992). Research communities are generally considered as knowledge intensive organizations engaged in producing, promoting and sharing scientific knowledge (Håkanson, 2010). The main purpose of the scientific communities is to create knowledge and make it easily usable, systematized and replicable. This principle is based on the "knowledge-based view" according to which explicit knowledge is easier and less costly to pass on and replicate than is tacit knowledge (Winter, 1987).

The importance to manage knowledge as a strategic resource for scientific development have long acknowledged. Advances in digital technologies offer the opportunity to face the proliferation of information emerging as results of scientific research. In this context, the exploitation of methods and tools for data extraction, analysis and visualization represent a fundamental approach to support scientific knowledge management, defining new ways of knowing and producing knowledge.

As stated by Shahid et al. (2020) extracting relevant knowledge from scientific publications is an increasing challenging task, given the proliferation of published works. Currently available systems provide researchers with huge lists of results that must be manually explored. Recently, several authors suggested approaches to select relevant scientific publications (Habib and Tanvir, 2017; Waheed et al., 2019; Wan et al., 2019). The different methods proposed converge in highlighting the importance of considering content, citations and editorial collocation in the selection criteria.

Data analysis and visualization has been pointed out as an essential dimension of modern knowledge management to support decision making in organizations

(Lurie and Mason, 2007; Schiuma et al. 2012; Miah et al., 2017). In this sense, many approaches supporting individuals along the knowledge value chain have been proposed.

Knowledge extraction, analysis and representation are particularly meaningful in scientific research since the research landscape is becoming more and more dynamic, transdisciplinary and characterized by the interaction among several stakeholders.

## ***2.2 Systematizing knowledge in scientific community: an analysis of review-based approaches and tools***

Review-based research is considered a valuable tool allowing scholars to identify research gaps, new research directions and emerging theoretical frameworks (Marabelli & Newell, 2014). The need to evaluate and synthesize extant research in a reproducible and transparent way (Vrontis and Christofi, 2019; Kumar et al., 2020) is prompting many researchers to propose methods aiming to provide guidelines to carry out review-based research (Palmatier et al., 2018). Several approaches for review-based research have been proposed in literature. The choice of the approach to be adopted mainly depends on the type of objective to be pursued and the maturity level of scientific research in the reference domain to be analysed (Snyder, 2019)

Systematic literature review (SLR) is a procedure that collect and synthesizes contributions and scientific evidence to answer a certain research question with particular attention to the sources, which must be highly referenced in order to assess high quality in the process of identify, highlight and evaluate all the evidence regarding the specific topic.

SLRs was originally implemented for investigating scientific literature in health sciences, but it has become an established methodology in the management field as of the previous literature review process (Tranfield et al., 2003).

Several approach for SLR are provided in literature. Paul and Criado (2020) classified SLR articles into three main categories, namely theory-based, method-based and domain-based approach. Theory-based review articles aim to synthesize and help advancing a body of literature that uses and/or empirically applies a given underlying theory (Hassan et al., 2016; Gilal et al., 2019). Method-based review papers aim to synthesize and extend a body of literature using an underlying quantitative or qualitative methodology (Sorescu et al., 2017; Ji et al.,

2019). Domain-based review articles aim to identify research gaps with reference to methods, theories and constructs based on the compiled information in a specific domain (Paul & Feliciano-Cestero, 2020). Through this approach, researchers aim to organize, analyze, and discuss existing literature on the basis of theoretical themes or concepts that are considered relevant for a given domain. Domain-based review articles can use Framework-based approaches (e.g. Antecedents, Decisions and Outcome (ADO), Theory, Construct, Characteristics and Methodology (TCCM)) to model knowledge in a specific domain (Sharma et al., 2020).

Several tools have been proposed to support researchers in systematic literature reviews through the application of the LDA algorithm, some focusing on automating the literature review phases, others on graphical presentation of the results using illustrations such as dendrograms or result comparison matrices (Talafigaryani, 2021; Lakshmi Prasanna et al., 2019; Mo et al., 2015). However, the same authors highlight some limitations concerning, for example, the use of the tools by expert researchers or the absence of comparative performance analysis of different topic modelling configurations or algorithms such as LDA and Mallet (Tauchert et al., 2020; Asmussen et al., 2019).

### **3 Towards an automated methodology for Systematic Literature Reviews**

#### ***3.1 The proposed method***

In what follows, we attempt to provide an answer to RQ1, characterizing the process of SLRs according to a knowledge management perspective. According to the principles of SLRs in management studies made by Denyer and Tranfield (2009), SLR-based works are generally organized in the following steps, namely papers location and selection, papers analysis, results synthesis.

##### ***3.1.1 Papers location and selection***

The review of the literature process in the initial phase involves the identification of a large number of articles. The search process is usually conducted using repositories such as Web of Knowledge or Scopus. However, defining the correct keywords and selecting the suitable papers can be challenging and time-consuming (Ishida et al., 2020).

The process continues with selecting a limited number of articles for in depth review. The inclusion and exclusion criteria are defined after the search question has been finalized but must be applied before the search is carried out. Inclusion and exclusion criteria can be generic such as publication year, language other than English, but they can also be more restrictive to the point of selecting articles published in academic journals and journals with impact factors indexed in certain Citation Reports (Ammirato et al., 2020).

According to a knowledge management based perspective, this phase addresses the need to extract relevant knowledge from scientific publications. As suggested by extant literature, metadata analysis is crucial to find an appropriate set of paper to be analysed. The systematic literature review, in the screening phase, allows the automatic identification of contributions ordered by relevance (citations, journal ranking, etc.) according to some well-defined protocols (Barza et al., 2009; Boudin et al., 2010).

### *3.1.2 Papers analysis*

The aim of the analysis is to examine and dissect individual studies and explore how the components relate to one another. This phase deals with the definition and the application of appropriate methods to analyze selected documents. Until now, the management of large collections of articles has been organized and treated by topic using spreadsheets (Demner-Fushman and Lin, 2007), dictionaries or supervised methods (Jones and Baumgartner, 2005). These methods are quite expensive and require a priori knowledge of the topics and the research domain. Thanks to the recent development of machine learning techniques, many activities of the review process can be automated to reduce the researcher's burden and times (King and Lowe, 2003). This phase addresses the need to analyse available data to create new knowledge.

### *3.1.3 Results synthesis*

Synthesis is a process of putting the findings from individual studies together *"into a new or different arrangement and developing knowledge that is not apparent from reading the individual studies in isolation"* (Denyer & Tranfield, 2009, p. 685). Narrative approach is the most common method to synthesize SLR results in management field of study (Paul and Criado, 2020). This approach attempt to address different aspects of the same phenomenon and build them into a bigger picture, map, or mosaic (Hammersley, 2001). According to a



knowledge management based perspective, knowledge visualization offer scholars the opportunity to understand greater insights and perspectives surrounding a given topic. This help researcher to describe and synthesize results of SLR.

### **3.2 SMILE Architecture**

The SMILE tool is developed in Python through the Django framework. It is equipped with a graphical interface that simplifies the operations of research and extraction of contributions from the most relevant scientific databases.

SMILE implements the SCOPUS and Web of Science REST APIs to retrieve information and it enables search on different levels:

- Search API, used to launch a general search on abstracts, titles and keywords;
- Abstract retrieval API, the API interface to retrieve abstract documents;
- Citation Overview API, used to perform queries on citation counts broken down by year.

The definition of an appropriate initial set of keywords is crucial for knowledge extraction (Rose and Kitchin, 2019). The choice of keywords to include in the query string is decisive for the direction of research, as not all journals provide guidelines or recommendations on the choice of keywords to associate with articles leaving to the authors the freedom of choice. For this reason, some keywords are not included in the title or abstract but they appear with synonyms.

SMILE also allows the launch of new searches by modifying the initial set of keywords by suggesting new keywords discovered in the titles and abstracts identified by the previous search. On each launch the tool simulates the behavior of the model in terms of perplexity and coherence in order to support the researcher with a stop condition to move on to the next steps.

#### **3.2.1 Documents selection**

The next step of the methodology provides support on location and classification of papers over the selected scientific databases available. The tool initially allows the search string building in order to query the SCOPUS and Web of Science databases to create the main corpus used by LDA genism algorithm. Based on the results obtained, it subsequently allows the application of further filters to refine the search and improve the quality of the results in terms of

citations and journal impact factor. In particular, Source Normalized Impact per Paper (SNIP) is associated with each contribution from SCOPUS database. The SNIP parameter measures contextual citation impact in a subject field using Scopus data.

For contributions extracted through query strings from the Web of Science database the Journal Impact Factor (JIF) is associated.

### 3.2.2 LDA technique

Topic modelling using LDA technique is a very popular approach for inference of topics and semantic analysis and exploration. The LDA approach, thanks to its adaptability, has allowed the start of numerous contributions in classifying documents (Kraus et al., 2020) or scheduling of information extraction systems (Ionescu et al., 2015).

The main representation of LDA, as described in (Blei et al., 2003), is a Bayesian model in three-level hierarchy, in which each item of a collection is modelled as a finite mixture over an underlying set of topics (Nahar et al., 2018). In LDA  $k$  topics  $\phi_k$  with  $k \in \{1, 2, \dots, K\}$  are representative of a discrete distribution over a fixed vocabulary of words.

Compared to pLSA (Probabilistic Latent Semantic Analysis), LDA introduces two hyper parameters  $\alpha$  and  $\beta$  of Dirichlet types extending the model with generative capability of inferring the topics on new documents (Deerwester et al., 1990).

The following pseudocode illustrates the general flow of the LDA algorithm:

---

```

for all  $k = \{1, 2, \dots, K\}$ 
    generate  $\phi_k \sim \text{Dirichlet}(\beta)$ 
end for
for each document  $d$ 
    generate  $\phi_m \sim \text{Dirichlet}(\alpha)$  over topics
    for each word  $w$  in document  $m$ 
        sample a topic  $x_{wd} \sim \text{Dirichlet}(\phi_d)$ 
        sample a topic  $y_{wd} \sim \text{Dirichlet}(\phi_{x_{wd}})$ 
    
```

---

SMILE adopts a method for systematic literature review conducted through machine learning (ML) for natural language processing (NLP) and text analytics technique. In particular the authors developed a software tool that implements LDA (Latent Dirichlet Allocation) topic modeling technique to identify dominant

topics and relevant contributions for each topic discovered by Gensim and Mallet LDA implementations. Gensim is an open-source Python library (Nahar et al., 2018) that includes word2vec algorithm, latent semantic analysis and LDA.

#### **4 An application of the proposed approach**

We carried out an application of the proposed approach by carrying a domain-based systematic literature review to investigate the impact of Industry 4.0 in human resources management.

Innovative technologies that belong to the Industry 4.0 paradigm such as Artificial Intelligence, Internet of Things, Cloud and Big Data are influencing and automating most Human Resources processes towards more efficient work teams' management (Xu et al., 2018). The development of new technologies that enables smart working are generating a significant impact on changes in large as well as small and medium-sized enterprises (Sommer, 2015), as well as with the introduction of these new technologies in work places also employee's working conditions and approaches are changing (Lasi et al., 2014). The purpose of the application of the new tool to HR4.0 is to investigate and analyze influences on all phases of Human Resource Management in the context of Industry 4.0 in order to identify greatest impact technologies and directions for further research.

An initial set (I) of keywords was defined based on previous literature on Industry 4.0 and Technological Innovation in Industry domain. A second set (H) of keywords related to Human Resources Management synonymises was also defined to be used in combination with set I in order to query the selected scientific databases.

The procedure of documents extraction was implemented using Pandas library to archive information in Data Frames through Scopus and Web of Science web services through API rest. The figure below explains how LDA process work over a document collection.

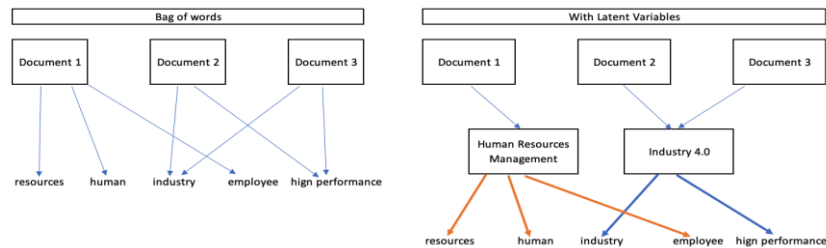


Figure 1 - LDA approach with latent variables (topics) vs Bag-of-words approach

The LDA technique is able to map each document to its corresponding topic based on the probability distribution of the document over  $k$  topics, obtaining a vector of length  $k$  for each document as shown in *Table 1*.

Table 1 - Probability distribution of the document over  $K$  topics

	Topic 1 (HRM)	Topic 2 (Industry 4.0)
<b>Document 1</b>	0.9	0.1
<b>Document 2</b>	0.2	0.8
...		
<b>Document N</b>	0.3	0.7

A user-friendly graphical interface has also been implemented in order to facilitate the systematic literature review process and displaying results in a web environment.

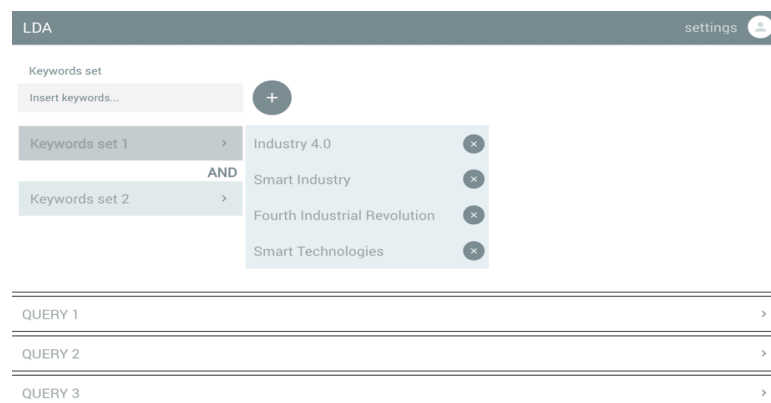


Figure 7 - Web interface of the tool for the search query string building

The main reason for using an automated procedure for extraction was to build a set of documents in a compatible format with the Python libraries used in the systematic literature review process. The automated procedure also allowed a metadata analysis with detection of new keywords included in the query string. After several runs of the extraction script, we built a starting sample of 3387 documents.

In order to select only documents relating to the research domain and achieve high scientific quality, the query string has been refined with "publication type" and "subject area", selecting respectively only academic journals and "management", "business", "economics" and "business finance" both for Scopus and Web of Science databases.

As a result, a total amount of 899 papers net of any duplicates over the two scientific databases has been included for the subsequent analysis phases (846 Scopus, 286 WoS, 233 duplicates).

#### **4.1 Topic modeling evaluation**

##### *Perplexity*

Perplexity is a statistical measure of how well the probability model predicts a sample. As applied to LDA we can estimate the LDA model for a given value of  $k$ . Then given the theoretical word distributions represented by the topics, compare that to the actual topic mixtures, or distribution of words in documents.

The benefit of this statistic comes in comparing perplexity across different models with varying  $k$ . The model with the lowest perplexity is generally considered the "best" (Scaccia and Scott, 2021).

##### *Topic coherence*

Topic coherence measures the degree of semantic similarity between high scoring words in the topic. This coefficient helps measure model quality by distinguishing arguments that are semantically interpretable arguments from statistical inference artifacts (Xi and Allan, 2008). As an early intrinsic method, Alsumaith et al. (2009) defines measures based on three prototypes of junk and insignificant topics. The three prototypes for "junk distribution topics" are the uniform word-distribution, the empirical corpus word-distribution, and the uniform document-distribution:

$$p(w|topic) \propto 1 \quad p(w|topic) \propto \text{count}(w \text{ in corpus}) \quad p(d|topic) \propto 1$$

Then a topic significance score is computed from various dissimilarities and similarities (KL divergence, cosine, and correlation) to these three prototypes. However, the significance score is a complicated function with free parameters that seem to be arbitrarily chosen, so the risk of overfitting the two datasets used for experiments is high.

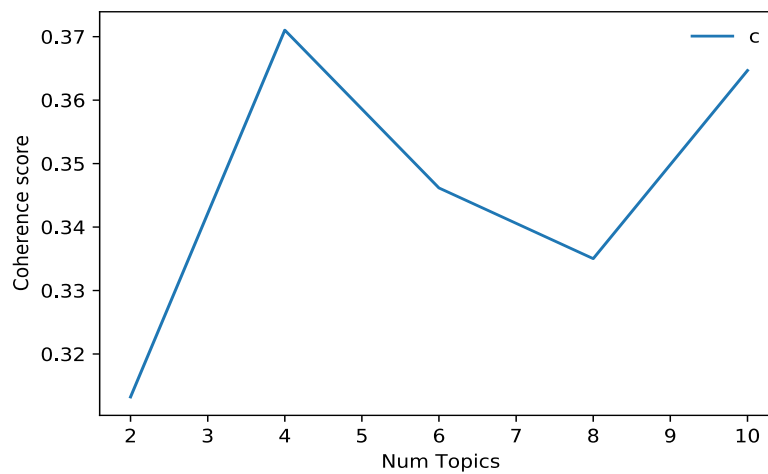


Figure 2 - Optimal number of topics for the model with coherence score evaluation

#### 4.2 Analysis and findings

In this section, we report all findings based on the analysis of topics discovered by Mallet LDA. Each document is composed of multiple topics contributions, but is possible to identify the dominant topic by weighting the topics and the keywords for each sentence. This procedure allows the association of each contribution to the dominant topic. This facilitates the exploration of the contents that can be classified by relevance in terms of citations and journal impact factor.

Document_No	Dominant_Topic	Topic_Perc_Contrib	Keywords
0	1.0	0.6219	firm, management, technology, industry, high, performance, research, company, work, organization
1	3.0	0.5174	Industry, innovation, development, product, process, project, system, university, knowledge, technology
2	3.0	0.4446	Industry, innovation, development, product, process, project, system, university, knowledge, technology
3	0.0	0.4456	Construction, american, machine, plant, robot, cost, operation, environmental, soviet, defence

Figure 3 - Dominant topic for each document

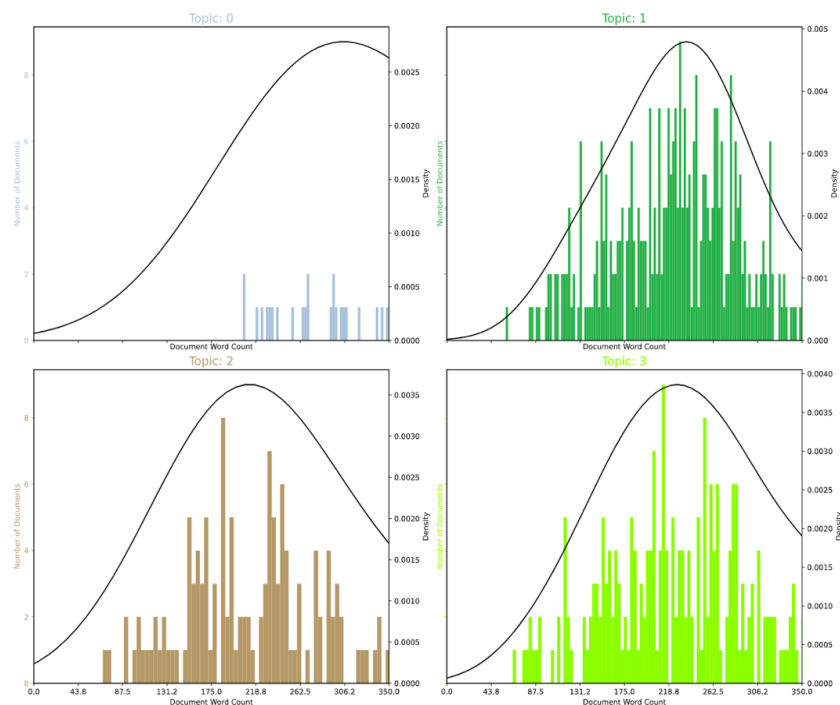


Figure 4 - Word count and importance of keywords per topic

Figure 4 shows word counts distribution for each topic extracted, this representation is useful to the researcher in the analysis phase to know how big the papers are as a whole and also by theme or topic.

The weights of the keywords and how frequently words appear in the papers is also indicative to evaluate the coherence of the model in relation to the research domain., as shown in figure 5.

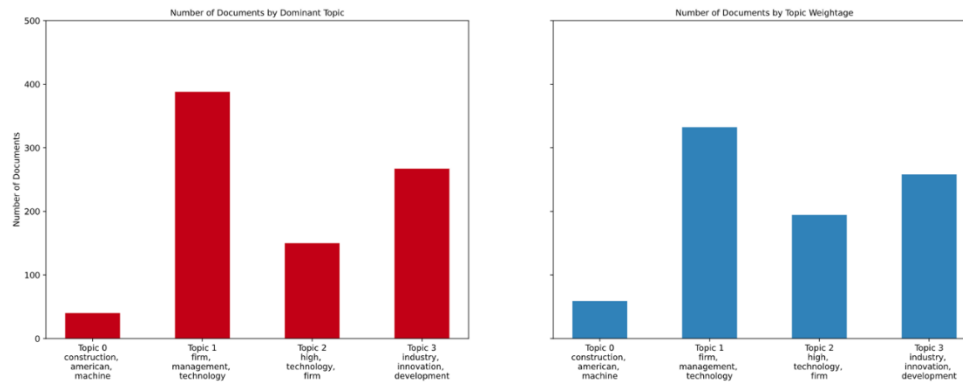


Figure 5 - Word counts and the weights of each keyword

Through pyLDAVis, a most commonly used graphical tool contained in Gensim Python library, is possible to explore in HTML the content for each topic. The graphic and interactive exploration in the web environment offers the researcher the possibility to compare the different topics discovered by the tool in a single view window, facilitating the analysis of the entire base of contributions.

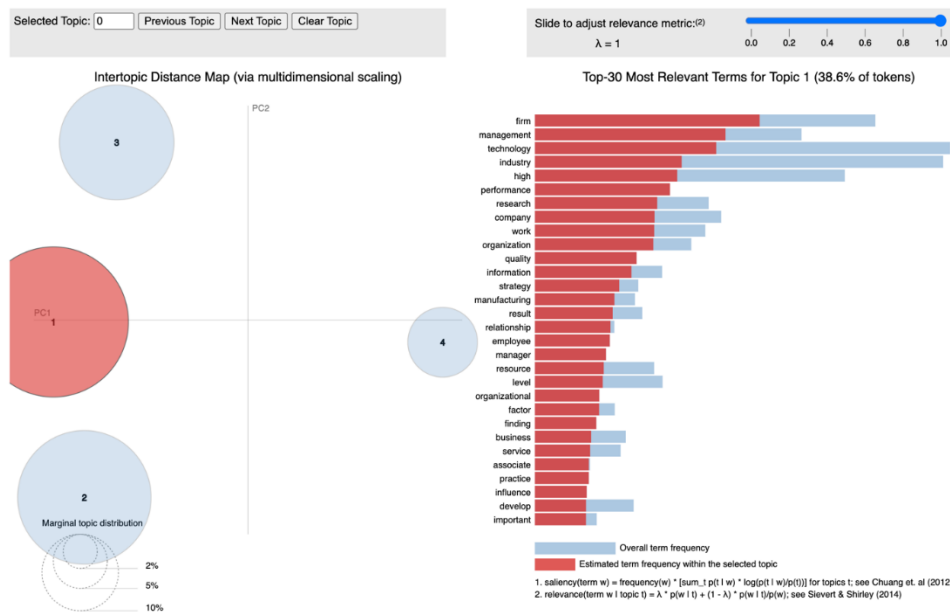


Figure 6 - HTML topic exploration tool



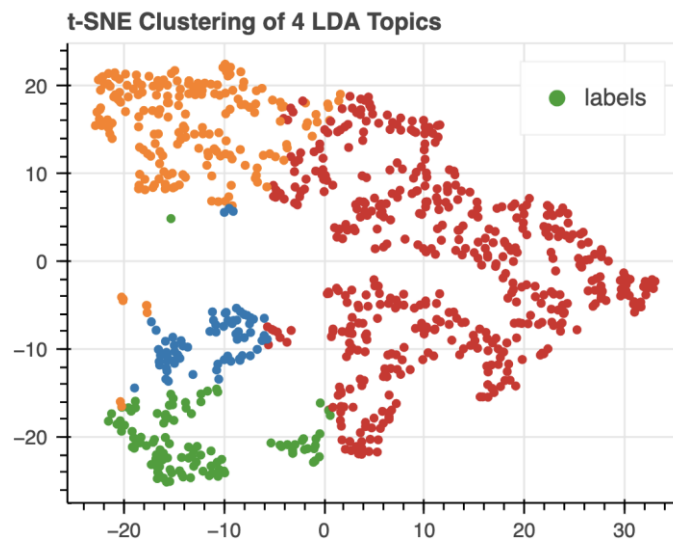


Figure 7 - t-SNE 2d visualization

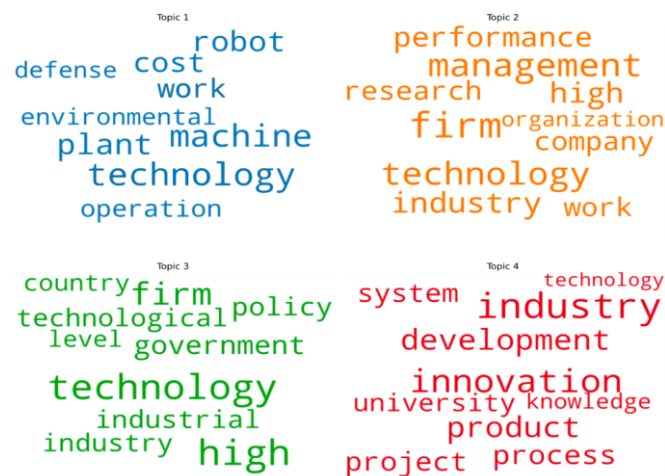


Figure 8 - Word clouds per topic

As presented in Figure 7, the tool allows the visualization of clusters of documents in 2D space through the t-distributed stochastic neighbor embedding (t-SNE) algorithm.

We used as title for each topic a description based on the most representative text identified by the LDA procedure, also using words clouds with the size of the words proportional to the weight in each topic. A brief description is provided in the following table.

Table 2 – A brief description of the identified topics

Topic	Keywords	Description
Topic 1	machine, plant, robot, cost, operation, environmental, sustainable, human health,	Identification of environmental effects in the application of new technologies for sustainability and the improvement of working conditions
Topic 2	firm, management, technology, industry, high, performance, research, company, work, organization, readiness	Industry 4.0 readiness assessment based on the current organizational structures in companies and employees' perspective, supporting staff with material reward and career development opportunities or reducing workload by assigning appropriate task.
Topic 3	high, technology, firm, government, policy, industrial, industry, technological, country, level	Analysis of the relationships between local policies to encourage the use of new technologies and the implementation of industry 4.0 development paradigms in companies
Topic 4	industry, innovation, development, product, process, project, system, university, knowledge, technology	University - Industries collaboration aims to improve companies readiness to industry 4.0 thanks to targeted recruitment systems and continuous training on new technologies

## 5 Conclusions

The rapid growth of scientific publications evidently calls for a systematization of the available body of knowledge (Shahid et al., 2020). Several challenges for research, such as poor theory understanding and lack of novelty emerge especially when scholars do not have a systematic understanding of the underlying body of knowledge (Paul and Criado (2020). High quality, systematic review papers and meta-analyses can provide this state-of-the-art understanding to scholars and thus play an important role in a discipline's progress. Systematic literature reviews represent an important approach to understand extant business research and to provide ideas and directions to undertake novel studies, instead of doing replete and recycled types of research.

Although several approaches are available for SLRs, a clear definition of how SLR can contribute to value creation in the scientific knowledge management process is still missing. With this paper, we tried to fill this gap. As first result of

our research, we structured and systematized the SLR methodology in order to clear connect it to the phases of the research process according to the knowledge management perspective.

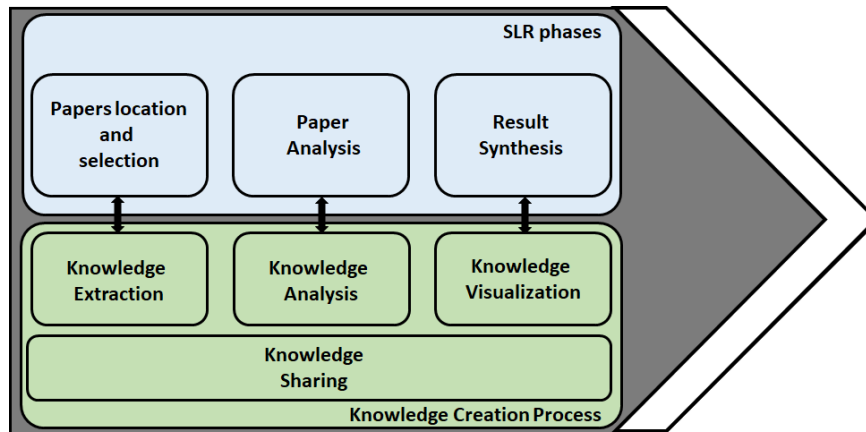


Figure 8 – The interrelation between SLR phases and the Knowledge Creation Process

Moreover, while in the past much attention has been paid to tools supporting the analysis of bibliometric networks (such as co-authorship, bibliographic coupling, and co-citation networks) (Perianes-Rodriguez et al., 2016), much less attention has been paid to the design of software tool supporting researchers throughout literature review process.

The second result of our research was specifically thought to overcome this further limitation. We implemented a DSS tool useful to automate some step of the SLR methodology and support the decision process of researchers along the four phases of the knowledge creation process we identified. A synthesis of the main advantages provided by SMILE is provided in the following table.

Table 3 – Main features provided by SMILE

Knowledge creation Process phase	Tool Features
Knowledge Extraction	<ul style="list-style-type: none"> <li>- Support in keywords definition</li> <li>- Support in search string building</li> <li>- Automated search and extraction from WoS and Scopus scientific databases.</li> </ul>
Knowledge Analysis	<ul style="list-style-type: none"> <li>- Choosing among several classification algorithm</li> <li>- Comparing classification results</li> </ul>

	- Topic description
Knowledge Visualization	- Keywords and topics statistics
	- HTML topic exploration tool
	- t-SNE 2d visualization
	- Word clouds for each topic
Knowledge Sharing	- Share results among research group members

In order to facilitate scholars in carrying out SLRs based research, a tool implementing an interactive procedure that allows researchers to supervise all the fundamental phases envisaged by the SLR has been presented. The tool, starting from a set of initial keywords, allows to modify the search query and to interactively evaluate the research results.

The optimal number of topics  $k$  is calculated for each query, as well as the coherence coefficient based on the LDA technique evaluation. The representative text for each topic is also shown in order to verify the consistency of the methodology with respect to the main topic.

The current version of the tool allows the choice between two options (Gensim LDA and Mallet LDA) of the algorithm that best classifies the contributions and discovers research topics based on coherence coefficient, overcoming the limitations of the tools currently available as highlighted by different authors (Tauchert et al., 2020; Asmussen et al., 2019). The feature of the tool of comparing the results of different algorithms on the same corpus opens the doors to a possible future development of the methodology, represented by the implementation Latent Semantic Analysis (LSA), pLSA (probabilistic-LSA) or any other machine learning algorithm for knowledge extraction from scientific literature.

According to a Knowledge-based view of scientific organizations (Cummings and Kiesler, 2014), SMILE provides a boost for the continuous acquisition and transfer of knowledge among scientific community members. Universities and Research Institutions build their knowledge by recording it as papers, documents, books, etc. Access to this knowledge for researchers and students is essential for continuous growth. Also important is the access to tools that enable knowledge extraction and facilitate the creation of shared knowledge repositories.

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## Assessing Virtual Learning Spaces Performances: a Conceptual Framework

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### Abstract

The ongoing pandemic has forced public and private organizations to shift from in-person to virtual teaching and learning, giving new emphasis on the usefulness of virtual learning spaces. (Karam et al., 2021; Krishnamurthy, 2020)

In such a context, how to assess the performances of virtual learning spaces has become a key topic. Despite that, to date assessing the performances of virtual learning spaces remains under-investigated.

This study proposes a conceptual framework that highlights the relevant variables and dimensions of a virtual learning space (VLS) to assess. For this purpose, the study combines a theoretical approach with empirical evidences. First, a literature review is carried out to describe learning spaces, their features and forms, and their main performance dimensions. Then, a conceptual framework for assessing virtual learning spaces performances is developed. The framework is tested on a case example that allowed to enrich the

theoretical insights with practical findings. The theoretical findings suggest specific variables and dimensions to consider in assessing learning spaces supported by digital technologies. Moreover, the paper provides managers with a conceptual framework for the assessment of the performances of virtual learning spaces.

**Keywords** – learning spaces; virtual; performance evaluation; knowledge; decision-making.

**Paper type** – Academic Research Paper

## 1 Introduction

Active learning approaches are acquiring growing importance in the current scenario, favoring the emergence of innovative learning spaces (LS) (Alstete and Beutell, 2018, Ellis and Godyear, 2016) These spaces are oriented and designed towards the learner and the learning process, with particular attention on learning mechanisms and teaching goals. An LS is a space of action and interactions and its key features influence the learning processes and knowledge creation and exchange processes.

Recently, virtual learning spaces (VLS) took hold (Marconato, 2014). A VLS is a combination of elements enhancing the learning process, with a strong technological component.

The ongoing pandemic has emphasized the usefulness of these spaces (Karam et al., 2021; Krishnamurthy, 2020), as it has forced public and private organizations to shift from in-person to virtual teaching and learning.

Given the new emphasis on the relevance of VLS, how to assess their performances and effectiveness has become a key topic that is gaining growing attention. (Karam et al., 2021; Krishnamurthy, 2020; Grigol et al., 2014).

In this perspective, several authors propose some examples of evaluation frameworks, such as: i) the SAMR model, based on an ex-ante selection of technologies to implement in VLS; (Hamilton et al., 2016) ii) the Confirmatory factors model with a stakeholder-oriented perspective; (Selim, 2007) iii) the conceptual framework for hybrid distance delivery (Piccoli, 2001), and iv) the Web-based virtual learning environment (Dennis et al., 2002), both mainly focused on the ex-post effectiveness of VLS.

Despite this, performance assessment of VLS remains under-investigated. To the best of our knowledge, indeed, to date most of literature is focused on the

description of these spaces. In this vein, this study proposes a conceptual framework that highlights the relevant variables and dimensions to assess a VLS.

In particular, the study tries to answer the following research question (RQ): What are the essential dimensions to consider for a comprehensive assessment of a virtual learning space's performances? For this purpose, from a methodological point of view, the study combines a theoretical approach with empirical evidence. First, a literature review regarding learning spaces, their features and dimensions is carried out. Then a conceptual framework is developed. The framework draws on the logic underpinning the Balanced Scorecard (Kaplan and Norton, 2004).

The framework's purpose is to guarantee and enhance the effectiveness of a VLS. In this vein, it supports the identification of the relevant dimensions of a VLS that should be evaluated in an ex-post perspective.

The model, indeed, includes four main pillars, i.e. i) physical dimension; ii) relational dimension; iii) virtual dimension and iv) learning atmosphere and competencies. Lastly, the framework is tested through a case study that allowed to enrich the theoretical insights with practical findings.

The research results synthesize data and knowledge gathered from the literature review and the empirical case study and offer implications and insights both for theory and practice. The findings suggest specific variables and dimensions to consider in assessing learning spaces supported by digital technologies. Therefore, the paper provides managers with a conceptual framework for the assessment of the performances of a VLS.

The paper is organized as follows. In the next section, a theoretical background discussing the role and relevance of LS and VLS is presented. Then, the essential dimensions to consider for a holistic assessment of VLS performances are identified and described. The third section describes the conducted case study and discusses the results. Finally, theoretical and practical implications, as well as future research directions are illustrated.

## **2 Theoretical background – Role and relevance of learning spaces**

Nowadays, the traditional teaching model, lecturing, is becoming outdated, favouring the emergence of new perspectives. Different researchers (Alstete and Beutell, 2018, Raelin and Coghlan, 2006) claimed the importance of incorporating active learning possibilities in addition to the lecture method, (i.e. team exercises, cases presentations, class debates) facilitating interactions and relationships

between students and between students and teachers. Active students' participation in learning helps in creating and constructing knowledge. Active learning involves students in the learning process dynamically and experientially. When students are engaged with this methodology, they are more likely to retain what they have acquired and to achieve positive impacts on learning outcomes. (Karam et al., 2021)

Kickul and Fayolle (2007) asserted the importance of a complete shift from passive teaching to an active learning perspective. The latter is less oriented towards narrow and specialized-based approaches whilst it is more focused on contents and processes organized by the students and aimed at achieving learning outcomes.

According to the emergent perspectives, lecturing may continue to be a common practice in education, but it will be considered as a part of the pedagogical repertoire, integrated with more active learning approaches and innovative tools (Alstete and Beutell, 2018). In consequence, traditional classroom spaces are increasingly considered ineffective in supporting and favouring the achievement of learning outputs because they make too easy the knowledge broadcasting or "delivery" in a unidirectional flow of communication (Long and Ehrmann, 2005). Classroom design is, in fact, more oriented to space itself and not to the learner and the learning process (Alstete and Beutell, 2018).

Therefore, a relatively new research stream, namely learning space (LS), is acquiring increasing importance. Recalling Kurt Lewin's equation  $B=f(p,e)$  (i.e. B=behavior, p=person, and e=environment), a learning space may be conceptualized as a space of interactions among the individuals and the environment. In this perspective, the design and planning of learning spaces are driven by these interactions (Morris, 2019; Ellis and Goodyear, 2016). These spaces are oriented and designed towards the learner and the learning process.

Rigidity, immobility, discipline and control are substituted with flexibility, functionality, participation and empowerment (Santoian, 2012). Generally, according to Long and Ehrmann (2005), the architecture of the LS is no longer a container in which teaching and learning happen but it may provide several dimensions to support learning. The structure of a learning space, indeed, includes mutually influencing interactions between different kinds of nested dimensions and learning outputs. (Ellis and Goodyear, 2016) Therefore, the LS is a space of action and interactions; it is not static and neutral because its structure, its quality and its predisposition are key features influencing the learning

processes and the knowledge creation and exchange processes. Loiero (2008) claimed that developing effective learning spaces means focusing attention on the ways to create learning opportunities in a context where to learn and grow.

This perspective leads to the possibility of widening the definition of LS, considering further forms of LS, namely, i) Ba in organizations and ii) innovative milieu.

In knowledge management literature, Ba is a place or a field, where people learn and co-create knowledge. In an organization, the Ba can be composed of members with different ideas, experiences, sensitivities and ways of thinking. Consequently, members hold different kinds of knowledge that, combined and exchanged, create a source of innovation. The people participating in a Ba exchange knowledge through interactions and relationships because each individual can see himself in relation to the others and be engaged in understanding different points of view and values. Moreover, Ba can be a physical, virtual or cognitive space as well as it can be a formal or informal context. (Nonaka and Tacheuchi, 2019)

Regarding innovative milieu, several scholars describe this milieu as characterized by intense transfers of knowledge and learning processes, facilitated by technological dynamics and a common cultural, psychological, and political background (Maennig and Ölschläger, 2011). Another relevant element is the perception of the common image and an internal sense of belonging, enhancing common rules of conduct and value systems. (Camagni, 2004) An Innovative milieu facilitates social contacts, integration, the interaction of actors, and the creation of synergies. Therefore, milieu encourages innovation, diminishing uncertainties and accelerating collective learning processes. (Ejermo et al., 2015; Maennig and Ölschläger, 2011)

The review of literature suggests that a learning space can be defined as a space of action and interaction between individuals that drives knowledge creation and transfer and learning dynamics. These dynamics may be activated in formal and informal spaces, including several nested dimensions, namely: i) a flexible physical space; ii) a technological dimension, including tools for distance learning as well as tools supporting face-to-face interactions; iii) a motivating and creative atmosphere, reinforced by human capital's competencies; iv) strong relationships, synergies and sense of belonging. These dimensions characterize the learning dynamics that can result in positive and effective impacts on the

learning process. (Silva et al., 2019; Ejermo et al., 2015; Grigol et al., 2014; Maennig and Ölschläger, 2011; Santoianni, 2012)

### **2.1 Virtual learning spaces**

The reorganization of spaces oriented towards the learners and the learning process, gives emphasis to the diffusion of LS supported by innovative and digital tools, namely virtual learning spaces (VLS) (Marconato, 2014).

The ongoing pandemic has forced public and private organizations to shift from in-person to virtual teaching and learning. COVID-19 has altered the educational and training landscape and forced learning and training environments to quickly evolve to meet new unexpected challenges and to fully exploit digital technology for training purposes. Indeed, the digital transformation in education and training and the creation of virtual learning spaces are not new. The pandemic has just given a new emphasis on the usefulness of these spaces (Karam et al., 2021; Krishnamurthy, 2020).

Generally, a VLS is a LS with a strong technological component, that may enhance the learning process. Given the inclusion of several technological tools, a VLS is not limited to the boundaries of a physical space, but can connect remote realities.

VLSs have some specific components and features, such as: i) they are designed information space; ii) they include an explicit representation through several modalities, e.g. texts, graphic interface, 3D immersive worlds; iii) they are not limited to distance education, but may enrich classroom activities and be overlapped with the physical environments; iv) they integrate heterogeneous technologies with multiple pedagogical approaches (Murugaiah and Yen., 2019; Dillenbourg et al., 2002). Therefore, a VLS does not guarantee effective learning processes per se; pedagogical scenarios must be integrated with the choice of suitable technological tools. In this regard, new digital technologies have the potential to become powerful and potential changing agents and strategic allies for sustainable and inclusive development of innovative, cheaper and more user-friendly learning spaces and effective knowledge creation and exchange.

Accordingly, given that VLS are characterized by high knowledge intensity dynamics and activities, (Alexandropoulou et al., 2009; Veer-Ramjeawon and Rowley 2020), they may be supported by knowledge management systems (KMS).

Generally, several authors agree in defining KMS as technological and organizational tools and practices supporting and facilitating KM processes. They aim to optimize the knowledge resources use, activating innovation dynamics and improving companies' performances, efficacy, and effectiveness (Corso et al., 2003). Accordingly, two essential components of a KMS are KM-Practices and KM-Tools. KM-Practices are methods and techniques supporting KM processes (i.e. creation, storage, and transfer) whilst KM-Tools are organizational tools and digital technologies assisting KM-Practices. Therefore, the development of VLS can be supported by KMS, integrating technological and organizational tools and practices enhancing knowledge and learning dynamics.

#### *2.1.1 Assessing VLS performances*

Given the new emphasis on the relevance of the VLS, how to assess their performances has become a key topic (Karam et al., 2021; Krishnamurthy, 2020; Grigol et al., 2014).

Several authors propose some examples of frameworks evaluating one or more dimensions of a VLS, namely: i) Substitution, Augmentation, Modification and Redefinition (SAMR) model (Hamilton et al., 2016); ii) Confirmatory factors model (Selim, 2007); iii) a conceptual framework for hybrid distance delivery (Piccoli, 2001 and iv) Web-based virtual learning environment (Dennis et al., 2002).

In particular, the "SAMR" model is a four-level framework, based on a taxonomy approach for an ex-ante selection of technology to use in VLS. The SAMR model is increasingly popular among practitioners (Hamilton et al., 2016).

The "Confirmatory factors model identifies e-learning critical success factors" within universities, grouped into 4 categories: instructor, student, information technology, and university support. (Selim, 2007) The model is based on a stakeholder-oriented perspective, in particular the students' perspective.

The "model for hybrid distance delivery" is mainly focused on learning effectiveness emphasizing hybrid distance delivery (Dennis et al., 2002). Lastly, the "web- based virtual learning environment" is developed in the context of basic information technology skills training. (Piccoli, 2001) The last two models are focused on the ex-post effectiveness of VLS, describing and evaluating the relationships between several factors influencing the learning processes.

The models presented need to be renewed and adapted to the recent scenario. The SAMR model lacks a solid literature foundation. Critics about the SAMR model are focused on its absence of context, its hierarchical structure, and the

emphasis placed on product over process (Hamilton et al., 2016). The other three models identify some of the key dimensions to evaluate in a VLS, however, they are mainly linked to distance learning and e-learning. Moreover, they are based on basic technological tools (i.e. emails, videoconferencing, chat) without considering the emergence of several innovative digital technologies because they were developed during the early XXI century (Selim, 2007; Dennis et al., 2002; Piccoli, 2001).

Therefore, to date, the performance assessment of VLS remains under-investigated and fragmented.

In this vein, this study proposes a conceptual framework that highlights the relevant variables and dimensions to assess performance of a VLS. In particular, the study tries to answer the following research question (RQ): What are the essential dimensions to consider for a comprehensive assessment of virtual learning spaces' performances?

In this perspective, this study discusses the opportunity to readapt the BSC to the VLS setting (Kaplan and Norton, 2004). The BSC has been chosen for its acknowledged effectiveness in assessing public and private organizations' performances. It is, indeed, a performance evaluation model and a management tool that translates the organizational strategy into objectives and measures accessible to all the stakeholders. In this vein, it fosters a continuous dialogue between all the individuals and it pays great attention to the measure of the intangible assets.

The conceptual framework developed for the aim of this paper proposes the same structure of the BSC, adapting and modifying its relevant dimensions to fit in a VLS setting (Kaplan and Norton, 2004).

The resulting conceptual framework has the purpose to guarantee and enhance the effectiveness of a VLS supporting the identification of its key dimensions, that should be evaluated in an ex-post perspective. In this vein, it may support the decision-making process, that assumed strategic importance nowadays, providing organizations with key data and knowledge to make informed decisions and plans.

The proposed conceptual framework, includes four main pillars; i.e. a) physical dimension; b) relational dimension; c) virtual dimension and d) learning atmosphere and competencies. In the following, the dimensions are briefly discussed.



## **2.2 Physical dimension**

The physical dimension of the VLS any space where an individual learns, such as a classroom, an external place, a lab or an informal location. In this vein, informal spaces for collaboration and learning are relevant and essential for the enhancement of the learning processes (Alstete and Beutell, 2018). Generally, the physical design should favour flexibility and creativity. A smart and comfortable design, associated with an adjustable and wide layout, should be preferred over anonymous and "box-type" spaces. Internal and external design elements, characterizing the space, should be blended into a synergistic whole.

## **2.3 Relational dimension**

The relational dimension is highly influential. VLS should facilitate interactions, teams' cooperation and the emergence of heterogeneous ways of expression. (Silva et al., 2019; Santoianni, 2012) Internal and external relationships favour learning and knowledge dynamics creating stimulating and motivating environments. (Mosa and Tosi, 2016) The relationships considered are those between peers, those with external stakeholders and those between learners and teachers. In this vein, teachers become facilitators of interconnected learning, and develop relationships of trust and respect with the learners. They become active agents of change to respond to the demands of a global world. (Silva et al., 2019)

## **2.4 Technological dimension**

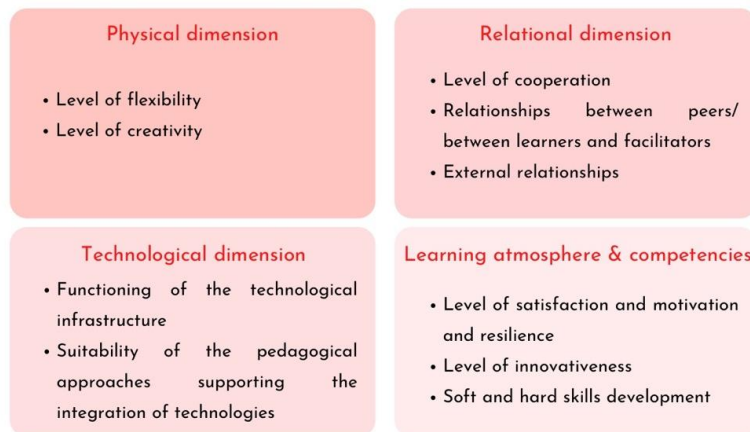
The importance of the technological dimension must be acknowledged as well. There is a combination of technological tools and internet infrastructure that have a great potential for their application in education. (Grigol et al., 2014) Planning and designing a VLS may be challenging because different technological tools may foster different impacts. Therefore, implementing any sort of digital technology, without the support of a pedagogical purpose, entails the danger of ignoring the most effective solutions that may enrich education. Some examples of emerging technologies that may enhance VLS are Internet of Things (IoT) and big data, which have the potential of institutionalizing continuous learning and sharing protocol. (Di Vaio et al, 2021) Other technologies that may potentially add value to the learning process are virtual and augmented reality devices

(Elmqaddem, 2018) digital platforms, AI, computers, mobile phones, tablet, projectors, eReader, touch screens, 3D printers and digital whiteboards.

## 2.5 Learning atmosphere & competencies

The learning atmosphere influences the effectiveness of VLS and it should be motivating, creative and innovative. Other intangible elements influencing the learning process are the competencies, namely soft and hard skills developed by the stakeholders. For instance, facilitators should be creative and committed in the assumed didactics, but also responsible and rigorous. Learners and facilitators should develop digital competence, dynamicity, flexibility, resilience as well as critical and lateral thinking (Silva et al, 2019; Connor & Davidson, 2003).

For each of the dimensions of the conceptual framework, in the following figure are synthetized the relevant variables to consider for the assessment of VLS. (Fig.1)



Tab. 1 – Conceptual framework to assess and manage a VLS

## 3 Case study analysis and findings

A case study (Yin, 2013) has been developed to test the framework in a real setting, which allowed enriching the theoretical insights with practical findings. The case study method can be successfully to probe beneath the surface of a situation and to produce a rich context for understanding. In fact, it contributes

enriching empirical base especially when quantitative or statistical data are difficult to extract (Robinson and Shumar, 2014).

### **3.1 Research Context**

The case study is focused on the project *One Class!* The project is developed by Openet Technologies, an innovative organization situated in Matera, in cooperation with "Agenzia Spaziale Italiana" (ASI) and European Spatial Agency (ESA). Openet technologies is an innovative organization that offers satellite-based solutions, operating in the ICT sector in the field of *Edutainment*.

*One class!* is a project aimed at solving a problem faced by some schools in Basilicata (Italy) and other small towns in Italy. In particular, when schools are located in isolated areas, they may face the problem of multi-classes. *One Class!* was developed as an affordable and effective solution to the isolation of the multi-classes and the Digital Divide. Several reasons motivate the choice of *One Class!* as a convenient case to analyze. The project, indeed, involved 56 classes and was aimed at transforming the isolation of territory from a limit to an opportunity to innovate. The analyzed VLS are innovative and formal learning spaces connected between them through tools for videoconferencing. In fact, Openet technologies provided advanced technologies and satellite-based solutions to enrich the learning spaces of schools situated in isolated areas. In this vein, multi –classes, through a distance learning approach, were daily connected with the correspondent level of a standard class in another school. This was an opportunity for the students living in small countries, to attend lectures in standard classes, whilst it was also the chance, for the standard classes, to obtain advanced technologies to integrate into their learning spaces.

### **3.2 Data collection and analysis**

The first step was an audit of all the resources characterizing the VLS, technological as well as organizational (i.e. technological tools, furniture, decorations etc.). Then, the data collection process was carried out with four approaches, namely: i) document analysis (i.e. analysis of documents and Openet website); (Bowen, 2009); ii) participant observation; (Longhurst, 2003); iii) semi-structured interviews with teachers, headmasters and Openet; iv) Surveys with schools' students. The approaches are presented in the following table (Tab.2).

Tab. 2 – Data collection process

<b>Data collection process</b>	<b>Timing</b>	<b>People involved</b>	<b>Performances analyzed</b>
I) Document analysis	1/05/2019 – 30/06/2019	<ul style="list-style-type: none"> <li>• Authors</li> </ul>	<ul style="list-style-type: none"> <li>• Functioning of the technological infrastructure</li> <li>• Suitability of the pedagogical approaches supporting the integration of technologies</li> </ul>
II) Participant observation	3/06/2019 - 14/06/2019	<ul style="list-style-type: none"> <li>• Authors</li> </ul>	<ul style="list-style-type: none"> <li>• Level of flexibility and creativity of the spaces</li> <li>• Suitability of the pedagogical approaches supporting the integration of technologies</li> <li>• Level of cooperation</li> <li>• Relationships between peers/ between learners and facilitators</li> </ul>
III) In- depth interviews	3/06/2019 - 14/06/2019	<ul style="list-style-type: none"> <li>• Authors</li> <li>• Openet technologies</li> <li>• 2 headmasters (primary school)</li> <li>• 6 teachers (primary school)</li> </ul>	<ul style="list-style-type: none"> <li>• Functioning of the technological infrastructure</li> <li>• Suitability of the pedagogical approaches supporting the integration of technologies</li> <li>• Level of satisfaction, motivation and resilience</li> <li>• Level of innovativeness</li> <li>• Level of cooperation</li> <li>• Relationships between peers/ between learners and facilitators</li> <li>• External relationships</li> </ul>
IV) Surveys	3/06/2019 - 14/06/2019	<ul style="list-style-type: none"> <li>• Authors</li> <li>• 44 students of the 4<sup>th</sup> and 5<sup>th</sup> grade from the primary schools</li> </ul>	<ul style="list-style-type: none"> <li>• Level of satisfaction, creativity, resilience</li> <li>• Level of innovativeness</li> <li>• Level of cooperation</li> <li>• Relationships between peers/ between learners and facilitators</li> </ul>

Validity was secured by the adoption of multiple methods (i.e. document analysis, participant observation, in-depth interviews and surveys) to analyze the case and collect data. Reliability can be demonstrated by the storage of all the data collected and recorded during the programs' activities.

### 3. 3 Research findings

According to the purpose of this study, the last step presented is the analysis of the data collected. The data derived from the audit of the resources and the conceptual framework have been merged. The framework has been adopted as an interpretative model that allowed the identification of the main dimensions of the analyzed VLS. It has been applied to the case study through document analysis, participant observation and in-depth interviews, as showed in table 2.

The findings are discussed below.

About the *Physical dimension*, the level of flexibility and creativity was high thanks to moveable chairs, work tables and colourful walls included within the space.

About the *technological dimension*, each class participating in the project was provided with an advanced laptop computer, an interactive digital whiteboard, access to the satellite network, the OAT monitoring system and an e-learning platform (*Spontania*). 100% of interviewed teachers and headmasters were satisfied with the tools provided, used also beyond the scope of the project. The technological infrastructure was well functioning and advanced for 50% of the respondents (3/6), however, 100% of them (6/6) was particularly satisfied of the technical assistance and the training provided by Openet engineers. Moreover, half of the respondents (50%) claimed that the software *Spontania* was easy to use. Despite this, some issues arose with the satellite signals, not always stable for 50% of the interviewed. Generally, the most important problem concerned the integration of digital technologies into classrooms' daily routines. In fact, only 50% of teachers (3/6) implemented suitable pedagogical approaches and learning methodologies.

The data collected have also confirmed that the *relational dimension* is a key factor in enhancing the effectiveness of a VLS. The level of cooperation detected was high. Students were continuously interacting, to achieve specific learning and pedagogical objective. This finding was confirmed by 75% of teachers and headmasters and 100% of students. Moreover, 50% of teachers acted as facilitators (3/6), motivating and driving students in their learning processes. The external relationships were developed between standard classes and multi classes, situated in different towns, as well as between different schools participating to the project.

Lastly, the *learning atmosphere & competencies* was positive. In fact, the satisfaction level was high, 91% of students were motivated, enthusiastic and involved in the lessons. However, 33% of teachers claimed that sensitive students should acquire a higher level of self- confidence to be active and interested during the distance learning activities. Generally, not all the teachers showed positive attitudes towards the VLS (only 50% of them), and thus they need further stimulations. This aspect reduced the level of innovativeness perceived within the schools participating to the project. The negative attitude of some teachers arose by the fact that many of them (50%) did not have the basic technical and digital skills needed to interact with innovative tools. On the other hand, students were considered digital native, and, therefore, innate digital skills favored them in the interaction with technological tools.

#### **4 Conclusions and discussion**

This research has focused on the development of a conceptual framework that identifies the relevant dimensions to consider for a systematic and holistic assessment of VLS performance.

First, a literature review to define role and relevance of a learning space was carried out. Then the conceptual framework was developed, drawing from the literature on VLS.

The literature review has provided a consistent theoretical background for the development of the conceptual framework, identifying the relevant dimensions that enhance the dynamics within the VLS.

The framework was thus tested on a case study regarding a VLS implemented in schools, to overcome the isolation of students living in rural areas. Each of the frameworks' dimensions has been evaluated with the analysis of interviews and surveys with the stakeholders as well as the document analysis and the participant observation.

The derived practical findings enriched the theoretical insights, confirming the usefulness of applying the framework to effectively manage a VLS. In fact, it highlighted the relevance of the assessment for managing these spaces. Through the identification of the key dimensions, the framework pointed out weaknesses to overcome and strengths to monitor, to develop effective VLS.

For instance, it detected a low attitude of some teachers towards the VLS and the lack of basic technical skills that may hamper the innovation dynamics.

Moreover, the framework measured a high level of motivation and cooperation inside and outside the boundaries of the schools, strengths that need to be monitored and maintained.

From a theoretical viewpoint, the paper contributes to the further development of the literature about LS and VLS, providing a definition suitable to different levels of application. Moreover, given the growing attention on VLS, the study identifies specific variables and dimensions to consider in assessing learning spaces supported by digital technologies.

Concerning the practical implications, the paper provides managers with a conceptual framework and some insights for the assessment of the performances of VLS that may allow them to make informed decisions and management plans based on key data and knowledge.

However, the study presents some limitations. The main limitation regards the analysis of a single case study that may hinder the generalizability of the results. Moreover, the conceptual framework should be tested in other fields of application, such as the higher education sector as well as in organizations and territories. In conclusion, considering future research avenues, the research highlights the importance of developing measurable key performance indicators to integrate within the conceptual framework to assess VLS performance effectively.

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## **Leveraging Knowledge-Based Dimensions to Implement Entrepreneurship Education (EE) Programs in Higher Education**

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### **Abstract**

Although the relevance of knowledge assets dimensions influencing EE is widely recognized, a holistic knowledge-based perspective about EE is missed. The paper provides a literature review on EE through knowledge management lenses. Drawing on the results of the literature review, the paper proposes a framework describing knowledge assets categories founding an EE program, i.e. "*Knoware Tree for EE programs*". The study, through the proposal of the conceptual framework "*Knoware Tree for EE programs*", identifies the knowledge assets dimensions grounding EE programs. The assets are grouped into two main pillars: i) structural knoware and ii) stakeholder knoware.

The framework "*Knoware Tree for EE programs*" allows to identify, analyse, manage and assess knowledge assets grounding an EE program. It represents, indeed, a useful tool that practitioners can adopt to disentangle knowledge roots of EE programs and to effectively design, manage improve and assess them. From a theoretical point of view, this paper contributes to further develop the literature on EE by providing an analysis of EE programs through knowledge management lenses. Moreover, the research extends the applicability of the conceptual framework "*Knoware Tree*", by testing and implementing it in the setting of EE programs.

**Keywords** – Entrepreneurship Education, Knowledge-based dimensions, Entrepreneurial mindset, Conceptual Framework.

**Paper type** – Academic Research Paper

## 1 Introduction

In the current VUCA context (Bennett and Lemoine, 2014) the importance of developing an entrepreneurial mindset allowing the identification of opportunities and challenges and their consequent transformation into innovative solutions suitable to face the sudden changes and the unpredictability of the competitive context, becomes even more relevant (O'Connor, 2013; Solomon, 2007). The processes of transformation of challenges, barriers and obstacles into new entrepreneurial opportunities, which fall within the broader concept of entrepreneurship, therefore, nowadays, are increasingly capturing the interest of both academics and practitioners (Fyen et al., 2019; Secundo et al., 2020). This attention is furthermore motivated by the COVID-19 pandemic and the consequent socio-economic crisis, the need for developing skills and attitudes prone to problem solving and to be able to make decisions in risky and unpredictable contexts, generating creative and innovative solutions and enabling dynamics of transformation and innovation of business models is increasingly felt (Santarsiero et al., 2021; Secundo et al., 2020).

To enable the development of entrepreneurial skills, educational institutions, and universities in particular, are activating Entrepreneurship Education (EE) programs, often supported by government bodies. Within this scenario, entrepreneurship is assuming a considerable and growing relevance in higher education systems where there is an expansion of curricular and extracurricular

programs, aimed at promoting entrepreneurial mindsets (Hahn et al., 2017). EE programs are in fact defined by several authors as one of the most promising activity in terms of development of entrepreneurial skills (Raposo and do Paço, 2011; Sousa et al., 2019; Florin et al., 2007). In this vein, several authors have paid attention to assess the relevance of these programs (Liu et al., 2021; Hahn et al., 2020; Karimi et al., 2016; Athayde, 2009; Costa et al., 2018; Morris et al., 2013; Peterman and Kennedy, 2003; Sanchez, 2013; Wilson et al., 2007).

At the basis of EE approaches, however, is that entrepreneurial skills and attitudes are not an innate gift. On the contrary, they are learned with time (Volery et al., 2013). Becoming a recognized entrepreneur, thus, is the result of learning processes influenced by tangible and intangible knowledge assets (Dickson, Solomon, and Weaver 2008; Klandt 2004; Kolvereid 1996). EE, therefore, develops in the learning process through the application of the knowledge spiral and the presence of learning situations like, for instance, best practice benchmarking, the stimulation of creative and innovative thinking, and guaranteeing a direct connection between learning and real environment (Nonaka, 2007; Frolova et al., 2021). Similarly, other authors have focused their efforts on the search for sets of distinctive dimensions, namely knowledge assets, that characterize successful EE programs to identify best practices and provide guidelines to facilitate the emulation and dissemination of effective EE programs (Dulcembre, 2019; Apostolopoulos et al., 2018; Secundo et al., 2020; Fretschner and Weber, 2013; Al-Atabi and DeBoer, 2014; Sousa et al., 2019; Secundo et al., 2021). Consequently, it follows that the development of effective EE programs directly depends also on a set of knowledge assets that require effective management procedures (Raposo and Do Paço, 2011; Sousa et al., 2019).

Generally, the role of knowledge management has a great relevance for supporting organizational performance improvement and business and entrepreneurship dynamics (see e.g. Heisig, 2016; Millar, 2016; Byukusenge, 2017; Schiuma, 2012; Schiuma et al., 2008b; Nonaka, 2007). Moreover, EE is characterized by high knowledge intensity, in fact, several studies and researches investigate the role and potential of knowledge management in educational organizations (Rodríguez-Gómez and Gairín, 2015) and mostly in higher education systems (Rowley, 2000; Alexandropoulou et al., 2009; Veer-Ramjeawon and Rowley 2020).

In this respect, several attempts to provide frameworks for mapping knowledge dimensions and assessing the effectiveness of knowledge management in

organisational context have been registered (see e.g. Nonaka and Tacheuchi 1995; Driessen et al., 2007). The SECI spiral model, for instance, is one of the most acknowledged contributions in the field. The same attention in identifying and assessing the critical knowledge assets dimensions distinguishing EE programs has still not been paid. Therefore, a structured and rigorous approach that identifies and assesses knowledge asset dimensions and tools holistically is lacking. According to Fayolle and Gailly (2008), Maritz and Brown (2013) and Liu et al (2021) the need for a framework based on EE's knowledge assets providing management recommendations on how to design, manage, assess and educate through EE programs is felt.

Accordingly, this paper aims to contribute to this research stream by investigating and identifying the compelling knowledge assets dimensions distinguishing a EE program, to manage for effective business and entrepreneurship education. The paper attempts to provide an answer to the following research question (RQ): what are the compelling knowledge asset dimensions to consider to design and manage effective EE programs? To answer this RQ, the research tests and extends an established conceptual framework, the Knoware Tree (Schiuma et al., 2008), by applying it to a new, theoretically applicable setting in the BEE sector. The conceptual framework was originally developed to identify and assess knowledge dimensions affecting innovation and development dynamics in regional and territorial contexts, as well as in change management programs within organizations (Schiuma et al., 2008a; Schiuma et al., 2008b). Therefore, considering its peculiarity and potential adaptability to the EE context, the framework has been readapted to the EE context.

The study sheds more light on how to design and manage an EE program by leveraging several knowledge assets related to human, relational, tangible, and intangible factors affecting the learning experience.

The research aims to provide theoretical and practical contributions. From a theoretical point of view, this paper contributes to further develop the literature on EE by providing an analysis of EE programs through knowledge management lenses. Moreover, the research extends the applicability of the conceptual framework Knoware (Schiuma and Lerro, 2010; Schiuma et al., 2008a; Schiuma et al., 2008b), testing and implementing it in a new setting, the EE programs. On the other hand, the conceptual framework represents a useful tool that practitioners can adopt to disentangle knowledge roots of EE programs and to effectively design, manage improve and assess them.

The paper is organized as follows. In the next section, an analysis of the role and relevance of the EE is discussed. Then, drawing on the Knoware Tree (Schiuma et al., 2008), and triangulating the framework's theoretical assumptions with evidence gathered from a review of literature on EE, the compelling EE's knowledge assets categories are pointed out and described. Lastly, theoretical and practical implications, as well as future research directions are illustrated.

## **2 Role and relevance of the EE**

The critical role of entrepreneurs and businesses is widely and traditionally acknowledged as relevant for the development and well-being of societies (Sousa et al., 2019). They stimulate a wave of positive impacts on different fields such as higher employment and increasing productivity and play an important role in economic, social development, and sustainable growth. (Maritz and Brown, 2013) In particular, entrepreneurship is considered as one of the most important economic forces as well as a dynamic process of vision, change and creation (Raposo and do Paço, 2011). Data from the Global Entrepreneurship Monitor (GEM) 2019-2020 confirm the importance of entrepreneurship as an engine for change in economic and social fields and introduce the innovative dimension in the entrepreneurial dynamics. Moreover, entrepreneurship is raising even more interest among students. In fact, according to the results of the GUESSS report (Sieger et al., 2018) based on surveys distributed to 208000 students from 3000 universities in 54 countries, 9% of students intend to be an entrepreneur directly after studies, whilst 34.7 % of them plan to be entrepreneurs 5 years after completion of studies. (Sieger et al., 2018)

Accordingly, education about entrepreneurship recently emerges as a relevant enhancing factor aimed at fostering entrepreneurship and developing entrepreneurial culture (Sousa et al., 2019; Raposo & Do Paço, 2011; Rideout and Gray, 2013). Entrepreneurship education (EE) is thus considered one of the most important components of entrepreneurship development because it stimulates progress and innovation (Vakili, 2016). EE is a newer area of focus in business education and includes courses, programs and co-curricular/ extracurricular activities that teach entrepreneurial management, strategy, innovation, and venture development as well as entrepreneurial traits, attitudes and skills. (Rideout and Gray, 2013; Sarooghi et al., 2019) According to Kirby (2003, as cited in Kirby, 2007 pp. 21) EE aims to *"develop graduates who can be innovative and*

*take responsibility of their own destinies not just in a business or even a market economy context*". In such a prospect, the role of EE is to teach students how to become an entrepreneurial person, entrepreneur's role in the economy and society, and attributes and behavior of business people (Kirby, 2007). EE should enhance people's capacity to observe, describe and analyze, people's ability to see opportunities, cope with uncertainty and ambiguity, anticipate changes in the real business and entrepreneurship scenario, and, most of all, the ability to innovate. Recent researches reveal that a good and valuable entrepreneurial person needs to acquire contents concerning functional management but also values and soft skills useful to develop a sustainable competitive advantage within the entrepreneurial ecosystem surrounding him/her (Raposo & do Paço, 2011; Vakili et al., 2016). This aspect is highly significant because entrepreneurship programs involve cognitive approaches and emotional processes aimed at influencing and empowering learners' values, attitudes, behavior, knowledge, and skills (Fretschner and Weber, 2013).

The actuality of the topic is fueling the debate whether and under which conditions EE contributes to students' entrepreneurial learning because entrepreneurial skills are particularly hard to acquire and teach, as well as students have to be an active part in the learning process to foster the process of skills development (Hahn et al., 2017; Nabi et al., 2017; Wright et al., 2017; Hahn et al., 2020). In this regard, and according to Fyen et al. (2019) and Sieger et al. (2018) universities play a key role in influencing entrepreneurial intentions and activities and, therefore, are becoming environments where students might be supported in developing their entrepreneurial mindset. In this perspective, universities are becoming increasingly aware of the important role they must play in teaching students how to generate value in organizations, economy and society, and therefore contribute to the entrepreneurial ecosystem development. In higher education, in fact, the amount of EE programs is increasing in the last years (Wilson, 2008; Fretschner and Weber, 2013). In particular, in Italy, the Italian Ministry of Education, University and Research (MIUR) supported the development of a national network of entrepreneurship laboratories delivering EE programs: Contamination Labs (CLabs). CLabs are laboratories located in more than twenty universities around Italy, organized in a blended form, aimed at boosting students' entrepreneurial and innovative culture. The programs involve students with multidisciplinary backgrounds and different educational levels, providing new learning models aimed at developing innovative and

entrepreneurial projects, rooted in a specific territorial context. CLabs fully support and enhance the interdisciplinary cooperation required by entrepreneurial disciplines. (Fyen et al. 2019; Secundo et al., 2020).

Initially, the main focus of EE programs was the creation of new ventures and startups, whilst more recently the main objective is a wider concept which emphasizes entrepreneurship as a way of thinking and behaving (Hahn et al., 2017). Therefore, to shape a successful entrepreneurial person, universities and whoever designs a program has to systematically identify, manage and exploit the spectrum of resources, assets, and competencies grounding entrepreneurship education programs (Sousa et al., 2019).

### **3 EE: a knowledge-based perspective**

Despite the growing importance of EE in the current competitive landscape, the effectiveness of these programs is highly dependent from the result of learning processes influenced by tangible and intangible knowledge assets (Dickson, Solomon, and Weaver 2008; Klandt 2004; Kolvereid 1996).

EE is, therefore, characterized by high knowledge intensity, as well as all the educational activities. Focusing on the educational field, some studies and researches investigate the role and potential of knowledge management in educational organizations (Rodríguez-Gómez and Gairín, 2015) and mostly in higher education systems. (Rowley, 2000; Alexandropoulou et al., 2009; Veer-Ramjeawon and Rowley 2020). In fact, according to Alexandropoulou, et al (2009), Veer-Ramjeawon and Rowley (2020) universities' missions are linked to knowledge management activities that are creation, transformation and sharing of knowledge.

Entrepreneurship, in particular, is further linked to knowledge dynamics. In fact, it is developed in the learning process through the application of the knowledge spiral and the presence of learning situations like, for instance, best practice benchmarking, the stimulation of creative and innovative thinking, the conversion between tacit and explicit knowledge and guaranteeing a direct connection between learning and real environment (Nonaka, 2007; Frolova et al., 2021).

Therefore, developing an effective EE program directly depends also on a set of knowledge assets that require effective management procedures (Raposo and Do Paço, 2011; Sousa et al., 2019).



In this perspective, the identification and the management of the strategic knowledge-based resources grounding EE programs emerge as relevant research streams to be addressed to successfully design and manage such programs, and, to foster successful and effective learning actions (Schiuma et al., 2008; Schiuma & Lerro, 2010).

Thus, the paper's aim is to identify the compelling knowledge assets dimensions to consider to design and manage effective EE program.

Several researchers identified sets of distinctive dimensions and characteristics of a EE program that may be classified as knowledge assets. (Othman, 2019; Sousa et al., 2019; Volery et al., 2013; Raposo and Do Paço, 2011; Kirby, 2007). Although knowledge assets have been fundamentally considered as intangible, it is essential to recognize that some of them stand as tangible resources incorporating knowledge. These assets have strategic importance because they can create and deliver value and, at the same time, can support knowledge development. (Schiuma, et al., 2008)

In the field of EE, some insights about tangible and intangible knowledge assets for EE are provided by Dulcenombre (2019) and Apostolopoulos et al. (2018) that focused their studies on the importance of structural tangible dimensions, namely the attitude of learning environments to favor the development of business and entrepreneurial skills and attitudes. On the other hand, Al-Atabi and DeBoer (2014), Sousa et al. (2019) and Secundo et al. (2021) analysed structural tangible as well as intangible dimensions, assessing the effectiveness of EE courses delivered towards online tools, like Distance Learning Platforms or Massive Open Online Course (MOOC), identifying useful tools, technology, processes and practices to follow. Moreover, Secundo et al., (2020) and Fiore et al. (2019) emphasized the role of networking and relationships for entrepreneurship programs. Lastly, other studies highlighted the relevance of the role of human capital and soft skills (i.e. personal and behavioral beliefs and attitudes) for the EE programs. (see e.g. Othman, 2019; Fretschner and Weber, 2013; Raposo and Do Paço, 2011; Kirby, 2007).

Despite the literature on EE underlines the importance of tangible and intangible knowledge dimensions in EE programs, there are no structured and rigorous approaches that allows to identify, assess and manage comprehensively the knowledge components, tangible and intangible, characterizing a EE program.

Accordingly, some entrepreneurship education scholars, such as Fayolle and Gailly (2008), Maritz and Brown (2013) and Liu et al. (2021), claimed the lack of a

common framework or agreed good practices regarding how to teach, educate and assess EE.

Generally, several attempts to provide framework for mapping knowledge dimensions and assessing the effectiveness of knowledge management in organisational context have been carried out (e.g. Nonaka and Tacheuchi, 1995; Driessen et al., 2007; Schiuma et al., 2008). Schiuma et al. (2008), proposed the Knoware Tree as an interpretative framework analysing the knowledge-based dimensions of regional development dynamics, through the discussion of the positive and significant role of the identified knowledge assets dimensions that play a fundamental role in activating and sustaining development dynamics. This framework was originally thought as an interpretative and normative model useful to enhance the innovation dynamics taking place at regional, territorial and organizational level. The framework provides useful insights and guidelines to disentangle and analyse the plethora of knowledge assets founding the functioning of an organizational system, be it region or a private or public organization. More generally the Knoware Tree proved to be a useful interpretative model to disclose the knowledge roots of any system, be it organizational or functional to organizational development.

In the light of the Knoware Tree's potential, the research has adopted the model and applied it to disclose the knowledge asset dimensions founding EE programs.

In this vein, the architecture of the original framework has been modified drawing from the literature on EE. The knowledge assets dimensions of the Knoware Tree and its sub categories have been tailored to the investigated setting, i.e. EE program context.

The resulting framework, called "*Knoware Tree for the EE programs*" identifies and describes strongly interrelated knowledge assets shaping an EE program. Moreover, it analyzes and assesses the potential derived by their interactions, considering them in a systematic and holistic perspective (Maritz, 2017; Maritz & Brown, 2013).

Specifically, the framework is composed of two main pillars: the *structural knoware* and the *stakeholder knoware*. The identified pillars and related sub-dimensions are discussed below in details.

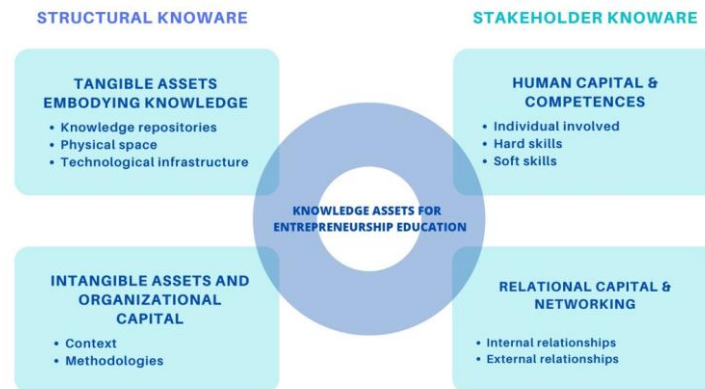


Fig. 1 – The Knoware Tree for the EE programs  
Source: adapted from Schiuma et al. (2008)

### 3.1 Structural Knoware

The first pillar characterizing the revised “*Knoware Tree for the EE programs*”, includes tangible and intangible assets that are relevant for the development, acquisition, management, and diffusion of knowledge in education and training. In particular, the knowledge asset dimensions are *the tangible assets embodying knowledge* and *the intangible assets and organizational capital*.

#### 3.1.1 Tangible assets embodying knowledge

The dimension *Tangible assets embodying knowledge* includes all the tangible organizational and structural assets grouping know-how important for knowledge management, transfer, or application (Schiuma & Lerro, 2009).

In particular, for the EE perspective, this dimension includes three different sub categories: knowledge repositories, physical learning spaces, and technological infrastructures. The *knowledge repositories* are physical infrastructures representing a precondition to the transfer of tangible and intangible knowledge assets in the specific contexts where they rise (e.g. incubators, co-working spaces). (Sarooghi et al., 2019; Kirby, 2007). The *physical learning spaces* are the classrooms or any space where the students participate to EE programs. According to Dulcenombre (2019), tangible resources and facilities may provide a significant influence on different aspects of the learners, such as cognitive beliefs, satisfaction and outcomes. The physical aspect is the layout of the classroom, the

spaces and the arrangements, study spaces, lighting and furniture. The setting of innovative spaces should be different from the one of a standard classroom because versatility and flexibility facilitate activities enhancing knowledge transfer activities. (Sarooghi et al., 2019)

Lastly, the *technological infrastructure* represents the technical assets and tools supporting knowledge transfer, creation, development processes and include ICT, digital communication systems, emerging technologies and networks (Schiuma & Lerro, 2009). IT infrastructure has to be stable, functional, and advanced. Empirically, different innovative technologies could be integrated into entrepreneurship programs. Some example are software components, e.g. digital platforms (EdModo, GSuite and others), IOT systems and sensors, artificial intelligence, chatbots, ERP platforms; and hardware components e.g. computers, mobile phones, tablet, projectors, electronic books, touch screens, 3D printers, digital whiteboard, tools of virtual and augmented reality, drones, and wearable devices can play a significant role.

### 3.1.2 Intangible assets and organizational capital

The *Intangible assets and organizational capital* dimension includes all the structural and organizational assets having a soft value. Some examples are routines, procedures, processes, task designing, organizational culture, value and leadership, corporate management philosophies (Schiuma et al., 2008). In the field of EE, these assets are reflected in the notions of *context and methodologies*. The *context* includes the learning atmosphere and the knowledge dynamics of the EE program (Nonaka and Takeuchi, 1995; Kickul and Fayolle, 2007; Maritz and Brown, 2013). According to Kirby (2007), a diffused and well-constructed entrepreneurial culture is a key intangible prerequisite for empowering learners and facilitating entrepreneurship learning processes. Moreover, there are several examples of innovative methodologies that may enhance EE programs or, in general, can improve teaching and learning of business subjects: project based-learning, problem based-learning, digital stories and storytelling, collaborative communities, augmented reality, gamification and simulation (Sousa et al. 2019; Sousa and Rocha, 2019; Sarooghi et al., 2019; Lee et al., 2017; Fiertler, 2020). These notations are not exhaustive of all EE literature, but provide a general overview of the main methodologies.

### **3.2 Stakeholder Knoware**

The second pillar of the “*Knoware Tree for the EE programs*”, refers to the human capital, in the form of actors involved in the educational and training activities, namely teachers, students, mentors, trainers, external stakeholders and related competencies and relationships. It is characterized by two knowledge asset dimensions, namely *the human capital and competencies* and *the relational capital and networking*.

#### **3.2.1 Human capital and competencies**

The *Human capital and competencies* dimension refers to all the knowledge influencing human behavior, namely the know-how, abilities, and competencies. The concept of human capital pertains to the individual’s knowledge and abilities that allow for changes in action and economic growth (Coleman, 1988). According to a EE perspective, the human capital contributes to the improvement of the overall learning experience and the achievement of learning outcomes. The dimension can be analyzed considering both the engaged individuals and the hard and soft skills to develop. The *individuals involved* in a EE program are the audience and staff. The audience of the EE programs can be composed of students aimed at becoming future entrepreneurs, belonging to heterogeneous group of people. Students may have, indeed, different learning needs and belong to different categories, according to a classification based on socio-demographics, stage of the, type of degree and other features. Understanding the composition of an audience participating in EE programs means addressing the different needs and engage all the stakeholders in the process (Maritz & Brown, 2013). Moreover, EE programs need to address effectively the need for the development of the hard and soft skills of the participants. In this vein, it is important to identify and analyses them appropriately. The *hard skills* are linked to the learning outputs in terms of managerial, economics skills, use of business tools, operational procedures, and knowledge of the startup process. (Fetschner and Weber, 2013). On the other hand, a future entrepreneur should develop different soft skills, such as motivation, self-regulation, self-awareness, self-efficacy, and social skills. Moreover, learners also need to develop personal connections with peers and trainers, to co-construct knowledge. (Liu et al., 2021; Othman 2019; Raposo and Do Paço, 2011; Kickul & Fayolle, 2007).

### 3.2.2 Relational capital and networking

The *Relational capital and networking* dimension refers to the knowledge assets linked to internal and external, formal and informal relationships among all the stakeholders involved in the organizational and business dynamics both at a micro-level and macro-level (Schiuma & Lerro, 2009; Schiuma et al., 2010). In the EE field, cognitive relationships may stimulate knowledge transfer and share from tacit to tacit, tacit to explicit, and explicit to explicit, to promote interest and involvement of the participants. *Internal relationships* should be developed to support the students, by considering their mindset and their well-being. Generally, in universities, students may benefit of a multidisciplinary environment that, according to Fyen et al. (2019) and Secundo et al. (2020), is the right environment for the development of entrepreneurial culture. In fact, this specific environment allows individuals with different backgrounds to work together for the development of advanced entrepreneurial knowledge and innovative solutions to problems and challenges. However, internal relationships are not sufficient, an environment that is supportive and helpful for the development of the entrepreneurship activity and, in consequence, for the education of future entrepreneurs, may be a stimulus for the overall process because entrepreneurs interact continuously with the external environment. The *external relationships* include partnerships among schools, universities, research institutions, business incubators and accelerators, co-working spaces and companies involved in EE courses. The perspective can be widened, by considering policies, regulations, government, and business environment also at a national level (Sousa et al., 2019; Sarooghi et al., 2019).

## 4 Conclusion and implications for future research

There is increasing debate regarding the conditions according to which entrepreneurship education (EE) contributes to students' entrepreneurial learning considering the difficulties in developing and teach entrepreneurial skills. According to Fyen et al. (2019) and Sieger et al. (2018), universities play a key role in influencing entrepreneurial intentions and activities. They are, thus, becoming environments where students might be supported in developing their entrepreneurial mindset.

Generally, EE is characterized by high knowledge intensity, as all the educational activities. (Rowley, 2000; Alexandropoulou et al., 2009; Veer-

Ramjeawon and Rowley 2020). Moreover, entrepreneurship develops in the learning process through the application of the knowledge spiral and the presence of learning situations (Nonaka, 2007; Frolova et al., 2021). Therefore, developing an effective EE program directly depends also on a set of knowledge assets that require effective management procedures. (Raposo and Do Paço, 2011; Sousa et al., 2019).

In this perspective, the identification and the management of the strategic knowledge-based resources grounding EE programs emerge as relevant research streams to be addressed to successfully design and implement such programs.

Thus, the paper provides an answer to the following Research Question (RQ): what are the compelling knowledge assets dimensions to consider to design and manage effective EE programs?

This paper contributes to identify and analyze the knowledge dimensions grounding effective EE programs in a holistic perspective. From a knowledge-based perspective, EE programs can be re-seen and interpreted according to the availability and use of specific sets of knowledge assets managed by effective knowledge management initiatives. In this vein, the research discusses the opportunity to readapt the Knoware Tree to the EE (Schiuma et al., 2008). To answer the above described RQ, the established conceptual framework has been extended and readapted, by applying it in the EE sector. The resulting *"Knoware Tree for the EE programs"* identifies and describes strongly interrelated knowledge assets dimensions to leverage for the design and management of a successful EE program.

About the future avenues of the research, the proposed framework, i.e. *"Knoware tree for the EE programs"* may be the foundation for the development of a set of indicators assessing the effectiveness of EE programs, considering the compelling knowledge asset dimensions identified.

The research provides theoretical and practical contributions. About theoretical implications, the paper provides a conceptual framework that offers a holistic and systematic knowledge-based perspective to drive the designer of EE programs to develop more effective and impactful plans, and to support the ex-ante, in-itinere or ex-post assessment of EE programs.

Moreover, the research extends the applicability of the "Knoware Tree" model, by testing and implementing it in a new setting, the EE programs.

Regarding managerial and practical implications, the proposed model can be useful to different actors as, for example, lectures, universities, educational

institutions, consultants, companies, and public administration offices, to identify and analyze new conceivable learning patterns, approaches, and tools capable to stimulate mindsets and capabilities of the entrepreneurship among students and support virtuous cycles of learning and innovation in entrepreneurship education.

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## Measuring and Managing the Performance of Organisational Digital Transformation in Industry 4.0

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### Abstract

In today's digital age, companies are challenged to invest in digital innovation and adapt their business models to the challenges of the digital world. In recent years, various studies have addressed the question of how organisations can foster digital innovation attitudes and skills to respond to the new challenges and embrace digital transformation. Organisations are taking and implementing various initiatives to deal with the challenges of digital transformation. These initiatives range from adopting, developing, and integrating new digital technology solutions to create new business processes and customer experiences or modify existing ones, to creating an innovative organisational culture and mindset to meet changing value paths and ways of working.

An analysis of the current theoretical and practical literature on digital transformation shows that this important process is associated with an increase in several dimensions of organisational performance, including innovativeness, financial performance, firm growth, and reputation. However, as reported in a recent Forbes survey (2020), these positive outcomes are not assured. The failure rate of all digital transformation initiatives is 70%. This failure is not surprising since, as Gartner (2017) and Forbes (2020) pointed out in their

recent surveys, nearly half of CEOs do not have metrics for digital business transformation and lack systems of record for the work and impact of digital initiatives.

Indeed, one of the reasons for the failure of the digital initiatives is the lack of a performance measurement capable of tracking and adequately managing the progress in the digital transformation of an organisation.

In this vein, based on an abductive approach derived from an extensive literature review on digital transformation, business model innovation and related performance measurement and management models, including those in R&D, this paper proposes a framework for assessing and managing digital transformation initiatives and their impact on organisational performance. The proposed framework provides new insights into both the key challenges in assessing digital transformation processes and their impact on organisational performance, and the role that performance measurement models play in the design and implementation of digital transformation initiatives. In addition, the framework represents a first attempt to shed light on the approaches required to measure and evaluate the impact of digital transformation initiatives on organisational performance.

**Keywords** – Performance Measurement & Management framework, Digital Transformation, case examples

**Paper type** – Academic Research Paper

## 1 Introduction

In today's business landscape companies are challenged to become more and more flexible, intuitive, imaginative, resilient, and creative to face the increasing complexity, turbulence, unpredictability, and pace of change of the competitive environment (Santarsiero et al., 2021). Indeed, organisations have to face unexpected and unclear scenarios dealing with new emergent challenges and business problems that require the development of organisational capacity for creativity and innovation to survive and sustain sustainable growth.

In today's digital age, more than ever promoting innovation processes and, in particular, digital innovation, becomes imperative for managers (Schwartz, 2002). Indeed, markets are becoming even more digital as well as consumers' behaviours, attitudes and needs are affected by digital technologies. As a result, organisations need to adapt their business models to the challenges of the digital world and industry 4.0 revolution (Bharadwaj et al., 2013).

Both private and public organisations are searching for mechanisms, approaches and initiatives that can support the development of digital innovation capacity and digital transformation processes by defining continuous learning, knowledge and technology management approaches for creativity and

innovation, as well as building collaborative and open innovation capabilities also through the engagement of stakeholders and customers according to user-driven innovation approaches (Cheng and Chen, 2013; Vial, 2019).

Recent literature on digital transformation has put great attention on how firms can take advantage of digital opportunities and drive innovation and enterprise-wide change (e.g. Pagani, 2013; Westerman, 2016).

Organizations embarked in digital innovation, have to choose whether to digitally transform their existing businesses and take advantages from these technologies or yield to the disruptions of their organizational processes and traditional business models (Nwankpa and Roumani, 2016).

Whatever the choice, digital innovation entails several challenges.

A number of studies have analysed the significant challenges and issues that have emerged for firms struggling with how to ignite digital transformation within their organization (e.g. Bordeleau et al., 2020; Vial, 2019). Among these challenges emerge the lack of digital organisational capabilities among employees, the lack of an organisational digital innovation culture, the availability of financial resources to invest, as well as the rigidity of the organisational and management models (Gasser and Palfrey, 2007; Solis, 2018).

Overcoming these structural, organisational and cultural barriers is not effortless but is fundamental to successful digital transformation.

A further relevant factor undermining the effectiveness of digital transformation initiatives is the lack of performance measurement able to track progress in digital organisational transformation and to properly manage it (Turrin, 2019).

Gartner's latest CIO survey points out that digital initiatives are the top priority for 2019. Only 4% of organizations have no digital initiative at all (Gartner, 2019). However, as reported in a recent Forbes survey (Forbes, 2020), 70% of all digital transformation initiatives fail. This failure is unsurprising and can also be attributed to the fact that almost half of CEOs have not metrics for digital business transformation and systems of record for work and effects of digital initiatives are absent.

How detecting the impacts of digital progress in an organisation and how digital transformation breaks into organisations performance measurement and management practice remains little known.

Therefore, based on a comprehensive literature review on performance measurement and management model in the field of R&D and Digital

Transformation, the paper proposes a framework to evaluate and manage the performance of organisations Digital Transformation in Industry 4.0.

The proposed framework provides fresh insights both concerning the main challenges of evaluating digital transformation processes and their effects on organisational performance, and the role played by performance measurement models in designing and implementing digital transformation initiatives. Furthermore, the framework represents a first attempts to shed light on required approaches to measure and assess the impact of digital transformation initiatives on organisational performances. Further on-field empirical investigations are recommended to apply the framework in real organisational context and to identify with practitioners and managers the key indicators and metrics required to monitor and evaluate digital transformation initiatives and to address future organisational digital innovation strategies.

The paper is organised as follows. The next section, explores the field of Industry 4.0 and digital transformation, identifying from literature, the digital transformation critical success factors, as well as the main causes of failure. Then, considering organisation's digital transformation dynamics similar to that of R&D, and thus, acting as a soft system, approaches to the performance measurement and management in R&D are discussed. The fourth section proposes the framework and illustrates some relevant indicators and metrics. Finally, insights, implications and future research avenues are discussed.

## **2 Industry 4.0**

If the fourth industrial revolution was initially conceived as a digital revolution in the manufacturing industry, Industry 4.0 is now described as the digital transformation of the entire industrial value chain (Culot et al., 2020). Digital transformation in the context of Industry 4.0 consists of the implementation of specific digital technologies (Indri et al., 2018) and the development of valuable design principles (Hermann et al., 2016).

Industry 4.0 technology trends are modern digital innovations or advanced manufacturing technologies at low or high levels that enable the digital industrial revolution (Kumar et al., 2020). Low-level technologies include smart sensors, industrial robots, smart wearables and machine controls. They can be acquired and implemented in organisations as part of digitization projects. In contrast, the Industrial Internet of Things, cyber-physical Production Systems, digital twins built

on the integration of various digital and operational low-tier technologies such as network infrastructure, sensors, machines and even networked human components are examples of high-tier technology trends (Drath and Horch, 2014). Moreover, the design principles that distinguish Industry 4.0 as a building block of digital transformation are required to enable members of the industrial value chain to reap the benefits offered by the transition to Industry 4.0. Several studies address the issue of identifying and describing Industry 4.0 design principles (Dev et al., 2020; Hermann et al., 2016). The most widely recognised are horizontal integration, vertical integration, real-time capability, and customer orientation.

Industry 4.0 and Digital Transformation as a reconfiguration of corporate vision, strategy, processes, capabilities and culture based on alignment with the challenges of the evolving business context are thus resetting markets and industries in addition to simply digitizing organizations. Organizations in any type of industry face the challenge of developing and implementing digital transformation initiatives and strategies to maintain the pace of change and seek to improve organizational performance with the aim of gaining a sustainable competitive advantage (Santarsiero et al., 2019; 2020). Therefore, identifying the opportunities and challenges of Industry 4.0, as well as the critical success factors and reasons for failure of organizational digital transformation initiatives, have increasingly attracted the attention of researchers and practitioners (Clauss, 2016; Ghobakhloo and Iranmanesh, 2021; Gurbaxani and Dunkle, 2019).

In particular, Gurbaxani and Dunkle (2019) identify six critical success factors of digital transformation initiatives and associated metrics. These are the firm's strategic vision, the alignment of the vision and its investments in digital transformation, the suitability of the culture for innovation, the possession of sufficient intellectual property and know-how, the strength of its digital capabilities, and the use of digital technologies.

A company's strategic vision, which describes its awareness of digital needs and the capabilities required to meet those needs, is an essential prerequisite for successful digital transformation initiatives. Aligning the digital transformation strategy with the goals and strategies of the overall business is therefore fundamental to developing a comprehensive understanding of how technology and digital capabilities can support business goals (Santarsiero et al., 2021). The measurement of this dimension depends on the effectiveness of the strategy



adopted to pursue the vision and the associated capabilities required to lead a digital transformation journey.

The second dimension relates to the culture of innovation, which is an enabler of digital transformation. Indeed, it is widely acknowledged that digital transformation is a process that involves not only technology but also, and above all, changes and transformations in the culture and mindset of the organization (Schiuma et al., 2021). Measuring the culture of innovation in organizations is done by looking at and evaluating the management practices and work climate that are conducive to innovation.

In addition, to ensure the success of digital transformation initiatives, know-how and intellectual property should be considered to implement the strategic vision and to understand and enable the codification of know-how, including through the use of management software to promote the diffusion of practices and routines that impact business performance.

Similarly, digital capabilities to support digital transformation should be considered to capture the know-how already present in the company and assess the lack of skills needed to implement the strategies designed.

The fifth dimension refers to strategic alignment, intended as coherence between digital transformation investments and the strategic vision, while the last dimension aims to identify attitudes towards the use of innovative digital technologies (i.e. Big Data, analytics, cloud, IoT, etc.).

In parallel with the critical success factors of digital transformation initiatives, several scholars addressed the barriers to digital transformation and the main pitfalls that hinder these processes (Furjan et al., 2020; Gurbaxani and Dunkle, 2019). This topic is relevant due to the alarming data that is evident in digital transformation initiatives. Although the estimated investment in digital transformation initiatives averages \$ 1.3 trillion, 70% of these initiatives do not pursue the estimated goals, resulting in a significant waste of resources for organizations (Zobell, 2018).

According to Zobell (2018), there are two main reasons for the above data. First, organizations often lack comprehensive communication between business units regarding the implementation of digital transformation initiatives. Too often, organizations set up digital transformation units that are compartmentalized from the rest of the organization, and the other business units struggle to understand the potential value of implementing technology and digital solutions. However, successful digital transformation initiatives take place in organizations where

there is alignment of strategic vision and goals to be pursued, and where a working climate conducive to change and innovation is fostered, as well as active employee and stakeholder engagement (Turrin, 2019). Second, most organizations lack metrics, indicators, and systems to track digital transformation and innovation activities, including the financial return on investment. Too often, organizations lack an operational system of record that acts as an authoritative source of truth for the organization's labor investments, progress, and outcomes.

With this in mind, and in order to address this gap, the following is an initial attempt to systematize a framework that identifies the critical dimensions to consider, assess, and measure in order to execute successful digital transformation initiatives. In particular, the framework is based on the assumption that digital transformation initiatives can be compared from a performance management perspective to the dynamics of R&D initiatives and thus soft systems, namely situations where performance cannot be measured by collecting data and evidence from physical devices or sensors and the focus is therefore on processes (Lazzarotti et al., 2011). Therefore, an overview of R&D and soft systems performance measurement is provided below.

### **3 R&D and soft system performance measurement**

Measuring the performance and value contribution of R&D has become a fundamental concern of R&D managers and executives in recent decades (Kerssen-van Drongelen and Bilderbeek, 1999). However, it is still recognized that measuring R&D performance is a challenging task because the level of effort is not always easy to observe, success is uncertain and influenced by uncontrollable factors, and it can usually be assessed only after long delays. The definition of the characteristic to be measured - "R&D performance" - is usually loose and highly context-dependent. As a consequence, many studies have been written in recent years in the literature on performance measurement, innovation and R&D management (Hauser, 1998; Kunz, 2010) and also in the contributions of practitioners discussing the topic and suggesting possible approaches. Some remarkable and interesting attempts to define rigorous models for measuring R&D performance have been published recently (Gwynne, 2015; Schwartz et al., 2011). These attempts are based on the performance measurement dynamics of soft systems and therefore aim to ensure the numerical characterization of R&D performance by pursuing objectivity and intersubjectivity. Specifically, objectivity

is the attitude of considering for measurement only information about the system under consideration and not about the environment. Objectivity is thus a condition for the reliability of the information generated by the evaluation process. Intersubjectivity then, aims at ensuring the same interpretation even among different subjects. Therefore, intersubjectivity is a condition for the public interpretability of the information generated by the evaluation process (Lazzarotti et al., 2011).

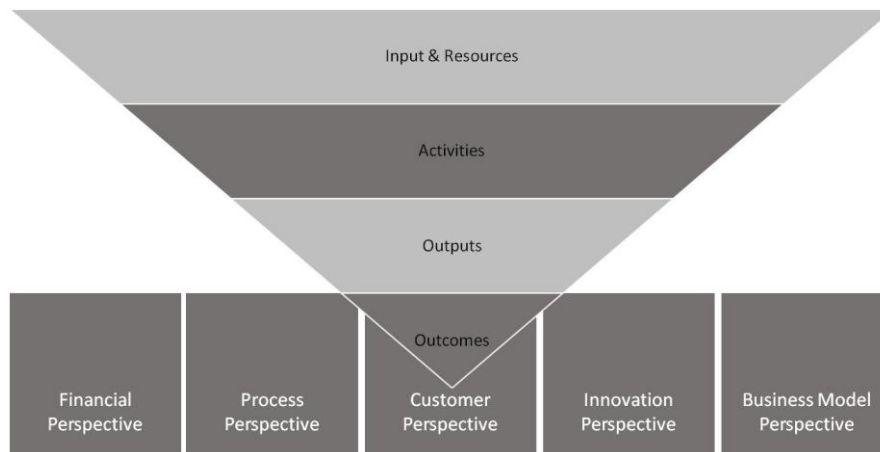
Moreover, R&D initiatives have been considered as soft systems consisting of a set of inputs and activities (basic and applied research, development activities such as technology and knowledge transfer, market analysis), resources (tangible and intangible), as well as outputs (results achieved immediately after the activities have been carried out) and outcomes (medium-term results). These dimensions may be located in a particular R&D unit or alternatively, particularly in the case of SMEs, may be distributed throughout the organization and intertwined with other units, activities and resources.

In order to effectively measure R&D performance, several researchers adapt their proposed models to the accepted balanced scorecard approach (Bremser and Barsky, 2004; García-Valderrama et al., 2008). According to this approach, there are five perspectives to be considered in R&D performance (Kaplan and Norton, 2006; Mari et al., 2009): i) the financial perspective, where performance is defined as maximizing the quantitatively measured return on R&D investments; ii) the customer perspective, where high performance is seen as exceeding or at least meeting customer expectations; iii) the innovation and learning perspective; iv) the internal business perspective; v) the alliance and network perspective.

#### **4 Measuring the performance of organizational digital transformation: a conceptual framework**

Triangulating the insights gained from the research, through an abductive analysis of approaches adopted in performance measurement and management in R&D and soft systems, a framework for measuring and managing organizational digital transformation is proposed and discussed below. The framework thus assumes that digital transformation mimics soft system dynamics, and the measurement system adapts the balanced scorecard approach to the digital transformation context. However, the analysis of the conducted review and the perspectives in the balanced scorecard suggests to provide an extensions of

dimensions to consider appropriate for organizational digital transformation performance. Figure 1 illustrates the emerged dimensions that are discussed below.



*Figure 1 – Framework for measuring organisational digital transformation*

The framework focuses, at the same time, both on inputs & resources, activities, and output & outcomes that drive an organisation towards digital innovation processes (Lazzarotti et al., 2011; van Geenhuizen, 2018).

The evaluation of inputs used to develop activities and the achieved outputs allows assessing the efficiency of a digital initiative.

The activities describing a digital initiative can be related to the development of digital capabilities and innovation culture, as well as to the use of digital approaches and technologies such as AI solutions, analytics, mobility, social media and smart embedded devices to develop new products, services, and proof of concepts, to better manage relations with customers, partners and stakeholders, to better understand and analyse consumers' behaviours, to change internal processes and, more widely, the value proposition to better navigate the emergent digital ecosystem.

The outputs are those results which are achieved immediately after implementing the activities for digital transformation. Examples of outputs are, among other things, the innovative solutions in terms of new digital products, services or processes; digital capabilities among employees and managers, innovative mindset, and so on.

Outcomes can be considered as short mid-term results of the activities. They concern the changes expected to result from digital transformation initiatives. Examples of outcomes are improved customer experience and satisfaction, more profound customers' insights and needs, reduced costs of operations, improved profitability, increased revenue, operational efficiency, product differentiation, reduced business risk, etc.

The outcomes require measurement at every phase of the digital transformation journey.

Moreover, the framework, in order to measure the different dimensions of organizational digital transformation is built on the concepts of performance, effectiveness and efficiency (Soderwuist and Godener, 2004). The notion of effectiveness is considered as the ability to generate a result, while the efficiency means how the result is achieved, also considering the ability to manage resources avoiding or producing wastes. Performance, therefore, are considered as broader concept that integrates and combines efficiency and effectiveness. Their combination results, for instance, in the attitude to transfer knowledge or technology exploited during a carried out project, and assessing and evaluating the employed resources. The integration means objectively measuring both goal achievement and resource used, according to an input-output ratio. This common approach (Werner and Souder, 1997), which focuses on both outputs and inputs, allows the measurement of goal achievement (outputs) as soon as it is observable, as well as the provision of continuous data on resource use (inputs) that might later improve or affect outputs.

The analysis of the literature on performance measurement in the field of R&D and Digital Transformation processes suggest that the outcomes of digital transformation initiatives can be comprehensively evaluated considering five performance perspectives: financial perspective; process perspective; customer perspective; innovation perspective; business models perspective (Bremser and Barsky, 2004; Lazzarotti et al., 2011; Solis, 2018).

The financial perspective considers the return on investments in resources and activities required to develop innovative outputs (i.e., technologies acquisition, digital innovations implementation, training, etc.).

This perspective represents a set of objectives of operational, financial and investment activities, and strategic objectives of the company's financial position should also be defined. The achievement of the strategic objectives of digital transformation enables the increase of the long-term shareholder value of the

company. The strategic goals of the customer, internal process and organizational capacity perspectives are specified by decomposing the goals of the financial perspective via drivers. According to this perspective, the value depends on the the cost of capital, the tax rate, and the duration of the firm's value growth, as well as by drivers of operational process management of the logistics network as revenue growth, working capital, supply chain operating costs, and asset efficiency. It follows that organisational digital transformation's objectives and dimensions to consider and measure are the increase of products or services sold, and consequent increase of the market share; extension of the customers served and improvement of customer experience; optimization of costs and use of resource.

The process perspective considers the ability to effectively manage and digitize processes in terms of quality, time and costs. Their management is monitored along the entire supply chain, from the demand identification to the delivery and resultant revenue management. To evaluate his perspective, Maydanova et al. (2019) suggest to refer to the Supply Chain Operation Reference Model (SCOR) (Christopher, 2005) according to which internal process drivers are performance, processes, practices, people; while strategic aims and dimensions to evaluate are determined as strategic characteristics of supply chain performance: Reliability, Responsiveness, Agility, Cost, and Asset Management Efficiency.

Performance under a customer perspective is seen as the level of engagement and involvement of customers or users in co-creation activities, and their degree of satisfaction. In particular, customer perspective drivers reflect the processes that occur in supply chain management and the factors that influence their changes, such as the obtainment of information about real demand; the management of customer relationships; the flexibility and efficiency for customers; the integrated end-to-end management of the supply process; the flexibility of resources; the focus on the processes that create value for customers; the effective use of resources and competencies of partners; the use of digital marketing tools.

In this vein, the identification of possible strategic objectives from the customer perspective, is based on the strategic model of the marketing mix and on strategic and digital marketing tools. It follows that the dimensions to consider and evaluate under this dimension are, among others, the assessment of current needs and challenges, as well as competencies and resources of partners or competitors; lead generation; improvement of the quality of the customer service,

store locators, distribution channels, delivery and revenue management (Maydanova et al., 2019).

The innovation and technology perspective captures the effects of the development and application of new digital solutions in terms of technologies, knowledge management and diffusion. Here performance is considered as a positive conversion of research activities and gathered knowledge into new products, services or organisational solutions. This transformation, if enabled by an effective employment and management of digital technologies can result in high performance. In this vein, the identification of possible dimensions to consider and evaluate are, among others, the improvement of the innovation capacity, intended as the attitude to generate innovative solutions; the attitude to change; the ability to apply and spread across the organisation the generated solutions (Neely and Hii, 2012).

Finally, the business model perspective measures the changes in value creation's dynamics. It is widely acknowledged that digital transformation is an enabler of business model innovation, and successful digital transformation initiatives impact longitudinally on many areas of business and in the way the business is conceived and exploited. In particular, inspired by Clauss (2016), to effectively evaluate the impact of digital transformation to the organisation's business model, three main dimensions to consider and evaluate are proposed: value creation, value proposition, and value capture. The value creation considers the value generated adopting and exploiting new technologies or new digital solutions; the value proposition focuses on the change and innovation provoked by digital transformation in terms of value offered and proposed to customers; the value capture defines, then, how value proposition is translated into revenues.

## **5 Findings and discussions**

Understanding the effectiveness and the value generated from digital transformation initiatives cannot disregard a careful and systematic evaluation of their effects on an organisation's performance.

As previously outlined, to date the measuring digital transformation progress in the organization even if essential, is still in its infancy. The analysis of the theoretical and practical literature, reveals the lack of studies on the subject.

Adopting the right performance measures and dimensions to detect the success of digital transformation and to achieve the expected business outcomes, is crucial to manage and drive this complex organizational change.

Attempting to fill this gap, the paper, based on the results of a comprehensive literature review on metrics and methods of performance measurement in R&D centres, and in Digital Transformations strategies, identifies the critical dimensions of performance measurement to take into account to evaluate the effectiveness and efficiency of digital transformation initiatives and their impacts on organisational performances.

These dimensions represent the building block of a framework proposed to measure and manage Organisations Digital Transformation in Industry 4.0.

The framework considers the notion of performance as the integration of the concepts of effectiveness and efficiency (Soderquist and Godener, 2004). It focuses, at the same time, both on inputs & resources, activities, and output & outcomes that drive an organisation towards digital innovation processes (Lazzarotti et al., 2011; van Geenhuizen, 2018).

The evaluation of inputs used to develop activities and the achieved outputs allows assessing the efficiency of a digital initiative. Then, five performance dimensions to evaluated the outcomes of digital transformation initiatives have been detected and discussed. These perspectives are included in the proposed framework and analysed. In particular, the reasons and purposes to measure each aspect are illustrated. Moreover, some key performance indicators and measurement methods are explained and listed.

## **6 Conclusions**

Starting from a comprehensive literature review on management model and performance measurement in the field of R&D and Digital Transformation, the research identifies and investigates key dimensions to take into account when measuring and managing the performance of organisations digital transformation. These dimensions represent the building block of a framework that we propose to evaluate digital transformation initiatives and their effects on organisational performances.

The framework is proposed with twofold implications. On the one hand, it can help executives to manage and evaluate such innovation initiative. On the other hand, it can support scholars to understand the conceptual foundations of



performance measurement and management of organisations digital transformation in Industry 4.0 to better carry out further studies aimed to investigate related strengths and limitations empirically.

Future empirical studies are required to validate the framework and test it within organisational contexts. Furthermore, the research should be extended through the identification and proposal of a set of guidelines and practical tools that suggest how to manage and evaluate the performances of companies in their digital transformation journey.

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## **Fostering Tourism Organisations' Digital Transformation and Business Model Innovation in Times of Uncertainty: Insights from a Case Study**

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### **Abstract**

Digital Transformation and Business Model Innovation, in which Digital Age became a crucial enabler of development and competitiveness for organisations. Despite the relevance of this topic, which has recently increased due to the Covid-19, the search for solutions and ways to support tourism and cultural organisations in the adoption of digital innovations has not yet been structurally explored. In this sense, and in order to broaden the research stream, the article below aims, through the analysis of a case study of a Innovation Lab to support tourism organisations in promoting digital transformation and business model innovation to overcome the crisis, enabling growth dynamics, to highlight methods and approaches useful for both scholars and practitioners to promote innovation in organisations in times of crisis, starting from the identification of challenges and the consequent transformation into opportunities for growth and development.

**Keywords** – tourism innovation; digital transformation; business model innovation; case study

**Paper type** – Academic Research Paper

## **1 Introduction**

In the age of digital tourism, the capacity of a tourism organisation to produce a smart, sustainable, responsible and accessible offer requires innovative digital solutions that ensure integration with the territory and the safeguarding and enhancing of cultural heritage and landscape, as well as the comprehension and adaptation to customers' needs and attitudes. New products, services and tourism offers based on the new emerging demand, and a strategic and holistic vision of cultural and tourism development, allowing an increase of attractive capacity of the territory are required.

Consequently, the tourist offer requires an adjustment and realignment with the changes in demand mentioned above. Ease of travel, access to detailed and up-to-date information, the ability to personalise the way of using them, the simplicity and speed of purchasing services strongly affect the choice of destination. Therefore, Digital Transformation and Business Model Innovation processes become essential to improve the reputation and to increase the degree of customisation of bids, customer satisfaction, and therefore the attractiveness of the site, products and services offered.

Besides, after the covid-19 pandemic, Digital Transformation in the tourism industry has been heavily accelerated. Health and economic crisis, indeed, acted as an accelerator of pre-existent dynamics. Therefore, the innovation that was a hot topic, with the crisis upgraded to a mandatory priority. Tourism organisations due to the health protocols and new safety requirements have found to be forced to invest on innovation, to implement digital technologies, to embrace Digital Transformation, to rethink services, products, processes, and business models.

It follows that a further challenge in the digital ecosystem is the promotion and definition of conditions, roadmaps and management models for the implementation of digital innovation strategies to manage digital knowledge and foster continuous innovation (Nonaka and Takeuchi, 2019). However, these processes are not immediate, in particular for SMEs, distinguishing the tourism and cultural sector, where resistance to innovation and insufficient skills, finance, culture and attitudes are particularly accentuated. It follows that these organisations require forms of support to foster DT and BMI to improve offers, competitiveness, efficiency, as well as customisation and customer relationships.

Despite the relevance of this topic, the search for solutions and ways to support tourism and cultural organisations in embracing digital innovation journeys has not structurally explored yet.

In this sense, through the analysis of a case study of a Innovation Lab to support tourism organisations in promoting digital transformation and business model innovation to overcome the crisis enabling growth dynamics, the paper aims to highlight methods and approaches that are useful for both scholars and practitioners to promote innovation in organisations in times of crisis, starting from the identification of challenges and consequent transformation into opportunities for growth and development.

Moreover, the study contributes to the identification and proposal of the decalogue of challenges and that of opportunities during Covid19 pandemic, to intends to focus attention on the dimensions that must be grasped by organisations to be ready for generating digital innovative solutions for the relaunch of tourism industry.

The paper is structured as follows. Section two reviews the main literature on digital transformation and business model innovation. Section three and four discusses the conducted case study. Section five illustrates the research findings. Then conclusions and future research avenues are presented.

## **2 Digital Transformation and Business Model Innovation in Tourism**

In tourism, like other sectors, DT offers opportunities to scale, grow, improve efficiency and productivity, gain a competitive advantage and foster innovation. In the specific, in tourism, DT might contribute to innovate the offer, the destination management; to customize offers and develop new typologies of products, services, tourism packages; as well as to offer policy guidelines and insights for the development and improvement of local tourism ecosystems.

In this regard, it is essential to recognize that DT *“provides the tools, frameworks, and technologies to create and/or add value to tourism products and experiences but the success of digitalization depends on the capacity of the tourism sector to share, learn and collaborate”* (Dredge et al., 2018, p. 6).

Compared with other productive sectors, tourism presents a fragmented offer and its sub-sectors are inherently *labour intensive*, namely characterized by humanization and direct contact with clients. Therefore, by nature, reluctant to

innovation and digitalization (Meyer and Mayer, 2015). That means that for the tourism organizations, the path towards DT is complex and challenging.

Therefore, to guarantee an effective DT process in tourism organizations, a holistic vision that contemplates and engage the whole sector is needed. DT must be a process not only linked to technological development, but to the development and promotion of an integrated ecosystem, based on innovative solutions, that involves and creates value for all parties involved.

Moreover, technologies and digital innovation even though they can be new, they rarely impact radically on a market or ecosystem. What has the potential to be radical and disruptive is the way by which they are exploited. So, the logic behind technologies and the business model deriving from their usage and application. Hence, the concept of Business Model Innovation.

Tourism, as a highly competitive sector, requires Business Model Innovation as a differentiating factor to innovate, exploiting emerging digital technologies, the offer and to allow a tourism organization to take a leading role in the market.

Globalization of tourism flows, high competitiveness between destinations, sustainability, slow and smart tourism, the emergence of rural areas as new destinations, the development of new technologies supporting travels, and new travellers' needs contributed over the time to the creation of new market segments, niches, as well as the possibility of identifying new products and services allowing organizations to answer the changing demand of new travellers efficiently. Therefore, new or upgraded business models are establishing in tourism as enabling factors determining the arising of innovation management and Business Model Innovation in tourism.

Despite the relevance of this topic, further increased recently due to the Covid-19, the search for solutions and ways to support tourism and cultural organisations in embracing digital innovation journeys has not structurally explored yet.

On this vein, and to extend the research stream, in the following, through the analysis of a case study, of a Innovation Lab to support tourism organisations in promoting digital transformation and business model innovation to overcome the crisis enabling growth dynamics, the paper aims to highlight methods and approaches that are useful for both scholars and practitioners to promote innovation in organisations in times of crisis, starting from the identification of challenges and consequent transformation into opportunities for growth and development.

### **3 Methodology**

The methodology is based on an inductive research approach, represented by an exploratory case study. This research therefore examines an Innovation Lab developed to support tourism organisations in enabling digital innovation journeys to overcome the crisis triggered by the Covid19 pandemic, and focuses on how this management initiative supported tourism organisations in digital transformation and business model innovation, and how it helped to generate innovations that turned crisis into opportunity.

The data were collected thanks to the direct involvement of the authors in the activities of the analyzed Innovation Lab. The research was conducted following the approach of Yin (2009) to increase the validity and reliability of case studies. In particular, to ensure validity, the researchers used a variety of data collection methods. In particular, semi-structured interviews were conducted with tourism experts, operators and key territorial stakeholders (Spradley, 2016). In addition, thematic online webinars were organized with tourism stakeholders and local communities, following flexible approaches to understand informants' perspectives and revisit or confirm previously collected findings (Myers, 2013). The resulting data was then triangulated with theoretical insights from the literature review to reduce the typical bias of a single observation (Eisenhardt, 2002) and to identify reliable and valid findings.

### **4 Case study**

To understand methods and approaches employed to promote digital innovation in organisations in times of uncertainty, a case study has been developed.

The case study involved and Innovation Lab developed to support tourism organisations in enabling digital innovation journeys to overcome the crisis triggered by the Covid19 pandemic, and focuses on how this management initiative supported tourism organisations in digital transformation and business model innovation, and how it helped to generate innovations that turned crisis into opportunity.

Innovation Labs are conceived as management initiatives focused on creating spaces for creative and innovative thinking. They can take different forms, with different contents and actions, using a wide variety of human, organisational,



relational and technological resources, with the core objective of supporting the development of innovation activities (Santarsiero et al., 2019; 2020; 2021).

In particular, the Innovation Lab under analysis was developed to support companies wishing to undertake their digital innovation paths and to be able to generate innovative solutions for relaunching their business after the enforced blockage caused by the pandemic. The lab, thus, supported the engaged tourism organisations in designing and exploiting a digital innovation journey.

To this end, the Lab planned and implemented a series of initiatives structured around the principles of user-driven innovation, open innovation, agile and lean innovation, and stakeholder value-based and participatory innovation.

The activities were grouped into two main phases based on the broader objectives of the initiatives: i) identify challenges, ii) outline opportunities, that laying the foundations for informing and implementing a third phase aimed at defining and testing possible innovative solutions, according to an iterative approach of continuous and validated learning.

The first phase is based on the assumption that to redesign the future of tourism, and transform the crisis into opportunities for positive transformation, it was necessary to start from a diagnosis of problems and critical issues generated by the crisis. Therefore, the first phase is aimed at identifying the challenges of tourism organisations through an auditing of companies, operators accompanied by focus groups, semi-structured interviews, and a series of thematic webinars which involved the main players in the sector, i.e. entrepreneurs, experts, tour operators, DMOs, institutions, citizen, and tourists.

The second phase, then, is aimed to transform the challenges identified previously into opportunities for the revitalization and growth of tourism organizations affected by the pandemic. In this perspective, a first set of initiatives organized by the Lab consisted in an intra- and intersectoral action to explore, benchmark and analyze best practices and case studies on exemplary examples of projects, practices or initiatives that have allowed organizations to face the crisis in an innovative way.

The results of these actions served as inspiration and discussion material for the community of tourism stakeholders, experts, entrepreneurs, DMOs, citizens, tourists and institutions involved in another series of focus groups, semi-structured interviews and thematic online webinars. During these activities, and thanks to the support and guidance of the experts from the Lab, emerging

opportunities were discussed, clustered, prioritized and then adapted to the reference context.

The results of these phases served as an informative basis to stimulate innovative thinking and innovation capacity of the participating organisations. Thus, starting from identified challenges and opportunities, they were able to generate, test and validate possible innovative digital solutions in the form of new services, products, processes or business models that are helpful to foster development dynamics and enable the achievement of a sustainable competitive advantage.

## **5 Findings**

The case study contributed to understanding methods and approaches useful for both scholars and practitioners to foster innovation in organisations in times of crisis, starting from the identification of challenges and consequent transformation into opportunities for growth and development. The activities started by an on-field analysis considering the point of view of tourists, local communities, and tourism operators. The attention paid on the point of view of tourists was helpful to identify and understand new emerging tourism habits, needs and expectations. Moreover, the focus on local communities, allowed to involve them in the new path of innovation and territorial promotion. Finally, the consideration of the tourism organisations and tourism operators' point of view, allowed the identification of concerns and needs, as well as enabled the first attempt of stimulating their creativity and innovation capacity to rethink approaches, processes, services and products characterizing the regional tourism offer. At the same time, it was helpful to imagine and define new forms of communication and relational logic to guarantee the promotion of the territory and the future development of a tourism ecosystem based on authenticity, hospitality, wellness, security, and trust.

Thanks to these methods and approaches, the lab allowed the achievement of the results that are discussed below.

### **5.1 Identify challenges**

The first phase contributed to identify a decalogue of challenges to highlight the dimensions to consider to transform challenges into opportunities, and then

into innovative solutions for the recovery of tourism. Detected challenges (Figure 1) will be listed below.

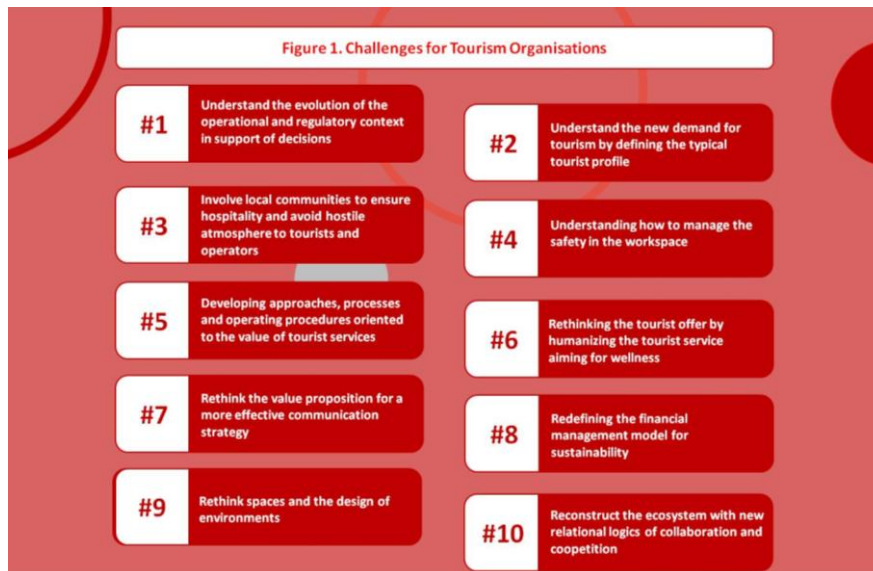


Figure 1. Challenges for Tourism Organisations

#### 5.1.1 Understand the evolution of the operational and regulatory context in support of decisions

Sector studies and national and international research present different possible scenarios for the tourism sector post Covid-19 (SKIFT, 2020; UNWTO, 2020). Regional tourism companies are therefore called to understand the changes taking place, to get informed, to catalyze and analyze data which will act as a support in taking the strategic decisions that will characterize the upcoming activities. Among these, the information related to rules, protocols and precautionary measures to adopt to manage tourism activities in full regularity and security are relevant. It is also important to gather relevant information in terms of strategic value, such as the 'sentiment' of tourists during the covid19, the propensity to resume traveling, the expense, the type and duration of the new trips that will be scheduled.

### *5.1.2 Understand the new demand for tourism by defining the typical tourist profile*

The customer care will be the basis of a successful innovation path (Desouza et al., 2008). Regional experts and operators are paying attention and curiosity to new habits of post-pandemic tourists. Results of surveys (Moggia, 2020) shows how tourists are impatient to resume travelling, despite being worried about the pandemic and the possibility of contagion. 97% of them say they want to leave within 6 months of the end of the emergency, and 66% within two months. Another interesting data to consider is that new priority tourists will change their habits, behaviors, needs and travel flows when they start traveling again.

The means chosen for the trip will also tend to change. New tourists will travel by own vehicles paying more attention to sustainability and ecology. The way of packing and filling bags will also change. Tourists will bring along products that will guarantee safety and hygiene. Moreover, travel seasonality will also vary. Travelers will distribute holidays throughout the years, avoiding festivity periods. Finally, customers' needs will vary. Customers will want to feel safe and receive all the necessary guarantees. But to obtain that they will also be willing to spend more.

### *5.1.3 Involve local communities to ensure hospitality and avoid hostile atmosphere to tourists and operators*

Local communities can become part of the differential value of a tourist destination. The local community can become the differential factor that drives a tourist to choose a vacation destination. They can guide tourists in experiential activities, to discover traditions, customs and unique paths, which go beyond mass itineraries, which respond to the 'slow tourism' demand that is re-emerging.

At the same time, the resident's perception of the possibility of reopening must be considered in order to protect the safety of the premises as well and ensure collaboration in promoting a welcoming and not hostile atmosphere towards tourists who will return to attend the regional points of interest. It is therefore necessary to consider both the citizen accustomed to the flows of tourism and potentially afraid of the new incoming masses, and also the residents of the more rural areas that presumably will welcome the new emerging forms of tourism.

#### *5.1.4 Understanding how to manage the safety in the workspace*

In order to be able to offer tourists an experience of well-being in the name of hospitality and authenticity, it is necessary to guarantee the worker the safety conditions so that he can feel protected and able to perform his functions. The tourist will perceive trust and safety only if the tour operator and the worker in every job feels safe and perceives these elements firsthand. It therefore becomes essential to make the accommodation and tourist facilities safe equipping workers with all the necessary personal protection. Moreover, new tools and approaches should be identified to train employees on new protocols and new emerging practices regarding reception and the use of the digital technologies for managing new processes that will characterize the tourist offer that will be developed in the future.

#### *5.1.5 Developing approaches, processes and operating procedures oriented to the value of tourist services*

The quality of provided services is the distinctive element of a company aiming at creating and delivering value to customers.

The adaptation to the hygiene, sanitation and social distancing standards imposed by the Covid-19 requires the completion of some new services by tourism companies. It will be necessary to avoid queues at the entrance, distribute arrivals at different times and days to avoid gatherings; breakfast will no longer be a buffet, the restaurant must ensure the right space between the tables; rooms, fabrics and various objects must be sanitized after each use, etc. Therefore, it will be necessary to rethink each operating method, service, process characterizing the activity before the pandemic and adapt it to the new required standards.

#### *5.1.6 Rethinking the tourist offer by humanizing the tourist service aiming for wellness*

This lockdown phase offers the opportunity to rethink and redesign the tourist offer on the basis of emerging trends and needs emerged following the new protocols, preferences, and habits that will characterize the new categories of tourists.

The reopening, which will take place gradually, will initially affect intraregional tourists, then interregional ones, and then reopen national borders not before

2021. Therefore, an internal proximity tourism favoring nature, villages, rural areas, large and uncrowded spaces will characterize the new scenario. Consequently, the tourist who initially will only travel in the region, will be led to discover new places and itineraries little advertised and outside traditional circuits.

These aspects, if properly enhanced and integrated into the regional tourist offer, can act as a distinctive and attractive element for the entire region. However, local traditions, rituals, including religious ones, flavors, festivals, the cultural heritage fragmented and immersed in rural contexts, can act as attractors only if rethought and reorganized according to managerial methods and new imposed requirements.

#### *5.1.7 Rethink the value proposition for a more effective communication strategy*

To date, communication has proved to be the only form of contact with the loyal customer. Therefore, communication activities should not be interrupted during the lockdown. Therefore, it is essential to adopt storytelling to tell what is being done to better prepare for the restart and to guarantee the right level of hygiene, safety that will convince tourists to come back. However, communication is also and above all a promotional tool for acquiring new customers. Communication strategies that target and convince new post-pandemic tourists to choose the destination must be planned. After rethinking the offer, therefore, the proposed value proposition must be communicated effectively and through the right channels.

#### *5.1.8 Redefining the financial management model for sustainability*

Currently, one of the main problem for companies and tour operators is the lack of cash due to the lockdown and the consequent decrease, if not zeroing, of turnover. Reservations have been cancelled, and all the scheduled plans need a review.

At this stage, customers are paying more attention to flexibility and unwilling to pay for a holiday they have been forced to cancel. It is therefore necessary to identify flexible mechanisms that protect operators and companies by guaranteeing them immediate receipts to face fixed costs and recurring expenses. Moreover, flexible mechanisms to 'cuddle' customers by inducing them to book, reschedule (also for the future) in full security and without risk must be imagined.

With a view to projecting the objectives towards a new tourist offer, it is also necessary to imagine new sources of revenue such as results of new types of experiences and services that will be offered. New digital and virtual experiences, new services provided thanks to the connection with other supply chains, such as agri-food, transport, ICT, publishing and entertainment.

#### *5.1.9 Rethink spaces and the design of environments*

Social distancing seems at the moment the only measure against Covid-19. In addition to rules and behaviors to adopt to respect the minimum safety distances, spaces must also be reorganized to avoid gatherings. However, building elements for social distancing can inhibit the client and contribute to provoke anxiety and fear. Therefore, creative solutions based on design and digital are required to comply social distancing and maximize company's productivity, as well as instill customer safety.

#### *5.1.9 Reconstruct the ecosystem with new relational logics of collaboration and cooptition*

The crisis accelerates trends and dynamics already underway, emphasizes on the criticalities of the regional tourism system, which appear as fragmented in the distribution of cultural heritage and sites of interest, and above all in relations and logics of collaboration and cooptition between organizations, as well as in relationships with the decision maker and publicly owned entities.

Therefore, an overall rethinking of the entire regional tourism ecosystem appears necessary. For this purpose, it is necessary to create synergy, involve and systematize the various experiences of stakeholders, both public and private and foster an effective dialogue that consider data, trends and future scenarios. It is necessary to leverage the creation and promotion of the regional love mark which requires a responsible, sustainable approach and a feeling of true love towards the territory and which aims to promote its identity by involving private and public operators, as well as local community.

### **5.2 Identify opportunities**

The second phase contributed to identify a decalogue of opportunities for the reboot of the tourism after the pandemic. Detected opportunities (Figure 2) will be listed below.

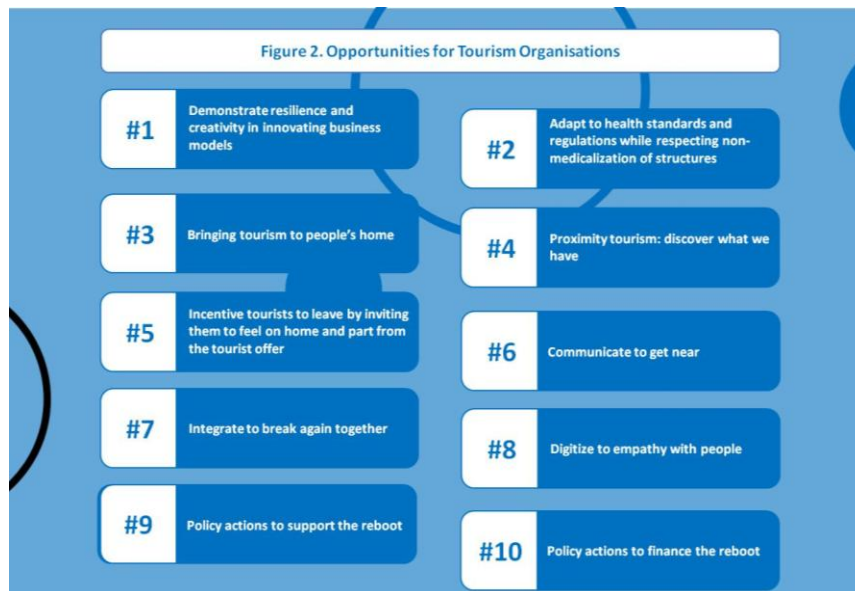


Figure 2. Opportunities for Tourism Organisations

#### 5.2.1 Demonstrate resilience and creativity in innovating business models

Resilience is one of the essential qualities for an entrepreneur, an innovator, an organization that wants to move with the times and play a leading role in the current scenario in which it operates. Covid-19 has imposed a long freeze that has brought tourism businesses in particular to their knees and has given rise to a new concept of normality that has suddenly thrown the "sharing economy" into crisis, enabling new habits and behaviors that bring about the necessary change in processes, services and operations. For many businesses, therefore, it will no longer be conceivable or profitable to operate in the traditional way. There is a need to be creative and think outside the box by generating solutions that are sustainable and useful even after the pandemic. It is therefore necessary to focus on new revenues from ancillary services, redesign offers and packages, provide for the possibility of upselling and cross-selling, and create synergies with other operators.

#### 5.2.2 Adapt to health standards and regulations while respecting non-medicalization of structures.

Accommodation providers and tour operators must adapt to current regulations and equip themselves with the necessary PPE to ensure and convey



safety and confidence to customers. It is therefore necessary to pay close attention to adapt to the rules and protocols and equip the structures with what is necessary for hygiene and sanitation, but without risking medicalization of the structures. So there are many opportunities for those who want to focus on the design of PPE and items for social distancing, on the packaging of cleaning products for sanitation and on the creative design of health control processes (thermal scanners; measurement of body temperature, serological tests, etc.) taking into account the different target customers. PPE, sanitation and social distancing will lead to standardization of procedures and objects. Those who manage to stand out will gain a significant competitive advantage, especially in a sector where differentiation is the key to success.

#### *5.2.3 Bringing tourism to people's home*

Many businesses reinvented themselves and adjusted to this time, so as not to remain idle and succumb to the enormous fixed costs that gave no respite even during the months of closure.

Citizens have got into the habit of buying online and getting everything at home, enjoying virtual experiences and services and meeting remotely. Consequently, many businesses in tourism have also worked to adapt to the new trends. Practices that are necessary to face the crisis, but above all they can be fundamental in this relaunch phase, integrated with communication strategies to generate interest, curiosity, expectation and make tourists leave, return to the familiar places or explore new ones that they can rediscover through these actions.

#### *5.2.4 Proximity tourism: discover what we have*

Staycation is the most popular term advertising vacations close to home. According to surveys conducted by Officina Turistica (2020), short-term travelers who perceive a high degree of uncertainty prefer destinations in their own region or, at best, in neighboring regions. This is an opportunity to enhance territories, to discover, rediscover and fall in love with closely country's treasures, which are too often snubbed at the expense of more glamorous destinations and beyond regional and national borders.

#### *5.2.5 Incentive tourists to leave by inviting them to feel on home and part from the tourist offer*

The tourist must be at the heart of the tourist offer. Covid-19 does nothing but accelerate the trends already underway in recent years that saw the emergence of human-centered approaches aimed at co-creating itineraries, products, services directly with the customer, guaranteeing him the opportunity to live unique experiences as a protagonist. Tourists have always wanted to feel pampered, to be desired, to "demand" special attention and today, according to Covid-19, they will want even more to feel at home in the places they choose.

#### *5.2.6 Communicate to get near*

Communication, especially in tourism, is an essential strategy to attract tourists' interest and convince them to visit a place. Especially at this time, it is essential to communicate in order to convey the message that the destinations being advertised are safe, to build trust, and to convey a sense of well-being and authenticity.

The implementation of promotional and communication strategies to convey trust, safety, authenticity and well-being is a fundamental action that allows destinations and operators in the sector to reconnect with customers and attract new tourists.

#### *5.2.7 Integrate to break again together*

Today, communication is the only form of contact with the loyal customer. In this sense, it is important not to break contact at this stage, but to have a different communication. For this reason, it is important to adopt storytelling practices, especially used in this phase, to tell what is being done to better prepare for the new start and guarantee the right level of hygiene and safety that will convince tourists to return. However, communication is also and above all a promotional tool to attract new customers. It is necessary to plan communication strategies that will influence and convince new tourists to choose the proposed destination after the pandemic.

#### *5.2.8 Digitize to empathy with people*

Now that social distancing seems to be the only certain precaution against Covid-19, digital technology plays a fundamental role in guaranteeing operators in the sector both to get in touch with tourists through digital promotion and communication channels, and to convert practices, processes and contactless services aimed at improving the customer experience in all phases characterizing the planning and use of an experience.

There are many initiatives and solutions developed in this regard. Digital menus; app to manage entrances and queues in front of museums, clubs; solutions for booking appointments, activities, experiences; digitize check-in, order and purchase directly from the smartphone.

The implementation of these services also offers a valuable opportunity for operators to profile and get to know customers, so that they can then improve and customize the offer based on the real preferences of customers.

#### *5.2.9 Policy actions to support the reboot*

Any action that can be taken to facilitate the restart of the sector cannot be separated from the policy actions of the public policy maker, who must act as a guide and reference for operators. In addition to measures relating to rules to be followed, protocols and containment measures, strategically targeted actions and fiscal, monetary and prudential measures, as well as private sector burden-sharing measures will play an essential role.

#### *5.2.10 Policy actions to finance the reboot*

To reboot, organisations need to be able to turn challenges into opportunities and take concrete actions aimed at generating and implementing effective, innovative and sustainable solutions. These actions represent investments for the actors who want to develop and implement them. In order to support the work of these subjects, public and private institutions promote investment support measures (credits, loans).

## **6 Conclusions**

The coronavirus pandemic poses dramatic challenges for businesses. No industry is spared the disruption caused by Covid-19. Workforce issues, supply chain disruptions, lost demand, employee safety, financial and market volatility,

and cash flow issues are just some of the problems companies are currently facing.

However, the pandemic can also be a good opportunity for companies to embark on new journeys, such as rethinking the business model, improving innovation capabilities and embarking on the digital transformation process to remain competitive and strengthen the business. Certainly, these "innovation journeys" are not effortless and require resources, competence, culture and attitudes that are not even easy to raise and manage.

This paper uses a case study to highlight methods and approaches useful for both scholars and practitioners to foster innovation in organisations in times of crisis, starting from the identification of challenges and consequent transformation into opportunities for growth and development. Moreover, the study identifies the challenges and opportunities distinguishing the uncertain current socio-economic landscape and provides useful guidelines and sources of inspirations for tourism practitioners aiming at starting digital innovation journeys.

Future developments of the research will focus on the development of exploratory research of further case studies in the field and on the assessment of the impact of the described initiatives.

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## Thriving in Uncertain Times: Learning Organization on Employee Resilience via Serial Mediation Analysis of Adaptability and Self-Efficacy

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### Abstract

Organizations experience multiple challenges in the modern era, and to maximise performance and value creation, they typically require resilient and committed employees. Despite the body of literature on HRM and organizational behaviour, there is a rare studies which examined the impact of learning organization on employee resilience, especially in the service sector (banking) in developing countries like Pakistan. This study aims to develop a serial mediation model that addresses research gap between adaptability and self-efficacy in learning organizations with this commandment in mind. The findings of this study are based on the principles of resource conservation theory. A cross-sectional survey of 298 employees in Pakistan's banking sector was used in this study. Structural equation modelling was used to test the study hypothesis empirically. According to the findings, learning organisation has a positive impact on employee resilience. Furthermore, our

findings revealed that serial mediation analysis of adaptability and self-efficacy positively mediates the relationship between learning organization and employee resilience. Theoretically, this study offers valuable insights to HR managers for improving workplace resilience, which can help create a suitable engaged workforce. The future implications of human resource management principles and practices are discussed.

**Keywords** – Learning organization, Employee resilience, Adaptability, Self-efficacy

**Paper type** – Academic Research Paper

## 1 Introduction

Given turbulent uncertain times, the concept of employee resilience is receiving increasing attention in many organizations. Importantly, organizations have to respond to external threats in the business environment, resource scarcity, technological advancements and changes due to pandemic in the economic and political environment. Succeeding in this challenging, unpredictable and drastically evolving environment is dependent upon the resilience of an organization and its constant ability to adapt to changes. Learning organization is an emerging aspect for organizations to adopt and respond timely in the dynamic environment due to competition in the industry (Malik and Garg, 2020).

More attention is thus warranted to understanding how and why learning organization is an imperative for organizations to develop resilient workforce, while other scholars ignored the role of adaptability and self-efficacy. In this way, our study explored the influence of learning organization on employee resilience with potential serial mediation mechanism of adaptability and self-efficacy to know better understanding. In the business world, employee resilience and learning organization are widely regarded as a critical sources of business excellence and competitive advantage in an increasing changing environment due to uncertain market fluctuations. Learning organization and employee resilience is receiving increasing attention at the micro-macro level perspective. Resilience is defined as the ability of an individual to bounce back from a traumatic experience and is related to the capacity to recover from a setback, any difficult situation or toughness (Bardoel et al., 2014). Prior research explored HRM practices with employee resilience (Tonkin et al., 2018).

Several studies conducted research on organizational capabilities with organizational resilience (Duchek, 2019). Importantly, other studies have failed to

examined the role of learning organization on employee resilience (Nyaupane et al., 2020). Similarly, there has been less previous evidence on adaptability and self-efficacy as a mediation effect to know the indirect impact on employee resilience (Richard, 2020; Nisula and Olander, 2020). Despite the evidence of a relationship between learning organization and employee resilience (Malik & Garg, 2020). However, employee resilience has been overlooked by the previous research in the uncertain times for sustainability of organizations. A recent study highlights that “to date resilience has been inadequately theorized and empirically tested within a work setting” (Cooke et al., 2019, p. 1252). Previous research paid rare attention on learning organization with employee resilience in the existing literature (Jiang et al., 2021). For this reason, this study addresses a research gap by responding a recent call to explore learning organization and employee resilience via serial mediation mechanism of adaptability and self-efficacy (Richard, 2020). Importantly, this study is to understand why so many employees in banking sector of Pakistan are high or low resilient and what exactly are the reasons and factors that affects resilience like optimism, physical fitness, relationship with colleagues, working environment, culture etc.

Previous research on adaptability and self-efficacy in the context of employee resilience and having to learn organisations has been limited (Tokin et al., 2018). Self-efficacy, according to early research, refers to the growth of resilience by virtue of the victories people have while completing job duties, obligations, and accountabilities (Bandura 1989). Furthermore, earlier studies has shown that employees' ability to rapidly recover from disturbances is critical for them to undertake well in an uncertain work environment (Shin et al., 2021). Ego refers to the growth of resilience by allowing people to succeed as they traverse position assignments, responsibilities, and obligations (Bandura 1989).

Previous research clarifies adaptability are perceived by employees as contributing to an ability to adapt to changes, thereby extending the employee resilience literature in public sector (Dahles & Susilowati, 2015). However, this study examined employee resilience in the private sector (Banking) which is neglected by scholars. It has been suggested to explore the serial mediation mechanism of adaptability and self-efficacy especially in the service sector in context of developing country (Pradhan et al., 2021). Prior research demonstrated that adaptability is important for survival of organizations if they adopt change initiatives for the competitiveness (Orth and Schuldis, 2021).



The present study contributes to this literature by explaining how learning organization affects employee resilience in the workplace. A notable strength of our research lies in expanding knowledge on the serial mediation mechanism of adaptability and self-efficacy which learning organization is linked to employee resilience. Second, the present study broadens knowledge on the antecedents of employee resilience by demonstrating how learning organization activates employees to survive in challenging workplace environment. In so doing, it responds to recent calls for further research in the area, as exemplified via an excerpt: To date, there has been very little research on the factors that foster workplace resilience and its impact on work outcomes, and there has been only a constrained interconnectedness of multiple perspectives to describe what resilience evolves (King et al., 2016, p. 783).

This study has numerous theoretical contributions. Firstly, this study examined the relationship of learning organization on employee resilience, it is an emerging phenomenon with under-researched in the existing literature. Secondly, our study explored serial mediation model of adaptability and self-efficacy. Adaptability and self-efficacy are important drivers towards resilience for employees at the workplace. In this way, this is an original contribution to the body of knowledge. Finally, this study conducted in the developing country context (Pakistan) especially in the service-sector (banking). Previously scholars rarely examined this sector and this geo-graphical region. For this reason, this study also contributes contextual/sectoral gap to studied this novel phenomenon.

### ***1.1 Conservation of resources theoretical perspective***

Shin, Taylor, and Seo (2012) argue that resilience is an individual resource that can be enhanced, based on conservation of resources theory (Hobfoll 1989, 2010). Employee resilience is a resource that can be valuable regardless of organizational change, according to our findings, and that learning organizations, adaptability, and self-efficacy can effectively establish and implement resilient workforces. Pertinently, this resource should help employees achieve goals like organizational performance and competitiveness, which helps employers achieve goals like improved organizational performance. As a result, the value of proactive resourcefulness practices is explained by COR theory. Learning organization in particular coping skills, for example, could be beneficial after a loss of resources. Comparably, COR theory explains the importance of employee

involvement to the extent that it enables staff members to prioritize the available services that must be preserved in a crisis.

### ***1.2 Serial Mediation of Adaptability and Self-Efficacy***

Adaptability and self-efficacy were considered as a potential mediators that may influence the relationship between learning organization and employee resilience. Adaptability has been defined as the "behavioural capability to leverage work resources in order to become resilient worker (Kuntz et al., 2017, p. 224). Similarly, adaptability is a to reestablish a state of fit with a changing environment. Importantly, self-efficacy refers to employees' judgments toward their capabilities to organize and execute the required actions to attain designated types of performance (Bandura, 1986). Prior research revealed employees with high self-efficacy perform more challenging tasks than with low level of self-efficacy at the workplace (Kasikci & Alberto, 2007). In the existing literature, there is dearth of studies on adaptability and self-efficacy as serial mediation to know the indirect effect on employee resilience (Djourova et al., 2019). In this way, this study attempts to highlight the role of employees to adaptability and self-efficacy at the workplace during challenging working environment.

## **2 Materials and Methods**

This explanatory deductive study explains what considerations (potentially learning organization, ability to adapt, and self-efficacy) are important in the regulation (employee resilience) (Blaikie, 2003). In the defined research, a quantitative research approach was used to understand the attitude, uniqueness, and actions of the targeted population (Creswell & Creswell, 2017). For data collection, survey questionnaires were used, which were quantitative so that associations between varying factors could be explored (Saunders et al., 2009). Purposive sampling was used in our research. Because of the precision of this measurement and the large number of responses that could be gathered in the limited circumstances of the COVID-19 pandemic, an online survey was chosen. As a result, our research gathered 298 responses from employees and managers in Pakistan's banking sector. HR Managers, HR Officers, Compliance Officers, Branch Managers, Operation Managers, and Customer Service Officers-Cash and Clearing made up the study's sample population. Our research focused solely on

the Sindh Province of Pakistan, collecting data from both private and public banks in Karachi's metropolitan area.

### 2.1 Measures

This study was adopted eight-items of learning organization (Yang et al., 2004). Adaptability was assessed as a potential mediator by using a four-item questionnaire (Dam & Meulders, 2021). Also, our study measured five-items of self-efficacy using Chen et al., (2001). Employee resilience eight-item scale was adopted from Luthans et al., (2007)

## 3 Results and Discussions

### 3.1 Power Analysis

Using the G\*Power 3.1.9.2 software, a priori power analysis was used to determine sample size (Faul et al., 2007). The findings show that an 85-person sampling frame is required to achieve 80 percent statistical power with an understanding implies (0.15) at a significance level of 5% (0.05) again for framework. To achieve our research objectives, we used 298 samples, which is similar to other standard guidelines (Hair et al., 2010; Kline, 2005; Roscoe, 1975).

#### *Common method bias*

The Harman single factor test assessed that there is approximately 26% variation in our data, indicating no common method bias. The variance inflation factor (VIF) values in Table 2 are less than 3, indicating that collinearity is not a severe issue in this study (Diamantopoulos and Siguaw, 2006).

Table.1 Demographic Characteristics

Demographic Variable	Characteristics	Frequency	Percentage (%)
Gender	Male	175	58.73
	Female	123	41.27
	Total	298	100.00
Age	Under 30	105	35.23
	30-40	87	29.2
	40-50	51	17.12
	50 and Above	55	18.45

Education Level	Total	298	100.00
	Bachelor's	139	47.11
	Master's	107	35.00
	MS/MPHIL	52	17.89
Work Experience	Total	298	100
	Less than 1 year	79	26.52
	1-3 years	82	27.51
	4-6 years	51	17.11
	7-10 years	46	15.43
	Above 10 years	40	13.43
Positions	Total	298	100.00
	HR Officer	45	15.10
	HR Manager	32	10.73
	Compliance Officer	27	9.06
	Branch Manager	48	16.13
	Operation Manager	33	11.07
	Customer Service Officer-Cash	67	22.48
	Customer Service Officer-Clearing	46	15.43
	Total	298	100.00
Bank	Public Sector	101	34.00
	Private Sector	197	66.00
	<b>Total</b>	<b>298</b>	<b>100</b>

*n=298 Source: Field Survey (August 2020- February 2021)-Pakistan* **Source: Authors' own**

Table 2. Measurement Model for Constructs

Constructs	Indicator	Factor Loadings	VIF	CA	Rho_A	CR	AVE
Learning Organization (LO)				0.863	0.867	0.896	0.554
	LO1	0.787	2.494				
	LO2	0.815	2.233				
	LO3	0.719	2.361				
	LO4	0.655	1.670				

	LO5	0.627	1.557				
	LO6	0.788	2.008				
	LO8	0.795	2.166				
Employee Resilience (ER)				0.757	0.791	0.863	0.509
	ER2	0.695	1.599				
	ER3	0.668	1.481				
	ER6	0.746	1.809				
	ER7	0.838	1.927				
	ER8	0.596	1.322				
Self-Efficacy (SE)				0.732	0.793	0.760	0.514
	SE1	0.769	1.210				
	SE2	0.666	1.071				
	SE4	0.711	1.188				
Adaptability (ADP)				0.792	0.797	0.865	0.615
	ADP1	0.777	1.714				
	ADP2	0.761	1.652				
	ADP3	0.768	1.690				
	ADP4	0.830	1.823				

**Note:** Excluded Items due to low loadings (LO7, ER1, ER4, ER5, SE3, and SE5) VIF=Variance Inflation Factor, CA= Cronbach Alpha, (CR)=Composite Reliability, AVE=Average Variance Indicator

The Heterotrait-Monotrait ratio was also used to confirm discriminant validity, as per Henseler et al. (2015). (HTMT). As shown in Table 3, each HTMT ratio was less than the 0.85 restraining threshold.

Table 3. Discriminant Validity Heterotrait-Monotrait ratio (HTMT)

	ADP	ER	LO	SE
ADP				
ER	0.610			
LO	0.810	0.697		
SE	0.832	0.732	0.789	

### **3.2 Structural equation modelling: Direct analysis**

The bootstrapping technique was used to determine the parameter's statistical importance (5,000 subsamples, one-tailed significance). H1 and H4, Adaptability (ADP) and Self-efficacy (SE) ( $O=0.619$ ,  $t=17.089$ ,  $p=0.000$ ; and  $O=0.338$ ,  $t=9.601$ ,  $p=0.000$ ) were significantly associated with employee resilience (ER). Moreover, H2 and H3 Learning organization (LO) was shown to be substantially related with adaptability and self-efficacy ( $O=0.769$ ,  $t=24.522$ ,  $p=0.000$ ;  $O=0.622$ ,  $t=18.007$ ,  $p=0.000$ ).

### **3.3 Serial Mediation analysis (indirect effect)**

The table.4 demonstrate serial mediation analysis was performed to test H5 and H6. Our results revealed H5, Adaptability (ADP) mediates a significant relationship between learning organization and employee resilience ( $O=0.476$ ,  $t=11.481$ ,  $p=0.000$ ). Importantly, H5 Self-efficacy (SE) mediates a positive link between learning organization and employee resilience ( $O=0.210$ ,  $t=7.885$ ,  $p=0.000$ ).

### **3.5 Coefficient of determination ( $R^2$ )**

The regression model's coefficient of determination ( $R^2$ ) was used to assess the research constructs' predictive power (See Table.4). The coefficient denotes the percentage of variance explained by the predictor (independent) variable in the dependent variable. Although the dependent variable Employee Resilience (ER) (0.726) has a model  $R^2$  of 0.726, it only accounts for 72 percent of the total variation in the construct employee resilience. Which can be explained by the interaction of individual constructs; learning organisation (LO). Serial mediation constructs ability to adapt and self-efficacy (0.591) and (0.385), respectively, show 59 and 38 percent.

Table 4. Results of hypotheses testing (direct and indirect effect)

Construct	Original Sample (O)	Sample Mean (M)	STDEV	t value	p-value	Decision
<b>Direct Effect</b>						
H1: ADP----> ER	0.619	0.618	0.036	17.089	0.000	Supported
H2: LO ----> ADP	0.769	0.770	0.031	24.522	0.000	Supported
H3: LO ----> SE	0.622	0.626	0.035	18.007	0.000	Supported
H4: SE ----> ER	0.338	0.341	0.035	9.601	0.000	Supported
<b>Serial Mediation Analysis (Indirect Effect)</b>						
H5: LO ---> ADP --->ER	0.476	0.476	0.041	11.481	0.000	Supported
H6: LO--->SE--->ER	0.210	0.214	0.027	7.885	0.000	Supported

Construct	Coefficient of determination (R <sup>2</sup> )	Adjusted R <sup>2</sup>
Adaptability	0.592	0.591
Employee Resilience	0.728	0.726
Self-Efficacy	0.387	0.385

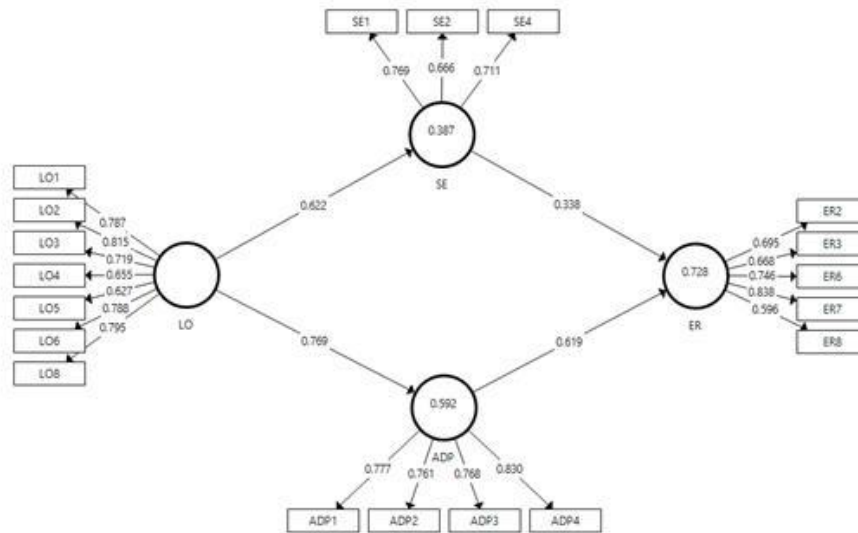


Figure.1 Structural Equation Model (Extraction from SmartPLS 3.0)

### **3.6 Theoretical Contribution**

Theoretically, this study contributes to the academic argumentation on employee resilience in a number of ways. To begin, this study looked at the impact of learning organisations on employee resilience, which would be rarely studied in the service sector in developing country context such as Pakistan. Second, serial mediation analysis of adaptability and self-efficacy was examined in this study. This is an original contribution to the body of knowledge on employee resilience. Finally, in order to gain a better understanding of the micro-foundation of employee resilience on an individual level, this study empirically tested theory conservation of resources. In terms of COR, we make an argument that resilience can be a precious asset irrespective of whether or not change is present, because even if there is no transition within the organization, employees' non-work lives are often turbulent, so employee resilience can still help with attitudes and behaviours.

## **4 Conclusions**

Drawing upon conservation of resources theoretical perspective. This research examined the influence of learning organization on employee resilience via serial mediation mechanism of adaptability and self-efficacy in the banking sector. The data revealed learning organization is driver for employee resilience. Also, our study found that adaption and self-efficacy mediates positive link between learning organization and employee resilience. Importantly, this study extends body of knowledge on resilience literature. Our study also suggests conservation resource theory is a valuable for organizational competitiveness and business excellence. Furthermore, this study suggest future research may explore employee resilience in the uncertain times such as recent COVID-19 pandemic to get better understanding of working environment and employees' response in challenging circumstances. Finally, our study provides guidelines to HR manager and policymaker to response quickly in uncertain times and they should also train and motivate their employees as they can adapt any change quickly to achieve sustainability.



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## Contemporary Challenges in the EU Pharmaceutical Industry: A Systematic Literature Review

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### Abstract

The COVID-19 global pandemic has broken healthcare systems globally and locally in this on-going uncertain time. In that instance, the European Union (EU) was not an exception. The main aim of this study is to highlight the contemporary challenges faced by the pharmaceutical industry in the European Union region (EU). Importantly, this topic is emerging but under-researched in the existing literature. For this reason, this study attempts to bridge the research gap by examining the issues. Methodologically, this study employed a systematic literature review method to generate new knowledge. Our study conducted data analysis with Microsoft Excel software. This study analysed 27 published studies from Web of Science, Scopus, and indexed journals from the top reputed Chartered Association of Business Schools (CABS). Our study highlighted the complexity of EU pharmaceutical industry through the systematic literature review method. The systematic review revealed that the vulnerability of EU pharmaceutical industry, such as default patent system, ineffective research and development (R&D), debate on the role of alliances, low level of expertise in EU health care system and pharmaceutical supply chain management.

**Keywords** – Contemporary Challenges, Systematic-literature Review, Pharmaceutical Industry, European Union (EU).

**Paper type** – Academic Research Paper

## 1 Introduction

The COVID-19 pandemic creates inefficiencies in the health care system by having devastating consequences. In that instance, the European Union (EU) was not an exception, while the pharmaceutical sector is a highly capital and knowledge-intensive industry in the world, which spends around 15 % of the total revenue on research and development (R&D), (Downs & Velamuri, 2018). Besides, EU has the second largest market by sales account in the world and the increment of total investment becomes more than double during the pre- pandemic period (Azierta, 2019). For-instance, the spending in the health sector was an average 8.3% of GDP and the pharmaceutical production cost was almost one-sixth of total health expenditures in 2019. The retail pharmaceutical bill was around Euro 190 billion in 2018 (OECD, 2020) and it is a major contributor to the investment in innovation (European Commission, 2020).

According to (le Deu & Santos Da Silva, 2019), the increment of total investment in Europe's biotech firms was more than double, for instance, during the seven-year period (2005-2011) it was \$5.1 billion but it upgraded more than twice in the next seven-year period at 11.9 billion between 2012 to 2018. That is why public expectation to get access to safe, eminent, and affordable medicines, therapies, and vaccinations is an upward demand in general, although the advantages may vary in European countries (European Commission, 2020). Moreover, there remains a scarcity of pharmaceutical products in the EU, and patients do not have access to medicines due to the shortage. This practicality has been demonstrated amid the Covid-19 pandemic in Europe and raises an important issue as to how to ensure the availability of pharmaceutical products during a crisis. European Commission recent reports and Global Health Summit of G20 Nations at Rome in 2021 suggest coordinating pharmaceutical and nonpharmaceutical interventions and emergency response.

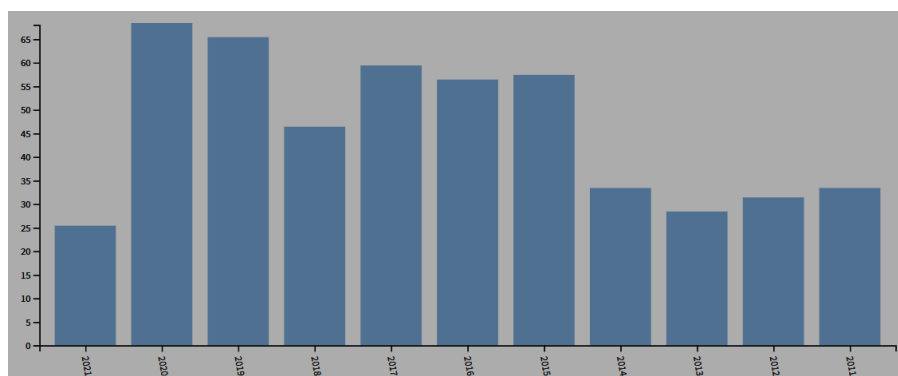
It is true that typically the pharmaceutical business in the EU is currently facing several challenges, such as the growing number of aging people, rising burden of diseases regarding Covid-19 pandemic, patients, having difficulty in bearing the cost of medicines, increasing dependence on medicines and pharmaceutical products imported from non-European countries, and business formulation responding to the investment capacity (European Commission, 2020).

Our study argues that previous research neglected the contemporary challenges of EU pharmaceutical industry and it becomes ineffective to tackle the

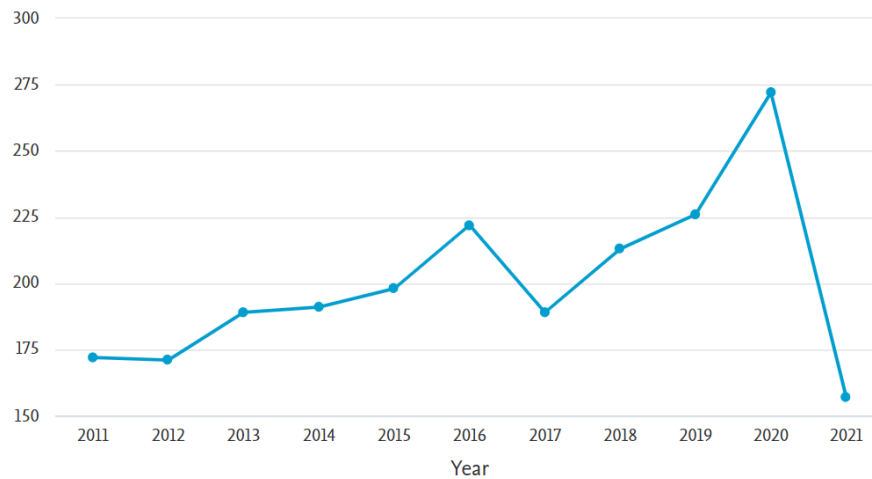
crisis period. The main aim of this study is to explore the contemporary challenges faced by the pharmaceutical industry in the European Union region (EU). Importantly, this topic is emerging and under-researched in the existing literature. For this reason, this study attempts to bridge the research gap to highlight an important issue.

## 2 Materials and Methods

This study employed a systematic literature review method (Denyer, & Tranfield, 2009). Our study adopted inclusion and exclusion criteria after constructive reviewing articles from Web of Science and Scopus databases along with the ranked journals in CABS to search the following key terms “challenges” and “pharmaceutical industry” during the period from January, 2011 to April 2021: The terms are set to be searched in the title, abstracts, and keywords of the publications. This study reviewed 2701 papers and selected only 21 due to relevance of phenomenon such as challenges in the pharmaceutical industry of EU and 6 more papers are selected from the past of the period to have an overall scenario of the contemporary challenges in pharma industry typically in EU.



*Figure 1. Web of Science's record of 501 papers*  
Source: Authors (2021)



*Figure 2. Scopus's record of 2200 papers*  
*Source: Authors (2021)*

For this study's relevance on the existing literature of contemporary challenges in pharmaceutical industry, we limit the fields of results to Pharmacology, Toxicology and Pharmaceutics, Medicine, Biochemistry, Genetics and Molecular Biology, Chemistry, Chemical Engineering, Business, Management and Accounting, and Social science, specially, the search mainly focus on EU so other countries and regions are excluded. The search includes the most updated journal articles, review papers, and conference papers and published in English only. After removing the duplicate results, we have 689 relevant papers.

In the next step, for high quality assessment, we sort out the most quality publications among 689 papers from high-ranking journals based on the standard of the Chartered Association of Business Schools (CABS), which are evaluated at the ranks of 4\*, 4 and 3. After this step, we narrow the selection to 137 papers. Then, we read the title, abstracts, and keywords of these papers to determine whether they are relevant for the research purpose or not. Finally, we selected 27 papers for constructive review. Our study conducted data analysis with Microsoft Excel software as well.

### **3 Results and Discussion**

Several issues in the EU pharmaceutical firms are identified in the systematic literature study, including the patent system, R&D, healthcare systems,

outsourcing and alliances, and supply chain management. Each segment's results and discussion sectors have been segregated to better grasp the main problem.

### **3.1 To specify the weakness of EU pharmaceutical patent system**

The goal of WTO (2006) paper is to take note of the provisions of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) that pertain to the patent standards to be applied to pharmaceutical innovations. Patent rights are not absolute under the TRIPS Agreement and can be subject to limitations or exceptions. There can be categorised in four major issues, such as: Many EU countries authorize third parties to use a patented innovation for research purposes with the goal of better understanding the invention as a foundation for science and technological advancement. Without the permission of the patent owner, members can permit usage by third parties (compulsory licensing) or for public non-commercial reasons (government use). The Agreement recognizes members' right to adopt anticompetitive measures in accordance with its rules and offers more flexible circumstances for the granting of compulsory licenses. The TRIPS Agreement makes it clear that WTO members' practices regarding the exhaustion of intellectual property rights (e.g., a Member's decision to have a national exhaustion regime, in which rights holders can act against parallel imports, or an international exhaustion regime, in which they cannot) are unchallengeable under the WTO dispute settlement system, provided that the TRIPS Agreement is followed.

Table 1: Summary results for the challenges in EU pharmaceutical patent system.

<b>Author (s)</b>	<b>Focused issue</b>	<b>Challenges in the Pharmaceutical Industry in the European Union</b>
WTO (2006)	Patent system	In the transition provisions, there is flexibility, limitations, and exceptions to the rights that are authorized.
(Tuominen, 2011)	Patent system	No obvious legislative in pharmaceutical patents.
(Liu & la Croix, 2015)	Patent system	The European Union takes longer than competitors to obtain a valid patent right.
(Montaña i Mora, 2017)	Patent system	The EU lacked a patent office, and the institutions were unable to enforce patent laws. A Supplementary Protection Certificate ("SPC")



(Garattini & Padula, 2017)	Patent system	Questioned on the existing regulatory system and proposals to overcome.
(Minssen et al., 2019)	Patent system	With counterfeit medications in developing nations, there are a number of barriers that must be overcome.

Source: Authors (2021).

Importantly, (Tuominen , 2011) discussed that there are no clear legislative answers to specifics regarding EU strategic patenting in the pharmaceutical industry and when it becomes an abusive activity. Undoubtedly, it will be a continuous issue among the stakeholders (generics, consumers, and customers) and a widespread demonization of the pharmaceutical business, of which the Commission may be accused in some of its conclusions, is not productive in this regard. This issue goes to be crucial when prior research supports the absence of an institutional framework in EU to establish a robust patent system. According to the Court of Justice of the European Union ("CJEU"), 18 July 2013; cited in (Montañá i Mora, 2017) that the EU and its member states are in an impossible condition as a result of patent law. That was because the EU did not have a patent office and the institutions that would be capable of dealing with such patent security obligations (administrative and judicial authorities of Member States) would no longer be competent.

Therefore, (Garattini & Padula, 2017) proposed three crucial initiatives for the EU pharmaceutical patent system, such as without revolutionizing the whole structure, a drastic reform is expected to create a separate institutional body to handle pharmaceutical patents. Secondly, pharmaceutical patents can be limited to substances that are used for one (or more) declared indications (s). Finally, pharmaceutical patents can only be held for substances that begin a first clinical trial within five years of being granted and in terms of the importance of public health, it is time to rethink the EU regulation. (Minssen et al., 2019) added that a new European Union strategy could boost the availability of legal pharmaceuticals in developing countries, reducing the issue of counterfeit drugs, but there are still many obstacles to overcome. Moreover, patents on drugs assist in the recoupment of costs incurred during the research and development period. Since rivals can quickly replicate a drug's production, drug patents can protect against infringement cases. However, European Union did not issue patents for new medical products until 1980; approved orphan drugs in 2000 and drugs tested on paediatric population in 2007; while the USA, Australia, Japan and Canada were

having patent rights before Europe. Nevertheless, European Union was the first to provide biological marketing exclusively in 2006 (Liu & la Croix, 2015)

### ***3.2 Challenges in EU pharmaceutical R&D investments and expenditures***

On the one hand, pharmaceutical R&D spending is quite expensive, while the risk and uncertainty of accomplishing the output rate is very low. As a result, the R&D system in the sector is fraught with challenges. For example, the EU invests the most on pharmaceutical research and development (Greer, et al., 2014; European Commission, 2020). Downs & Velamuri (2018) accounted the rate is as 15 % revenue of the company. The study of Banerjee & Siebert (2017) and Cowrick et al. (2011) illustrate that at the early stage of a pharmaceutical company, it is tackled by high demand, profit, and technological uncertainties and improving the chances of completing drug development. R&D collaborations established later in the R&D phase are driven less by these delays and more by R&D funding scarcity. While Spain is an example of a country where R&D spending as a percentage of GDP is extremely low. With just 1% of GDP allocated to research and development, Spain ranks 24th out of 30 OECD member countries in terms of R&D investment Desmet et al., (2004). Furthermore, Sieg et al., (2019) investigated the managerial finance challenges companies face when working with an innovation intermediary to solve R&D problems. Researchers explore three managerial challenges (enlisting internal scientists to collaborate with the innovation intermediary, choosing the correct problems, and formulating problems in such a way that they can be solved). Magazzini et al. (2016) emphasized that there is a lack of access to knowledge from project portfolio managers about the effectiveness of different methods in choosing target markets, a lack of knowledge about project R&D costs, and how companies can completely contribute their failed research projects. Leten et al. (2011) added that pharmaceutical R&D investment is unpredictable due to a lack of portfolio management skills.

Table 2: Summary results for the challenges in EU pharmaceutical R&D.

<b>Author/s</b>	<b>Challenges in the Pharmaceutical Industry in the European Union</b>	<b>Focused issues</b>
(Brusoni & Geuna, 2003)	R&D	Absence of basic research in pharmaceutical studies
(Desmet et al., 2004)	R&D	Spain allocated only 1% of GDP to R&D and too little attention is paid to the R&D's actual execution or implementation.
(Leten et al., 2011)	R&D	Pharmaceutical R&D investment is unpredictable due to a lack of portfolio management skills.
(Cowrick et al., 2011)	R&D	Uncertainties and risks are particularly in the early stages of pharmaceutical development.
(Chaudhuri, 2013)	R&D	In the manufacturing process, generic pharmaceutical products face significant obstacles.
(Magazzini et al., 2016)	R&D	Project portfolio managers' lack of knowledge of the efficacy of various strategies.
(Banerjee & Siebert, 2017)	R&D	High uncertainty and low likelihood of success in passing pharma research phases and frequently having R&D funding scarcity.
(Downs & Velamuri, 2018)	R&D	The pharmaceutical spends around 15 % of the total revenue on research and development (R&D) in the world but considerable uncertainty in output.
(Sieg et al., 2019)	R&D	Managerial challenges companies face when working with an innovation intermediary to solve R&D problems.
(OECD, E.U. 2020)	R&D	High rate of investment in pharma industries in EU countries.
(European Commission, 2020; Greer, et al. 2014).	R&D	European pharmaceutical industry is a major contributor to the investment in innovation.

Source: Authors (2021).

Some studies have raised concerns about the use of R&D design in the pharmaceutical industry, such as Chaudhuri (2013) examined that generic pharmaceutical product production presents specific challenges, and businesses must develop a well-designed method to minimize development costs and time while maintaining product quality. (Desmet et al., 2004) used the detailed firm-level data, Spain's National Pharmaceutical Research Program focuses more on design than implementation. The result indicates that excessive attention might be paid to analysing the design's optimality or concerning more on the achievement of the objectives. At the same time, too little attention is paid to the design's actual execution or implementation. Even if the selection criteria are ideal, the plan will fail if it is not implemented correctly.

### ***3.3 Challenges in EU pharmaceutical alliances, health care system, and others***

There are other literatures concerning the alliances and outsourcing among pharmaceutical firms. Alliances among large and small firms are typical in the pharma industry and the advantages of outsourcing R&D include, such as the outsourcing company may have more experience, the business may have a labor shortage, outsourced R&D may be less costly, and it may mean a quicker time to market for a product or service (cited in Inc.com, 2009). Business leaders most often outsource R&D for component development, construction, new process innovation, new product innovation, and software design. The institutions that outsource R&D work to businesses are universities, government laboratories, independent R&D organizations, suppliers, and other companies. Kneller (2003) paper argued either a drug development process would be in house or at a university is a debate in the pharmaceutical production process. Howells et al. (2008) mentioned several obstacles to the agreement on alliances. Mukhtar (1996) paper suggested that technology-based small firms are dominated by large partner companies.

Table 3. Summary results for other challenges in EU pharmaceutical industry

<b>Author/s</b>	<b>Challenges in the Pharmaceutical Industry in the European Union</b>	<b>Focused issues</b>
(Mukhtar, 1996)	Outsourcing or alliances	Technology-Based Small Firms are dominated by large partner companies.
(Kneller, 2003)	Outsourcing or alliances	A drug discovery debate would be held in the house or at a university.
(Howells et al., 2008)	Outsourcing or alliances	The obstacles to outsourcing agreements
(Fernald et al., 2015)	Outsourcing or alliances	Not enough to compensate for a shortage of pharmaceutical innovation.
(Hu et al., 2017)	Outsourcing alliances	Fraught with challenges that frequently lead to project cancellations or delays in new drug production.
(Kousi et al., 2021)	Health Care System	The Greek health care system has suffered as a result of the economic downturn, the refugee crisis, and the Covid-19 outbreak.
(Rechel et al., 2013)	Health Care System	The demographic reasons like the aging of Europe's population poses additional problems to health, long-term care, and social systems.
Haseeb & Bashir, 2020)	Health Care System	Physicians and patients encounter challenges in receiving proper treatment.
(Sarkis, et Al. 2021)	Supply chain management	Emerging Challenges in Pharmaceutical Manufacturing and Distribution

Source: Authors (2021)

The Global Health Summit of G20 Nations at Rome (2021) addresses that in the sense of a sustainable and inclusive recovery, with investments in health, preparedness and response, and policies guided by scientific advice, coordinate pharmaceutical and nonpharmaceutical interventions and emergency response (including online coordination of crisis and operation centres). Policies can help to accelerate progress toward the SDGs, combat the root causes of health crises, such as social determinants of health, poverty, systemic injustice, and environmental degradation, develop human capital, accelerate green and digital

transformation, and boost prosperity for all. According to European Commission (2020), EU Pharma sector is facing several challenges, such as unavailability of innovative therapies or medicines to all EU patients, equally less efficiency in responding a crisis-resistant system, more ageing population with higher demand, the cost of medicine is often unbearable for patients and EU is increasingly dependent on Non-EU medicine and raw materials import. Due to the lack of a robust pharmaceutical business infrastructure, these problems became even more acute during the covid-19 pandemic. As a result, it is important for the EU pharmaceutical industry to look for any potential problems ahead of time. It is required to consider the weaknesses exposed by the covid-19 pandemic and challenges the pharma industry has before, and it needs to take appropriate actions to strengthen the system.

#### **4 Conclusion**

This study examined the role of challenges in the pharmaceutical industry in the context of European Union (EU). Our study reviewed 27 peer-reviewed articles on the relevant rare phenomenon. Interestingly, this study found numerous issues such as patent systems, R&D, healthcare systems, outsourcing and alliances, and supply chain management. Theoretically, this study contributes to the body of knowledge to address an imperative issue in the pharmaceutical industry, which is rarely researched in the context of EU. Practically, this study provides new useful insights to policymakers, global leaders, and managers to devise policies to achieve performance-oriented culture in their institutions and firms. Finally, this study suggests that future research may explore the challenges of multi-sectoral and cross-country perspectives to get a better understanding and for the long-term sustainability of public pharmaceutical spending, new models of enhancing research investments are needed, and the EU can still play a leading role in its tradition structure within capturing innovative ideas.

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## Supply Chain Resilience: Preliminary Results from a Systematic Literature Review

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### Abstract

Our study reviews scientific papers that have been published in high-quality journals on supply chain resilience (SCR) with regard to the latest developments registered in this field in the pre- and post-Covid-19 era. Adopting a rigorous method for review, i.e., systematic literature review (SLR), our work is a snapshot of the preliminary results of a broader analysis on the available literature on this topic. Although studies on SCR have been widespread for at least twenty years, our findings show that scholars' interest in SCR has been boosted by the pandemic period led by SARS-CoV-2, with publications on SCR nearly doubled in 2021 from the previous year. The preliminary thematic content analysis of our review showed three principal macro-pillars in SCR domain that are worth of further investigations. We also discuss what are, according to our review, the principal gaps in these sub-topics that offer avenues for future research. We ascertain that the main issue these three topics have in common is the fact that unitarian views of the phenomena are actually missing or very underexplored, while single-perspective studies are more frequent. Finally, conclusions and limitations of the study are discussed at the end of the paper.

**Keywords** – supply chain resilience, systematic literature review, supply chain disruption, business continuity

**Paper type** – Academic Research Paper

## 1 Introduction

After the beginning of Covid-19 pandemic, several organizations have faced the important challenge of improving the resilience of their global value and supply chain (GVSC) to optimize operations; to guarantee the quality of outputs and an omni-channel seamless management; to ensure the sustainability of processes; to redesign the supply network; to update knowledge and capabilities etc. (Ivanov, 2018; Ivanov and Dolgui, 2019; Rossi, 2019; Faggioni, 2019). Although supply chain resilience (SCR) is not a new term in the managerial lexicon (Christopher and Peck, 2004; Sheffi and Rice, 2005), it is undoubted that after the recent pandemic SCR has become one of the major issues for supply chain managers that are now extremely committed in searching solutions to guarantee high level of resiliency for their supply chains (Bak *et al.*, 2020). Over the years, several definitions have been addressed for SCR. For example, Christopher and Peck (2004, p. 2) pointed out that SCR is *"the ability of a system to return to its original state or move to a new, more desirable state after being disturbed"*. Ponomarov and Halcomb (2009, p. 131) defined SCR as *"the supply chain adaptation capability to prepare for unexpected events, respond to interruptions, and recover from them to maintain continuity of operations at the desired level of connection and control over the structure and function"*. In essence, SCR is seen by scholars as the capability of a company to guarantee a business continuity (BC) to its operations and activities, increasing its effectiveness in disruptions absorption and diminishing the time-to-recovery, i.e., the time necessary to recover after a disruptive negative event (Kamalahmadi and Parast, 2016). However, despite these general definitions, there is agreement among authors that current definitions of SCR are rather vague and may easily lead to misconceptions among practitioners and researchers; then, further literature reviews could be useful to better understand the nature and the characteristics of SCR (Katsaliaki *et al.*, 2021).

As said, to overcome the above-mentioned issues related to SCR field of research, we believe that a systematic literature review (SLR) of the current state-of-the-art is needed to shed more light on the topic. Even if we are aware that other review papers have been published in the last years, many of them are non-systematic reviews and/or are related to very specific firms/markets aspects (e.g., on SMEs, like in the valuable work of Bak *et al.*, 2021), while a more comprehensive and holistic view on this thematic is currently missing and

therefore needed. In addition, in the last two years Covid-19 pandemic has enhanced the importance of being resilient for GVSC, as it has been acknowledged as one of the most impactful disruption of the last decades (e.g., BCI, 2021). In fact, Covid-19 has not only led firms to a “new normal” to which they have necessarily adapt, but it will also have significant disruption tails for GVSC (Ivanov, 2021). The complexity of achieving resilience for GVSC lies also in the nature of the latter, as they switched from a “linear” configuration to a more “reticular” (i.e., network) one in the last decades, *“which advocate horizontal and vertical collaborations based on the interconnection of the existing logistics networks for sharing the logistics resources and services involved”* (Pan *et al.*, 2021, p. 1). These interoperability and interconnectivity transformations in GVSC networks, together with Covid-19 well-known consequences, are another strong rationale for our investigation and for choosing a specific and rigorous methodology such as the SLR. This is also due to the fact that pandemic is not over yet (i.e., in June 2021) and new worrying Covid-19-related issues are still threatening social and business environments (e.g., Delta coronavirus variant, that ECDC estimates to be the cause of the 90% of future Covid-19 contagions in Europe by the end of August 2021 – ECDC, 2021) (Pujawan and Bah, 2021). In essence, major disruptions like Covid-19 spreads their effects all over the GVSC interconnected network and causes a significant ripple effect (Ivanov *et al.*, 2014; 2021; Ho *et al.*, 2015; Faggioni, 2019; Katsaliaki *et al.*, 2021) all along the chain. This effect encouraged scholars and practitioners to make new and deeper efforts to understand how firms resilience strategies have changed in the pre- and post-Covid-19 era (Deloitte, 2020; Zhu *et al.*, 2020). To this end, with the preliminary results of our SLR we aim to achieve two major objectives:

1. Documenting, synthesising and summarising the existing research-informed studies in SCR research in the pre- and post-Covid-19 era (2018-2021);
2. Identifying those areas of SCR research which need scholars’ further development, as well as providing recommendations for future research.

The remainder of the paper is organized as follows. The second section discusses the adopted methodology and turns our research objectives into the form of specific research questions that we aim to satisfy. The third section is dedicated to the preliminary analysis of the findings emerged from the descriptive and thematic content analysis of the related papers, focusing on the

main sub-research fields and on the emerging research gaps. The last section discusses the findings of this study among with its limitations.

## 2 Methodology and research questions

To undertake the SLR we chose to conduct an extensive search on the principal management literature search engines to which we had access through our Institution. In particular, we used ScienceDirect, Emerald, EBSCO Business Source Complete, Google Scholar, and ResearchGate databases for our keyword search and to collect articles. The search began in February 2021 and ended on the end of May 2021 due to the deadline for full paper submission fixed by IFKAD 2021 Conference by the end of June 2021, in order to have at least one month to analyse our results.

For our analysis, we adopted the 7-stages approach proposed by Fan and Stevenson (2018), that consists in the following steps: *questions formulation, keyword search in identified databases, removal of duplicates, article quality and relevance assessment, capturing other relevant articles, full-text analysis, reporting*. We searched for articles published in high-quality journals from 2018 and 2021 (i.e., pre- and post-pandemic era) to compare how research on SCR has changed with the paradigm shift led by Covid-19 and to highlight what are the major themes and challenges that managers have to face to make their companies to survive and to gain new competitive advantages in this disruptive period of change. That said, our research questions are the following:

*RQ<sub>1</sub>: What is the state-of-the-art in SCR research and how have the scholars changed their approach to this topic after Covid-19 pandemic?*

*RQ<sub>2</sub>: What are the major gaps arising from the existing SCR literature and which areas of research should scholars address first?*

To define specific RQs is essential to provide valuable results from a SLR and "to enable the researcher both to map and to assess the existing intellectual territory, and to specify a research question to develop the existing body of knowledge further" (Tranfield et al., 2003, p. 208).

Regarding the keywords search phase, we followed the approach of Ho et al. (2015) that suggested to use broad terms to be sure not to miss relevant papers that may not being correctly indexed by the search engines. Thus, we used the following strings of research: "supply chain resilience", "supply chain" AND "resilience". After a first search that led us to find 2,355 articles for the selected

time span (2018-2021), we made an exception to our searching protocol including also papers founded by typing "business continuity" and "business resilience" as keywords as they are often used as synonyms for SCR. After this second search, 353 new papers were found. In total, we collected 2,708 scientific papers on the topic in the considered period. Then, all the papers have been analysed for a first screening by authors to remove all the duplicates and to understand, on the basis of the contents included in titles and abstracts of papers, if they were actually treating the topic of interest. After the screening, more than 50% of papers were excluded from the SLR because of their different scope or because their typologies were different from journals' articles (conference papers, working papers, thesis, PhD dissertations, books, managerial literature etc.). To address the quality of the remainder set of papers, we choose to include in the final set only papers published in journals with an impact factor (IF) higher than or equal to 2.66, as this value is considered a very good IF for "Business, Management, and Accounting" journal category according to Sci Journal (2018) ranking. This second screening resulted in a final set of 189 papers, that were consequently included in the review process to answer to the RQs.

The final set was subsequently analysed for the full-text analysis stage of research methodology, the results of which are then presented in the next section dedicated to findings in the form of a descriptive and thematic content analysis. Before we continue, we synthetize in Figure 1 (see next page) all the stages that composed our methodology to facilitate the understanding of the overall process.

### **3 Findings**

For reasons of space, findings are briefly presented in the following sub-paragraphs, as this article has the sole objective to show the preliminary results of a more extensive systematic and structured literature review.

#### **3.1 Descriptive analysis**

Descriptive analysis helps us to understand what are the general trends in literature on the focal topic of this paper. Out of the 189 analysed papers, 28 (14,8%) have been published in 2018, 41 (21,7%) in 2019, and 45 (23,8%) in 2020. Accordingly, papers published in 2021 are in total 75 (39,7%). As it is immediately clear, interest in SCR by scholars has increased by the years, with a significant acceleration in 2021. This is not surprisingly, as papers published in 2021 have

likely been submitted for review to scientific journals in 2020, i.e., the year of Covid-19 advent.

<p><b>1) RQs formulation</b></p> <p>RQ1: <i>What is the state-of-the-art in SCR research and how have the scholars changed their approach to this topic after Covid-19 pandemic?</i></p> <p>RQ2: <i>What are the major gaps arising from the existing SCR literature and which areas of research should scholars address first?</i></p>
<p><b>2) Keyword search 3) Removal of duplicates 4) Quality assessment</b></p> <p><i>Keywords:</i> «supply chain resilience» and «supply chain» AND «resilience»</p> <p><i>Additional search:</i> «business continuity» and «business resilience»</p> <p><i>Initial set of papers:</i> 2,708</p> <p><i>Inclusion criteria:</i> only papers published in journals with an IF higher or equal to 2.66 between 2018 and 2021</p>
<p><b>5) Capturing other relevant articles 6) Full-text analysis 7) Reporting</b></p> <p>After searching for other relevant papers, a final set of 189 papers has been chosen for full-text analysis, that will led to:</p> <ul style="list-style-type: none"> <li>- <i>Descriptive analysis</i></li> <li>- <i>Thematic content analysis</i></li> </ul>

*Figure 1: Synthetic overview of the 7-stages research methodology process*  
*Source: Self elaboration*

So, a quick look to this general trend partially answers to the first RQ, showing a significant growing interest from researchers for this topic after the beginning of the pandemic period if compared to the previous years, as shown in Figure 2 and in Figure 3.

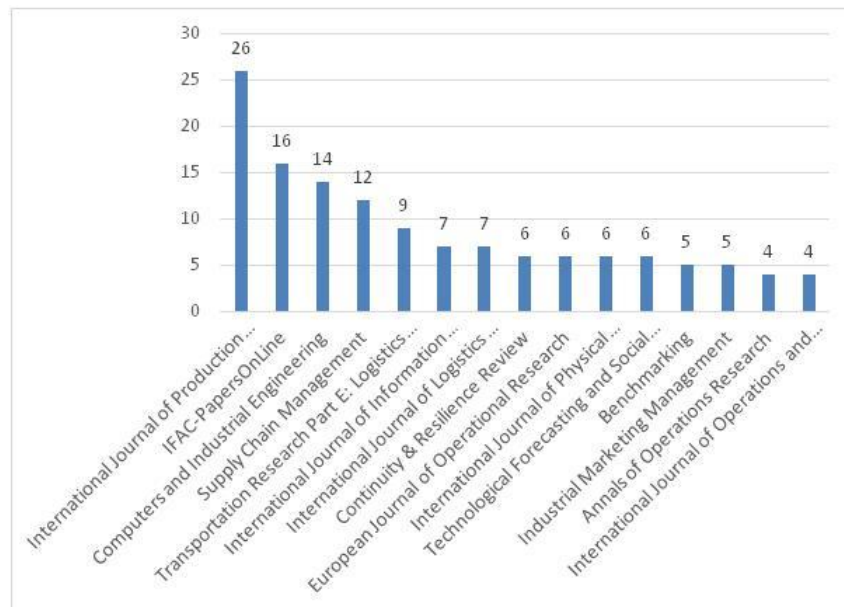


Figure 2: Number of articles by journal (first 15 journals by number of published papers on SCR between 2018 and 2021)  
Source: Self elaboration

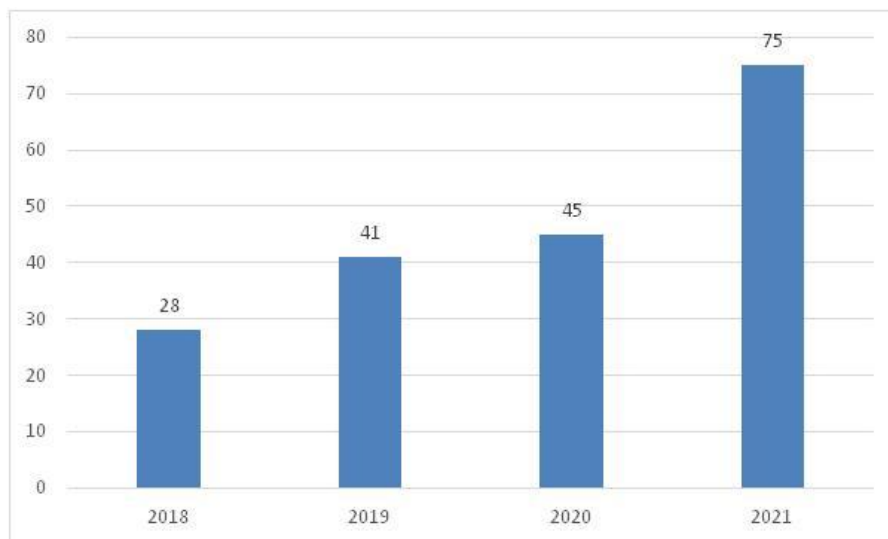


Figure 3: Number of articles by year  
Source: Self elaboration

With regard to the most studied industries in our final set of papers, we observed that the most investigated economic sectors are: Food (Ali *et al.*, 2018;



Hendry *et al.*, 2019; Kumar *et al.*, 2021), Automotive and Construction (Gupta *et al.*, 2020; Afraz *et al.*, 2021), Manufacturing and Service (Liu *et al.*, 2018; Belhadi *et al.*, 2021), Fashion and Luxury (Bin Makhashen *et al.*, 2020; Shen *et al.*, 2020; Hsu *et al.*, 2021). In 2021, we found in addition an increased number of publications concerning the SCR of the Vaccine industry, compared to the previous years (Sazvar *et al.*, 2021; Sinha *et al.*, 2021). This result confirms how the attention on SCR has been significantly influenced by Covid-19 pandemic.

Finally, the methodologies that have been used in our final set of papers are both theoretical and empirical, with 19 ( $\approx 10\%$ ) papers conducting systematic and non-systematic literature reviews (Karl *et al.*, 2018; Chowdhury *et al.*, 2021; Al Naimi *et al.*, 2021) and 170 ( $\approx 90\%$ ) empirical papers adopting qualitative, quantitative, and mixed-method approaches (Ali and Gölgeci, 2019; Ahmadian *et al.*, 2020; Gu *et al.*, 2021). It is notable that there is still a huge difference in terms of number between theoretical/review papers and empirical articles (notwithstanding the unquestionable growing interest from researchers both from theoretical and empirical side), confirming our statement in the introduction section in which we observed that deeper efforts from a theoretical/review perspective are currently needed in this field of research.

### **3.2 Thematic content analysis**

From thematic content analysis, we identified three macro-pillars that correspond to the main gaps and principal areas of investigation for future research, namely: *technology*, *risk management and metrics* and *sustainability*. In the remainder of the paragraph, we briefly analysed the main content for each of the pillar.

*Technology.* Technology is by far one of the main issues pointed out by scholars, as it is seen both as a tool to gain resilience (e.g., with the use of blockchain, additive manufacturing and digital twins technologies – Min, 2019; Nandi *et al.*, 2021; Verboeket and Krikke, 2019; Ivanov and Dolgui, 2019) and as an environment in which disruptions may come from either physical and virtual disruptions (e.g., cyber-attacks) (Colicchia *et al.*, 2019). This is a first useful insight since SCR is often treated only as a “physical” phenomenon, that may consequently be affected only by physical and material disruptions. In our review we saw that the “cyber-side” of SCR is very under-investigated, but the rapid

escalation of new digital technologies, artificial intelligence and other robotic innovations should lead researchers to do more in that direction.

*Risk management and metrics.* Significant research has been made by scholars in the field of risk management and metrics for SCR (Fan and Stevenson, 2018; Behzadi *et al.*, 2020). By our review we noted that many papers treated risk management from a single/specific viewpoint (i.e., they look at a specific risk/disruption occurrence and management) without integrate all the SC risk management stages, as remarked in the valuable study by Fan e Stevenson (2018). In this regard, we strongly encourage researchers to do more efforts in including more risk/disruption categories in their future empirical studies, both including physical and digital threats for supply chain (as said for the *technology* pillar). From the metrics point of view, there is a fervent stream of research that aim to understand metrics and KPI for resilience (Karl *et al.*, 2018; Behzadi *et al.*, 2020; Fattahi *et al.*, 2020) but still there is – to the best of our knowledge – an under-explored area of research that consists in identifying metrics capable to synthesize available “traditional” supply chain metrics (e.g., DOH, inventory velocity, warehousing costs etc.).

*Sustainability.* Sustainability, associated to SCR management, is considered a topical thematic by scholars (Nayeri *et al.*, 2021; Flores-Sigenza *et al.*, 2021). Sustainability has been treated by the lens of sustainable performance (Di Vaio and Varriale, 2019), sustainable production and procurement (Kaur *et al.*, 2018), and from ecological and green viewpoints (López and Ruiz-Benítez, 2020). This is the research area of the three above identified in which we found more articles in number and more comprehensive studies, also because, according to some currents of thought in academia, resilience is considered a driver for sustainability (e.g., in the LARG – lean, agile, resilient, green – paradigm, Raut *et al.*, 2020). Similarly to our conclusions on metrics pillar, we believe that further research in this domain must be focused on multi-actor and multi-sector perspectives, in order to verify if the general consensus about current theories in sustainability applied to SCR are sufficiently robust to be generalized regardless of the specific actor/sector of investigation.

#### **4 Conclusions and limitations**

This paper extends prior SCR research by arguing that this topic is an important, yet underexplored thematic in SCM domain and there is a need to

further understand this complex phenomenon especially after the Covid-19 pandemic. Our results showed, from a descriptive view, that scholars are doing significant efforts to better understand the nature and the characteristics of being resilient for a SC, but still there are some sub-domains that need to be addressed as soon as possible to respond to an eventual third wave of Covid-19, that is expected in the following months with the worrying escalation of Delta coronavirus variant contagions in Europe and in the West in general. We have synthesised these further areas of investigation in three macro-pillars (*technology, risk management and metrics, sustainability*), discussing what are, according to our review, the principal gaps in these sub-topics that offer avenues for future research, finding that the main issue these three topics have in common is the fact that unitarian views of the phenomena are actually missing or very under-explored, while single-perspective studies are more frequent in literature.

Limitations of this study can be attributed to its nature, not only because it is a mere theoretical study, but also because these are only the preliminary results of a broader and deeper analysis that we aim to continue in the following months. However, we are sure that scholars and practitioners can benefit from this study, finding tips, recommendations, and ideas to further develop academic and professional studies they conducted until now on SCR.

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## Role of Knowledge in Managerial Decision Making

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### Abstract

In modern-day organizations, managers are expected to rely on business analytics tools and models when making decisions. Business analytics related literature offers various business analytics related capability models that should help organizations to increase the role of data in managerial decision making. However, these models do not seem to take into consideration that the ultimate decision making accountability often lies in the hands of an individual manager, whose task is to select and combine various types of knowledge in order to understand the aspects of different types of decision-making situations, and to come into feasible conclusions in different contexts. To be able to better support their managers and to ensure they can realize the expected value of their business analytics investments, organizations should pay more attention to what kind of knowledge their individual managers use in decision-making situations, and how they use it. With the help of four initial propositions, this paper demonstrates the underlying reasons for individual managers to use various types of knowledge when making decisions, even when they are expected to make data-driven decisions supported by business analytics. Based on these initial propositions, further research ideas are suggested, to help increase the understanding on how different types of knowledge are affiliated into managerial decision making.

**Keywords** – decision making, knowledge management, business analytics

**Paper type** – Academic Research Paper

### 1 Introduction

Fast-paced development of increasingly efficient and effective digital technologies used by individuals and organizations has resulted in having more data available than ever before. For most organizations, it has become obvious to use data from various sources to gain deeper understanding of their external environments and internal operations and to make “data-driven” and “fact-based”



decisions to improve their performance. (Davenport and Harris, 2007; Hindle et al., 2020).

Business analytics is one of the toolsets applied by organizations to generate new knowledge and make better decisions (Pauleen and Wang, 2017; Kudyba, Fjermestad and Davenport, 2020; Lepenioti et al., 2020). The more the analytics capabilities have been developed, the more precise and holistic support the analytics models and tools have been able to provide for decision making; data and information derived with the help of business analytics can be used as input for purely human decisions or fully automated decisions, or for any combination of both. (Davenport, 2018; Lepenioti et al., 2020).

The actual value arising from analytics is often considered to be based on leveraging analytical capabilities that combine human and technological elements (Cosic, Shanks and Maynard, 2012; Gupta and George, 2016; Vidgen, Shaw and Grant, 2017). Through human interaction, also the knowledge created with the help of business analytics becomes embedded into organization's human, relational and structural capital that supports leveraging organization's other assets and resources and thereby forming unique capabilities that are a prerequisite for creating competitive advantage. (Grant, 1996; Spender, 1996; Marr, 2008; Handzig, 2017; Inkinen et al., 2017).

Business analytics related literature has addressed the role of managers as the drivers of business analytics strategies, listing various sets of common managerial capabilities that they should possess to utilize business analytics and to make data-driven decisions (Vidgen, Shaw and Grant, 2017; Chen and Nath, 2018). While organizations and their managers face different types of decisions (March, 1991a; Luoma, 2016), business analytics related capability models (Cosic, Shanks and Maynard, 2012; Gupta and George, 2016) mainly seem to suggest a list of generic capabilities that assumes similar role to business analytics in all managerial decisions

Also, business analytics related capability models seem to assume that all managers approach decision making in a similar manner. Even though managerial decisions are becoming increasingly data-driven, it should not be forgotten that – at least in the “western world” – the accountability for a particular decision often lies with an individual manager (Brown, 1999; Martinsons and Davison, 2007; Brown et al., 2019), and that – besides the data and information acquired with the help of business analytics – these individual managers use also other sources of knowledge, including their personal knowledge and accumulated experience in all

their activities (Gavetti and Levinthal, 2000; Argote and Miron-Spektor, 2011; Csaszar and Levinthal, 2015).

Knowledge in its different forms, originating from different sources is combined and exchanged as part of managerial decision making (Gray, 2001; Choo, 2016). Whereas analytical capabilities and data-driven decision making have been an area of interest for academic researchers in recent years (Mortensen et al., 2015; Hindle et al., 2020), research community seems to put less focus on how the knowledge derived with the help of business analytics interacts with other types of knowledge in decision-making situations, and how this knowledge is leveraged and further developed by managers when making decisions.

Exploring how individual managers acquire and use different types of knowledge when making decisions would help understand the manager's role in data-driven decision making in a modern-day context where decisions are increasingly relying on business analytics tools and models. With this kind of deeper understanding, the organizations could also offer more holistic support for their managers in various decision-making situations, and thereby find new ways to realize the value potential of business analytics.

Using previous literature on managerial decision making and business analytics, this paper establishes a high-level theoretical background for investigating how managers acquire and use different types of knowledge when making decisions. First, managerial decision making and the role of knowledge as part of managerial decision making are explained, and two initial propositions on using different types of knowledge in managerial decision making are made using previous research. After this, the role increasing of business analytics in decision making is discussed. Again, two initial propositions are made based on previous literature. Finally, conclusions are made regarding what has been previously discussed about the role of knowledge in supporting managerial decision making in the context of data-driven organization, and some suggestions for further research activities are introduced.

## **2 Decision making**

### ***2.1 Managerial decision making***

Competitive advantage of an organization depends on what kind of resources it possesses and how these resources are combined and used (Barney, 1991). To

find ways to generate competitive advantage, organizations are continuously required to sense and shape opportunities and threats, select and seize opportunities, and manage, transform, and reconfigure the tangible and intangible assets (Teece, 2007). Organizations have several alternatives they can pursue, and they must decide between these alternatives. Decision makers identify alternatives and approach decisions in terms of their existing resources, referred to as exploitation, or by exploring new possibilities, referred to as exploration, which may also require developing or acquiring new resources. (March, 1991a; Gavetti and Levinthal, 2000).

Organizations face decision making situations that involve exploitation, exploration, or both. Compared with exploitation that aims at identifying and evaluating decision alternatives in terms of the current resources and scope of the organization, exploration requires more effort, as it expands this search outside the organization's existing boundaries to identify new alternatives. As exploitation involves more clarity and certainty from the organization's perspective, it is often preferred at the cost of exploration in mapping strategic alternatives. (March, 1991a; Gavetti and Levinthal, 2000). Organizations can develop and improve their capabilities in terms of both exploitation of existing scope and resources and exploration of new alternatives (March, 1991a; Luoma, 2016).

Individuals working in organizations, including managers, have different decision-making accountabilities depending on their role (Floyd and Lane, 2000). Most managerial roles are involved in decisions regarding daily activities of the organization within the scope of existing resources, hence, exploitation-type of decisions. However, the more responsibilities the manager has, the more likely they are also involved in decision activities that include novel aspects, require exploring new alternatives or may even result in redefining the scope of the work for managers on other levels of the organization (Noda and Bower, 1996; Courtney, 2001).

Routine-type, repetitive decisions are sometimes referred to as "programmed", as they are relatively easy to define, and potential solutions are easily identifiable. Organizations can establish processes for making these decisions, and for example decision automation is based on this idea. (Simon and Norton, 1960; Choo, 1996; Davenport and Harris, 2005) However, organizations also face decisions that may include such a level of complexity as well as elements of uniqueness or novelty that they cannot be easily structured and can be viewed as "non-programmed". (Simon and Norton, 1960; Cyert and March, 1992; Courtney,

2001). Different types of decisions benefit from different types of approaches, and the tools, models and methods that are feasible for supporting routine decisions may differ from those needed for solving complex and somewhat unique problems. (Simon and Norton, 1960; Cyert and March, 1992; Luoma, 2016; Kunc and O'Brien, 2019).

In strategic management and operational research related literature, decision making involving non-programmed decisions is often described as problem-solving: when an event occurs (problem is identified), it is first analyzed to form an understanding of its quality, scope and context (classification, structuring and definition of the problem) before it can be thoroughly modelled and analyzed to identify potential solutions and to make recommendations for the decision. After the decisions are made, they are implemented, and the outcomes are monitored and evaluated. (Simon and Norton, 1960; Courtney, 2001; Krajewski, Ritzman and Malhotra, 2007). This kind of "problem-solving/decision-making" process is of an iterative nature and can utilize a quantitative or a qualitative approach, or a combination of both. (Simon and Norton, 1960; March, 1991a, 1991b; Cyert and March, 1992; Winter, 2003; Anderson et al., 2009).

## ***2.2 Role of knowledge in managerial decision making***

Knowledge as an organizational asset manifests through organization's human, relational and structural capital. It is essential for leveraging organization's other assets and resources for developing valuable and rare capabilities that are required for creating competitive advantage (Grant, 1996; Spender, 1996; Marr 2008; Handzig, 2017; Inkien et al., 2017).

The role of knowledge in "problem-solving/decision-making" activities is often linked to knowledge creation, learning and accumulating experience. As part of decision making, organizations utilize various knowledge assets within and outside the organization to support decision making (Courtney, 2001). Combining and exchanging knowledge creates new knowledge and intellectual capital for the organization (Nahapiet and Ghoshal, 1998). Individual managers contribute their knowledge into the "problem-solving/decision-making" process and use it to interpret and combine the new knowledge they receive in return. Managers also learn through this experience, and this experiential learning accumulates their knowledge. (March, 1991b; Nonaka, Toyama and Konno, 2000; Easterby-Smith and Prieto, 2008; Argote and Miron-Spektor, 2011).

Accumulated knowledge and experience are at the core of decision making situations involving exploitation of existing resources, as this approach mainly seeks for solutions among what already exists (Gavetti and Levinthal, 2000). As the scope and context are more familiar, experience accumulating through decision making may also bring a certain routine to such decisions (Luoma, 2016).

Exploration requires more forward-looking intelligence, including making new assumptions and connections based on beliefs rather than experience. This kind of cognitive search of solutions takes more time and effort than the search that relies on prior experience. (Gavetti and Levinthal, 2000). On the other hand, cognitive and forward-looking search may result in a larger variety of decision alternatives or even redefining the scope of the original decision. (Gavetti and Levinthal, 2000; Csaszar and Levinthal, 2015). From knowledge management perspective, exploration and exploitation seem to require somewhat different approaches regarding knowledge creation and utilization, as exploration assumes viewing the situation from a broader perspective than the exploitation (Gray, 2001). To summarize the role of knowledge in managerial decision making, Proposition 1 is presented:

*Proposition 1: When making decisions, managers use different types of knowledge in different ways depending on whether the problem-solving/decision-making process involves exploratory vs exploitative elements.*

In addition to different types of decisions, decision making research also discusses various aspects that may limit organizations from finding a satisfying solution for identified problems. These aspects vary from contextual/situational factors (e.g., availability of information, availability of time, complexity of the decision and its context) to cognitive and psychological factors that affect the decision makers' perception and behaviour (e.g., logic of appropriateness, absorptive capacity, temporal orders, and – in general - cognitive systems). (Simon and Norton, 1960; Tversky & Kahneman, 1986; Simon, 1987, March, 1991b; March, 1994; Raiffa, 2002; Kahneman, 2003).

Accumulated knowledge and experience may generate cognitive limitations for decision making. Prior experience and knowledge may help save time and make more realistic decisions, but the accumulated experience of both the individuals and the organizations also limits problem solving and decision making situations, as it tends to steer the identification of problems and search of potential solutions into areas that are already more familiar to decision-makers (March,

1991a; Ocasio, 1997; Gavetti and Levinthal, 2000). This kind of limiting aspect is present in decisions that require exploitation but also in decisions that require exploration: in both situations, decision makers tend to define the scope of the problem/decision based on their existing mental representations that result from their prior experience, and then search for the potential alternatives based on that scope, potentially leaving out those alternatives that do not fit into their understanding of the world (Csaszar & Levinthal, 2015). Based on this, the following can be proposed:

*Proposition 2: Managers' prior experience impacts on what kind of knowledge they use when making decisions, and how they use this knowledge.*

As discussed in this chapter, it seems that that managers face various types of decision-making situations that require using different types of knowledge, and managers themselves define what type of knowledge is needed when making decisions. While these two aspects address potential reasons for managers for using different types of knowledge in decision-making situations, also the potential role of business analytics needs to be considered in order to estimate its impact on the types of knowledge used by managers when making decisions.

### **3 Business analytics**

#### **3.1 Increasing role of business analytics in decision making**

Organizations have more data and more computing power available than ever before. Business analytics and analytical capabilities are considered an important source of competitiveness for organizations, and this view has been growing stronger as the use of analytics systems has increased in organizations (Vidgen, Shaw and Grant, 2017; Lepenioti et al., 2020). "Business analytics" or "analytics" refers to a combination of data (sometimes described as "big data"), analytical tools, and descriptive, predictive and prescriptive models that organizations use to support their decision-making and action planning (Hindle et al., 2020). The data used in business analytics can originate from various kinds of intra- and extra-organizational sources, and the tools and approaches for analyzing this data are mainly based on statistical or other mathematical methods, such as simulation, evolutionary computation, or machine learning. (Davenport and Harris, 2007; Vidgen, Shaw and Grant, 2017; Hindle et al., 2020)

Analytical methods and models have developed significantly in the past decade. The first implementations of business analytics were mostly based descriptive models, finding patterns from historical or current data to identify potential problems or opportunities. Since then, using statistical analytics, probabilistic modeling and machine learning to create predictive models to forecast alternative futures has become increasingly common. (Lepenioti et al., 2020). During the past years, the increased computing power together with the flexible cloud-based environments have enabled to take these models even further. This area of business analytics, prescriptive modeling, involves building “networks of models” that aim at creating decision recommendations by simulating various circumstances and potential events, and even how the logics between the elements within the network would be impacted in case some of the inputs, algorithms, or rules would be changed. In theory, prescriptive models would help organizations in making decisions already by predicting them before the need for decision making even arises. (Praseeda and Shivakumar, 2014; Van Rijmenam et al., 2019; Lepenioti et al., 2020).

As the role of business analytics in decision making increases, organizations are expected to become more “data-driven” and discontinue making decisions that cannot be backed up with data. Data-driven decision making is considered to outplay the more “traditional”, experience and expertise-based decision-making approach, as it offers a faster and more “fact-based” approach. (Van Rijmenam et al., 2019; Lepenioti et al., 2020). Increasing amount of decisions that were once considered to be non-programmed are benefitting from the increased availability of data, improved computational capacity and development analytics methods and models, to the extent that they can be extensively supported with decision automation (Davenport and Harris, 2005; Burkart, Robert and Hubert, 2021). Regarding those decisions that continue having more non-programmed nature in this new context, the amount and quality of methods and tools that can be used for simulating cognitive search of different decision alternatives, testing different scenarios, and evaluating their outcomes using different models and parameters has increased dramatically (Luoma, 2016; Lepenioti et al., 2020). The more experience the organization accumulates when it supports decision making with business analytics, the more it can leverage the value of analytics. (Davenport, 2018; Van Rijmenam et al., 2019; Lepenioti et al., 2020).

Organization’s ability to realize the value potential of business analytics is considered to depend on its ability to develop and establish analytical capabilities

that combine human and technological elements (Vidgen, Shaw and Grant, 2017; Chen & Nath, 2018). While technological and modeling capabilities help organizations to improve their data quality and to generate information based on this data, the various business analytics capability models also mention organization, culture, processes, people and business analytics strategy as crucial elements for realizing the potential value from analytics (Davenport and Harris, 2007; Cosic et al., 2012; Gupta and George, 2016; Lin, Kunnathur and Long, 2020). Based on this, it can be proposed that

*Proposition 3: The maturity level of organization's business analytics capabilities impacts on how managers balance the use of business analytics vs. other sources of knowledge their decision making.*

### **3.2 Limitations of data-driven decision making**

In business analytics literature, data-driven decision making and utilizing business analytics is often contrasted with human decision making that relies more on experience and intuition. Decision making is considered to be more rational and fact-based when it is supported by business analytics, as human decision making is limited by various aspects (as discussed in chapter 2.2.). (Van Rijmenam et al., 2019; Lepenioti et al., 2020). However, data-driven decision making also contains some limitations that deserve attention.

First, as in all decision making, also the success and quality of data-driven decision making depend on contextual factors, such as data and information available for the analysis, or the complexity of the decision (Simon, 1987; March, 1994; Vidgen, Shaw & Grant, 2017). Even though data processing capability of business analytics solutions may outplay human processing capabilities, these solutions are not necessarily able to pull together all possible data, information and knowledge that may be required for decision making. Trusting too much on business analytics solutions to process all the feasible data and information, and to do it with the "best possible" approach and algorithmic structure considering the decision at hand may bound decision-making processes and create a false impression that all the alternatives and their outcomes are covered within the process. (Pachidi and Huysman, 2018; Kunc and O'Brien, 2019).

Another factor impacting decision making are the cognitive limitations of decision makers (March, 1991b; Kahneman, 2003). While business analytics systems themselves lack certain human aspects, they are created and used by



people. Numerous human decisions are made constantly to choose between various alternatives regarding the implementation and use of each component of the business analytics capability. (Pauleen and Wang, 2017; Vidgen, Shaw and Grant, 2017). This means that the limitations embedded into human knowledge and capabilities are built into business analytics systems and models, and that these limitations impact on how they function and how they are used. (Simon and Newell, 1958; Simon, 1987).

Also, the more complex the decision, the more judgment is needed for defining what aspects should be considered and evaluated as part of the decision. Whereas an organization can utilize its existing knowledge, information and data to create a digital model of its existing business in terms of scope and resources and use this as a basis for evaluating different scenarios, more assumptions are required to be made regarding the analytics models, as the level of novelty and complexity of the decision making situation increases (Luoma, 2016).

Decision making responsibility does not lie with the analytics solution but rather with managers, and the role of business analytics in different decision-making situations needs to be decided by human decision makers. Hence, it is the individual decision maker who makes the final choice on how much they rely on the support from business analytics when making strategic decisions. (Kunc and O'Brien, 2019). This leads to the following proposition:

*Proposition 4: The level of complexity of the decision-making situation at hand impacts how managers balance the use of business analytics vs. other sources of knowledge when making decisions.*

Propositions 3 and 4 provide additional aspects on using different types of knowledge in managerial decision making, suggesting that business analytics capabilities and the nature of decision define how managers use different sources of knowledge. Next chapter discusses how these propositions, together with the other two other initial propositions, should be viewed in terms of the role of knowledge in managerial decision making, and how the research work should be continued.

## **4 Conclusions**

Knowledge exists within individuals and organizations, and organizations use knowledge from different intra- and extra-organizational sources when making decisions (Gray, 2001; Courtney, 2001). As part of this process as well as other

interaction the individual managers are engaged in, new knowledge is created (Cook and Brown, 1999; Nonaka et al., 2000; Easterby-Smith and Prieto, 2008).

Business analytics is one of the tools to help organizations generate new knowledge (Pauleen & Wang, 2017; Kudyba, Fjermestad and Davenport, 2020). Organizations can use this knowledge to make more data-driven decisions that help them generate more business value. To realize this value, organizations need to build adequate business analytics related capabilities (Hindle et al., 2020).

In business analytics literature, the role of decision-making managers has mainly been discussed in terms of analytics capabilities they should possess in order to make data-driven decisions and to create business analytics strategies (Vidgen, Shaw and Grant, 2017; Chen and Nath, 2018). These capabilities are mainly described on generic level, assuming similar roles to all managers and making no difference between different types of decisions (Cosic, Shanks and Maynard, 2012; Gupta and George, 2016). However, individual managers face various types of decisions that require different types of approach and knowledge (March, 1991a; Gavetti and Levinthal, 2000).

Based on previous literature, this paper introduces four initial propositions that discuss the potential factors that may impact on how individual managers use different types of knowledge in decision making situations. It is proposed that the nature of the decision at hand as well as individual manager's prior experience impact on what kind of knowledge they use and how they use it in decision-making situations (Propositions 1 and 2). Additionally, it is proposed that the business analytics capabilities that are available for managers and the complexity of the decision at hand impact on how managers balance the use of business analytics vs. other sources of knowledge when making decisions (Propositions 3 and 4).

While the four initial propositions serve as indicators about the presence of different types of knowledge in managerial decision making, combining previous research from different fields, mainly knowledge management, operational research, and business analytics requires more analysis than what has been prepared for this paper. A structured literature review should be conducted to further detail the theoretical background and the initial propositions presented here.

Also, the four initial propositions discuss the potential contextual factors that may impact on how different types of knowledge are affiliated in managerial decision making. However, they do not provide much clarification on what kind of

knowledge managers use when making decisions, and how they use it. Thereby, further research is also required to develop deeper understanding on how individual managers approach data, information, and knowledge as part of their decision-making activities.

Future research should investigate decision-making in the context of data-driven organizations by answering the research question [RQ]: "How are different types of knowledge affiliated to managerial decision making?". This question should be supported by two relatively wide sub-questions. The first sub-question [SQ1] should be answered to create a connection between different types of knowledge and managerial decision making: "What kind of knowledge managers use when making decisions?". The second sub-question [SQ2] is required to form a deeper understanding on the role of knowledge as part of decision making processes and practices: "How do managers use different types of knowledge when making decisions?"

Besides more in-depth theoretical research, empirical investigation would support testing the research assumptions and propositions in practice and developing deeper understanding on how managers themselves would describe the role of knowledge in various decision making situations.

Theoretical contribution of such future research would include building bridges between three different fields: knowledge management, operational research, and business analytics. It should also aim at providing additional understanding of the role of different types of knowledge in a data-driven context and offering new insight into the role of human actor, in this case, the manager, in various decision making situations. Using the results of such research, also individual organizations could better understand how to realize the value potential of their decision making capabilities and how to ensure business analytics capabilities become an essential component within their intellectual capital.

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## **Managing Change: Exploring Knowledge Sharing Barriers and Channels among NHS Hospital Estates and Facilities Management Departments**

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### **Abstract**

Hospital providers are facing unprecedented challenges such as ambitious sustainability targets while remaining resilient to adverse events, e.g. COVID-19. However, instead of leveraging the collective knowledge of all UK National Health Service (NHS) hospital providers, Hospital Estates and Facilities Management (HEFM) departments have to resort to using their own resources to find guidance and innovative solutions to their safety-critical infrastructure issues.

This exploratory study draws upon academic studies from four domains: the institutional complexity of public healthcare systems, facilities management (FM), the ability to effectively manage change and inter-organisational knowledge sharing (KS). Various studies have stressed the lack of effective KS among NHS HEFM departments. However, so far, research studies exploring KS barriers and channels have either focused on KS among clinical disciplines or on FM organisations unaffected by the complexity of healthcare systems. Therefore, this paper develops a theoretical framework illustrating the underlying concepts and addresses the following question: What KS barriers and channels exist among NHS HEFM departments?

Due to the complexity of the UK healthcare system, a complete understanding of the environment is needed before being able to understand the system itself. A systems approach is adopted, utilising mixed methods to study the dysfunctions of the existing system by understanding the interactions on multiple levels and identifying barriers to KS. The research incorporates a thorough review and analysis of the literature and 12 exploratory qualitative interviews with healthcare stakeholders and academic experts.

The findings uncover a multitude of barriers throughout the KS process. Continuous structural reorganisations of the NHS, silo-thinking, inter-hospital competition, a lack of

investment in professional development and additional complexities due to different ownership and service outsourcing models create a challenging environment for effective inter-organisational KS. Regarding KS channels, the NHS is still lacking a holistic strategy through which different types of documented and undocumented knowledge can be shared.

**Keywords** – Knowledge sharing, NHS hospitals, Facilities management, Managing change

**Paper type** – Academic Research Paper

## 1 Introduction

Hospitals are facing unprecedented challenges as the COVID-19 pandemic threatens the capacity and resilience of the workforce and infrastructure. However, the current pandemic is only one of many demanding challenges for the healthcare sector. Others include new care models, continuous economic burdens and a net-zero carbon target by 2040 which are forcing hospitals to operate resource-efficiently while preserving resilience to adverse events. In the recent publication of the UK report *Delivering a "Net Zero" National Health Service*, the NHS ambitiously sets the goal to be the world's first carbon-neutral health system by 2040 (Jennings and Rao, 2020), requiring a "wide range of interventions focused on air conditioning and cooling, ventilation [...]" (NHS England and Improvement, 2020). Additionally, the COVID-19 pandemic uncovered capacity limits – as seen with the medical oxygen infrastructure (Booth and Campbell, 2020) – and complex challenges such as virus transmission routes in hospitals necessitating process adaptations.

Hospital estates and facilities management (HEFM) departments are responsible for maintaining safety-critical infrastructure and essential support services. Therefore, HEFM departments need to be able to manage changes – regardless of whether they are caused by external stressors or internal initiatives. Successes and failures are valuable experiences in the process of managing change. However, rather than only passively accumulating experience, HEFM staff need to derive lessons learned which can be shared with other HEFM departments facing similar challenges. Hence, effective knowledge sharing (KS) activities across the NHS are required (AHSN Network, 2019). However, currently, individual HEFM departments have to resort to using their own resources to find guidance and innovative solutions to their safety-critical infrastructure issues.



Hence, this paper aims to explore the role of KS among NHS HEFM departments in enhancing the ability to manage changes faced by hospitals.

The paper is structured as follows. Firstly, we explore relevant literature domains, illustrate key concepts in a theoretical framework, and summarise findings from previous research studies. Then, we review the methods that were used to collect, analyse, and present data for the research. Finally, we present and discuss the collected data in light of previous studies and conclude by outlining academic and practical contributions, acknowledging the limitations of this study and highlighting further research opportunities.

## **2 Literature review**

This research is positioned within four areas of knowledge: complexity of public healthcare systems, facilities management, managing change and knowledge sharing.

### ***2.1 Complexity of healthcare systems***

To provide a common understanding of health systems, the WHO published a framework that identifies six building blocks: (i) health workforce; (ii) information systems; (iii) technologies and infrastructure; (iv) service delivery; (v) leadership and governance; and (vi) financing. The four major system goals are improved health and health equity, responsiveness, social and financial risk protection, and improved efficiency (World Health Organization, 2007). Most European countries face the challenge of unsustainable healthcare systems, with health expenditures growing faster than national incomes and hospitals being pushed towards operating at their maximum capacity (Jovanović et al., 2020). Similarly, the UK NHS – as a tax-funded organisation – is suffering from continuous cost and rising efficiency pressures (Lafond et al., 2016; NHS England, 2015).

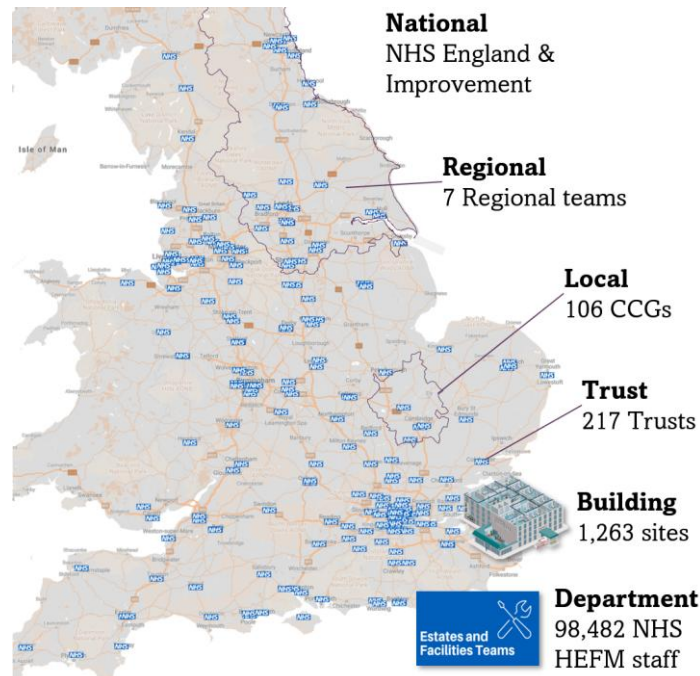


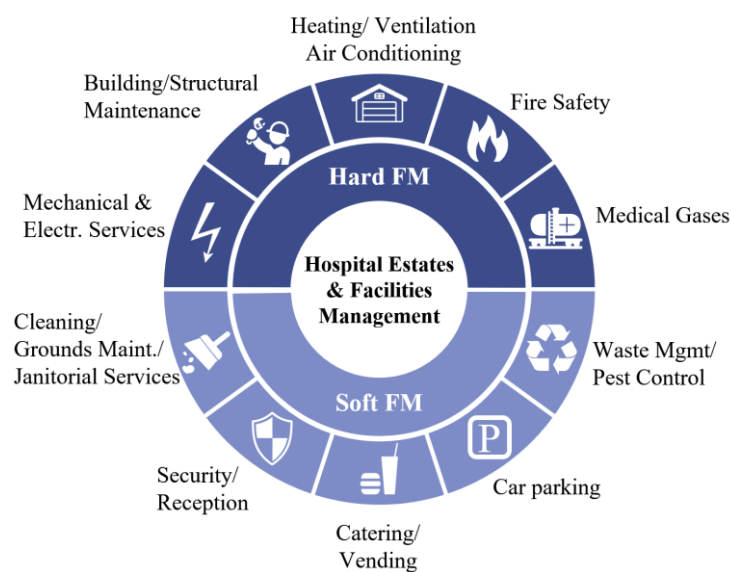
Figure 1: System levels in NHS secondary hospital landscape (Data and hospital locations from NHS ERIC return 2019/20)

The NHS consists of primary (e.g. general practices (GPs)), secondary (hospitalised patient care), and tertiary (specialised medical centres) care. Secondary care hospitals are geographically dispersed and also have a significant variety of organisational structures. Although the common goal of high-quality patient care unites the entire healthcare system, multiple system levels (as visible in *Figure 1*) and varying degrees of freedom to respond to local obligations depending on the organisational type (Auschra, 2018) cause the NHS to act as a group of organisations with their own interests – displaying characteristics of a pluralistic organisation (May, 2018). Hence, knowledge flows among NHS hospitals are less straightforward than one might expect in a single-payer healthcare system.

## 2.2 Estates and facilities management

Alexander (1996) describes FM as the process by which an organisation integrates multi-disciplinary activities within the built environment and the management of their impact on people and the workplace. FM departments

ensure that their buildings, systems and services support the core operations and processes, contributing to organisations' strategic objectives in changing conditions. Thus, FM involves both strategic and operational considerations there as well as multiple disciplines that can be categorised into hard (management and maintenance of property and infrastructure) and soft (management of support services) FM (*Figure 2*).



*Figure 2: Multi-disciplinary services in HEFM departments*

The nature of hospitals requires HEFM to operate buildings safely 24/7. Hence, HEFM departments have to respond to challenges in the environment promptly. To respond to such challenges, staff can use official NHS documents such as Health Technical Memoranda (explained in more detail in section 4.2.1) or they can draw on experience from similar situations in the past. However, if neither of these strategies succeeds, HEFM workers need to tap into the experience of fellow HEFM workers. Hence, knowledge needs to flow across organisational boundaries effectively, especially when considering the risks involved in ensuring patient safety at all times. The policies in many hospitals require HEFM departments to ensure that services are provided based on national best practice (Portsmouth Hospitals NHS Trust, 2019). However, previous studies have highlighted that KS among NHS Trusts is very limited (Barlow et al., 2009).

Furthermore, while the lack of inter-organisational communication is often stressed, only poor attempts to “remedy the situation” (Pathirage et al., 2008) are evident such that Nutt suggested, that the KS “may be the most underutilised tool in FM” (2000).

### **2.3 Managing change**

The terms resilience and sustainability have both gained widespread attention over recent decades. The sustainability concept originated from the Club of Rome’s *The Limits to Growth* (Meadows et al., 1972) which stressed the limits of economic growth, while the resilience concept emerged as a descriptive paradigm for analysing disturbance and change in the ecology domain (Zanotti et al., 2020). Both concepts have been interpreted in multiple ways, depending on the domain and the ultimate purpose, e.g. different answers to questions such as ‘of what’ and ‘to what’. Applications of this can be seen in the disaster resilience literature (Tiernan et al., 2019) or the triple-bottom-line sustainability equivalence in business literature (Elkington, 1999). While both concepts lack terminological clarity, some scholars regard this absence of clarity as a strength since it allows for a shared vocabulary across interdisciplinary spaces (Purvis et al., 2019). In the context of complex adaptive systems, sustainability is described as a process by which a system mitigates changes to maintain resources above normative levels, whereas resilience is a process by which a system adapts to changes by building capacities to return to the desired state (Lew et al., 2016). Blanchet et al. (2017) proclaim the need to combine and integrate different forms of knowledge to react to changing environments. Thus, both concepts include the need to manage changes through the application of knowledge.

### **2.4 Knowledge sharing across organisational boundaries**

Davenport and Prusak describe knowledge as “a fluid mix of framed experience, values, contextual information, and expert insight [which] [...] often becomes embedded not only in documents or repositories, but also in organisational routines, process is, practises and norms” (1998). Knowledge can be categorised in various ways such as codified and non-codified knowledge. Well-known works have framed the terms explicit and tacit knowledge (Nonaka, 1994; Polanyi, 1966). Explicit knowledge is “what can be embodied in a code or a

language and as a consequence it can be verbalized and communicated, processed, transmitted and stored relatively easily”, whereas tacit knowledge is rooted in our experiences and is difficult to express and transfer to another person since we are unaware of it and how it could be useful to others (Nonaka et al., 2000).

However, epistemological studies argue that tacit knowledge is developed through practice and is so deeply rooted in human beings that it cannot be shared, as it is by its very nature hidden and inexpressible (Athens and Tsoukas, 2003). Powell and Ambrosini (2012) build on this epistemological issue and adopt the terms documented and undocumented knowledge, as it provides “distance from the confusion over the tacit-explicit knowledge dichotomy”. Documented knowledge is a direct analogue to explicit knowledge, whereas undocumented knowledge is “simply knowledge that has not been written down, which can be articulated in a discussion or documented at a later time” (Powell and Ambrosini, 2012).

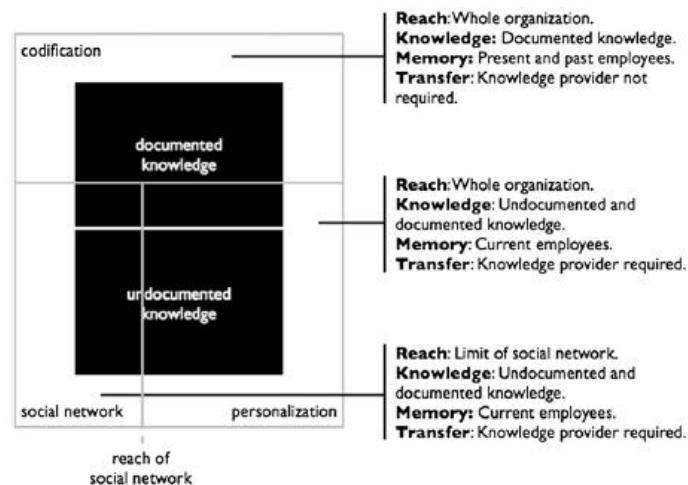


Figure 3: Knowledge sharing strategies (Powell and Ambrosini, 2012)

As visible in *Figure 3*, there are three mechanisms through which documented and undocumented knowledge can be shared (Powell and Ambrosini, 2012). Without any formal KS approaches, external knowledge is accessed via social networks, through which staff reach out to contacts within teams and other organisational units. To overcome the limited reach of social networks,

personalisation techniques can facilitate the efficient identification and use of the 'best' organisational knowledge. Another KS strategy is to codify undocumented knowledge and collect relevant documents in repositories in which knowledge can be systematically searched and accessed without the need to contact the knowledge source. However, especially when using IT systems, there can be significant resistance from HEFM staff as it might feel like the codification process adds yet another task to a system lacking necessary resources (Karam et al., 2018).

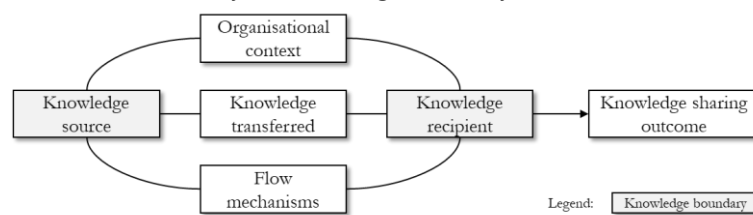


Figure 4: Adapted CHAT framework to analyse knowledge flow (Amended from Lin et al., 2008)

The effectiveness of KS activities is influenced by various factors throughout the process. To explore the underlying complexity of human behaviour involved in KS, the cultural-historical activity theory (CHAT) model provides a practical framework (Lin et al., 2008). It focuses on the relationship between knowledge source and recipient, as well as the nature of the knowledge transferred and the organisational and knowledge flow context as visible in Figure 4.

## 2.5 Literature summary and theoretical framework

The review of the relevant literature domains introduced the relevant literature domains and underlined the importance of effective KS for HEFM departments facing sustainability and resilience challenges. The theoretical framework in Figure 5 provides a common understanding of relevant concepts, capturing links between them. Although the framework is a simplified model of the complex healthcare reality, it is a useful tool to convey the theoretical assumptions of this research. The framework consists of four major sections: (i) building blocks, (ii) activities, principles, mechanisms, (iii) impacts, and (iv) changes.

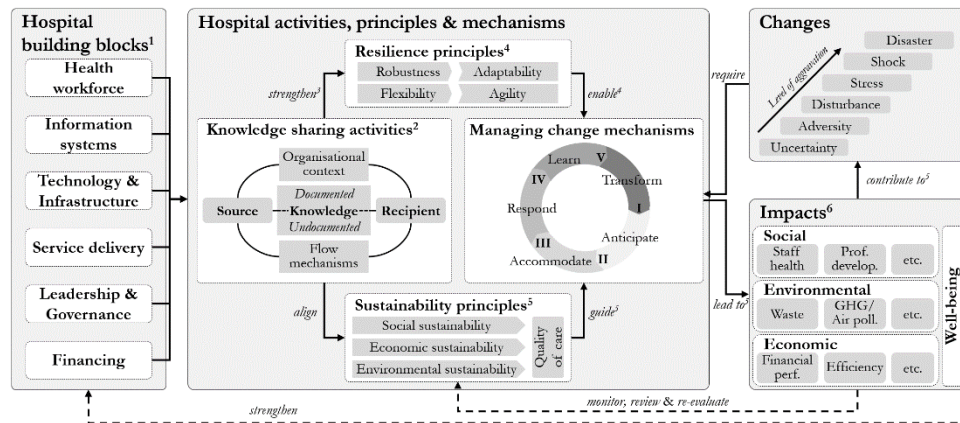


Figure 5: Theoretical framework connecting reviewed literature domains and concepts  
<sup>1</sup>WHO, 2010; <sup>2</sup>Amended from Lin, Tan, and Chang, 2008; Powell and Ambrosini, 2012;  
<sup>3</sup>Blanchet et al., 2017; <sup>4</sup>Fricke and Schulz, 1999; <sup>5</sup>Marmot, 2010; <sup>6</sup>Buffoli et al., 2013)

Firstly, the six building blocks represent essential inputs for the hospital system, such as workforce and financing (World Health Organization, 2007). Although there are limitations of the WHO model when analysing dynamic, complex and interlinked systems for applied research, its simplicity provides a common understanding and language for researchers (Mounier-Jack et al., 2014). All of these inputs contribute to organisational activities, principles and mechanisms. For example, the organisation of the healthcare provider landscape – belonging to the “service delivery” building block – significantly influences KS practices (Kim et al., 2012).

Secondly, the organisational activities, principles and mechanisms are illustrated in the centre of the framework. There are a great variety of organisational activities related to managing changes, e.g. risk management, leadership for change or technology management. However, since KS activities are the focal point of this research, the CHAT model, adapted to distinguish between documented and undocumented knowledge, is used to demonstrate knowledge flows from a source to a recipient within or across organisational boundaries. These KS activities strengthen the resilience principles (Blanchet et al., 2017), outlined in Table 1.

Table 1: Resilience principles as formulated by (Fricke and Schulz, 2005)

<b>Resilience principles</b>	<b>Definition</b>
<b>Robustness</b>	Capability to deliver intended functionality under varying operating conditions without being changed.
<b>Adaptability</b>	Capability to adapt itself towards changing environments to deliver its intended functionality. Robustness is a prerequisite to achieve adaptability. Change from external is required.
<b>Flexibility</b>	Property of a system to be changed easily without undesired effects.
<b>Agility</b>	Property of a system to implement necessary changes rapidly. Flexibility is a prerequisite to achieve agility. Change from external is required.

Sustainability principles integrate normative values with organisational processes. Balancing these social, environmental, and economic sustainability principles as well as providing high quality-of-care are increasingly recognised and integrated into organisational objectives of hospitals. These sustainability principles, which are described by numerous terminologies or normative statements, guide organisational mechanisms in hospitals (Buffoli et al., 2013; Marmot, 2010). The mechanisms of managing change are divided into five stages: anticipate, accommodate, respond, learn, and transform. These terms capture the most commonly described actions, systems can take when exposed to changes, as confirmed in a recent scoping review on resilience by Fridell et al. (2019).

Thirdly, hospital operations have social, environmental, and economic impacts and also affect the well-being of staff and patients. These broader categories of impacts can be broken down into a multitude of criteria and measurable indicators, as proposed by Buffoli et al. (2013) in their hospital sustainability evaluation tool.

Fourthly, multiple studies have found that healthcare systems can contribute to environmental changes (Lenzen et al., 2020) as well as social and economic inequalities (Marmot, 2010; Serapioni, 2017). These changes – differing in their frequencies, likelihoods, lead times, durations, etc. – can affect hospital systems and require mechanisms to manage those changes. There are external stressors, e.g. natural disasters or financial pressures, as well as internal changes, e.g. initiatives to decarbonise operational activities or demographic shifts in the workforce.



## 2.6 Research gap and collection of barriers and channels identified in the literature

Various studies have stressed the lack of effective KS among NHS HEFM departments (Kothari et al., 2011). However, so far, research studies have either focused on KS among clinical disciplines or FM organisations operating outside the complexity of healthcare systems (McCracken and Edwards, 2017; Pathirage et al., 2008). To enhance the understanding of effective KS among HEFM departments, this paper addresses the following question: What KS barriers and channels exist among NHS HEFM departments?

To build on already undertaken research, the literature on healthcare and FM was thoroughly reviewed and analysed for KS channels and barriers.

Table 2 summarises different KS channels. For documented knowledge, codification strategies such as guidance documents and library services provide effective storage tools, while newsletters, bulletins or blog posts provide effective ways by which to disseminate topical knowledge (Adeyemi and Olla, 2020). For undocumented knowledge, there are various mechanisms – such as communities of practices and action learning – beyond informal social networks. These channels enable individuals to share undocumented knowledge of value in the same or different HEFM disciplines (Kothari et al., 2011).

Table 2: Channels for different KS strategies (Adeyemi and Olla, 2020; Kothari et al., 2011; Pathirage et al., 2008)

Strategies	Codification	Social Network	Personalisation
<b>Channels</b>	<ul style="list-style-type: none"> <li>▪ Guidance/ Technical Manuals/ Reports</li> <li>▪ Intranet</li> <li>▪ Library Services</li> <li>▪ Newsletter/ Bulletin boards/ Blog</li> </ul>	<ul style="list-style-type: none"> <li>▪ Informal networks within organisations</li> </ul>	<ul style="list-style-type: none"> <li>▪ Communities of Practice</li> <li>▪ Brainstorming</li> <li>▪ Action learning</li> <li>▪ Post project reviews</li> <li>▪ Discussion groups</li> <li>▪ Expert directory</li> </ul>

Similarly, a list of KS barriers from previous studies was collected and structured according to knowledge boundary (source and recipient), knowledge transferred, organisational context and knowledge flow mechanisms as visible in Table 3. For boundary-related barriers, sub-categories of leadership, operational staff and culture were created to provide more structure.

Table 3: Collection of identified KS barriers in the FM and healthcare literature

Structure	Barriers
Boundary	<b>Leadership</b>
	<ul style="list-style-type: none"> <li>▪ Lack of adequate knowledge among FM managers (Baaki et al., 2016)</li> <li>▪ Leadership programmes for collaborative behaviour are required (Hailey et al., 2017)</li> </ul>
	<b>Operational staff</b>
	<ul style="list-style-type: none"> <li>▪ Lack of awareness of tacit knowledge in operational &amp; middle management workers (Pathirage et al., 2008)</li> <li>▪ Pre-existing expertise required (Kothari et al., 2011; Naylor, 2017)</li> <li>▪ Education of staff about sustainable FM practices (Baaki et al., 2016)</li> <li>▪ Lack of trust in other people's knowledge (Adeyemi and Olla, 2020)</li> <li>▪ Fear for loss of hegemony (Lin et al., 2008)</li> <li>▪ Reliance on techn. manuals, documents and intranets due to limited social networks due to lack of professional development (Pathirage et al., 2008; Wetherill et al., 2007)</li> </ul>
Knowledge transferred	<b>Culture</b>
	<ul style="list-style-type: none"> <li>▪ Unopen to KS (Adeyemi and Olla, 2020; Kothari et al., 2011)</li> <li>▪ Punitive environments (Kim et al., 2012; Waring et al., 2013)</li> <li>▪ Risk aversion of HEFM staff (Barlow et al., 2009)</li> <li>▪ Lack of motivation &amp; "asking why" thinking (Kothari et al., 2011)</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Immobility (tacitness) of knowledge (Lin et al., 2008; Nonaka, 1994)</li> <li>▪ Explicit &amp; tacit knowledge of staff not effectively used in standards (Puddy et al., 2001)</li> <li>▪ Some knowledge types are difficult to share with external peer groups (Pathirage et al., 2008)</li> <li>▪ Information overload (Kothari et al., 2011)</li> </ul>
	<ul style="list-style-type: none"> <li>▪ In- &amp; outsourcing of services (Currie et al., 2007; Yousefli et al., 2017)</li> <li>▪ PFI ownership model affects capital spending (Barlow et al., 2009; May, 2018)</li> </ul>
Organisational context	<ul style="list-style-type: none"> <li>▪ Partly low degree of autonomy &amp; support for HEFM (May, 2018)</li> <li>▪ Benchmarking/ competitive pressures (Agostini et al., 2020; Currie et al., 2007)</li> <li>▪ Lack of overarching Estates strategy (Naylor, 2017)</li> <li>▪ Critical knowledge is often siloed and at risk of getting lost (British Standards Institute, 2018)</li> </ul>
Flow mechanisms	<ul style="list-style-type: none"> <li>▪ Top-down communication approach only useful to pass down information, not knowledge (Kothari et al., 2011; May et al., 2006)</li> <li>▪ Bureaucratic procedures (Adeyemi and Olla, 2020)</li> <li>▪ Lack of formalised collaboration &amp; professional role clarification (Adeyemi and Olla, 2020; Karam et al., 2018)</li> <li>▪ Relevant knowledge is fragmented in various documents (Wetherill et al., 2007)</li> </ul>

### 3 Research design, data collection and analysis

To address the research question, a deep understanding of the complex healthcare system – described as a “tangled web of interdependencies” (Becker and Carthey, 2007) – is required. Due to this, many issues in healthcare systems are systemic and rarely caused by any one single factor (Loosemore et al., 2012). To explore this complex system consisting of people, resources, processes and institutions, a systems approach is required to enable a holistic understanding of all system elements and their interrelationships.

A thorough literature review investigated the existing literature and built an understanding of the existing concepts as well as KS barriers and channels. This literature review was further informed through exploratory, qualitative interviews with stakeholders, including HEFM operational staff, managers and directors, NHS England & Improvement staff, and academic experts as visible in

*Table 4.*

Table 4: Overview of conducted interviews with NHS and external stakeholders

#	Interviewee Code	Company	Job level	Interview Date
1	NHS1	NHS Trust	HEFM Manager	10.02.2021
2	NHS2	NHS Trust	HEFM Manager	10.02.2021
3	NHSE/I1	NHS England/Improvement	Top Management	19.02.2021
4	Academia1	University Researcher	PhD	23.02.2021
5	NHE/I2	NHS England/Improvement	Top Management	25.02.2021
6	Contractor1	Sustainability Consultancy	Top Management	26.02.2021
7	Prof. Body1	Top Management	HEFM Professional	26.03.2021
8	Academia2	University Researcher	PhD	04.03.2021
9	Academia3	University Researcher	Professor	25.03.2021
10	NHS3	NHS Trust	Carbon & Energy Manager	26.03.2021
11	NHS4	NHS Trust	Energy & Sustainability Manager	14.04.2021
12	NHSE/I3	NHS England/Improvement	Top Management	07.06.2021

The primary qualitative data was analysed following a two-step process of structural and axial coding using the coding software Nvivo. The first iteration of coding identified and summarised themes relevant to the identified research questions in coding nodes. Then, the second coding iteration was performed to identify previously overlooked passages. Lastly, axial coding was performed to

find overarching categories and themes. Each theme contained multiple codes, was analysed by comparing interviewee quotes, and then interpreted in the context of existing literature.

## **4 Findings and Discussion**

In this section, the data from the exploratory interviews (indicated through the use of *Italics*) is discussed in light of the barriers and channels already identified in the literature, as summarised in *Table 3* and

*Table 2.*

### **4.1 Barriers to KS**

#### **4.1.1 Boundary**

The interviewees mentioned already well-known barriers in the wider KS literature. These included the 'knowledge is power' issue (Lin et al., 2008), with one interviewee stating that "for more hand-on staff retaining knowledge about the systems [...] provides job security". Another barrier mentioned by interviewees was the lack of pre-existing expertise, since operational workers have "nobody invest in [their] education or professional development for 20 years", as already identified by (Kothari et al., 2011; Naylor, 2017).

A factor that has not been identified in previous HEFM studies is that the career pathways and educational background of Estates Managers and Directors have changed. While "15 years ago, we encountered Estates Managers who had worked in the Trust for a decade [...] and really knew their building and understood all of the properties [...], the next generation of Estates Managers" seems to have more of a management background and "probably a lot less knowledge" about the buildings. Although Baaki et al. (2016) previously identified the lack of adequate knowledge among facilities managers as a barrier to KS, the findings from the data provide a possible root cause for the lack of expertise. Furthermore, HEFM Managers and Directors are "forever moving between organisations [so] it is a constant churn of resource [...] and therefore decisions made at a high level are often lost in the midst of time". Another interviewee described that different "personalities of [...] managers" also lead "to a massive disengagement between the workforce and management" in some Trusts.

#### 4.1.2 *Knowledge transferred*

Despite previous studies pointing at tacit knowledge as the focal point of KS barriers (Lin et al., 2008; Puddy et al., 2001), interviewees predominantly mentioned knowledge types of which people are mostly well aware, namely successes and failures: “We find people doing really great things and they've never told anybody. [...] So sometimes we are our own worst enemy.” One interviewee mentioned that this could be a cause for “a lot of examples of really not understanding the building type and doing very silly things”. However, as another interviewee described, “sometimes people don't want to be held up as being the poor example of anything.” This is particularly interesting, as the causes for not sharing successes and failures could be rooted in specific leadership styles, potentially creating punitive environments as identified by Kim et al. (2012).

#### 4.1.3 *Organisational context*

With regard to organisational context barriers, four major topics emerged from the data. Firstly, the fragmentation of the healthcare system was highlighted, with “every organisation [being] so siloed” that it “feels like every hospital makes it up as they go along [and] they are captains of their own ships”. Secondly, many hospitals have buildings that were financed through private finance initiatives (PFI), and hence have external stakeholders that have “got full control of buildings”. This presents additional barriers in the pursuit of sustainability initiatives since – according to one interviewee – external PFI investors can tell the Trust management: “you've made this commitment to zero carbon. If you want to do that project, it's going to cost you this”. In addition, many hospitals outsource some or all HEFM services to external contractors. As a result, these external contractors sometimes do not have access to internal NHS knowledge sharing tools such as the Collaboration Hub (explained in section 4.2.1). Outsourcing of services also leads to a loss of knowledge about the respective HEFM discipline so that Estates departments' personnel “often don't have the expertise in many areas”. These issues have also been identified in previous studies (Barlow et al., 2009; Yousefli et al., 2017).

Thirdly, already identified issues regarding competitive pressures among NHS Trusts through Trust-level benchmarking were observed. The “degree of competition [...] means [HEFM departments] tend to hold things a little bit closer to their chest, rather than sharing quite so freely in some respects”. Since

knowledge sharing involves complex human interaction, “it’s a tall order to [...] expect today’s leaders to re-engineer their mindsets away from the last 30 years’ emphasis on competition and towards collaboration” (Hailey et al., 2017). Fourthly, the political standings of HEFM departments vary among Trusts. There are “Estates directors sitting on the boards in some trusts, but no means all of the trusts”, and since “Estates departments fight over budget with the medical departments, there is this enormous power struggle going on”. Hence, the varying degrees of autonomy and support for HEFM create greatly varying political environments for HEFM departments in different NHS Trusts as observed by May (2018).

#### *4.1.4 Knowledge flow mechanisms*

Regarding flow mechanisms, two barriers emerge from the data. For top-down knowledge flows from the central NHS body – NHS England and Improvement (NHSE/I) – there are very long approval processes for standard operating procedures. Hence, official guidance such as ‘Health Technical Memoranda’ are only updated once every 5-10 years and more topical issues such as urgent oxygen capacity issues during COVID-19 require long bureaucratic processes to publish, as identified by (Adeyemi and Olla, 2020). Hence, top-down communication only proves useful to pass down information (Kothari et al., 2011; May et al., 2006) and relevant knowledge becomes fragmented in various documents (Wetherill et al., 2007) and is often outdated.

Furthermore, multiple reorganisations of the NHS have led to the loss of forums where HEFM managers could “speak to each other”. Previously, HEFM managers “met regularly every three months and shared knowledge between [themselves], [...] and how [they] could help each other [...]. That no longer exists.” Since another interviewee described that there is not “anyone in the Trust who would be able to advise” on issues regarding system efficiency, the lack of opportunities to discuss such challenges with peer groups across organisational boundaries is alarming.

## **4.2 KS channels**

### *4.2.1 Codification*

The NHS has multiple strategies by which to disseminate codified knowledge among NHS Trusts. Firstly, NHSE/I disseminates guidance documents. These

consist of Health Building Memoranda (HBNs) and Health Technical Memoranda (HTMs). However, as seen in Figure 6, these are only reviewed and published after long approval processes over the course of many years. Hence, even though the guidance documents are useful to provide a good understanding of buildings, they do not prove helpful when facing complex challenges regarding the resilience or sustainability of buildings.

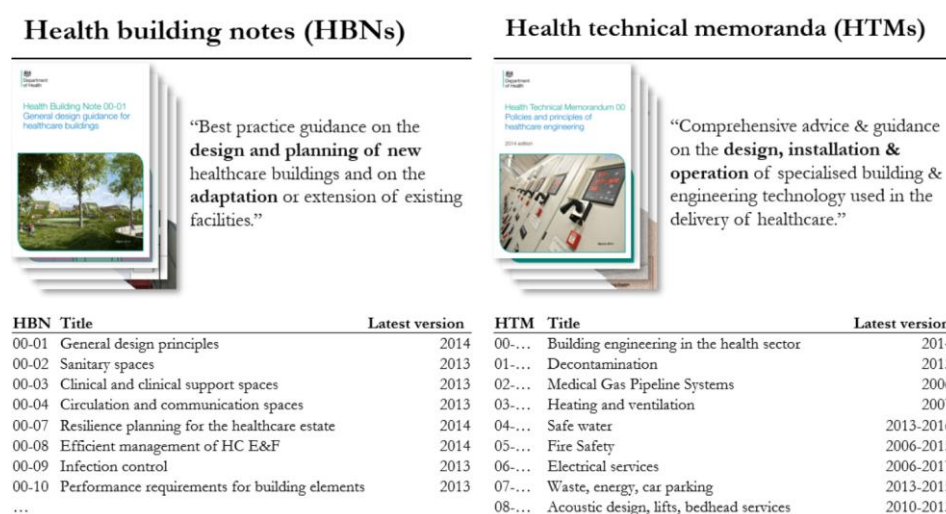


Figure 6: Overview of official guidance documents for HEFM  
(Source: UK Department of Health Website)

Furthermore, NHSE/I has created an online 'National Estates Team Collaboration Hub' to which only NHS HEFM staff have access. The Collaboration was initially *“just a place for key documents around the Carter efficiency program”*. Within the Hub, different channels such as 'Hard FM Hub' or 'Soft FM Hub' and sub-channels such as 'Electrical' or 'Fire' provide central locations for important documents. Furthermore, discussion channels allow users to ask questions and receive answers from their peer groups. However, as one Estates Manager interviewee stated, *“the Collaboration Hub isn't used because it isn't timely and you get lost in the chats”*, whereas another interviewee describes it as a *“self-help environment”* for day-to-day questions rather than a channel for sharing domain-specific knowledge. As a result, the Collaboration Hub currently has *“relatively little interaction”*.

#### 4.2.2 *Social Networks*

As discussed in section 4.1.1, HEFM Managers and Directors are appointed to different Trusts relatively often and can therefore build extensive social networks. As Pathirage et al. (2008) point out, HEFM Managers and Directors also have more opportunities to attend professional development programmes in which they can meet with their peer group and extend their social networks. In contrast, operational-level staff do not have the same social network reach, as they are provided with fewer opportunities to attend professional development programmes. Nevertheless, multiple interviewees reported that there seems to be “a reluctance to talk to each other [...] even between Trusts that are just 30 miles apart”. Therefore, it appears that currently social networks of HEFM staff are both limited in reach and not effectively utilised.

#### 4.2.3 *Personalisation*

NHS Estates – the former arm’s length body and executive agency representing the Department of Health – was responsible had a central role in disseminating knowledge and fostering collaboration among NHS Trusts (May, 2018). However, after its abolishment in 2004, these KS mechanisms were essentially lost. One academic interviewee mentioned that HEFM Directors who had participated in previous research studies mentioned “that they missed interacting with each other on hospital-level” after the abolishment of NHS Estates. Some KS mechanisms were then taken over by external professional bodies, e.g. the Health Estates and Facilities Management Association (HEFMA). These are membership bodies, within which members can meet regularly to discuss topics of interest. Moreover, some of the bodies publish guidelines such as ‘A Healthcare Engineering Roadmap for Delivering Net Zero Carbon’ by various bodies including HEFMA. However, due to the membership model, the reach of these networks is inherently limited.

In addition, there are various formal and informal networks on more regional bases. As visible in *Figure 1*, the NHS Figure 1 is made up of 106 Clinical Commissioning Groups (CCGs), each combining multiple local Trusts. As part of the change of regional structures towards Integrated Care Systems (ICS), various CCGs have already been converted into ICSs. Moreover, there are so-called Strategic Transformation Partnerships (STPs) which also combine healthcare stakeholders in different regions. However, as the organisational structures have



changed multiple times in past years and the groups also include stakeholders such as GPs or social-care providers, KS concerning hospital infrastructure is limited. Multiple interviewees reported, that these groups meet irregularly and are often unsuitable for their requirements, so that multiple informal networks in specialist HEFM domains were formed driven by the lack of formal KS channels during COVID-19.

## 5 Conclusions

This paper has sought to explore the question: What KS barriers and channels exist among NHS HEFM departments? To address this question, primary data in the form of 12 exploratory interviews was collected and analysed in light of previously identified barriers and channels in the literature. In

Table 5, a summary of key insights is presented.

Table 5: Key take-aways from exploring KS barriers and channels among HEFM departments

KS structure	Barriers
<b>Boundary</b>	<ul style="list-style-type: none"> <li>▪ Different educational background of HEFM Managers/Directors</li> <li>▪ Disengagement between management &amp; staff</li> </ul>
<b>Knowledge transferred</b>	<ul style="list-style-type: none"> <li>▪ Lack of sharing successes &amp; failures</li> </ul>
<b>Organisational context</b>	<ul style="list-style-type: none"> <li>▪ Complexities through different ownership and service outsourcing models</li> <li>▪ Inter-Trust competition</li> <li>▪ Board representation of Estates Managers</li> </ul>
<b>KS Mechanism</b>	<ul style="list-style-type: none"> <li>▪ Long approval processes for official guidance</li> <li>▪ Frequent reorganisations lead to loss of KS structures</li> </ul>
KS mechanisms	Channels
<b>Codification</b>	<ul style="list-style-type: none"> <li>▪ Long &amp; bureaucratic procedures for guidance documents</li> <li>▪ Use of Collaboration Hub still limited</li> </ul>
<b>Social Network</b>	<ul style="list-style-type: none"> <li>▪ Limited reach &amp; reluctance to reach out</li> </ul>
<b>Personalisation</b>	<ul style="list-style-type: none"> <li>▪ Various informal KS channels but without consistent</li> </ul>

The academic contribution of this research lies in enhancing the understanding of KS in complex systems with multiple stakeholders and constraining factors.

While clinical, evidence-based KS is a topic of frequent interest for researchers, no studies have so far focused on KS in the area of HEFM.

The healthcare sector can also greatly benefit from the research. While some ad-hoc COVID-19 responses and structures will soon disappear, learning from disasters is critical for addressing future social and environmental shocks. Hence, observing what is working and what is not working is very important. Therefore, the identified barriers in this research can inform policy and decision-makers in enhancing the conditions for effective KS. Effective knowledge flows can then improve the economic and environmental performance of the healthcare system while preserving resilience to adverse events.

### **5.1 Limitations and further research**

Firstly, only 12 interviews were conducted, which is inadequate to reflect the vast complexity and uniqueness of the NHS hospital landscape. However, for the exploratory nature of this study, the number of interviews was deemed sufficient to enable an initial understanding of the dysfunctions of the system. Due to the ongoing COVID-19 pandemic, interviewees experienced greater time pressures and in-person interviews were not possible. Therefore, no face-to-face interviews nor on-site observations could be conducted.

This exploratory study uncovered previously unknown barriers and channels in the HEFM landscape which enhance the understanding of the complex healthcare system environment. Building on this, further research could analyse the following questions in more detail:

1. To what extent can disparities in managing challenges during COVID-19 be explained by different levels of knowledge sharing among HEFM departments?
2. What format is required to effectively capture the experience of the knowledge source and meet the requirements (time, pre-existing knowledge, etc.) of a wide range of HEFM recipients?

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## Diversity Beliefs and Diversity Climate: Potentials for Organizations? The Case of Germany

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### Abstract

Should managers be more trained in the topic of diversity? Must they develop specific skills and competences? Which strengths and weaknesses regarding diversity management do managers have? A qualitative investigation tried to answer these questions. Around 70 interviews with managers and employees of large DAX companies were conducted. It could be shown that there are tensions between self-perception and perception of others and the assessment of the significance of diversity attitudes and measures, competences, and their actual implementation. These findings suggest that there is the need to train competences, in particular intercultural competence.

**Keywords-** migration, diversity potentials, intercultural competence, human resource management

**Paper type** – Academic research Paper

### 1 Introduction

Diversity has become more and more important in Germany and in other European countries due to increased European integration and globalization. People from different cultures are interacting daily nowadays, whereas this was a very rare situation in the past (Fantini. 2009). While immigration postpones the ageing-process in (especially western) societies (Eurostat, 2017) and offers great

chances for the economy (Franken, 2015), cultural diversity also constitutes risks. Consequently, a strong interest of society and economy regarding diversity management has risen. Over 2.600 organisations signed the Diversity charter of German companies, committing to the aims of reducing discrimination and supporting inclusion. On the contrary, when looking at the national cross-section of organisations in Germany, approximately two thirds of the organisations are not actively implementing diversity management (KFW Research, 2017). People with migration backgrounds still face discrimination in several contexts, although they carry important potentials for organisations and societies.

Research has shown that in order to utilize the potential of diversity successfully, organisations need to promote diversity actively, especially for women, people with a migration background and older employees in Germany (Fuchs and Dörfler, 2005). This process requires sensitivity and competence towards diversity by managers and employees. Managers have the role to share a diversity strategy with the employees and to be an example in living openness and fairness. In a comprehensive article Martins (2020) describes the role of leaders in the diversity management process as twofold: framing a diversity vision and symbolizing the value of diversity in words and action. To fulfil this role, managers need to have a strong believe that diversity constitutes an advantage to their company, as well as a clear perception of what diversity means in the context of their company. Who is in which way diverse and to whom is diversity important, as well as whether there are inequalities and discrimination in their company. Based on this knowledge managers are ought to share their attitudes and behaviours with employees and thus shape the companies' culture towards diversity (Franken, 2015). However, there is little research on the perspectives of managers and employees on the specific challenges, risks and chances connected to diversity. The question remains, in how far managers are able to perceive diversity related issues within their company, the same way employees see them. The current study thus aims to explore and compare the subjective theories of managers and employers of big German companies in a qualitative study design.

## **2 Review**

*Diversity* refers to the diversity of people in companies (Becker, 2006) and the main attributes and differences of individuals (Mayer et al., 2018). This includes obvious, barely perceived, and salient characteristics like age, religion, sexual



orientation, cultural values as well as slowly and less obviously changing characters like language, competences and values (Genkova and Ringeisen, 2017). In 2015, approximately 4.7 million migrants immigrated to the EU, whereby 2.4 million of those came from third-world countries. Germany, the United Kingdom, France, Spain, and Italy showed the highest level of immigration. Around 35.1 million people born outside of Europe live in the EU. Inside the EU, 19.3 million people migrated (Eurostat, 2017). Of those, Romanian, Polish, Italian, Portuguese and English people made up the five biggest groups of EU-citizens who immigrated to another EU-state (Eurostat, 2017). Thus, European organizations are confronted with an increasing cultural diversity of the society, accompanied by the aging of western societies and an increasing attention towards gender diversity and equality. Consequently, age, gender, and cultural background are the most important and most considered dimensions of Diversity in Germany (Genkova and Ringeisen, 2017).

Diversity management intends to adapt the values, attitudes and behaviors of organization and working groups in a more diverse direction and integrate the concept of diversity into organizations (Ashikali and Groeneveld, 2015). To achieve successful diversity management, employees and their heterogeneity must be appreciated (Vedder, 2011). Regardless of their cultural individual characteristics, all employees should be treated fairly, and it should be possible for them to use their skills freely without any norms and prejudices (Vedder, 2011).

In general, research tries to find and give proof that diversity management has positive effects on the success of organizations. Nonetheless, findings strongly depend on specific circumstances (like leadership, organizational culture, employees attitudes, e.g., Genkova and Ringeisen, 2017). In practice, there are many motivations and normative convictions to integrate diversity in an organizational strategy and culture (Ely and Thomas, 2001; Jansen, Otten and Van der Zee, 2015). Studies show that organizations who do not use diversity management are confronted with negative consequences and weaken others and themselves. In research it was found that that even though diversity comes with many advantages, it can also be the reason why conflicts and contra productive behavior like discrimination and group-think arise (Kersting and Ott, 2016).

In past research, stress, physical and psychological health concerning migration have been looked at from a discrimination and fairness perspective (Eggert and Flynn, 2013). The burden of migration is high because of ineffective coping

behaviour and stressors that appeared (Eggert and Flynn, 2013). The well-being of people with a migration background can be influenced by discrimination, stress events and social isolation (Bozorgmehr and Razum, 2015). Organizations, not only individuals, can cause discrimination by having structures and processes that make it difficult for migrants to get access to the labor market and to work in the field of their key qualification. This phenomenon is called structural discrimination. To counteract this, structural integration, that can support people with an immigration background to work in their key qualification, is needed. Signs of structural discrimination can be seen in most organizations. Consequently, people who have an immigration background are less strong on the labor market, in comparison to people without an immigration background. Their foreign degrees are often not recognized, so that they are not allowed to work in the field of their qualification (Badura et al., 2010). Research has found that there is a negative relation between psychological integration and education. Consequently, immigrants with a high education surrender from the host society (De Vroom and Verkuyten, 2015). The "Glass ceiling effect" deals with gender and discrimination. People with an immigration background are more severely affected by it because frustration and disappointed career expectations lead to a negative view of the host society. In the current, fast changing world, people without an immigration background also feel stress as they must change their habitual, socially established perspectives. This stress is one of the main causes for intergroup hostility. Consequently, persons with and without an immigration background must adapt to changing points of view and unfamiliar methods (Van Assche et al., 2018).

Besides preventing such negative effects of diversity, it is becoming more and more important to find out which positive effects diversity management brings for organizations. Diversity can indeed have an enriching effect on companies and individuals, provided that the given degree of diversity within the group is worshiped and utilized (Page, 2007). Studies have shown that people, who think positively of diversity, believe that multicultural groups are better. They also tend to identify themselves more with the group (Van Dick et al., 2008). Wagner et al., (2008) have shown that people who believe that migrants are an enrichment have more contact with them and show less racism than those who do not share this belief. Stegmann (2011) demonstrated similar results in his Meta-Analysis and further showed that pro-diversity beliefs and a positive diversity culture contribute to valuable results for groups and individuals and increase job

performance. Similar results have been obtained for age diversity. In a meta-analysis by Finkelstein et al. (1995) it could be shown that younger people tend to estimate the development potential of older employees as small. Meanwhile, they considered older employees as reliable. Older team members show the advantage that they have experience and routine in e.g., cooperation with long-term customers, only if they feel worshiped and accepted (Wei and Lau, 2012). Also cultural and gender diversity only has a positive effect on team performance, if team members appreciate the given degree of diversity. Therefore, the diversity attitudes of colleagues and especially leaders are important.

The satisfaction, health and performance of employees is influenced by their leaders (Franken, 2015). Managers are key figures when integrating diversity management (Wildermuth and Gray, 2005). Leaders in a high position design the diversity strategy for the company and the middle management implements it. In this process, heterogeneity becomes obvious as managers are responsible for the success of diversity management and support diversity competences as well as reducing discriminating structures and individual behaviours (Thomas, 1990; Martins, 2020). Thereby, leaders must convince their employees of the importance of diversity (Dreas and Rastetter, 2016). In practice, leaders use different roles and many of them struggle with their role model function and performance pressure (Franken, 2015). While managers are ought to demonstrate openness and acceptance towards diversity theoretically, there is little research on the perspectives of managers and employees on the specific challenges, risks and chances connected to diversity. In order to actually implement diversity, leaders need to perceive the organization-specific aspects of diversity and assess challenges and chances realistically. This also means to assess the perspectives and hassles of employees with and without diverse characteristics. The current study thus aims to explore and compare the subjective theories of managers and employers of big German companies in a qualitative study design.

### **3 Method**

In order to investigate the perspectives and perceptions of employees and managers on diversity, 63 qualitative telephone interviews were conducted. The participants were asked about the issue of equal opportunities, especially equal opportunities of persons with an immigration background and elderly employees. To answer the leading questions, following hypotheses were set up:

*Explorative hypothesis: Managers and employees assess the need of diversity actions as equivalent.*

Quantitative hypotheses: Hypothesis 1: Managers and employees differentiate regarding the expression of the stress level of employees with and without an immigration background.

*Hypothesis 2: Managers and employees differentiate regarding the forms of the subjective assessment of the social competence.*

The method of a qualitative interview was used, because practice-relevant and scientific results of diversity, especially cultural diversity, and age diversity regarding managers, rarely exist. The study design makes it possible to show the relationships and backgrounds of the topic of diversity and the challenges of the Human Resource Management from the point of view of managers and human resource managers. In addition, it is possible to find out about diversity potentials and obstacles concerning the equal opportunities of people with an immigration background and ageing people. A structured interview guideline was used. With qualitative interviews, non-considered aspects can be found to derive new conclusions. Here, the focus is especially on diversity measures and competencies that lead to success (Mayer, 2013). Also, it is investigated to what extent stress has an impact on employees with and without an immigration background. Standardised interviews are deductive, theory-based and increase comparability of the data (Mayer, 2013).

Open and closed questions were asked. For example: "How stressed are employees with an immigration background in your company at the moment, in your opinion?". Closed questions were answered with a 5-Point Likert Scale (1= not at all stressed until 5 = very stressed). The use of both open and closed questions makes it possible to find out about the individual views of participants and to compare the interviews among each other.

The quantitative content analyses by Mayring (2015) were used to analyse the interviews. The elements of the data were counted and compared in their frequency with other elements using Excel (Mayring, 2015).

The sample consisted of 17 managers and 13 human resource managers. 17 of them were male and 13 female. 15 of the questioned employees did not have an immigration background and 18 employees had an immigration background. 20 of them were female and 13 male. The average age of the managers was  $M = 40.83$  years ( $N = 29$ ;  $SD = 9.30$ ). The average age of the employees was  $M = 35.48$  years ( $N = 33$ ;  $SD = 9.99$ ).

## 4 Results

The explorative hypothesis is that managers and employees both consider the need of diversity actions equivalently high. Findings reveal that managers and employees assessed the diversity quotas highly, e.g., quota of women and migrants. Yet, these quotas are usually not legally consolidated and there is a subjective lack of official guidelines. Managers claimed that such quotas exist and are also implemented in organisations as internal orientations. Further measures implemented are having a diversity department, an equal opportunities officer and a diversity representative.

Many diversity measures in Germany consider gender diversity. Managers listed various measures, e.g., language courses, trainings, and exchange programmes or culture trainings that help to implement diversity in organisations.

Recruiters stated that "individual intercultural competence trainings are offered for employees who would like to deal with intercultural competences and to analyse their own intercultural competence". These trainings included e. g. issues like "How to recruit internationally?" Which aims at the intercultural difference at the recruiting. Further issues are "anti-prejudice [...] or emotional competencies." Contrarily, employees expressed that they did not notice any diversity measures at all. Employees who had an immigration background viewed the implementation of diversity actions as insufficient and were unsatisfied. Most of the diversity measures taken concerned its communication in organisations through on- and offline platforms, diversity departments and diversity committees. Both interviewed groups stated that there are offers of diversity trainings in organisations.

As most of the interviewed employees work in companies belonging to the Diversity Charta of German companies (Charta der Vielfalt and Ernst and Young GmbH, 2016) they have diversity implemented in the strategy of their companies. Employees emphasized that for them, one's own professional development and the equal treatment at the personnel selection was important. They mentioned that for a greater diversity it would be good to implement that "Anonymous applications will not be asserted. [...] Those, who have employee responsibilities and make personnel selections, should do diversity competence training. They must reflect themselves, if they are poised to hire someone, who is different from them. [...] I think that is actually the question and has to be answered by the human resource managers: Am I ready to hire somebody, who is different than I?"

Following the statements of employees, also a form of benefit analysis can be helpful “[...] which hide the background of people as good as possible. So therefore, only the professional skills, social competence and media competences are measured without being influenced by the appearance of the person, e. g. gender etc.”

Openness and cultural interest were very important to all participants. Tolerance and self-reflection were also important, followed by intercultural competence, cultural knowledge, and awareness. Both, employees with and without a migration background listed up more competences and differentiated stronger regarding the promotion of intercultural competence. This finding is similar to previous results.

Managers said that in the future, diversity competence will be important, but for now, they did not see it as important. They attributed externally. Managers believed that risk tolerance is an important factor regarding diversity competence. They furthermore mentioned emotional stability, intercultural flexibility, social identity, intercultural anti-prejudice as well as sensitisation for cultural differences. Employees, on the other hand, mentioned empathy and openness, social competence, self-reflection, cultural knowledge, and tolerance.

In previous research it became clear that a change of perspective and exchange of experiences are stronger predictors for intercultural decision-making (e.g., Genkova and Ringeisen, 2017). Change of perspective is a stronger predictor than empathy. Risk tolerance is not considered relevant for diversity and increasing intercultural competence. Managers view diversity as a threat and their level of stress was as high as they are seen as multipliers for diversity (see Table 1).

Table 1: Importance of Diversity

<b>Managers/ Human Resource Managers</b>	<b>Employees with and without an immigration background</b>
Seriousness and urgency of diversity is not clearly recognized.	Seriousness and urgency of diversity is not clearly recognized by employees without an immigration background
Incorrect assessment of the stress of migrants	Good assessment of the stress level of migrants by employees without an immigration background
No consideration of the stress level of migrants in the day-to-day management	Risk to see diversity as a problem

Managers as well as employees believe that diversity measures are important. The Findings of this study show that employees are more confronted with diversity, based on the number of mentions and differentiation. A possible explanation for this might be that employees face more diverse situations in their daily life and work than managers. It became obvious that there was a difference between how managers and employees perceive themselves and the outside. Both groups see more need for diversity measures for the other group and attribute the deficits to them. Diversity processes usually work top-down (Dreas and Raststetter, 2016). These top-down processes can only be successful when there is a strong expression of diversity sensitive competences (Dreas and Raststetter, 2016).

*Hypothesis 1: Managers and employees differentiate regarding the expression of the stress level of employees with an immigration background.*

Findings regarding the first hypothesis show that the level of stress of employees with a migration background is assessed in the same way by managers and employees ( $t = .035$ ;  $df\ 1; 49$ ;  $p = .972$ ).

The qualitative analysis supported the findings. It was shown that especially prejudices and the impatience of others based on language problems. Also, different work attitudes due to intercultural differences are seen as stressing by employees with an immigration background. This was emphasised by employees with an immigration background: "People with an immigration background have the feeling: I have to give more than 120 % than my German colleagues. This is one reason why migrants feel more stressed."

*Hypothesis 2: Managers and employees differentiate regarding the forms of the subjective assessment of the social competence.*

No significant difference concerning the subjective assessment of social competence between managers and employees could be found ( $t = -.489$ ;  $df\ 2; 59$ ;  $p = .628$ ). It could indicate that both groups see themselves as prepared for the challenges of diversity management. Matching previous research, it underlines that the need to develop competencies is attributed to the other group.

## **5 Discussion**

Overall, employees and managers recognize the relevance of diversity in today's organisations. This feeling is, however, stronger expressed in the group of

employees. In the interviews, managers were mostly talking about the importance of diversity measures for the success of the organisation, as well as justice and fairness for employees. Nevertheless, they viewed this issue as important in the future, not in the present. They did not see the present need to act and were not aware enough of the level of stress concerning the diversity change of both employees with and without an immigration background. However, leaders understood the seriousness of the topic of diversity but did not see the urgency regarding cultural diversity and equal opportunities of people with an immigration background. In addition, human resource managers were not able to assess the additional stress of migrants precisely and to consider them sufficiently in their daily management.

Employees were aware of the importance of diversity. Those without an immigration background had difficulties recognising how important individual actions regarding equal opportunities of people with and without immigration background are. However, they assessed the level of stress of employees with an immigration background well. They also spoke and were aware of the risk that diversity is problematized. Concerning attitudes regarding diversity, differences within Germany became obvious. In western Germany, for example the Ruhr-region there is a high proportion of migrants, there it is seen as normal to work in a highly diverse cultural environment.

Intercultural and social competence makes up an important part of diversity competence. Participants mentioned empathy, tolerance and communication competences, openness, self-reflection, and emotional competences as well as cultural knowledge and awareness. Both groups, employees and managers pointed out that employees and managers both should receive more support in order to strengthen relevant competences. Proposed measures for this were trainings and gaining experiences abroad. This stands in contrast to the findings that managers and employees did not express significant differences regarding the subjectively assessed social competence. Additionally, their self-assessment was very high, even though the qualitative questionnaire classified it only as high.

Limitations to this study should also be mentioned. Issues of ageing employees and diversity measures regarding this target group were partly dealt with superficially in the conducted interviews. However, it is possible to differentiate from the sample due to other characteristics, e.g., size, structure, implementation of a diversity department. Based on the findings the interview guideline should be extended, also to investigate the quality criteria of the category systems. Also, the



finding that there is a regional difference concerning the importance of diversity measures in Germany must be viewed critically, as the interviewed persons have answered the questions differently detailed.

A positive aspect is that the sample had a relatively high diversification so that the different aspects of diversity could be seen from different perspectives by employees and managers, developing diversity strategies for their companies. It can also be positively highlighted that the interview guideline covered various issues regarding diversity management and by asking open and closed questions, the comparability of the interviews was increased. However, results of structured interviews are less comparable, inter alia because of the open questions that make the analysis more difficult. The whole topic of diversity, especially equal opportunities of persons with an immigration background has rarely been investigated making the explorative approach crucial to generate hypotheses and perspectives for future research. Limitations to the diverse sample also exist. Results of the interviews could only measure equal opportunities of people with an immigration background and ageing people. It is necessary to involve managers from different working fields, locations in Germany and other small, medium-sized, and large organisations in the study to create a representative sample. The results of this study were used to generate a new questionnaire. Additional aspects regarding equal opportunities of persons with an immigration background could be measured. These aspects could not be asked in detail in conventional quantitative surveys. The newly generated questionnaire could focus stronger on the urgency of diversity. Social desirability is also a problematic aspect that should be mentioned as the used survey method were interviews. Deliberate misinterpretations are not likely to happen because the respondents participated voluntarily and had not to expect any sanctions or other negative consequences that could arise from specific statements. The phenomenon of social desirability could be minimised by anonymizing the data. However, it could still appear because of the social interaction in the interviews. A consequence could be that results distort because e.g., the individual responsibility or the skills were presented in a more positive way by the questioned participant.

To summarize, the study at hand underlined that it is important to integrate diversity principles more in the manager and company guidelines. People with responsibilities should be trained more in the topic of diversity so that they can diagnose the need of diversity correctly and can implement effective measures now and not in the future.

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## Diversity-Oriented Leadership - a Success Factor in the STEM Sector

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### Abstract

Insights into emergence and influence of cultural diversity are becoming more important, due to an ongoing upward trend towards diversified societies. Yet, there is little scientific evidence on the specific attitudes of managers regarding cultural diversity, especially for technical and scientific professions. The present qualitative study examined the experiences, social influences, and competencies of managers in the STEM sector, which are important for managing cultural diversity. The results show that only a few of the respondents were aware of the opportunities and risks of cultural diversity and the specific challenges for people with a migration background. Furthermore, the respondents' own experiences and sensitivity, their own identification with the company and previous diversity measures in the context of the companies' position seemed to be relevant for the formation of attitudes. The respondents also stated a lack of interpersonal and intercultural competencies among junior managers, which should be addressed by both companies and educational institutions.

**Keywords** – Diversity Management, STEM, Diversity Beliefs, Leadership, Cultural Diversity

**Paper type** – Academic Research Paper

## **1 Diversity Attitudes of STEM-Executives**

Structures that are characterized by a high degree of heterogeneity among their members are more successful when they succeed in utilizing the diversity of competencies and perspectives (van Dick and Stegmann, 2016). This is the goal of the approaches and methods summarized under the term diversity management. Studies revealed that organization members' diversity beliefs (attitudes towards the functionality of diversity) predict whether organizations utilize or waste the potential of their members. Teams with positive diversity beliefs have been shown to react more positively to the perception of diversity within the team, experience less threat based on the heterogeneity, tend to discrimination practices less and be more able to share relevant knowledge (van Dick & Stegmann, 2016). Individual diversity beliefs are strongly influenced by the exemplified corporate culture and leaders' attitudes towards cultural diversity (Genkova, P. and Ringeisen, T., 2016; Guimond et al., 2013). However, many German companies exhibit a rather monocultural or pluralistic corporate culture (Cox, 1991), in which heterogeneity, especially with regard to cultural diversity, is understood as a disruptive factor, or economic disadvantage (Baporikar, 2021; Cox, 1991). On the one hand, this goes hand in hand with disadvantages for persons with diversity characteristics, and on the other hand, it can mean a loss of potential for the respective organization (Barmeyer et al., 2019). At the same time, the German labor market faces a shortage of skilled workers in academic professions in the fields of medicine, engineering in mechanical and automotive engineering, electrical engineering, IT, and software development and -programming (Bundesministerium für Wirtschaft und Energie, 2020), not completely but most of which are based in the STEM (Science, technology, engineering, and mathematics) sector. According to the Institute of the German Economy, the STEM sector is characterized by a high level of international mobility and a high proportion (19%) of foreign experts in German companies (Anger et al., 2018). While there is no data on the share of second and third generation migrants in the STEM sector available, the 26% of the German population currently has a migration background, i.e., they are immigrants themselves or have at least one parent who is an immigrant. Around half of this 26% of the German population are second and third generation migrants (Bundeszentrale für politische Bildung, 2020; Kemper, 2010). Consequently, diversity management is becoming increasingly important to prepare employees and managers for the challenges of dealing with

cultural diversity in their daily working life. In recent years, research has been able to present comprehensive findings on the establishment of diversity management in organizations (Ashikali and Groeneveld, 2015; Auferkorte-Michaelis and Linde, 2016; Genkova, P. and Ringeisen, 2016). In particular, they examined the ways in which intercultural and social competencies can be fostered among employees and which leadership behaviors are useful for diversity management. In their conference paper on the perception of aspects of cultural diversity, Genkova and Schreiber (2019) emphasize that managers play a crucial role in the implementation of diversity management. While the top management should develop a general strategy and public position, senior and middle managers are required to exemplify this strategy, for example, by demonstrating openness and flexibility (Franken, 2015; Wildermuth and Gray, 2005). At the same time, there is a lack of evidence on what attitudes towards cultural diversity exist among managers and how they develop, or even change. Leaders who communicate and live the strategy of diversity management are treated as information brokers in research, without addressing which experiences, influences, and information are relevant for their attitudes. In particular, technical and scientific leaders are under-researched while effective diversity management is neither established in curricula (Koller & Rudolph, 2017), nor in professional life in the STEM sector (Anger et al., 2018). For this reason, the present study took an exploratory look at the attitudes, experiences, competencies, and social environment of STEM leaders. The aim is to contribute to a better understanding of the development of diversity attitudes among leaders in general, while also highlighting opportunities and risks for diversity management practices in the STEM sector.

### ***1.1 Cultural Diversity, Identity, and Performance***

Thomas (2003) describes culture as a psychological orientation system that defines the belonging of its members through perceptions, thoughts, and actions. Culture is an aspect of an individual's social identity and is used to categorize one self and others. The social-identity approach (Tajfel and Turner, 1979) explains that the perception of identity varies on a spectrum between individual and social identity. The latter means identification by belonging to one or more groups. The moment one of these groups becomes more salient, or subjectively relevant, people tend to view themselves and others less as individuals and more as representatives of a single group (Hogg, 2016). The salience of the existence of

social groups is thus associated with a greater emphasis on subjectively perceived differences between groups and less individual differences within groups (Tajfel and Turner, 1979).

The Categorization-Elaboration Model (CEM, van Knippenberg et al., 2004) was the first model to explain differences in performance across diverse teams in a replicable way, based on the social-identity approach (van Dick & Stegmann, 2016). The core assumption of the CEM model is that groups with diverse members have a higher potential in terms of perspective, knowledge, or information when working efficiently with appropriate subgroups. Thus, information diversity should lead to deeper information collaboration, i.e., greater engagement with this information. Van Knippenberg et al. show convincingly that the categorization of team-members based on diverse characteristics might be connected to the perception of threat. Individuals tend to feel threatened by diversity, if they are convinced that the heterogeneity is disadvantaging the group performance (van Knippenberg et al., 2004), which is detrimental to individual as well as group performance (van Dick & Stegmann, 2016). If diversity is perceived in a negative way, team members might tend to form more homogenous subgroups. Subgrouping leads to negative affective consequences and consequently to poorer performance if the subgroups have an adversarial relationship with each other. According to the model, this occurs when the subgroups do not recognize each other or their respective contributions, i.e., when their identities are threatened (van Dick & Stegmann, 2016). In summary, the model states that any kind of diversity can contribute to the performance of a group. Van Knippenberg et al. (2004) further argue that the ability and the motivation of the team members influence the team performance. Thus, diverse teams are more successful, if they do not see diversity as a threat but are able and willing to utilize the potential of diverse competences and perspectives.

## **1.2 Diversity Management**

It becomes clear that cultural diversity holds both opportunities and risks for companies. Cultural diversity is an unavoidable factor in and around organizations in Germany, where the proportion of people with a migration background is just over a quarter of the population (Bundeszentrale für politische Bildung, 2020). In an overview chapter, van Dick and Stegmann (2016) describe that consequently the challenge for modern diverse teams and societies is not the diversity of their



members per se, nor the inevitable subjective relevance of differences, or Faultline's, between subgroups. The most important task of diversity management is rather to replace any threatening relationship between groups with a productive and meaningful relationship (van Dick & Stegmann, 2016).

One of the key goals of diversity management is thus strengthening an overarching identity that increases cohesion and commitment (van Knippenberg & Schie, 2000). Based on the self-group projection hypothesis (Mummendey & Wenzel, 1999), this also requires an awareness that the superordinate group, team, or organization is not culturally homogeneous, but becomes what it is only through the multiplicity of different perspectives (Reese et al., 2012; Waldzus et al., 2003). Accordingly, Gutentag et al. (2018) describe that the foundation for diversity-sensitive behavior is a nuanced awareness of cultural diversity of companies, as well as individuals. This runs on a spectrum between the perspectives culture-blind (assumption that there are no cultural differences, all people are the same) and color-full (consideration of cultural differences, Cox, 1991). In addition, individual attitudes towards diversity are critical. The term diversity beliefs was originally introduced by Van Knippenberg and Haslam to describe individual beliefs that diversity is beneficial to a group. They argue that this leads to diversity being perceived as something positive and thus to a stronger identification with the diversity of the superordinate group (van Knippenberg & Haslam, 2003). Diversity becomes a group characteristic, so to speak, with which one distinguishes oneself positively from other groups (van Dick & Stegmann, 2016).

The current literature in diversity management comprehensively presents how attitudes towards cultural diversity among employees are influenced by managerial behaviors (Choi and Rainey, 2014; Genkova, 2019; Moynihan et al., 2012). Ashikali and Groeneveld (2015) conducted a very large study with over ten thousand participants and showed that employees' perceptions of culturally fair selection procedures, perceptions of appreciation, and conscious competent management of cultural diversity were significantly positively related to diversity attitudes as well as to the commitment of the respective employees. This relationship was partially mediated by a transformational leadership style (Ashikali and Groeneveld, 2015). They explain that employees in general, and with a transformational leadership style in particular, adopted leaders attitudes and behaviors as norms and standards for evaluation and acting. They adopted / developed a diversity culture (Schein, 2010). Diversity culture, as a socially shared

set of opinions and behaviors (Schein, 2010) regarding the assessment of and handling of (in this case cultural) diversity, further has been shown to be a key predictor of the performance of heterogeneous work groups (e.g. Kundu and Mor, 2017, Stegmann, 2011). Summarized, the literatures shows that today's managers are faced with the tension of understanding the context and relevance of diversity management, developing sensitivity, and possibly leaving behind their own animosities and insecurities, while also taking into account their managerial and professional tasks (Ashikali and Groeneveld, 2015; Genkova, 2019; McCallaghan et al., 2020).

### **1.3 The Present Study**

While managerial behaviors can be studied relatively easily by interviewing employees, there have been very few studies dedicated to the attitudes and perspectives of managers, even though, they can be understood as multipliers of successful diversity management. In a qualitative study, Genkova and Schreiber (2019) compared how managers and employees from DAX companies assessed diversity management in their own organization. They showed that executives are often not aware of the shortcomings their employees see in their diversity management. Rather, the interviewed executives considered fair personnel selection and addressing their own prejudices to be tasks for the future, after subjectively more current tasks will have been dealt with. Auferkorte-Michaelis and Linde (2018) emphasize that a confrontation with one's own prejudices and one's own perception of diversity was most likely to happen during college, or even earlier. Especially in (German) STEM departments such topics are still hardly widespread (aside from the issue of promoting women in STEM professions), although other departments (social sciences, economics) have already established the topics diversity and leadership for a longer time (Auferkorte-Michaelis and Linde, 2016, Koller & Rudolph, 2017). Besides the lacking attention for diversity among STEM departments, the report of the STEM Employers Association neither sees cultural diversity as the challenge that it is. The report expresses optimism due to the high number of foreign experts, without addressing an efficient handling of cultural diversity (Anger et al., 2018). Considering the high international mobility, globalized markets and the high degree of international experts in the German STEM sector, the question remains important how leading staff perceives the situation of diversity management in the STEM sector.

The aim of this study was to contribute to a better understanding of attitudes towards cultural diversity among managers in STEM professions. For this purpose we explored which attitudes towards cultural diversity exist among the interviewed managers. Research on diversity management from a social psychological perspective considered experiences that shape people's attitudes, social influences and the surrounding diversity culture, as well as competencies that can be helpful for dealing with diversity (Genkova, P. & Ringeisen, T., 2016). Thereby, we aimed to identify potential for action and research regarding leaders' approaches to cultural diversity by examining experiences, social circumstances, and competencies that appear to be particularly relevant to their respective attitudes towards cultural diversity. The following guiding questions were formulated:

- What are the attitudes towards cultural diversity among the interviewed STEM leaders?
- What experiences are particularly relevant to attitudes towards cultural diversity among STEM leaders?
- What attitudes and perspectives in the social environment of STEM leaders are particularly relevant to their attitudes towards cultural diversity?
- What competencies and know-how do STEM leaders have that are particularly relevant to attitudes towards cultural diversity?

## **2 Method**

Since there are hardly any findings from empirical research for this specific field, a qualitative, explorative approach was used. The structured interviews were intended to provide a holistic picture of the subjective theories (Hilmer 1969) of STEM executives on diversity attitudes and intercultural competence. The interview guide contained a total of 58 questions. Of these, five were closed-ended self and peer-assessment questions. The guide was structured based on the topic areas of cultural diversity, personnel selection and assessment, leadership, stress, faultlines, and communication. The topic areas were derived on the basis of the theoretical considerations presented and taking into account practical experience with regard to the areas of everyday work of managers in Germany in which points of contact with cultural diversity exist. In order to ensure conceptual equivalence and comparability (Genkova 2019) across subgroups

(managers with and without a migration background, with a lot of experience and with little experience), the finalized interview guide was discussed by several diversity experts with and without migration background and approved after minor changes regarding general formulations.

### **2.1 Procedure**

The interviews took place between January and March 2020. Through academic and business networks, executives from various companies who hold degrees in STEM subjects and work in the field were recruited for the telephone interviews. In accordance with data protection guidelines, explicit consent was obtained for the interviews to be recorded and used for exclusively scientific purposes. The interviews took between 20 and 45 minutes. There were no incentives given.

The recorded interviews were transcribed and inductively analyzed using qualitative content analysis according to Mayring (2015). This methodological procedure has the advantage of allowing both qualitative and quantitative analyses and a great depth of interpretation (Bengtsson 2016, Krippendorf 2004). Subsequently, the category formation was discussed with three diversity experts from universities to ensure better objectivity as a basis for interpretation. This is in line with a triangulation approach suggested by Bengtsson (2016).

### **2.2 Participants**

A total of 22 executives from various German companies were interviewed. The respondents were between 26 and 69 years old ( $M = 49$ ). Three of the respondents were female, 19 were male. All respondents had a university degree in a STEM subject. Three of the respondents had a migration background (as defined by Kemper, 2010, according to which people who themselves, or for whom at least one parent, immigrated to Germany are counted as having a migration background). About half of the respondents were located in urban and half in rural regions, but most were in northern Germany (one person each lived in Stuttgart and Passau). Ten respondents classified themselves at the middle management level, twelve at the upper management level. Five respondents (23%) said they worked in a small company (up to 50 employees), eight (36%) said they worked in a medium-sized company (up to 250 employees), and nine (41%) said they worked in a large company with more than 250 employees. Eight

participants were working in the IT and software sector. Six were in building, civil, or plant engineering, two in steel and building materials production, two in consulting, and one each in automotive, energy, wood processing, and food. The managers estimated the proportion of people with an immigrant background in their company at 17.5% on average. Table 1 shows the proportions grouped by company size.

Table 1 Estimated share of people with a migration background in companies by size.

		People with a migration background			Total
		< 10%	< 30%	> 30%	
Company size	Small	2	2	1	5
	Medium	3	3	2	8
	Large	2	5	2	9
Total		7	10	5	22

### 3. Results

#### ***3.1 What are the Attitudes Towards Cultural Diversity Among the Interviewed STEM Executives?***

In order to answer the question of what attitudes towards cultural diversity are generally presented among the interviewed executives, various sequential questions were asked to reveal perceived and suspected advantages and disadvantages of cultural diversity in companies. Sixteen of the 22 participants said they saw an advantage in cultural diversity, while six saw neither an advantage nor a disadvantage. Table 2 presents the reasons for perceived advantages and disadvantages that executives expressed. It can be seen that individual respondents gave multiple, differentiated answers (for example: "Salespeople with a migration background may be well suited for sales in the respective country, but within teams, the additional perspectives in particular can be enriching", translated by the author), while nine of the 16 remaining respondents gave no or very brief answers at all. Among participants, there seemed to be a strong desire to present issues clearly and directly. A topic was rarely covered at length of time; rather, uncertainty was evident in short, choppy responses that tended to address general positions, sometimes combined with a

request to continue the interview. (e.g., "Uhm, diversity brings advantages (...) Especially in project work. Next Question!", translated by the author).

Table 2 Advantages of cultural diversity from the perspective of the interviewed executives

Do you see cultural diversity in your company as an advantage, a disadvantage, or neither? Please justify your statement briefly.	
Category	Count
Other perspectives	5
More efficient work	2
Additional competences	2
Other languages	1
Motivation to work	1
Diversity in the team increased openness in general	1
Other way of working	1
Promotes integration in Germany	1
Mutual learning	1
Interaction with partners	1
Intercultural competence	1
No grouping	1
Access to other markets	1

It was striking that 17 of the executives interviewed expressed the opinion that "everyone is equal" several times. In six cases participants emphasized that special importance is therefore attached to treating everyone equally. Therefore, no special measures were taken to support cultural diversity and equality. This attitude was reflected in the question as to whether diversity management measures have already been established ("What has been done in your company to support cultural diversity or to create equal conditions for all? - Just as little, everyone is equal", translated by the author). Similar answers occurred on questions about whether personnel selection procedures are designed fairly, whether employees with a migration background need different working conditions to work effectively than those without a migration background, and in the question about whether employees with a migration background behave differently in personnel interviews.

A separate questionnaire section asked about the perception of fault lines among employees. Twelve of the managers stated that they think that persons

with a migration background get along best with other persons with a migration background. However, only one of the respondents would allow shared, separate office spaces. Five of the respondents' reported feeling that there are informal cultural group spokespersons in their company. In terms of perceptions, it was also apparent that many of the managers surveyed do not see people with a migration background as part of the same hierarchical level. For example, they emphasized that problems of intercultural interaction in their company occur primarily among warehouse employees and truck drivers. In all cases, these 12 managers also believed that the most important skill for people with a migration background in their company is knowledge of the German language.

In contrast, seven of the executives believed that people with a migration background are more willing to perform or more disciplined than people without a migration background. In most cases, this seemed to be based on the attitude that people who have enjoyed the amenities of Western society less or for a shorter time work more conscientiously. This was illustrated by the very succinct phrase: "Yes, there are differences. And that certainly has to do with how one grew up and under what circumstances one grew up. If someone who has had cannonballs flying around his head is certainly different than someone who grew up well protected here in the west of the republic."

Six of the surveyed executives presented a nuanced picture of the benefits and risks of cultural diversity in their companies. They believed that the challenges and stress levels of employees with a migration background differ and describe both opportunities and risks for people with a migration background. Three of them have a migration background themselves (in two cases with parents from Poland, in one with parents from Turkey). Managers with a migration background showed similar attitudes as the managers without a migration background if the latter were aware of different challenges and issues for people with and without a first-generation migration background. They seemed to have a strong awareness of divergent requirements. At the same time, all of the interviewed migrant executives exhibited the attitude that you can't go wrong if you treat everyone the same. They were not aware of the possibility to actively influence the diversity culture, just like most of the other respondents.

Apparently, there were very different attitudes towards cultural diversity among the STEM leaders surveyed. At the same time, parallels emerged between the participants' responses that can help to understand the complex

interrelationships that may be relevant to the development of the attitudes described.

### ***3.2 What Experiences are Particularly Relevant to STEM Leaders' Attitudes Towards Cultural Diversity?***

During the interviews, the respondents expressed various experiences that seem to have shaped their views on intercultural interactions and cultural diversity. First, one could observe a difference between the attitudes of those managers who work a lot with international partners, customers, or colleagues and those who do not. Those who do a lot of international work, especially the executives from the IT sector and from the particularly large companies, had a culture-blind attitude in many cases, but at the same time had concrete action strategies for dealing with cultural diversity. These eight respondents with many international contacts were very focused on the interaction with foreigners, while second generation migrants played a subordinate role, but they could answer very concretely and self-confidently when it came to which characteristics are necessary to act, communicate, or lead successfully in intercultural settings. While they emphasized the need to speak a common language, they assumed that in most cases everyone involved can speak English.

Those executives who interacted little with international contacts or others with a migration background in their daily work (although the company may well serve international markets) and did not themselves have a migration background showed a significantly more negative attitude towards cultural diversity. This was evident in response to questions about whether diversity is an advantage, what working conditions people with a migration background need, and what culturally fair HR- and management methods have been introduced. All 12 managers who had the impression that cultural subgroups have formed in their companies have very little to do with people with a migration background in their personal day-to-day work. At the same time, these executives were less certain about what intercultural leadership requires and what people with and without a migration background can do to interact successfully. Again, the most common answer given was a common language base and the assumption that people with a migration background should learn German in any case. This is even more striking among those who believed that informal opinion leaders have formed in the cultural subgroups in their companies.



It is also striking that ten of the respondent's stated that it is not possible to communicate easily in German with everyone in the company. These managers either came from IT and had immigrants in their team or came from large companies. At the same time, 17 of the respondent's stated that language courses are particularly important for people with a migration background. For those who did not have frequent contact with people who speak other languages, the conclusion was that their own negative attitude was linked to arguments that were rationally justified and should appear to be in the interest of the company. It happened several times that one's own negative attitudes were presented as attitudes of the company, or of the board of directors: "Yes, well, I say once, in the management levels would certainly not be accepted here in the house if all of a sudden the carpet is aligned to Mecca. That is not acceptable to a German family business, German-led, from the management, so: they would never do that."

Regarding the experiences of managers and the connections with attitudes towards cultural diversity, it appeared that especially managers of small and medium-sized companies had negative attitudes towards cultural diversity in many cases, but above all had rarely have any direct experience with people with a migration background. Consequently, there seemed to be no knowledge about actual problems of integration or discrimination. The responsibility for known problems, for example language problems, was shifted to the people with a migration background ([we don't need to support them,] "they can go to night school or something") and there was no knowledge about what one could do differently or better oneself.

For the larger companies and the IT employees, the picture was more differentiated. The larger companies had both international contacts and a higher proportion of people with a migration background in their own ranks. In addition, larger companies in this survey were more likely to have a compliance agreement or corporate policy that explicitly addresses diversity. Most of the executives who work in large companies showed a more positive attitude towards cultural diversity, were able to give more concrete accounts of what is necessary for intercultural leadership and the extent to which optimal working conditions differ for people with an immigrant background.

The eight managers from the IT sector seemed to belong to a third pattern. They had predominantly positive attitudes towards international cooperation and reported working regularly with partners of various cultural backgrounds abroad. While there was a lot of experience, this did not seem to have led to a colorful

perspective in any case. The focus was less on understanding intercultural differences and more on avoiding unintentional intercultural friction. To this end, in three cases an agile way of working and the Scrum framework was also mentioned, which provides for equal treatment of all team members. Agile working summarizes an extremely popular set of methodological frameworks that, based on the so-called Agile Manifesto according to Beck et al. (2001), aim to enable efficient and flexible project management in the context of VUCA (Schwaber & Sutherland, 2020). However, there seems to be no awareness of issues related to proactively dealing with cultural diversity within organizations, such as integration or avoiding discrimination connected to the application of an agile framework.

The experiences that individual managers have had, or have not had, with individuals with migration backgrounds seem to provide explanations for existing attitudes among respondents. At the same time, it seems as if STEM executives deal with people with a migration background in a professional context less as individuals and more as representatives of the company or team. From this perspective, it becomes clear that the respective experiences and their interpretations are influenced by an interaction from the perceived corporate culture and the individual attitudes of the executives.

### ***3.3 Which Attitudes and Perspectives in the Social Environment are Particularly Relevant for STEM Leaders' Attitudes Towards Cultural Diversity?***

As described earlier, executives seemed to have more negative attitudes towards people with a migration background if they interact little with them and had no previous international experiences. This also seemed to be accompanied by perceptions of Faultline's and cultural subgroups within the company.

In the questions about personnel selection and assessment and leadership, there were indications that the respondents acted predominantly as representatives of the respective company. All but two of the managers argued from the company's perspective when it came to personnel decisions (e.g., "We haven't done that much yet; So, anyone can come to us") or, for example, how to deal with mistakes (e.g., "This is how we handle it"). They seemed to identify very strongly with their companies, which may also be due to the context of the survey. However, this became striking the more often indications of strong

identification occurred and the more the managers seemed to see themselves as typical representatives of the company, especially regarding the cultural background. In the small and medium-sized companies studied, personnel selection was primarily based on sympathy and team skills. At the same time, it became apparent that deviations, especially cultural deviations, were viewed very critically when identification was high. This became particularly clear with the following example:

"According to which criteria, apart from professional suitability, do you select your academic employees?" "Uhm yes, definitely German language, language quality (...) spoken and written, very important. EDP also means communication, and these are not just any tasks that have to be done in the back room, but you must be able to talk to people and communicate. And we are a German family business, so yes, I would say that we are actually very limited locally. We do have subsidiaries in France and in Poland, but even there German is definitely spoken at the management positions."

No such self-group projection was observed among the four respondents who see cultural diversity not only as an abstract advantage but as a concrete strength of their own company. While personnel selection processes are not always structured, these respondents did not indicate that they perceive Faultline's in the workforce. This was also true for those managers who had a culture-blind perspective, but either had a very culturally diverse workforce, or interact a lot internationally.

In addition to size, however, the attitude of the company also seemed to play a role. Among the managers who had a more positive and differentiated view of cultural diversity and intercultural communication, in six cases the company took a supportive role with regard to diversity and helped create appropriate conditions. Table 3 shows examples of the measures taken in the companies depending on whether the respondents could give specific reasons why cultural diversity was an advantage for the company. As can be seen, those who already had experienced more activities on the part of the companies had a more differentiated idea of why a company should take measures that support cultural diversity and equal opportunities.

Table 3 Categories to the question "What has been done in your company to support cultural diversity, or to create equal conditions for all?" depending on whether respondents cite reasons why diversity is an advantage.

<b>Was there a reason given?</b>	<b>Measures taken by the company</b>	<b>Count</b>
No	<i>total</i>	8
	Head-hunter	1
	Job postings in English	1
	Search for IT staff abroad	1
	Company agreement	1
	Events to be more attractive to women as employers	1
	<i>total</i>	12
Yes	Coaching	1
	Compliance agreement	1
	German courses	1
	English as company language	1
	English tenders	1
	Expatriation programs	1
	Executive training	1
	Joint activities	1
	Joint Ventures	1
	Cooperation with vocational school	1
	Cooperation with school	1
	Quotas	1
	Language courses	1

In addition to a generally positive attitude towards cultural diversity and a differentiated view of cultural diversity, concrete knowledge about the opportunities and risks of intercultural interaction and, above all, about leadership qualities in intercultural situations was repeatedly considered as an indicator of efficient handling of cultural diversity. In the following, it will be shown once again in a more detailed ways which competencies and which know-how was available among the respondents and which problems and needs were seen.

### **3.4 What Competencies and Know-How Exist Among STEM Leaders and are Particularly Relevant for Attitudes Towards Cultural Diversity.**

Overall, the respondents showed a heterogeneous picture of competencies that are necessary for intercultural leadership. As already explained, managers who see diversity as a strength of the company have already experienced various diversity management measures. Moreover, they usually work in companies,

where there is international interaction, so employees have a better understanding of how to deal with cultural diversity. The managers with a migration background did not differ in their response behavior from managers without a migration background. Although they were more sensitive than most other respondents, but they did not necessarily seem to think about the issue in a more differentiated way. Table 4 shows which leadership characteristics the respondents consider particularly important for leading intercultural:

Table 4 Qualities for leading intercultural teams

In your opinion, what characteristics do managers need to have in order to lead employees in an intercultural competent manner?	
Category	Count
Openness	9
Cultural knowledge	6
Diversity awareness	4
Empathy	3
Impartiality	3
Appreciation	3
Emotional intelligence	2
Respect	2
Flexibility	2
Leadership personality	2
Intercultural competence	1
Communication competence	1
Diversity sensitivity	1
Honesty	1
Sensitivity	1
Language skills	1
Own migration experiences	1
Build trust	1

Except for one respondent, the managers were convinced that they are good at intercultural leadership and are sufficiently sensitive to their employees. However, about half of the respondents (11) pointed out that junior managers often have problems in this area. Five respondents explicitly pointed out that this should be taught in university:

"More tools, more training. I also said at the beginning that leadership is virtually non-existent at university, at least I didn't have it as a subject choice at

all, not even as a compulsory elective. And I get that reflected from others as well. And when I think about the things I've learned in recent years, take Friedemann Schulz von Thun, his peer one model, or the different levels of communication and so on and so forth, all of these are actually basics, really basics, that you would normally have to pack into, let's say, the fifth to tenth grade. Because that is simply incredibly important for further progress. And leadership just must be part in the universities, and it has to be one of the most important subjects, because you're dealing with people afterwards, everywhere."

Those who particularly emphasized this point during the interviews had completed various "soft-skills" trainings themselves, either on their own initiative or through the company. Among the managers for whom this was not the case, there was often also little awareness that employees and managers can be prepared for intercultural leadership. None of the managers with a migration background have ever participated in such training, which may also be an explanation for the culture-blind perspective of these managers. This may also be related to the fact that in small and medium-sized companies in particular, the relevant competencies were generally not available, so that corresponding training courses were not even initiated.

#### **4 Discussion**

Previous studies have shown that the implementation of diversity management primarily follows a top-down process (Genkova & Schreiber, 2019; Auferkorte-Michaelis & Linde, 2018). In this process, diversity strategies of corporate management are passed on from managers to employees. This study highlights that senior and middle managers should not only be considered in this sandwich position, but that the development and promotion of diversity attitudes and action strategies, especially in STEM, requires special attention.

The results show that only a small proportion of respondents were aware of the opportunities and risks of cultural diversity and the specific challenges for people with an immigrant background. In this context, both the respondents' own experiences and sensitivity as well as the company's position and previous measures seemed to be relevant for attitudes towards cultural diversity and the interaction with each other. For example, different patterns emerged among respondents depending on how much or little they interacted with people with a migration background in their working life, the extent to which they identified

with their company, and whether or not they saw diversity as a concrete advantage. In addition, those whose companies had established diversity measures showed different and more nuanced attitudes towards cultural diversity.

Those managers who worked little with people with a migration background because the number of people with a migration background in the company is low or the company does not operate internationally showed little concrete competence in dealing with cultural diversity, were not very sensitive to challenges for people with a migration background and at the same time tended to represent a culture-blind perspective. By saying that all people are equal, they justified why diversity is important and that they treated everyone equally at the same time. This result was consistent with the findings presented by Genkova and Schreiber (2019). They showed that, on the one hand, low contact with a subjective foreign group was more likely to lead to negative attitudes towards that group, which is consistent with the contact hypothesis (Allport et al., 1954). Those managers who showed negative attitudes also believed that applicants should speak German to belong to the organization. Pehrson et al. (2009) showed in a cross-sectional study that the relationship between national identity and prejudice against foreigners was stronger when nationality was defined by ethnicity or language, compared to when nationality was defined by citizenship. In this study, it was not possible to differentiate whether the reservations about the language ability of people with a migration background relate to the national identity of the respondents, or to their identity as members of the company. However, the fact that the individuals spoke from a company perspective and presented reservations they themselves have as reservations of the company suggests that identification with the company can also lead to more negative and undifferentiated attitudes towards individuals with a migration background if the German language is perceived as a relevant part of the corporate culture. Future studies should verify this using larger samples.

Those who had contact with people from a migrant background were not necessarily more sensitive to people with a migrant background or more competent in dealing with them. Even people who often interacted with people from other cultures in their daily work environment, such as IT workers, tended to lack awareness of cultural differences. However, this awareness was present if measures have already been implemented to support diversity. It stands to reason that when companies are clearly positioned "pro diversity" and identification with the company is high, positive, and differentiated attitudes were more likely to be

adopted, which would be consistent with the findings of Ashikali and Groeneveld (2015) and the meta-study by Lee et al. (2015). In the case of high identification and lack of, or negative positioning of the company, there was always talk of "them" when it came to people with a migration background. People with a migration background were perceived as external to the organization or team, although a certain proportion of employees in the respective companies have a migration background. Following Mummendey and Wenzel (1999), this assessment can be traced back to the self-group projection hypothesis, which states that individuals experience a superordinate group, such as a company, as more homogeneous and similar to themselves than it actually is (Ehrke & Steffens, 2015). Prototypical of this is the statement: 'everyone is the same', which in the present study seemed to mean, on the one hand: I treat everyone the same, but at the same time: we are all the same, everyone is like me.

Nevertheless, some respondents seemed to have a lot of intercultural experience, i.e., managers with a migration background. Although they were in favor of equal opportunities for obvious reasons and were sensitive to discrimination, at the same time all three of them felt that cultural differences were better neglected and that they should "concentrate on the essentials." In other words, they understood cultural diversity as a social contextual factor that could not be avoided, but also did not add any significant value, except perhaps being able to target foreign markets. This perspective was also found by Gutentag et al. (2018) when examining attitudes towards cultural diversity, showing that on the one hand prejudice and xenophobia can be reasons for culture-blindness, but also the feeling of being overwhelmed by the complexity of the topic. This being overwhelmed was also evident among some of the managers interviewed, but it did not seem to have led to negative attitudes towards cultural diversity as in Gutentag et al. (2018), but rather to a trivialization of the topic, although potential problems may well be known, for example, to managers with migration background.

Against the backdrop that a differentiated discussion of the complex problems of cultural diversity tended to be avoided, it can also be concluded that executives were more likely to give the topic of cultural diversity time and attention if it is anchored in the corporate identity. Conversely, this would mean that managers, as well as employees, may disseminated a negative diversity culture as much as a positive one if they identified particularly strongly with the company and depending on whether they personally considered the issue



relevant. Future studies would do best to examine this relationship using a quasi-experimental longitudinal study.

This relationship between company positioning, further training opportunities and experience of competence was also supported by the fact that those managers who were more aware of the issues and challenges were also more likely to believe that leadership in general and intercultural leadership required special training or further training, which can only be partially substituted by experience. It was emphasized that junior executives often do not meet the requirements of intercultural leadership and go through a not unproblematic try-and-error process until they have reached a level at which they can work without interference. This is also in line with Barmeyer et al. (2019). Auferkorte-Michaelis and Linde (2018), generally called for diversity to be more firmly anchored as a topic in teaching. There are currently no specific (accessible) studies on this for the STEM world of work, but diversity and leadership currently receive little to no attention in the curricula of most STEM subjects, whose students are the STEM leaders of tomorrow (Koller & Rudolph, 2017). Therefore, a key finding of this study was that greater consideration of cultural diversity is needed from both the corporate and university sides to meet the demands of a culturally heterogeneous society.

The interviews further revealed that some of the IT professionals identified very strongly with the concept of agile working. The concept of Agile Work is rooted primarily in the field of computer science, but is established in other areas of project-based work worldwide (Pusenius, 2019). McCallaghan et al. (2020) demonstrated through a cross-sectional study that servant leadership, a core concept of agile work, was positively related to employee diversity attitudes. However, they also pointed out that they operationalized diversity attitudes only as an instrumental component (i.e., whether respondents believe diversity represents a business advantage) and did not capture diversity sensitivity. Similar to Ashikali and Groeneveld (2015), they showed that employee-oriented leadership behaviors were more likely to be related to employees' open attitudes. The results of this study implied that a co-employee-oriented leadership style allows the leader to pass on their attitudes which can have advantages and disadvantages. On the one hand, equality is firmly embedded in both agile frameworks and transformational leadership styles (Kearney & Gebert, 2009; Pusenius, 2019). On the other hand, neither concept addresses other facets of diversity management, such as prejudices, discriminating structures or cross-

cultural differences. The IT leaders who described their leadership style as agile emphasized equality but did not have in-depth knowledge or awareness of the opportunities and risks of cultural diversity. Although the other mechanisms outlined in this paper could also be at work for this attitude, a connection seems obvious and further studies should address a link between agile methods and diversity attitudes, especially given the increasing prevalence of agile ways of working.

## **5 Limitations**

The present study has some limitations. The sample was very small and transferability of results should be investigated for other STEM executives. Women and men showed no differences in response behaviour, but a separate consideration of possible correlations between attitudes and experiences was not made. However, very few women were interviewed, so the external validity of the results here must be considered severely limited. Although the perspectives of managers with a migration background were considered separately. Very few leaders with migration background have been interviewed. Future studies should take a closer look at this topic and specifically address women and people of diverse genders, as well as people with a migration background, also to consider possible effects due to intersectionality, which could not be investigated in this study. The structured interviews generated a differentiated picture of respondents' attitudes towards cultural diversity, but for further studies it would be useful to query not only advantages, but also disadvantages. Some respondents apparently interpreted the question of whether and why cultural diversity was an advantage or disadvantage to mean that they should only provide arguments about advantages or disadvantages, which may have led to less differentiated responses, despite asking. In addition, further studies of this kind should not only ask for perspectives and opinions, but also reline these with situational questions. While some respondents supported their discussions with many examples, others were very reticent, especially about negative experiences.

## **6 Conclusion**

Despite the aforementioned limitations, the present study was able to identify relevant connections for further research in the field of diversity and diversity management. It should be particularly emphasized that managers by no means

stand as mere intermediaries between an overarching diversity strategy and employees, as studies such as those by Ashikali and Groeneveld (2015) imply. Ehrke and Steffens (2015) point out that research on attitudes towards cultural diversity and diversity management needs to move beyond the phase of merely verifying whether an intervention has the desired effect on employees and instead turn to examining the how and why of the desired outcome. In practical terms, the findings of this study indicate that diversity management in STEM is relevant to supporting managers, that managers need to be equipped with the necessary knowledge and understanding to act effectively and appropriately, and to be able to pass this on to their employees. The present results also indicate that agile working does not create diversity awareness. Even university graduates cannot be assumed to have experience in this area. The globalized and digitized world of work makes it essential for diversity management to take these attitudes and influences on managers into account if one wants to understand the how and why of cultural diversity in STEM professions.

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## **What is Intercultural Competence and who Needs it? - An Exploratory Study of Attitudes of Students and Professionals towards the Content Validity and External Validity of Intercultural Competence**

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### **Abstract**

Advancing globalization processes, including the internationalization of labour markets, supply chains and consumer markets as well as migration movements, lead to a rise in cultural diversity within many societies. As a result, intercultural competence is becoming increasingly relevant. The central interest of this study was to identify facets of intercultural competence and to determine the breadth of situations in which intercultural competence is perceived as necessary. For the analysis on which this paper is based, 61 structured interviews were conducted. Results show that perceived facets of the content of intercultural competence could be categorized into (1.) relational level characteristics such as freedom from prejudice and empathy, (2.) attitudinal stances such as respect and acceptance, and (3.) skills such as flexibility and foreign language proficiency. With regards to specific situations in which intercultural competence is relevant, both stays abroad and everyday situations in one's own society were found, while the focus of participants was on stays abroad. The study provides important heuristic indications for the development of intercultural competence construct and indicates that future research should further explore possibilities for promoting competence in everyday life.

**Keywords** – Intercultural competence, diversity, validity, culture, stress

**Paper type** – Academic Research Paper

## **1 Introduction**

As a result of globalization processes, advancing digitization, and related developments, intercultural competence is becoming increasingly important. Global societal and economic challenges include high labour mobility, large-scale refugee movements, intergroup conflicts, and dealing with limited resources or even pandemics such as the Corona pandemic. Intercultural competence often recedes into the background of awareness during such phases. However, only a concerted approach and united endeavours enable to cope with challenges of global degree. This is where intercultural communication and intercultural competence take on crucial roles.

Intercultural competence is seen as a prerequisite for successful intercultural interaction. The modern world is characterised by an increasing amount of intercultural interaction situations. However, what actually makes an individual able to act appropriately and effectively in intercultural situations is still not fully understood in psychological literature (Genkova, 2019). The dynamics of the environment, which is developing during globalization, are also described with the acronym VUCA: volatile (nature and dynamics of change as well as nature and speed of drivers of change), uncertain (lack of predictability), complex (intertwining of issues, no [clear] cause-effect chain), and ambiguous (ambiguity of cause and effect) (Rychen, 2016). Many individuals feel threatened by the challenges that arise in the VUCA world. In phases of perceived threat, such as the Corona pandemic, feelings of relative deprivation and of being disadvantaged arise. Realistic group conflict and social identity thus become more relevant to those affected by threat. These phenomena are reason as well as explanation for the emergence and exacerbation of prejudice and discrimination and thus impede intercultural interaction severely. What constitutes cultural competence in the first place? And how exactly can it be measured and be promoted?

## **2 The concept of intercultural competence and its measurement**

Previous studies describe and discuss the challenges of interactions between members of different cultures (Barmeyer & Franklin, 2016). Culture can be defined as an orientation system shared between the members of a certain group, defining membership, and providing identification and meaning as well as norms for perception, thinking and acting (Thomas, 2007). Every group of individuals tends to develop some kind of psychological structure over time that can be



described as culture (e.g., organizational culture, culture in a certain village, scene culture; Schein, 2010). If individuals from different cultures get into contact with one another, they might feel challenged due to the different norms and standards for communication and acting. Moreover, members of different social groups often have prejudice against each other, which also impedes successful interaction (Barmeyer & Franklin, 2016). Threatening circumstances like the still ongoing globalization, loss of former certainties and the increasing speed of societal changes are linked to an accentuation of intergroup conflicts and threat rather than cooperation and understanding (Genkova & Schreiber, 2020). Especially national cultural differences have been shown to be related to communication issues and hostile intergroup attitudes.

Intercultural interaction thus is complex, often challenging and requires abilities, which are subsumed under the term intercultural competence. Intercultural competence is the ability to communicate with members of foreign cultures without conflict. This requires, among other things, empathy and tolerance of ambiguity (Genkova, 2019). However, the question arises of how to operationalize and measure intercultural competence, since the conceptualization of global challenges is strongly influenced by different norms of thinking and behaviour of different cultures. Different types of measurement methods are discussed and categorized. For example, Deardorff (2011) distinguishes between direct (self-reflection, behavioural observation in intercultural situations) and indirect (surveys or inventories) measurement procedures (Deardorff, 2011).

These measurement approaches can also be found in the discussion of Leung et al. (2014). They distinguish three measurement categories: measurement by self-report; measurement by observer ratings; and performance-based measurement.

The responses collected through self-report primarily allow conclusions to be drawn about the subjective degree of one's own intercultural competence. The main problem for validity in this survey mode is the influence of socially desirable response behaviour (cf. Leung et al. 2014; Lustig & Koester 2012). The assessment by observers can only be reliable and valid if objective assessment standards are defined for concrete intercultural contact situations. These assessment standards must be intersubjectively (i.e., across different observers) directly related to concrete behaviours. However, this narrow specification of concrete situations in which certain behaviours are expected implies that the situations selected in each case can represent only a small segment of reality. Performance-based

measurements, in turn, use standardized test procedures. Since this mode of measurement also can only represent small parts of reality, analogous questions about representativeness and standards of assessment arise as with observation-based procedures. Due to the strengths and weaknesses of the different measurement procedures, it is recommended to choose a multimethod approach, which combines different measurement procedures (see also Deardorff, 2006).

Valid assessment of intercultural competence can thus only be based in a comprehensive operationalisation and an in-depth understanding of the behaviours and situations in which intercultural competence manifests itself. Therefore, developing an operationalization of intercultural competence requires to consider the perspectives and experiences of those who apply intercultural competence in several situations.

### **3 Research question and participants**

The present study investigated two exploratory questions, to create a foundation for future operationalisations of intercultural competence:

1. What do the participants understand by intercultural competence?
2. How relevant is intercultural competence in everyday life and in which situations is it most needed?

In other words, the central questions address the requirements of content validity of the intercultural competence construct, by elucidating experiences with relevant characteristics in various intercultural contact situations. To address these initial questions in depth, a structured qualitative interview guideline with predominantly open response formats was developed. The guideline covered perspectives on what intercultural competence is (e.g., "Which individual skills are necessary in order to have a good intercultural competence?") as well as in which context intercultural competence is needed (e.g., "Have you already experienced a situation in which you wished to have better intercultural competence than you in that instance?").

Forty-one students and 20 working professionals were interviewed. The average age was 30.8 years,  $SD=13.7$ ; 56% of respondents were female, 44% were male, no participants identified as divers. Seventeen of the participants had a migration background, 8 of which were first generation migrants, 9 were second generation migrants. Students and professionals came from different companies and universities from all over Germany. Twenty-eight of the participants without

migration experience stated that they had stayed abroad for at least half a year before. The participants were recruited via the private and occupational networks of the researchers and their assistants. No incentive was offered.

To analyse the interview, quantitative content analysis (according to Mayring, 1996) was used. By forming categories, comparing these categories with each other, and quantifying cases in certain categories, a close coupling between hypothesis generation and interview material was ensured (Bengtson, 2016).

## **4 Results**

### ***4.1 What do participants understand by intercultural competence?***

Participants' experiences with intercultural competence and relevant characteristics with which it is linked were elucidated. The participants addressed a broad spectrum of characteristics related intercultural competence. Very often they mentioned aspects that referred to equal treatment (27 mentions). This category included statements that either directly described aspects of (in)equal treatment or referred to: freedom from prejudice, putting aside prejudice, impartiality.

Also frequently mentioned were facets related to understanding (25 mentions). Two subcategories arose; one category for having an understanding for actions that deviate from the expectations of a given cultural context and another for having an understanding that behaviours deviating from expectations in intercultural contexts can often be attributed to differences between cultures:

*...I think it's important to know in the first place that there can be differences in behaviour that can be attributed to cultural differences and not necessarily just to people's personalities. I think that's an important first step.*

Occasionally, the related construct of listening or hearing someone out was mentioned as important (8 mentions). Listening can support trust building and is in turn a prerequisite for mutual understanding.

However, understanding at the descriptive level alone has been described as not sufficient for successful living together. Many interviewees pointed to the importance of tolerating otherness (23 mentions). Aspects of difference mentioned were primarily actions, approaches, points of view and religions. A concept related to tolerance is that of acceptance. Acceptance was occasionally mentioned (15), especially regarding other customs, traditions, or characters.

Strictly speaking, acceptance goes beyond mere tolerance. While tolerance in the narrow sense means putting up with something despite one's own displeasure, acceptance implies an approving attitude. (It is questionable, however, whether participants were aware of this semantic difference in their descriptions).

Acceptance is facilitated when the thoughts or practices of the other can be comprehended on both a cognitive- and emotional level. Concepts that are directly related to this and which were mentioned frequently are empathy (24 mentions), perspective-taking (13) and sensitivity (8).

Also related to tolerance and acceptance is the concept of respect, which can mean on the one hand an inner attitude of respect, and on the other hand an outer observation of formal conduct towards the other as well as an inclusion of the other. Respect towards people from other cultures as well as respect towards different behaviours was mentioned by a few interviewees (3).

The interviewees also mentioned the process of reflecting on cultures as a characteristic of intercultural competence (20). They related this reflection either to the culture of their own group or to the culture of the foreign group. The content of the reflection can be the comparative strengths and weaknesses of cultures. This can include to consider different perspectives in one's own reflections, and refraining from cultural chauvinism, i.e., not showing arrogance regarding one's own culture (7). Further elements of reflection can be the willingness to change one's own worldview (2), as well as to develop an awareness that different paths can lead to a goal (2).

The respondents' answers further indicated a high level of self-reflection, or an awareness of a development process as a relevant prerequisite for intercultural competence.

*...I would say that you have to have had the experience of throwing your own convictions overboard at times. Because, on the one hand, it is important to question oneself. But if you always come to the conclusion that "Yes, my ways of thinking, all my approaches are correct," then that doesn't really help. And that can't be the case at all. That's why you have to have had the experience of holding a view that you later completely throw overboard.*

The interviewees also named numerous personal characteristics which they considered to be components of intercultural competence. These included adaptability (16), flexibility (7), a willingness to integrate (6), or dealing appropriately with conflict situations (8). Among skills that are culture-specific, foreign language skills played a prominent role (34).

To sum up, the participants seemed to be aware of several challenges in intercultural situations as well as of required skills in order to meet the challenges. Most interviewees were further aware of chances and risks of intercultural interaction (e.g., the chance to broaden one's horizon, and the risk for misunderstanding and conflicts). Participants' perception of intercultural competence could be divided into three categories of aspects, which are presented in Table 1.

Table 1: What do the respondents understand by intercultural competence?

<b>Understanding of intercultural competence</b>	Relational level characteristics, such as being without prejudice, having empathy, sensitivity, & understanding	Attitudinal characteristics, such as acceptance, respect, reflection, & absence of chauvinism	Personal characteristics, such as flexibility, adaptability, or foreign language skills
<b>Number of mentions</b>	97	42	71

#### ***4.2 How relevant is intercultural competence in everyday life and in specific situations?***

The participants were also asked about situations in which they considered intercultural competence to be particularly important. Respondents often perceived intercultural competence as important in situations abroad and while traveling. Frequently mentioned events were: (20) traveling; (10) working abroad (with frequent reference to manners and work ethics); (9) trying to assimilate abroad or trying not to stand out as a foreigner; (8) studying abroad, (2) student exchange year at school.

It was interesting that respondents less frequently mentioned situations in their home country in which they found themselves in a diverse, intercultural environment. Mentioned intercultural interactions in everyday life in the home country were: (18) everyday contacts while shopping, on the street, on the bus, at their hobby, in the neighbourhood, at the doctor's office or at the car repair shop; (5) unspecified contact with people from other cultures at home; (5) concrete situations in which cooperation with people from other cultures was important, and (5) communication with people from other cultures.

The respondents also described concrete situations in which their own intercultural competence was perceived as helpful. One example that is relatively well-known (and stereotypical) in relation to German culture is dealing with punctuality, which was also found among the interviewees (2).

*With my two former roommates who are from Iran, I had arranged once to talk about cleaning the kitchen, and then it was arranged to talk about it at 1:00 p.m. in the kitchen. And at 1:30 p.m. there was no one there, and I didn't get an answer when I asked, and then at 2:00 p.m. we just settled it in the hallway. If I hadn't been aware of the cultural differences in terms of time perception, I would probably have been a bit annoyed...*

The interviewees also described situations in which they, looking back self-critically, reported that more of their own intercultural competence would have been necessary. Examples of this are: dealing with punctuality or understanding time (2), or difficulties in recognizing emotions (2).

*...my semester abroad in Indonesia, well, I think the most difficult or most alienating thing is that people are always super-nice and smiling, but you never really know if that is really their attitude towards you, because a rejection would never be shown so openly, and I have the feeling that such things can be better classified and evaluated with a lot of intercultural competence...*

Another example was a lack of ability to take perspective due to a lack of understanding of collectivist ways of thinking and behaving.

## **5 Discussion**

In summary, intercultural competence and communication are relevant in a wide range of situations, both when traveling and in situations in the home country which are characterized by cultural diversity. Research on intercultural initially had initially a rather niche existence and was, for example, limited to foreign language teaching. More recently, common awareness for the importance of intercultural competence is rising, while intercultural communication is increasingly affecting everyday life of people all over the world, due to modern media, the internationalization of the economy as well as migration movements.

The aim of the present study was to investigate the practical experiences with intercultural competence in intercultural contact situations. This involved identifying perceptions of different facets and dimensions of intercultural

competence. Aspects of intercultural competence found in the interviews can be categorised into relational aspects, attitudes, and personality characteristics.

Specific situations in which intercultural competence is relevant were also identified, thus creating the foundation for the development of a measurement instrument of intercultural competence that covers a range of situations which is required for achieving external validity. It was found that the respondents had very detailed perceptions and experiences concerning facets and dimensions of intercultural competence.

In the specific situations described by the interviewees, cultural sensitivity was reflected to different degrees. Cultural sensitivity was more evident in the descriptions of stays abroad than in the descriptions of dealing with diversity in everyday life at home. Considering the advancing globalization, future research should explore further the possibilities for developing and promoting skills for dealing with diversity in everyday life.

The advantage of the present qualitative study is that it provided an exploratory insight into the perspectives of students and professionals with and without experience abroad on what characterizes an intercultural competent person in various situations. The interview guideline covered a range of topics on intercultural competence and asked about intercultural contact situations in a variety of contexts, such as university education, application processes, the workplace or situations of everyday life.

A potential moderating factor to be considered in future research is the potential influence of company sizes and of different economic sectors. For a more in-depth analysis, several employees and managers should be interviewed, covering various business sectors and company sizes, to systematically compare similarities and differences in corporate cultures and management styles. Moreover, the study design lacks the systematic consideration of different hierarchical levels of companies, such as top- and mid-level managers. A further limitation is constituted by potential social desirability effects or deliberate misrepresentation, even though care was taken in the study to avoid leading questions. Social desirability could lead to a distortion of the results with regard to, for example, personal responsibility or the abilities of the individual, so that the interviewees may have partly provided distorted statements. However, since participation in the interview was voluntary, and since no sanctions or other effects were to be expected from certain statements due to guaranteed anonymity, the extent of such effects might be limited.

Since participants came from a variety of companies and universities, context specificity and generalizability of the results could be further analysed in future studies.

## **6 Conclusion**

As intercultural communication is becoming increasingly relevant and present in the everyday lives of people around the world while the world continues to grow closer together (digitization, globalization, migration movements), the focus of this study was on perceptions of various facets and dimensions of intercultural competence (relational level characteristics such as freedom from prejudice and empathy, attitudinal characteristics such as respect and acceptance, and skills such as flexibility and foreign language proficiency). It was suggested that listening supports mutual understanding and thereupon can lead to acceptance. In addition, specific situations in which intercultural competence is relevant were identified. Particularly high cultural sensitivity was evinced when subjects were themselves foreigners in a country, e.g., during a stay abroad. Dealing with diversity in everyday life at home was less present in the awareness of the participants. In view of the ongoing globalization, it is a task of further research to explore possibilities for the development and promotion of awareness and skills for dealing with diversity in everyday life.

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## National Performance and Global Dynamics: an Unifying Knowledge-Based Approach

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### Abstract

Global dynamics is a pervasive phenomenon, influencing continuously national socio-economic systems and, in emergent cases, affecting directly even individuals. There are numerous scientific theories and frameworks, mostly identifying the unequal distribution and limited renewability of resources as the primary drivers of global dynamics. To minimize their undesirable consequences, considerable effort is spent on joint harmonization of international strategic and policies of single countries. This can hardly happen without innovative decision-support tools, breaking the originally intractable complexity into a set of well-structured, explainable, and straightforwardly applicable subproblems.

The main goal of this research was to simplify, systemize and structure the influences of global dynamics on single countries and help them to formulate viable strategies with respect to global changes. Rather than a detailed methodology, this paper proposes and with real-world examples justifies a reusable conceptual framework, based on qualitatively represented expert knowledge, specified with quantitative outputs from data mining, applied on selected national indexes.

In the design phase, a two-stage qualitative model of global dynamics was developed, validated, and functionally demonstrated. It merges traditional knowledge-based modelling of sustainable world with data-driven identification of the national-specific development drivers, complemented with global indicators, concerning the planet and humanity. The data-related level is built from the coherently selected global indexes, processed with different machine-learning tasks. Subsequent high-level qualitative model is expressed in the form of Causal loop diagram, extending the expert and domain knowledge with significant national-specific variables and relations, found in data.

The proposed way of individualized modelling of national strategies with respect to evolving global dynamics can facilitate policy-making processes on the governmental level. Its flexible and multilevel structure allows identification of a minimal set of key parameters, guaranteeing efficient and robust planning of country future. Application possibilities of such layered framework are presented for case of Germany.

**Keywords** – Data mining, Global dynamics, Global indexes, Qualitative modelling

**Paper type** – Academic Research Paper

## 1 Introduction

The world economy is currently undergoing significant changes. It is influenced by new phenomena that complement and condition each other, but also have contradictory manifestations. Globalization is one of the most debated terms of today. The term is very contradictory and there is no consensus among economists about its meaning - opinions differ fundamentally (Kivilcim, 2008). Globalization is perceived as a long-term process by the authors of the International Encyclopaedia of Business and Management (Warner and Kotter, 2002). The authors directly state that globalization is a process of growing integration of world civilization. This process is understood to be long-lasting and lasting practically since prehistoric times. For example, the authors state that the expansion of the first people into new territories through massive migration is a symbolic example of globalization. Siebert (2000) states that globalization means reducing market segmentation and increasing the interdependence of national markets.

According to Hamilton and Webster (2009) globalization refers to the social, economic, political, and technological links in different countries. Globalization is a contested concept that refers to shrinkage of time and space (Steger, 2009). According to another definition globalization is the elimination or diminution of state-enforced restrictions on exchanges across borders and the increasingly integrated and complex global system of production and exchange that has emerged as a result (Palmer, 2002).

By globalization in current economic and other theories we mean a complex transformation of market relations (but also other social ones events) on a global scale, which materializes in a number of changes in the economic and non-economic spheres (Duarte et al., 2021; .Manoharan, 2021) This transformation, for many reasons, is changing the world economy and the social establishment of the world towards greater coherence and dependence of individual economic subjects, not only adds links between individual elements, but also quality changes completely and completely structurally, or creates completely new typologically (Wu and Lee, 2021).

According to World Trade Organization (Azwar and Leviza, 2020) globalization is the substantive process of economic and technological expansion looking towards the opening-up and integration of the entire world into and under one economic system. At the OECD (Padhan et al., 2020) interpret globalisation as a process of closer economic integration of global markets: financial, product and labour. Globalization, by the UNO, is defined as the global integration of economies and societies. Globalization, the process through which an increasingly free flow of ideas, people, goods, services, and capital leads to the integration of economies and societies, is often viewed as an irreversible force, which is being imposed upon the world by some countries and institutions such as the IMF and the World Bank (Tate, 2020). According to World Health Organization (2021), globalization can be defined as the increased interconnectedness and interdependence of peoples and countries. It is generally understood to include two inter-related elements: the opening of international borders to increasingly fast flows of goods, services, finance, people, and ideas; and the changes in institutions and policies at national and international levels that facilitate or promote such flows.

Globalization has number of aspects that have a selective effect on individual states in both positive and negative ways. The International Monetary Fund (IMF, 2021) lists four main aspects of globalization: international trade, movement of

investments and capital, migration of persons and dissemination of knowledge. Many authors deal with these aspects and associated areas in their studies, e. g. studies about fair trade (Zhu et al., 2021), foreign trade (Hu et al., 2021), sense of migration (Bascuñan-Wiley, 2021), dissemination of CSR practices between international corporations and local companies (Kowalska, 2018; Tetreanova and Patak, 2019).

Today, we face many problems that are intricately interconnected and cannot simply be included in any traditional scientific discipline. Modelling of global dynamics is a very useful tool that can help. With models, we can make predictions (Hartzell et al., 2021), estimate the impact of various interventions in systems (Yun et al., 2020), and better plan various actions in addition to these concrete results, however, models are also very important on a mental level - just working with models significantly affects our way of thinking and looking at the world. Models force one to articulate our vague ideas clearly. They also make it possible to share ideas and pass on much-needed information between experts in different fields. Modelling of global dynamics is used by many authors in different areas, e. g. in healthcare (Zhang et al., 2020; Li and Zhao, 2021; Ma et al., 2021), in transport (Yoon, 2021; Danylkiv et al., 2020), in environment (Hartzell, 2021; Sverdrup et al., 2020) or in demography (Li and Xu, 2020).

GDP and the indicators that affect it can be considered as sources of global dynamics. The determinants of economic growth are made up of factors that are interrelated and together affect the rate of growth or decline of the economy. The Nature Conservancy (2021) deals with a group of factors affecting GDP. According to them, everything is connected to everything and the whole system of GDP creation is interconnected. The main factors mentioned include global employment and poverty, air quality and climate, the terrestrial, freshwater and maritime systems, energy resources, sanitation, human health, and the economic impact of disasters. It is therefore not only economic indicators that have the main influence on GDP generation, but also technological, social and environmental indicators. It points out, above all, the suitability of looking at systems from a holistic point of view and not focusing separately on each of the factors separately. On the contrary, Capra (2016) does not focus directly on the state and development of GDP, but on global problems that countries must face and be able to deal with as best as possible. It divides this issue into two main sections, namely population difficulties and environmental issues. Population problems include poverty, population growth, the pressure of demographic

change and social inequality. Environmental topics include climate change, "climate" refugees, fossil fuel consumption and food security threats.

The main factors influencing GDP growth include the following indicators (Agarwal, 2020; Saini, 2021):

- Natural resources - e.g., oil, mineral deposits, but also native land and water availability,
- Physical capital and infrastructure (resp. equipment) - increase in investments in physical capital, e.g., roads, machinery, and factories, thanks to investments in physical capital there is an increase in productivity and performance,
- Population and labor force (resp. employment) - a growing population can result in higher availability of labor, but can also lead to high unemployment,
- Human capital - increasing investment in human capital in order to improve the skills of the workforce and consequently increase productivity,
- Technology - increasing investment in technology in order to increase productivity while reducing costs and increasing competitiveness,
- Laws, resp. rules and regulations - regulation of economic activity by the state or other institutions.

There are also holistic theories and frameworks, explaining the internal mechanisms of global dynamics from different viewpoints (Donges et al., 2020; Liu et al., 2007; Smil, 2021; Thurner et al., 2018). These multidimensional approaches arise from a complex internal network of feedback loops, interactions of which are affected with a wide range of time constants, varying from weeks to millennia. Such extensive dynamic structure naturally possesses an oscillatory and conditionally unstable behaviour, when in critically exhausted sectors even neglecting parametric changes can result in catastrophic reactions, like the widely cited Butterfly effect (Lorenz, 1963). Based on these theoretical foundations, quantitative models of sustainable world, created in accordance with the system dynamic framework, introduced in (Forrester, 1961) were designed and successfully applied (Capra, 2004; Forrester, 1971; Meadows, 1974; Turner, 2008). They typically combine the dynamics of food, industry, population, environment, and non-renewable resources sectors.

Considerable official effort is spent on harmonization of global dynamics effects with joint strategic development goals of single countries (EUR-Lex, 2016;

UN, 2020). These interventions strive to control namely the publicly visible global impacts, including climate changes, lack of natural resources or economic, humanitarian, or migration crises. However, because of inherent spatio-temporal complexity and socio-economic character of global dynamics, it is hardly possible to design the realistic scenarios of its future evolvement or even to solve them and thus explicitly mitigate related risks (WEF, 2021). Despite the enormous effort and investments, it is evident that the worldwide distributed complex structural aspects and behavioural patterns of global dynamics, instantiated through nationally differentiated conditions, form the burning problem of the contemporary world.

## **2 Methods**

This research followed the traditional iterative methodology proposed, e.g., in (Mitroff, 1978) and enhanced it for the dynamic problems (Meadows and Wright, 2015) as follows:

- a) Problem definition, structuring, identification of key variables and formulation of dynamic hypotheses,
- b) Knowledge elicitation (review of resources, capturing of knowledge) and specification (formalization of problem-describing structure and behavior),
- c) Design of related model and its verification,
- d) Qualitative, quantitative, or combined experiments, concerning mostly practical impacts of sensitivity and scenario analyses. Existence of quantitative models allows also parametric optimization of original problem.

Methodological specificity of presented platform insists in the combination of low-level quantitative and high-level qualitative analyses, as it is shown in Figure 1. In the design phase, a two-stage qualitative model of global dynamics was developed, validated, and functionally demonstrated. This model merged the traditional system dynamics knowledge-based modelling with data-driven identification of national-specific GDP drivers, complemented with determining global environmental and social indicators.



*Figure 1: Applied two-stage methodology of national performance modelling*

Assumed temporal behaviour of selected variables results from their nontrivial synthesis within a complex systemic model, constructed from the collected data and knowledge artefacts. This model was represented with a set of simultaneously valid diagrams, gradually simplifying and specifying the real-world problem. Its highest level was represented with a mind map and further concertized in a form of system diagram. Related behavioural features were synthesized from joint contributions of mutually interconnected loops of related Causal loop diagram (CLD). Initial dynamic hypotheses were discussed with respect to the feasible execution of inner loops, exposed to typical configurations of external events. All these formalization techniques are tools thoroughly characterized in (Morecroft, 2015; Sterman, 2014).

The data-driven model processed national indexes concerning economy, population, and environment of the first 20 OECD countries during the period 2014-2019, ordered according to their GDP in the last year of analysed period (OECD, 2021): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Luxembourg, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States. The reason for somewhat obsolete selection was that although it includes the impacts of relatively persistent global changes like terrorism, migration or environmental hazards, it was not yet affected with the current pandemics. Raw source data were cleaned, normalized and transformed into two specific sets, convenient for further



processing by different algorithms of supervised and unsupervised machine learning. Supervised tasks considered equally discretized values of GDP per capita (GDP) as the target variable and single records were processed anonymously, i.e., without relation to the country. Instead of more typical classification or regression, the main goal of supervised analyses was dimensionality reduction, searching for a relevant subset of the most powerful GDO predictors. National-specific features were searched personally in outputs of different types of unsupervised learning procedures.

Two types of data sets for generally oriented static and nationally oriented dynamic analyses were prepared. While static data contained values of regular variables of complete indexes, dynamic, country-specific data consisted of total differences and slopes of linear approximations of every variable for the whole investigated period.

Different modules of the SAS Enterprise miner were used for machine learning tasks. StatExplore with Gini tree-based selection criterion implemented the dimensionality reduction procedures and Variable Clustering node with default parameters performed the unsupervised clustering procedures. Detailed information regarding particular machine learning and pattern recognition methods can be found in (Bishop, 2007; Witten *et al.*, 2016).

### **3 Results and discussion**

#### **3.1 Data-driven model**

Source data, containing the desired knowledge artefacts characterizing global and national drivers of GDP, were derived from a broader set of recognized yearly published international indexes, recommended by domain experts. During the selection stage, candidates were evaluated with respect to their diversity (D), independence (I), transparency (T), internal structure (S), availability of methodology (M), trustworthiness of resource (R), and range of local coverage (C). These features were quantified in scale from 1 to 5 and indexes with the highest total scores were adopted. Besides the score, the final set also had to address all basic dimensions of internal sustainable development, including population, industry, and environment, as well as the primary resources of global dynamics. Results of this evaluation are summarized in Table 1, from where the first five candidates were chosen and extended with the yearly national levels of

Unemployment rate (UNR) and GDP. From the system point of view, indexes of Competitiveness, Democracy, GDP, Human Development and Unemployment were considered as internal or national-level descriptors and represented the fundamental structural elements of subsequent CLD. Environmental performance index and Multidimensional poverty index, limited on developing countries, served as exogenous inputs of global dynamics and their role insisted especially in design of appropriate scenarios.

Table 1: Evaluated and selected global indexes, jointly constituting national GDP

<b>Global index/Feature</b>	<b>D</b>	<b>I</b>	<b>T</b>	<b>S</b>	<b>M</b>	<b>R</b>	<b>S</b>	<b>Total</b>
Democracy [DEM] (The Economist Intelligence Unit, 2020).	5	5	5	5	5	4	5	34
Competitiveness [CMP] (Schwab, 2019)	5	4	5	5	5	4	5	33
Environmental Performance [EPE] (Wendling et al., 2020a)	5	4	5	5	5	4	5	33
Human Development [HDE] (UNDP, 2020)	5	4	5	5	5	4	5	33
Multidimensional Poverty [MPO] (Conceição et al., 2020a)	4	4	5	5	5	4	4	31
Gender Gap (Schwab et al, 2020).	2	5	5	5	5	4	3	29
Knowledge (Ghriss et al., 2020).	4	3	5	4	4	4	5	29
Peace (IEP, 2019)	2	3	5	5	5	4	3	27
Terrorism (IEP, 2019a).	2	3	5	5	5	4	3	27
Climate Risk (Eckstein et al., 2020)	2	3	4	4	5	2	3	23
Migration (UNHCR, 2020a)	2	4	3	3	3	3	2	20
Crime and Safety (Numbeo, 2021a, Numbeo, 2021b)	2	3	2	1	2	4	2	16

Detailed structure of selected indexes is shown in Figure 2 with internal components marked as follows: solid lines: MPO Health (MPO\_HEA), EPE Environmental health (EPE\_HEA), dashed lines: MPO Education (MPO\_EDU), EPE Ecosystem vitality (EPE\_VIT), bold lines: MPO Living standards (MPO\_LIV).

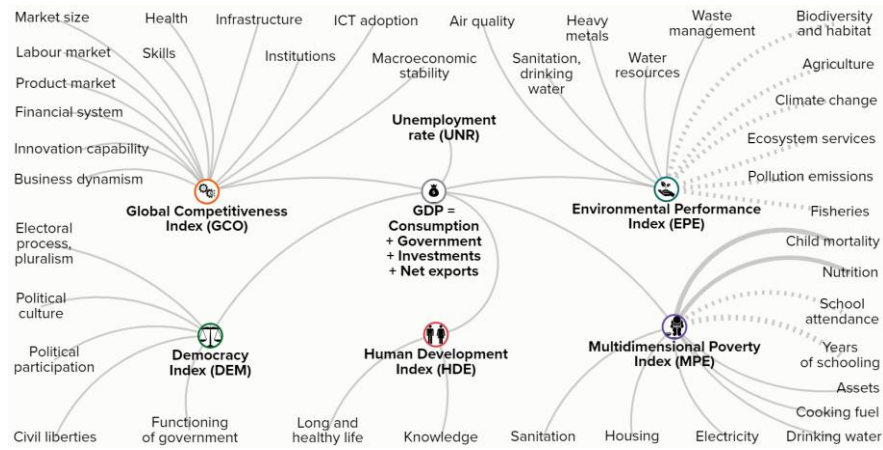


Figure 2: Internal structure of selected indexes

After this specification, complete and unreduced static set contained 120 21-dimensional records and the dynamic set had 20 28-dimensional records. Both sets were processed as follows:

- Task 1: static data processed with supervised learning, resulting to the set of general steady GDP predictors valid equally for all processed countries,
- Task 2: static data processed with unsupervised learning, resulting to the set of country-specific steady GDP predictors,
- Task 3: dynamic data processed with supervised learning, resulting to the set of general dynamic GDP predictors (data slopes) valid equally for all processed countries,
- Task 4: dynamic data processed with unsupervised learning, resulting to the set of country-specific dynamic GDP predictors (data slopes).

For better clarity, all presented graphs are relative. In absolute numbers, outputs of unsupervised tasks explain almost full variance of original data, while supervised algorithms covers only around 65% of the total variance. Moreover, the accuracy of dynamic predictions is lower because of small size of this dataset. Global indexes are not available in dynamic analyses, because their values are similar for all countries. This methodological limitation is acceptable, as in specific cases countries could promptly react on internal changes, but usually cannot simultaneously handle also considerable effects of global dynamic. Moreover, origins of these slow changes lie in the past, so the steady information could be satisfactory.

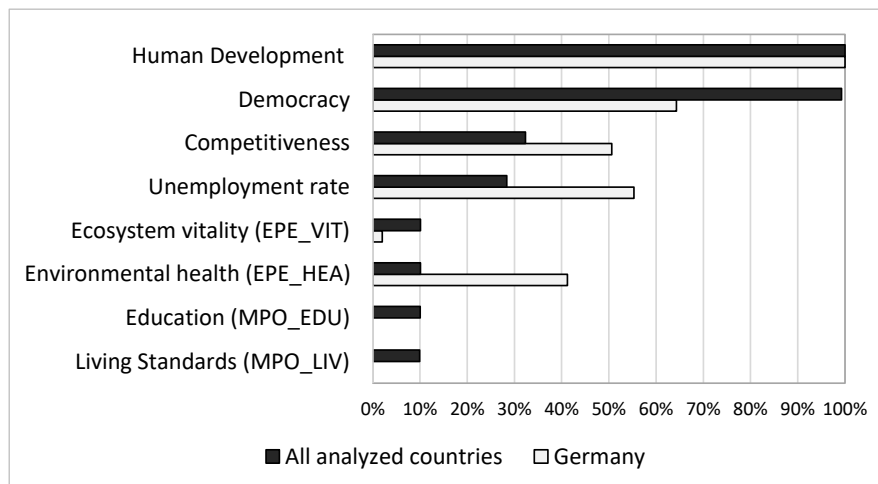


Figure 3: Comparison of regular values of the best steady GDP predictors for all analysed countries (results of Task 1) with specific findings for Germany (Task 3)

The ordered significance of general steady predictors (Task 1) in Figure 3 shows the key role of the human-related internal drivers HDE and DEM, followed by the more industrial ones, CMP and UNR. Influence of global predictors is lower and approximately equal. Situation in Germany, derived from the coordinates of the corresponding data cluster (Task 3) is slightly different (note: predictors Education and Living Standards are 0 for Germany). Although the paired dominance of HDE and DEM remained, there is a considerable mutual difference. Also, the roles of UNR and CMP increased and remarkable is also the national meaning of EPE\_HEA.

These finding suggests the most powerful causal relations with respect to GDP. Because of the later applied dynamic analysis, there is no need to distinguish between the cause and effect and the only limiting factors are the durations of incorporated loops. All discovered knowledge artefacts can decrease the overall complexity of originally posted problem, contribute to specification of final qualitative model and simplify the validation of dynamic hypotheses.

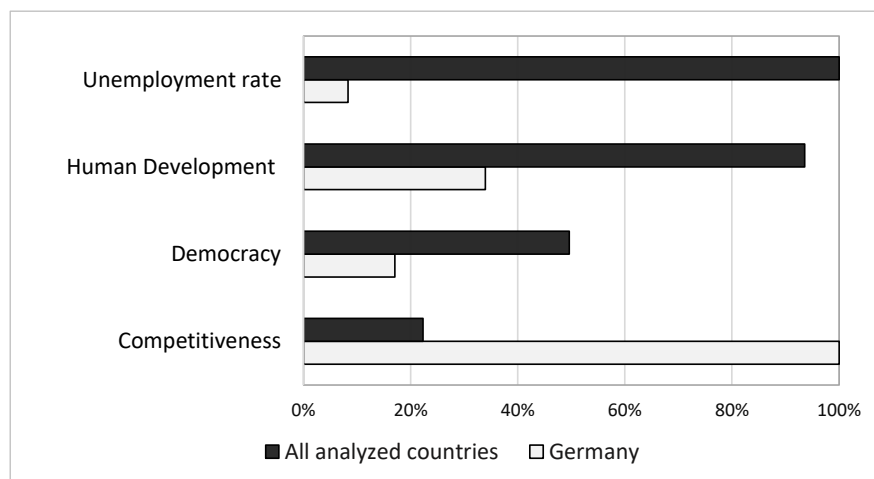


Figure 4: Comparison of slopes of the best dynamic GDP predictors for all analysed countries (Task 2) with specific findings for Germany (Task 4)

Although the dynamic analyses have rather supplementary character, in the presented case they showed the difference between the general and specific indicators. Results in Figure 4. show that in the general case UNR slope (negatively) corresponds with GDP slope, in case of Germany the significance of this indicator is minimal, and the strong role plays variable CMP. Also, the meaning of commonly influential human-related indicators HDE and DEM is suppressed in Germany.

### 3.2 Formulation of dynamics hypotheses

Dynamic hypotheses H1 – H5 were formulated to illustrate sample interventions between global scenarios and GDP related national-level decisions in Germany during the analysed period 2014–2019. Their starting point is represented with the annual GDP growth 3,7% in 2014. All hypotheses are indicatively quantified in Figure 5.

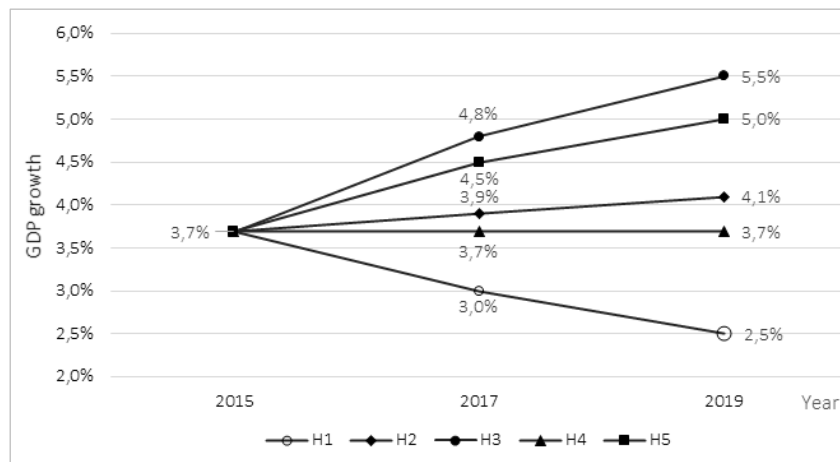


Figure 5: Dynamic hypotheses for sample scenarios

- H1, pessimistic: As a result of global changes, there is an increase in unemployment and poor availability of skilled labor. This has a negative effect on GDP growth. There are frequent gaps in the labor market, limiting the productivity of the public and private sector and reducing their competitiveness.
- H2, realistic: Global and national environmental impacts accelerate with increasing competitiveness and higher consumption. Efforts to address this situation through appropriate restrictions have a negative effect on GDP. Conversely, investment in innovation can slow down environmental change. This also has a positive effect on GDP growth.
- H3, optimistic: Life expectancy is increasing slightly, people are satisfied, and a large part of the population has an advanced level of education. The education system utilizes modern methods and technologies, the average state expenditure on education is at a higher level than the average of OECD countries. This has a positive effect on GDP growth and provides more financial opportunities to respond to negative global pressures.
- H4, conservative: Both major global factors – environmental change and global poverty – may result in population migration. At least for the time being, it has a rather negative effect on GDP growth. Efforts to directly combat these influences occur mainly through humanitarian aid and regulations.

- H5, progressive: External influences negatively affecting GDP can be indirectly compensated, for example, by higher investment in education. These have positive effect on the level of education and knowledge of the population. Better education helps to increase human capital and the growth of a skilled workforce. As a result, unemployment falls, which will have a positive effect on GDP growth.

### ***3.3 Knowledge-based model***

The set of key variables, discovered in the data-driven stage, was used for formulation of dynamic hypotheses and their validation through the corresponding predictive qualitative model. Such model is composed from patterns of the most relevant activities and can project their joint consequences into a realistic time horizon. Established predictive support helps managers to anticipate future performance with respect to determining external scenarios and efficiently reflect their impacts. Resultant improved resilience maximizes possible benefits, minimizes losses, orchestrates internal environment and harmonizes external relations.

To obtain the desired Causal loop diagram for Germany, linear structure of mind map from Figure 2 was specified using the index-based knowledge and transformed to a cyclic, behaviour generating structure, simplified version of which is in Figure 6. Even in this reduced form for publication it contains 61 loops with length from 3 to 11 edges. Knowledge fragments discovered from indexes were utilized for modification of general high-level causal loop diagram, in which the less sensitive segments were suppressed, and the more powerful parts were analysed to introduce and justify desirable policies or strategies. These arrangements should maximize the selected target variables with the most efficient internal levers and simultaneously minimize the influence of global perturbances. Inclusion of so far unaddressed pandemic just illustrates the straightforward scalability of presented approach.

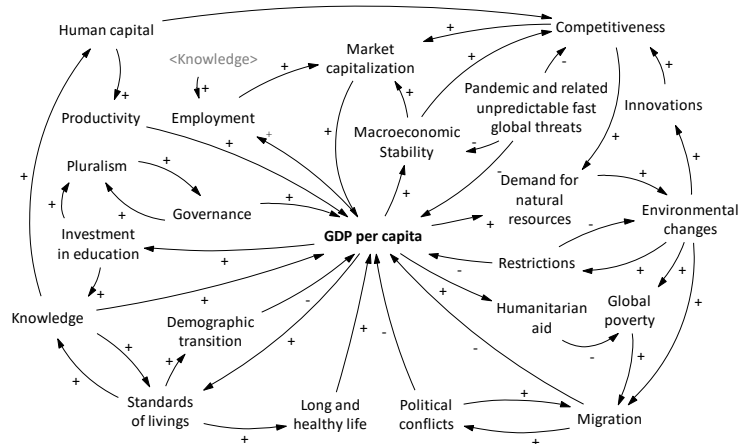


Figure 6: Causal loop diagram of presented problem, modified for German GDP

### 3.4 Discussion of dynamics hypotheses

- H1: There are several ways in which global factors can affect unemployment. Mostly they are linked through GDP and knowledge variables. CLD also shows the link between productivity, employment, and human capital. The raise of unemployment due to global influences has negative impact on human capital and its quality. This results in a reduction of productivity, GDP and employment. In addition, the CLD shows that employment has a direct impact on market developments, which also affect GDP.
- H2: CLD shows a link between competitiveness, natural resource consumption, environmental change, regulations, innovation, and GDP. It is also evident that higher competitiveness leads to higher consumption of natural resources, which negatively impacts the effect of environmental change. The relationship between these changes and regulations that have a negative effect on GDP is also present. Innovations arising from the need to act against environmental change lead to better competitiveness, which has a positive effect on GDP and thus offers more opportunities to combat environmental change. Although innovations resulting from environmental change do not directly lead to suppression of environmental effects, they contribute to higher GDP through the variable *Markets* and thus provide more



funding thanks to increasing competitiveness. This dynamics can also be used to combat environmental change.

- H3: In CLD, there is a leading loop connecting living standards, long and healthy life, knowledge, and investment in education. Thus, growing GDP stimulates increase of living standards, which will have a positive effect on a long and healthy life. This raises population satisfaction and, in turns, GDP. Higher GDP enables the expansion of investment in education, which will ideally be reflected in the more widespread use of information and communication technologies in education. The growth of investment in education accompanied by higher living standards has a positive effect on the level of knowledge. It has a positive effect on employment and human capital. This together leads to higher competitiveness and, through the variable *Markets*, to higher GDP. Human capital also has a positive effect on productivity, which again has a positive effect on GDP.
- H4: CLD in Figure 6 shows the interconnection of the parameters of environmental change, global poverty, and migration. Environmental change can lead directly to migration, for example due to acute threats and natural disasters, or indirectly because of poverty, caused, e.g., by drought or lack of food. Migration currently has a rather negative effect on GDP. Its potential is not being used and migrants are not fully integrated into everyday life. This, for example, hampers the effect of possible positive demographic changes. In addition, the growth of migration can lead to the intensification of political conflicts. These have a negative impact on GDP growth. Such effects can be compensated with regulations that have a negative impact on GDP and are intended to prevent further deterioration of the environment. In addition, it is possible to use humanitarian aid, which is primarily intended to prevent local unrest and improve the living situation of the local population. The more financial resources the country has, the more support can be dedicated to humanitarian aid programs.
- H5: There are many ways to respond to external influences. According to CLD diagram, a positive effect can be observed as a result of higher investment in education. This affects not only the level of educational attainment, the knowledge of the population, human capital, and

unemployment, but also addresses competitiveness and markets, which have a positive effect on GDP growth.

Previous discussions confirmed that all originally posted dynamic hypotheses are explainable through the presented qualitative model. It is also capable to demonstrate interactions between the German-specific and global GDP-related factors. We found that regulations, humanitarian aid or innovation serve as direct assistance in combating global negative effects and, in certain circumstances, can exacerbate environmental changes. Given the results of data mining, which showed only a minor influence of global factors on GDP growth, the positive effect of higher education or competitiveness will certainly prevail.

In the case of Germany, it is recommended to invest in education and satisfaction of the population. Investment should ideally be higher than the OECD average. The education of the population is a key indicator for the good functioning of the state and its prosperity. The quality of human capital and the level of unemployment are automatically linked to this matter. When such parameters are set correctly, competitiveness increases. The overall competitiveness of Germany can be also improved with systematic support of ICT and digital technologies, resulting into a higher productivity.

#### **4 Conclusions**

This paper analysed influence of global dynamics factors on national performance expressed in terms of GDP. To fulfil this goal, a two-stage model, combining related quantitative and qualitative aspects was proposed and discussed. The most significant decisive factors of GDP generation, composed of national and global drivers, were identified from results of different machine learning techniques, applied on selected global indexes. Based on these findings, the problem characterizing dynamic hypotheses were formulated and subsequently analysed through an accordingly designed Causal loop diagram. Applicability of resultant predictive behavioural patterns were demonstrated for case of Germany.

The authors believe that innovativeness of the suggested way of incorporation of global dynamic aspects into the national strategic decision-making processes insists in the following contributions:

- Straightforward and efficient simplification of the naturally complex problem,

- Standardized, widely applicable and easily replicable architecture of proposed solution,
- Layered structure, composed both from the top and bottom-level knowledge artefacts,
- Understandable internal representation, supporting group decision making,
- Partial validation of model during the data processing stage,
- Straightforward computational implementation within a system dynamics framework.

Such outcomes also synthesize an applicable solution for the originally posted research problem. The proposed way of individualized modelling of strategic development with respect to typically evolving global dynamics can facilitate policy-making processes on the governmental level. Its flexible and multilevel structure allows identification of a minimal set of key parameters, guaranteeing efficient and robust planning of country future by means of well-informed, creative dialogues of involved stakeholders. On the other hand, for the national governments with yearly planning cycles, it is practically impossible to appropriately respond to the fast and rare global events, such as the COVID-19 pandemics. These out-of-system events are considered as disturbances, and their elimination depends entirely on the momentary capabilities and resources of the national planning and control system.

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## The Intellectual Capital of Corporate Governance for Overcoming a Crisis

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### Abstract

Despite the growing interest in the field of IC, there is still a lack of evidence and literature on the importance of IC in companies' turnarounds, an issue that is even more pressing due to Covid-19.

The pandemic is impacting corporates' performances all over the world and most of them will face turnaround processes after the end of the emergency. In this scenario, our paper aims to study the positive role of intellectual capital on overcoming economic-financial distress.

More particularly, assuming that IC - represented by corporate governance' professional background, skills, knowledge, internal and external relationships - is one of the firm's key factor and that, through the turnover of corporate governance, new knowledge and organizational capital is introduced, we presume that IC helps the competitiveness and thus the positive conclusion of the recovery plan.

In order to demonstrate that some changes in the corporate governance could reconfigure the IC, increasing the chances to carry out a successful turnaround, we considered four case studies of Italian companies that have positively overcome a crisis.

The analysis showed that the intellectual capital of corporate governance influences the success of the turnaround processes. Even though further investigations are essential to fully understand the role of IC in the treatment of a crisis, our results suggest that it is

possible to view IC as a lever for overcoming economic-financial distress and, particularly, that the renewal of corporate governance positively influences the turnaround outcome.

**Keywords** – corporate governance, intellectual capital, turnaround, value creation

**Paper type** – Academic Research Paper

## 1 Introduction

In the XXI century, the knowledge-intensive economy fostered the study of intellectual capital (IC). Indeed, in the last decades, scholars and practitioners are focusing on IC, which is considered both a factor for the success of national economies and a company's strategic driver (Asiaei and Jusoh, 2015; Clarke et al., 2011; Iazzolino and Laise, 2016; Lerro et al., 2014; Martín-de Castro et al., 2019), developing different strands of research.

Despite the increasing interest in this field of research, the literature is still missing significant contributions concerning the role played by IC in corporate turnarounds. To the best of our knowledge, one of the few papers is that one of Schiuma et al. (2008).

In this paper, we assume that IC is a corporate key factor represented by professional background, skills, knowledge, organizational structure, and internal and external relationships (Mazzotta, 2018; Paoloni et al., 2020) and that to introduce new knowledge and organizational capital (Chen et al., 2014; Berezinets et al., 2016; Agostini and Nosella, 2017) helps the competitiveness. Therefore, we presume that changes in management could reconfigure IC (Keenan and Aggestam, 2001) in a way that might impact the turnaround outcome. In other words, our research question is "does the renewal of IC brought by new corporate governance members affect the turnaround outcome?" To answer this question, we qualitatively investigate four successful case studies in which authors have been involved as advisors, highlighting the relevance of the new directors and shareholders on the IC that positively impacts the recovery.

The paper is structured as follows. Section 2 reports a review of the literature, with regard to intellectual capital and corporate turnaround. Section 3 provides for the description of four business cases that point out the relevance of the change in terms of IC and its importance to solve the crisis. Section 4 illustrates the discussion of the results and our main conclusions.

## 2 Theoretical Background

Due to the relevant role played by IC, most authors consider – among others – its potential in terms of value creation, competitive advantage, and success (Agostini et al., 2017; Demartini and Beretta, 2020; Kato et al., 2015; Razafindrambinina and Anggreni, 2017; Wang and Zatzick, 2018; Guthrie et al., 2006; de Pablos and Edvinsson, 2014).

Although literature provides various descriptions of IC, most of the research agrees on defining it as the integration of human capital, structural capital, and relational capital (Bontis, 1998; European Commission, 2002; Tayles et al., 2007; Kamaluddin and Rahman, 2009; Kianto et al., 2014; Appuhami and Bhuyan, 2015). Following we provide a short description of each component:

- Human capital (HC) refers to explicit and tacit knowledge, expertise, aptitude, education background, competencies, and characteristics of human resources (Bontis, 1998; Dzinkowski, 2000; Edvinsson and Malone, 1997; Lönnqvist and Mettänen, 2002; Roos and Roos, 1997; Stewart, 1997; Subramaniam and Youndt, 2005; Schiemann and Guenther, 2013; Berezinets et al., 2016), including both top executives and employees. Indeed, Berezinets et al. (2016) focus on IC creation, underlining it is generated not only by employees, as traditionally assumed, but also by advisory councils, suppliers, volunteers, strategic allies, partners, and members of board of directors (BoD). BoD, thanks to their skills, experience, and networking connections, can properly define the firm's strategy, identify the vision and the mission, and give the guidelines to top management and all company's staff, in order to maximize performances. Having said that, the BoD's tasks and responsibilities "can be considered as the driver of IC generation that leads to a more effective work environment and the employment of other elements of IC in a company. [...] the BoDs is also the driver that makes other elements of IC work more effectively" (Berezinets et al., 2016).
- HC is one of the main sources of other intellectual assets within a firm (Abdulaali, 2018).
- Structural Capital (SC) includes organizational and technological capital (Martín-de Castro et al., 2019) and refers to the combination of knowledge, that is useful for building a proper, efficient, and effective

organizational structure, and the things like proprietary software systems and distribution networks, that are more strictly linked to companies' technical systems (Bontis, 1998; Edvinsson and Malone, 1997; Stewart, 1997; Petty and Guthrie, 2000).

- Relational Capital (RC) pertains to intrinsic value and knowledge embedded in corporate relationships with stakeholders, such as customers, suppliers, distributors, partners, and investors (Dzinkowski, 2000; Edvinsson and Malone, 1997; Roos and Roos, 1997; Pike et al., 2005).

With specific reference to the IC of the BoD, Nicholson and Kiel (2004) define it as "the intellectual resources such as knowledge, information, experience, relationships, routines, and procedures that a board can employ to create value". IC exists in every firm, regardless of corporate governance system (Keenan and Aggestam, 2001; Nicholson and Kiel 2004; Berezinets et al. 2016). However, much of a company's ability to create and leverage IC rests with its BoD members and shareholders.

Therefore, it is clear the role played by BoD, as well as by top management and shareholders, in the IC creation, is helpful to overcome financial distress. Indeed, corporate crisis is not irreversible (Guatri, 1986; Scherrer, 2003; Trahms et al., 2013) and, especially if promptly identified (Santana et al., 2017; Brodi, 2018), it can be solved by implementing significant strategic changes (Garzella, 2005). Literature provides contributions regarding the impact of corporate governance on the turnaround outcome (Mariani and Panaro, 2012; Miglani, 2014; Abebe and Tangpong, 2018; Miglani et al., 2020), but few references to the broader topic of intellectual capital exists. As posited by Schiuma et al. (2008), if people possess high levels of knowledge and skills, they can trigger a virtuous circle generating new ideas and techniques able to both launch changes in production and service delivery methods and increase relational capital and then improve performances. Indeed, also Santana et al. (2017) suggest that human resources in declining firms can replace the usual downsizing responses, highlighting its potential relevance.

Several studies show how top executives are essential figures to promote a new organizational structure, underlining their role for the strategic change which is necessary for a successful corporate turnaround (Lenz and Lyles, 1986; Barker and Patterson, 1996; Lohrke et al., 2004).

### 3 Materials and methods

#### 3.1 Research context

A distressed company can adopt multiple choices to survive at a crisis and avoid the failure by adopting several “procedures” (Ferri et al., 2020). In Italy, some of these procedures are formal and provided by the law<sup>1</sup> while others are informal, and their use must not be compliant with any rules<sup>2</sup> (Caputo and Tron, 2016; Tron et al., 2018; Tron, 2021). In any case, the turnaround should encourage virtuous behaviours, and if the crisis is irreversible, it should guarantee the liquidation of companies (Ambrosini and Tron, 2016).

#### 3.2 Methodological approach

The ability to identify the signals of corporate crisis plays a continuing and ever more important role in modern managerial finance. Recently, the specification of a firm’s debts becoming “unlikely to pay” (UTP) has taken on increased importance in Europe, and especially in Italy. The existing literature on distress prediction mostly considers the filing of bankruptcy procedures as a criterion for distress, which represents the final phase of a crisis. By adopting an earlier condition of financial distress, we have managed to consider the relevant inclusion of corporate governance and controlled variables. Most past research includes only economic and financial variables (Dallocchio et al., 2020).

In this article, we want to qualitatively study the usefulness of intellectual capital in successfully restructured companies. This kind of analysis allows us to acquire some information concerning the IC in the turnaround process. Moreover, some authors have been directly involved in the restructuring process and this gives the opportunity, on one side, to observe the recovery management and, on the other side, to obtain several and peculiar information able to better investigate the role of IC in the turnarounds. More particularly, we analysed four success stories to highlight the positive impact of governance changes on the turnaround process and, particularly, the significant effects that the introduction

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<sup>1</sup> As an instance, the crisis management must ensure at least rights of creditors, interests of stakeholders (e.g., employees), and the affordability of crisis management as provided by the specific laws, defined generally in this paper “insolvency code”.

<sup>2</sup> For example, the Preventive Arrangement with Creditors (“Concordato Preventivo” pursuant art. 161 R.D. n. 267 dated 16 March 1942), that is like US’s Chapter 11, is frequently adopted by small- and medium-sized companies to manage insolvency (Danovi et al., 2016).

of new IC has on crisis resolution. The case studies allowed us to acquire the knowledge of the IC brought by the new personality (like the directors and shareholders) involved in the turnaround.

### *3.2.1 Case studies analysis*

Due to confidentiality reasons, the real names of the companies are omitted.

#### **Case Study 1**

Alpha S.p.A. is an Italian public limited company operating since 1982 in the production and marketing of accessories and paper products for schools and leisure time. Its original success was due firstly to the entrepreneurial intuition to launch a new profitable market and then to the ability to innovate to the high quality its products, and to the wide and transversal offer proposed.

After years of significant growth, from 2008/09 the sales volumes have been declining and the Company began recording negative performances and financial tension, mainly because of the consumption decrease due to the global economic crisis, the inefficient organization, the bad changes in the business model, and some wrong strategic investments; hence, in 2013, Alpha presented a recovery plan, drawn up pursuant to the "insolvency code." The management, with the help of specialized advisors, outlined a turnaround strategy, for the period 2013–2015, primarily based on competitive repositioning, organizational restructuring, and financial structure's redefinition.

To successfully work on these three main guidelines, Alpha appointed a director with specific powers. Indeed, the pool of professionals involved in this recovery plan suggested inserting a new person able to, on one side, bring new ideas, new knowledge, and new relationships and, on the other side, oversee the turnaround process to guarantee all stakeholders. As a matter of fact, this insertion brought substantial value, allowing Alpha to overcome the crisis through the involvement and the renewal of human, structural, and relational capital. The success of the turnaround can be attributed to structural and specific actions that engaged managers, employees, business processes, and stakeholders (e.g., banks and suppliers). For example, the new BoD promoted the optimization of the organizational structure and the revision of ICT systems, the cost rationalization, and the development of proper commercial strategies. This mix of ventures allowed restoring the value creation and the competitive advantage to the point that, in 2018, more than 50% of Company's shares have been acquired by a

private equity fund with the scope to expand American and Asian markets, fostering the international growth.

The success of the turnaround can be seen in Table I that shows Alpha's positive evolution for the period 2012–2018.

Table I. Turnover, EBIT, net results and no. of employees of Alpha S.p.A. (2012–2018)

	2012	2013	2014	2015	2016	2017	2018
Turnover	41.023.250	39.753.263	41.952.474	47.439.578	57.399.423	62.187.500	59.788.807
EBIT	3.831.781	6.465.849	5.874.791	3.805.850	7.701.330	9.635.450	9.628.892
Net result	-7.805.284	616.696	1.643.412	3.079.675	7.770.200	6.373.133	5.651.481
N. employees	87	80	77	77	82	77	78

## Case Study 2

Beta S.p.A. is a public limited company operating since 1977 in the retail of distinctive sportswear and sports equipment. Its original success was due firstly to the continuous acquisition of highly prestigious distributors brands and then to the capability of innovating its products to the high-quality standards and to the strong collaborations and synergies with the main worldwide sector brands.

The Company enjoyed years of significant growth until 2012. Since then, mainly because of the decrease in consumption due to the global economic crisis, an unchanged business model even if there were an environmental evolution and some wrong strategic decisions, the Company recorded economic and financial distress; hence, in 2013, the Company presented a recovery business plan, drawn up pursuant to "insolvency code."

The management, with the help of specialized advisors, outlined a turnaround strategy, for the period 2012–2016, primarily based on competitive repositioning, organizational restructuring, financial structure's redefinition, and reduction in the costs of goods sold (COGS). To successfully work on these four main guidelines, Beta appointed a new BoD. Indeed, new managers' target of EBITDA, better days sales outstanding (DSO), days of payables outstanding (DPO), and days inventory outstanding (DIO) was achieved in the period considered. The success of the turnaround can be mainly attributed to structural and specific actions that newly engaged managers, employees, business processes, and stakeholders (e.g., banks

and suppliers) put in place to overcome the crisis. A very important role has been played by the new structural and relational capital.

For example, the new BoD promoted the optimization of the organizational structure and the revision of change in the sales mix, the cost rationalization, and the development of new commercial strategies. This mix of ventures allowed to restore the value creation and the competitive advantage to the point that, from 2020, the Company is examining the chance to go for an initial public offering (IPO).

The success of the turnaround can be seen in Table II that shows Beta's positive evolution for the period 2012–2018.

Table II. Turnover, EBIT, net results and no. of employees of Beta S.p.A. (2012-2018)

	2012	2013	2014	2015	2016	2017	2018
Turnove	344.044.000	314.526.000	310.215.000	323.213.000	339.407.000	350.876.000	379.713.000
EBITDA	2.375.000	-6.069.000	7.136.000	19.002.000	21.185.000	27.225.000	25.499.000
Net resu	-26.315.000	-17.469.000	-6.596.000	1.956.000	4.653.000	10.085.000	8.557.000
N. empl	2.200	2.086	2.062	2.147	2.283	2.391	2.585

### Case Study 3

Gamma S.p.A. is a public limited company operating since 1977 in the production and marketing of baked ham and similar products (like mortadella, raw ham, etc.). Since the 1980s, the Company has experienced exponential growth in production thanks to the great attention paid to the nutritional values and the creation of a new product suitable for the taste of an increasingly sensitive and attentive public. The removal of polyphosphates, together with the idea of the freshness-saving tray, launched Gamma on the road to success and guaranteed the high-quality level of cooked ham.

The crisis in the real economy which since 2010 has affected all sectors and caused a sharp contraction in demand, has also affected Gamma which, despite this, has managed to keep the corresponding sales volume substantially unchanged until 2012.

Since 2013, however, the Company has undergone a substantial drop in turnover which, together with the policy of strong expansion and development undertaken, has had a profound effect on Gamma's ability to meet its obligations on a regular basis.



The causes of the crisis mainly have an endogenous nature and concern excess production capacity, production inefficiencies of its main establishment, redundant organization chart, investments with lower-than-expected return rates, imposing structure of general fixed costs, interruption of supply flows in 2014 as a result of the situation of financial tension, and production inefficiencies deriving from the lack of supplies.

Due to the abovementioned reasons, in 2015 Gamma presented a recovery business plan, drawn up pursuant to "insolvency code."

The 2015–2017 recovery business plan envisaged the rationalization of the cost structure and the concentration of production and slicing activities at a single plant and the concentration of all further operational and administrative activities in a single building with a significant reduction in fixed costs and lease. All shareholdings have been placed in voluntary liquidation, the redundancy of employees has been cut off, and the increase in turnover has been monitored considering the EBITDA margin, DSO, DPO, and DIO target of the recovery business plan.

The success of the turnaround can be attributed to the new BoD that has been appointed in 2015. For example, the new BoD promoted the optimization of the organizational structure and the cost rationalization, the development of new commercial strategies, and a different approach to the market. This mix of ventures allowed restoring the value creation and the competitive advantage to the point that in 2018 the Company has been taken over by a new prestigious shareholder.

The success of the turnaround can be seen in Table III that shows Gamma's positive evolution for the period 2012–2018.

Table III. Turnover, EBIT, net results and no. of employees of Gamma S.p.A. (2012–2018)

	2012	2013	2014	2015	2016	2017	2018
Turnover	119.740.000	109.179.000	89.356.000	61.162.000	63.998.000	66.675.000	62.993.000
EBITDA	7.020.000	-26.602.000	592.000	288.000	1.380.000	5.047.000	6.781.000
Net result	281.000	-75.122.000	-23.178.000	-5.093.000	48.152.000	768.000	3.047.000
N. employee	249	232	208	161	139	139	140

#### **Case Study 4**

Delta S.p.A. is a public limited company with one hundred and sixty years of history and is among the leaders in Europe in the production of brass bars and strips in copper and its alloys, from brass to bronze and special alloys.

Serving both large industry and specialist customers, the development of increasingly high-performance copper alloy products is the daily challenge to give concrete form to a future that is more and more towards smart cities, renewable energy, and sustainable mobility.

The financial crisis of the Company appeared in 2016 due to exogenous and endogenous causes. The first ones were mainly referred to the conditions of the competitive environment (significant decrease in sales volume, increase in raw material prices, contraction in economic margins, and decrease in bank credit lines) and the second ones were mainly due to crisis of the laminate business unit, acquisition of an important shareholding, and conflict within the social structure.

In 2017, the Company presented a recovery business plan, drawn up pursuant to "insolvency code".

The industrial turnaround was based on the following:

- a) reduction in personnel costs, mainly due to the adjustment of the workforce in the context of the reorganization of the BU laminated.
- b) savings on costs related to high voltage electricity following the centralization of production activities at the main plant.
- c) savings on the costs of transporting materials between the various plants following the centralization of production activities.
- d) an expected benefit on net working capital deriving from the reduction in the average days of collection of trade receivables from "slash customers" due to the introduction, starting from 2017, of the new procedure relating to shipments and invoicing on a biweekly basis.
- e) confirmation of credit lines, on short-term lines, with partial modification of the rules of use and revision of the burden.
- f) a capital moratorium based on medium/long-term mortgage exposure.
- g) new board of directors.
- h) new management team.

The success of the turnaround can be attributed to structural and specific actions that engaged managers, employees, business processes, and stakeholders (e.g., banks and suppliers).

The new board of directors and the new management team are promoted as follows:

- a) improvement of the level of service offered to the market to recover the relationship with some important customers and increase the *Share of Wallet* on others in the portfolio.
- b) improvement in the quality level of the output (both in terms of reducing the percentage of waste and in terms of compliance) making the performance more efficient in terms of industrialization and quality control.
- c) achieving greater added value in the product output (surface coatings, packaging, shapes, and thicknesses).
- d) recovery of margins of the “laminates” business unit.

This mix of ventures allowed to restore the value creation and the competitive advantage to the point that, from 2020, the Company has a new promising industrial plan and has changed most part of the foster banks.

The success of the turnaround can be seen in Table IV that shows Delta’s positive evolution for the period 2012–2018 after the renewal of corporate governance that increased, above all, HC, and RC.

Table IV. Turnover, EBIT, net results and no. of employees of Delta S.p.A. (2012–2018)

	2012	2013	2014	2015	2016	2017	2018
Turnover	232.720.551	225.888.104	238.182.875	233.290.075	211.399.098	196.441.110	208.195.506
EBITDA	18.582.923	11.894.264	17.395.339	10.328.946	10.016.365	12.655.898	9.617.696
Net result	546.119	-2.551.259	699.486	-2.972.489	-17.644.373	683.032	5.004.823
N. employees	240	234	231	252	257	364	335

#### 4 Discussion and conclusions

The analysis shows the existence of a link between BoDs and shareholders succession and IC. Nowadays and more strongly after the emergency period due to Covid-19, one of the main concern of firms, regardless of their size and sector, is the threat of insolvency. This research intends to reveal that the incumbent manager assumes a special interest in a financial distress situation when the (new) shareholder’s structure ensures the selection of the optimal restructuring method/solution. The complexity of the decision situation in financial distress –

which includes time pressure and short terms targets – leads to increase in the risk of irrational biases in decision-making as compared to regular business situations. This is the reason why any action on the variables to bring new IC can have relevant consequences on the outcome of the successful turnaround.

The analysis of the four case studies of Italian companies seem to support the theoretical proposition that IC, when related to changes in corporate governance (Berezinets et al., 2016; Keenan and Aggestam, 2001), likely corresponds to a successful turnaround. Indeed, BoD is the main internal corporate governance mechanism that generally carries a certain amount of IC, which includes human capital (knowledge, skills, and experience) and relational capital (social ties and networks) of each individual member. As such, BoD is argued to drive the intellectual capital performance of the firm by making the various systems of IC work more effectively.

Therefore, once the review on the most relevant literature on intellectual capital and corporate turnaround is achieved, with specific attention to the Italian context, we assumed the renewal of corporate governance positively influences the turnaround outcome.

Despite the limitations and further investigations to be developed in the future, the current research seems to have taken a step forward compared to the existing literature (Berezinets et al., 2016; Demartini and Beretta, 2020; Martín-de Castro et al., 2019; Santana et al., 2017; Schiuma et al., 2008).

The analysis of the experiences from the selected four success stories presented in this article allows for a systematization of the main success elements for the solution of the crisis. In particular, we can derive an operational framework (reported in Table V) that shows the common causes of crisis, the action plan, the operational targets associated with the actions to take and a monitoring aspect that checks the achievement of said targets.

Table V. An operational framework for turnaround success

COMMON CAUSES OF CRISIS	ACTION PLAN	OPERATIONAL TARGET	ACHIEVEMENT
<b>Business Model</b>	Reschuffle of Business Model	Net Profit	Yes/No
	Cost Optimisation	Establishment cost reduction	Yes/No
	Net working capital optimisation	Positive cash flows	Yes/No

<b>Investments</b>	Outsourcing of some services	Net profit & NWC	Yes/No
	Transfer of operating area leasing	NFP Optimisation	Yes/No
	Overturning and sharing costs	Contingent asset from disposal	Yes/No
	Revision of ICT systems	Efficiency	Yes/No
<b>Management Team and staff</b>	Redefinition of the Management Team	Net Profit	Yes/No
	Staff cost reduction	Reduction of staff cost to the benchmark level	Yes/No
	Skills needs assessment	Coverage of needs skills	Yes/No
<b>Oversizing of the organisational</b>	Cost reduction (consultancy, insurance, credit services, staff charges, etc.)	Overhead cut-off and optimization	Yes/No
<b>Net Working Capital</b>	Payments to suppliers (DPO)	Reduction of WC requirements	Yes/No
	Collection from customers (DSO)	Reduction of WC requirements	Yes/No
	Optimisation of inventories (DIO)	Reduction of WC requirements	Yes/No

In terms of practical implications, our findings suggest that governing bodies may act as drivers of IC efficiency and that a change in both the shareholder's and BoD's composition has a positive impact on the success of a turnaround strategy. Indeed, the qualitative analysis allowed to demonstrate the role played by IC in the case studies. These results could be helpful for managers and practitioners in the current context where Covid-19 strongly affects companies' performances, leading to a huge number of businesses in a state of crisis.

Due to the inherent limitations of this research, further studies are necessary to refine and validate our results.

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## **Business Valuation in Emergency Contexts: Crisis Analysis Impact Due to the Covid-19 Pandemic**

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### **Abstract**

The aim of the paper is to investigate about the way the economic environment crisis, and particularly the Covid-19 emergency, affects the business valuation drivers, as well as to identify the adjustments requested to esteem a reliable value of a business, that reflects the market conditions.

Covid-19 has not only caused a health emergency, but also a real economic crisis, whose effects are destined to last for many years and whose recovery, following the most recent events, seems to take the shape of a "W". Specifically, the measures adopted to contain its propagation have seriously damaged companies all over the world, interrupting, even for a limited period, production and sales, with strong consequences in terms of lack of liquidity, worsening of financial structure and, definitely, greater risk of insolvency. However, not all companies have been affected in the same way. As with any financial crisis, the impact proves to be different depending on the industry the company operates in, as well as its characteristics.

The main research questions, therefore, are: "Are business valuation methods able to capture the impact of the crisis on companies? How is this impact reflected on corporate value? Are there sectors that have not been affected by the crisis or that have even benefited from it?".

To answer the research questions, we set a data sample of the top five companies, on a global scale, by market capitalization, with reference to two industries, air transport and telecommunications, and we observed the trend of their share prices. We found that although there is a decline for both sectors during the worst period of the pandemic (March-April 2020), over a longer time horizon (January 2019 to November 2020) these industries show opposite trends. In particular, while the telecommunications sector shows an overall positive trend, the air transport one presents a negative trend, with the latest observations being at a significantly lower level than the average level recorded over the reference period.

**Keywords** – Business valuation, Emergency contexts, Covid 19, Uncertainty

**Paper type** – Academic Research Paper

## 1 Introduction

The economic context has always had a deep influence on the process of business valuation, reshaping, in each step of its evolution, the concept of “economic value of capital” and the metrics to measure it. In fact, the value of a company is essentially related to three main factors: its current operations, its future prospects and its intrinsic risk (Massari, Gianfrate, Zanetti, 2016). Particularly, the risk variable, during unplanned events, should not be treated as one of the input variables, but rather as the main driver of the valuation process. In such circumstances, the DCF and multiples approaches turn out to be the most valid methods for estimating the economic value of capital, even if they must be carefully re-examined in order to incorporate the effects of the crisis (PWC, 2020).

Even though the field of business evaluation has been extensively analyzed (Guatri, Bini, 2005, Zanda, Lacchini, Onesti, 2013), a few number of studies have previously focused on the topic of valuation in the context of a crisis (Massari, Gianfrate, Zanetti, 2016). After the great recession of 2008, some researches were dedicated to the companies’ valuation in financial distress and, particularly, to the last phase of their life cycle, the decline (Damodaran, 2009). In the last twelve months the topic of the effects of the shock caused by Covid-19 on the drivers of business valuation has been analyzed, particularly in the studies conducted by consulting firms (Duff & Phelps, 2020, KPMG, 2020, PWC, 2020), even if the pandemic is currently ongoing and the level of uncertainty regarding its future developments is too high. The aforementioned studies converge in indicating that the unpredictability of the scenario must be taken into account through higher

discount rates and/or lower cash flows, for the DCF method, and lower multiples, for the multiples approach.

In order to give evidence of the different impact of the pandemic depending on the industry we tried to answer to the following research questions: are business valuation methods able to capture the impact of the crisis on companies? How is this impact reflected on corporate value? Are there sectors that have not been affected by the crisis or that have benefited from it?

We observed the performance of two sectors that have been involved in opposite ways by the crisis: the air transport sector, particularly disadvantaged due to the blocking measures and restrictions introduced worldwide, and the telecommunications sector, fundamental for the management of the emergency as it allowed the normal continuation of activities during a period characterized by social distancing. Particularly, we set a data sample of the top five companies, on a global scale, by market capitalization, with reference to the aforementioned industries and we studied the trend of daily share price during the worst period of the pandemic (March-April 2020), over a longer time horizon (January 2019 to November 2020).

## **2 The impact of COVID-19 on Business Valuation**

Between the end of 2019 and the beginning of 2020, COVID-19 has spread all over the world, turning quickly into a global pandemic causing a severe health emergency, as well as a social and economic disruption, a significant downturn in capital markets, and an increased market volatility (Van Vleet, 2020). Thus, the international economy, which had already experienced a moderate deceleration over the past two years, is going through a severe recession, due to both supply and demand shocks, that is far worse than the one experienced during the financial crisis of 2007-08, the most significant since the Great Depression (IMF, 2020).

In fact, the measures adopted to contain the propagation of the virus had a strong impact on the financial and economic performance of the companies.

The greatest impact occurred in terms of lack of liquidity: if on one hand companies have continued to incur charges and undeferrable expenses (including, among the main ones, salaries, taxes and social security contributions), on the other hand they had to deal with a strong compression of revenues, due to the interruption, even if for a limited period, of production and sales. At the

same time, the liquidity need has increased (to continue to cope with fixed costs), leading to a rapid thinning in reserves, with a consequent reduction in the ability to face demand's exogenous shock and phenomena of economic and financial instability, resulting in a realistic possibility of insolvency for many companies.

Further consequences on the balance sheet of companies are detected in terms of financial structure: the reduction in net working capital has led to greater financial requirements, which must be financed through external sources; in these scenarios, it is plausible that a certain number of companies are forced to increase their short-term liabilities, adding new debt to their financial structure.

In such an environment, where it is nearly impossible to predict the future pandemic developments, uncertainty has become remarkable, to the point of influencing the concept of economic value of a company and the metrics to measure it.

## **2.1 Critical aspects**

When referring to business valuation, economic value is estimated from going concern perspective and on the basis of future expectations, both sensitive to an economic scenario such as the one described above. As regards going concern, it has been substantially compromised by the measures adopted to contain the virus, as inactivity translates into absence of continuity. On the other hand, it has become more difficult to estimate future expectations, as in standard approaches these are estimated using historical data that, in this case, given the sudden disruption and uncertainty caused by the COVID-19 pandemic, would not reflect the current and future economic conditions in which the businesses are conducted.

Another critical aspect is the date of valuation, as it determines whether Covid-19 affects the value of a company. In fact, by doing a business valuation you can only consider what was known or knowable as of the date of the Appraisal (AICPA), implying that the impact of COVID-19 should not be considered in evaluations conducted prior to when it appeared. Most experts agree that little was known about COVID-19 as of Dec. 31, 2019, so, up to that date, this should be considered as a non-adjusting event and it didn't affect the valuation while, in March, it was widely known and should therefore be reflected in the valuation (Kaiser, 2021). However, Covid-19 could represent a triggering event whenever its effects, even if subsequent to the valuation date, have a significant impact on the

value of the company; in this case, a "roll forward" of the valuation date would be necessary.

Given these critical issues, although traditional valuation approaches remain fully usable, their mechanical application may produce business values that lack credibility and reliability (Van Vleet, 2020; Bancel, Mittoo, 2014): to grasp the nature and extent of the impact of market uncertainties, valuation methods would require reasonably supported adjustments.

## 2.2 Discounted Cash Flow

When using the discounted cash flow method, it is necessary to consider the impact of the crisis on its inputs: expected cash flows, discount rate and terminal value.

Table 1: Trend of the value as the model inputs vary.

DCF Input	Change to DCF Input	Impact on Value
Expected Cash Flows	Increase (decrease)	Increase (decrease)
Discount Rate	Increase (decrease)	Decrease (increase)
Terminal Value	Increase (decrease)	Increase (decrease)

With reference to expected cash flows, the interruption of activities and the consequent reduction of the demand for goods and services required extraordinary replanning, resulting in downward adjustments to cash flow forecasts.

Likewise, it is reasonable to assume that COVID-19 has resulted in a reduction of mid-term and long-term growth expectations, which must be reflected by a lower terminal value.

The risk of not achieving expected cash flows results in uncertain returns must therefore be captured by an appropriate risk adjustment. Considering the discount rate  $i_c$ , during market downturns, the flight to quality increases demand for safer investments such as Treasuries, which tends to bring their prices up. Lower Treasury yields, and so lower risk free rates, could lead to an overstated economic value. Thus, it may be appropriate to use a "normalized" or expected long-term Treasury yield and an upward adjustment to the risk premium rate. The weighted average cost of capital  $i_{wacc}$  was also strongly affected by the effects of

the crisis: the decline of the financial structure of companies has affected both the cost of equity and the cost of debt, leading to an increase in this discount rate.

In conclusion, all these adjustments will likely manifest themselves in lower corporate economic value, demonstrating that companies are worth less in times of increased risk and uncertainty.

### **2.3 Multiple methods**

When applying a market approach in contexts characterized by economic disruption, the main problems that arise concern the selection of the sample and the choice of the most appropriate multiple (Matschke, Brösel, 2010; Liu, 2020).

The high volatility of the company results and the different firms' reaction to the crisis, even of those belonging to the same sector, requires that the sample must be made up of companies that have experienced COVID-19 in a similar way in terms of impacts and consequences.

In this context, there are multiples whose use may be more appropriate than others. Looking at equity side multiples, a metric such as Price to Book value Ratio (P/BV) could provide more reliable estimates than Price to Earnings Ratio (P/E), which is usually preferred in "normal" times (Amendola, 2020), as the first is less related to exogenous or uncertain factors or uncertainties. Instead, with respect to entity-side multiples, it is interesting to note that some companies have experienced the use of normalized EBITDA, the EBITDAC (earnings before interest, taxes, depreciation, amortization, and Coronavirus), which eliminates the impact of the pandemic on EBITDA.

In any case, the pandemic has led to a decrease in market multiples which results, as for the DCF model, in lower economic value.

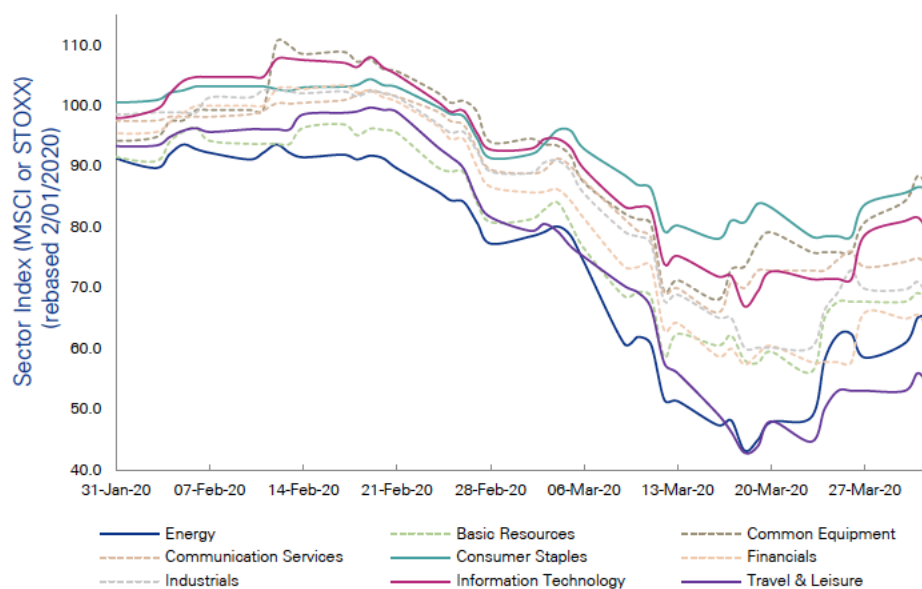
In addition to the above adjustments, for both the DCF and multiple methods, another way to make risk adjustment is to add a COVID-19 marketability discount for the current high level of uncertainty (Caruso, 2020) or, in alternative, to run different scenarios in order to consider all possible developments of the pandemic as well as the different forms of economic recovery.

## **3 Case Study: the impact of COVID-19 by industry**

Not all companies have been affected by COVID-19 in the same way. The exogenous effects on companies are heterogeneous and depend mainly on the

industry the company operates in, as well as on its specific characteristics<sup>1</sup>. For that reason, there will be some big winners and big losers as some changes will be permanent and game changing in certain industries (Signeur, 2021).

Generally speaking, as with any financial crisis, the companies most affected are those belonging to cyclical sectors, as they produce goods whose purchase can be postponed in time: the reduction in spending capacity has led to a recomposition of consumption decisions at the cost of these goods. On the contrary, companies belonging to anti-cyclical sectors, which are characterized by offering goods and services whose consumption does not depend on the economic cycle, are those least affected. Finally, in total contrast, there are those sectors capable of providing possible solutions to the pandemic, principally the pharmaceutical sector, given the primarily health-related nature of the crisis.



Graph 1: Trend of sector index by industry  
Source: Capital IQ, KPMG analysis

As shown, during the first quarter of 2020, sector index followed a general negative trend, but with some sectors more affected than others. The industries most affected by the Covid-19 crisis are travel and leisure, energy and resources

<sup>1</sup> Also the country in which the company operates is a relevant factor. However, since all countries have been affected by the crisis, this effect is not considered in order to focus on a sectoral analysis.



— mainly as a result of the lockdown measures and travel restrictions introduced worldwide, while consumer essential industries such as consumer staples, information technology and common equipment are least affected by the crisis (KPMG, 2021).

### **3.1 Methods of analysis**

In order to give evidence of the different impact of the pandemic depending on the industry, we observed the performance of two sectors that have been involved in opposite ways by the crisis: the air transport sector, particularly disadvantaged due to the blocking measures and restrictions introduced worldwide, and the telecommunications sector, fundamental for the management of the emergency as it allowed the normal continuation of activities during a period characterized by social distancing.

For each sector, we set a sample of the top five companies, on a global scale, by market capitalization<sup>1</sup> and simulated value trends observing daily share prices over a time horizon extending from early 2019 until November 2020, when the vaccination campaign had not yet been defined and the high uncertainty of the end of the pandemic made the market extremely volatile.

In fact, it is known that financial markets can hyper-react to crisis contexts by anticipating its effects (Miciula, Kadlubek, Stepień, 2020); however, it is difficult that even in these contexts, when considering a sufficiently long time horizon such as the one used, the markets are wrong in indicating the sign of the value variation undergone by the listed companies: these, more frequently, get the intensity wrong, but not the direction. For this reason, in a crisis context such as the current one, one of the references for analyzing the reasonableness of the valuation is represented by the reduction in the market share.

#### **3.1.1 The Air Transport Sector**

Over time, a particularly cyclical, as well as seasonal, trend has been observed in the air transport sector, whose performance is highly dependent on macro and microeconomic factors: any fluctuation in global economic capacity immediately affects its profits, highlighting its fragile balance and volatility. Specifically, factors such as economic growth, interest rates, exchange rates, and inflation rate have a

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<sup>1</sup> Based on the rankings at the link <https://companiesmarketcap.com> on November 13, 2020.

great impact on the operations of companies in the industry (Wittmer and Bieger, 2011).

Thus, the severe contraction of domestic GDPs that followed the spread of COVID-19, has severely affected this sector in a negative way.

As a matter of fact, air transport is facing an unprecedented crisis (McKinsey, 2020). According to estimates by IATA (International Air Transport Association), only in March, European airports recorded a loss of 106 million passengers. For comparison, during the financial crisis of 2007-08, it took 12 months to record a loss of around 100 million passengers. It has also been reported that during the worst period, in April 2020, was recorded a decline of about 95% in air traffic compared to the same month in 2019.



*Graph 3: Daily share price trend of the sample of companies belonging to the air transport sector*

*Source: Own elaboration from Thomson Reuters data base*

Looking at the trend of daily share prices for the sample analyzed<sup>1</sup>, we can appreciate the above considerations by looking at the long decrease recorded between mid-February and early June 2020, in correspondence of the introduction of the restrictive measures, and the closure of borders by most countries.

Only towards the end of the second quarter, after many countries loosened their restrictive measures and lifted travel restrictions, air traffic has slowly recovered, but the change in passenger behavior, due to lower incomes and greater fear of potential contagion, and the arrival of the second pandemic wave

<sup>1</sup> The sample is composed of the following companies, in order of ranking: Southwest Airlines (USA), Delta Air Lines (USA), Ryanair (Ireland), Air China (China) e China Southern Airlines, (China).

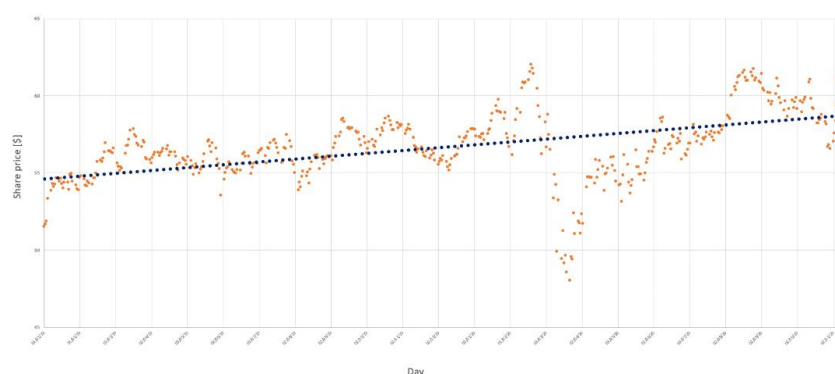
with the reinstatement of containment measures, are once again sinking this sector.

In fact, the sector has not restored to pre-crisis levels of activity yet, and presents a strongly negative trend over the reference period, with the latest observations being at a significantly lower level than the average level recorded during 2019 (respectively, 21,472 US \$/day versus 27,171 US \$/day).

### 3.1.2 The Telecommunication Sector

The telecommunications sector shows an overall positive trend, due to the central role of telecommunications infrastructures and services, with reference to internet, in satisfying work, economic and social needs.

Looking at the trend of the daily share prices for the sample analyzed<sup>1</sup>, we can notice three significant trend reversals.



*Graph 2: Daily share price trend of the sample of companies belonging to the telecommunications sector*

*Source: Own elaboration from Thomson Reuters data base*

Specifically, if in 2019 values remained relatively stable, a severe contraction is observed in coincidence with the declaration of the health emergency and the adoption of the first containment measures: during the months of February and March 2020, prices reached values significantly lower than those of the previous year due to the diffused concerns that led to a wide volatility of global stock markets.

<sup>1</sup> The sample is composed of the following companies, in order of ranking: Verizon (USA), Comcast (USA), AT&T (USA), T-Mobile (USA) and China Mobile (Hong Kong).

Nevertheless, following the lower peak on March 23, a rapid growth can be observed, leading to prices much higher than in 2019 and making the inclination of the trend line positive over the whole period considered, underlining the strong economic resilience of the sector and its key role in managing the pandemic.

#### **4 Conclusions and forthcoming developments**

The aim of the paper was to investigate about the impact of the economic environment crisis, focusing on the Covid-19 emergency, on business valuation drivers, as well as to identify the adjustments to be made so that the latter is able to return a reliable value that reflects the market conditions.

Specifically, in order to give evidence of the different impact of the pandemic depending on the industry, we observed the performance of two sectors that have been involved in opposite ways by the crisis: the air transport sector, particularly disadvantaged due to the blocking measures and restrictions introduced worldwide, and the telecommunications sector, fundamental for the management of the emergency as it allowed the normal continuation of activities during a period characterized by social distancing.

In light of the empirical findings reported in the preceding paragraphs, it is possible to answer positively the research questions reported in the paper with respect to the aforementioned sectors.

We found that although there is a decline for both sectors during the worst period of the pandemic (March-April 2020), over a longer time horizon (January 2019 to November 2020) these show opposite trends. In particular, the telecommunications sector shows an overall positive trend. In contrast, air transport presents a negative trend, with the latest observations being at a significantly lower level than the average level recorded over the reference period.

In order to develop and improve the present research the following steps will be taken in the near future:

- 1) increase the number of companies constituting the sample of each sector examined in the paper;
- 2) extend the empirical analysis to sectors in which the effects of the pandemic may have been counter-intuitive or, in any case, more difficult to predict.

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## Crowdfunding in the Crisis Context: an Overview of Covid-19 Era

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### Abstract

**Purpose:** This paper aims to identify and analyze the main areas on which scholars have focused in relation to crowdfunding (CF) and their contribution to the uncertain period. In particular, this review analyzes the role of this financial instrument during the Covid-19 emergency.

**Methodology:** The analysis was conducted through a systematic literature review (SLR) of 235 research contributions (articles, book chapters and books). An analysis of the content was performed to identify the main discussed topics, the main applied methodologies and the origins of contributions.

**Findings:** The findings show how the crowdfunding topic has been discussed in the literature, focusing specifically on crisis periods. The Covid-19's section, underlines the crowdfunding as a key instrument to overcome the crisis and to reach the organization's sustainability.

**Originality:** The present study contributes to the literature on alternative finance stream, confirming the positive effect of crowdfunding to overcome unforeseen periods.

**Limitations:** Limitations of the work concern the novelty of the theme and the few contributions produced. The effective contribution of crowdfunding during the coronavirus emergency could be definitively verified when the pandemic ends

Future perspectives: Future line of the work concerns the empirical studies aimed at analyzing the topics of intangible resources and organizations' sustainability in the crowdfunding and crisis context.

**Keywords** – Crisis, Financial Funds, Crowdfunding, SHSCM, Covid-19,

**Paper type** – Academic Research Paper

## 1 Introduction

Crowdfunding is a form of financing that allows organizations to obtain resources directly from the "crowd" (Modaffari et al., 2019; Paoloni et al., 2019). Crowdfunding born in the USA and, over the past few years, it has taken many forms (Dibrova, 2016). Its main 4 forms are donation-based, reward-based, lending-based, and equity-based (Cholakova and Clarysse 2015; Kuppuswamy and Bayus, 2018; Bottiglia, 2016; Ahlers, et al., 2015). However, the use of this particular instrument can also be found for funding charitable projects and recovery operations during emergencies.

In recent times, the world involved in a deep crisis due to Covid-19, a virus that imposes to implement measures to safeguard people's health. During the pandemic emergency, several organizations collaborated with the common goal of helping the community through the infrastructure and machinery needed for treatment. In this stream, several scholars highlight that, during the crises, the sustainability of organizations can be reached through appropriate technologies (ICT) and financial funds (Gold, 2017; Herlin and Pazirandeh 2012). Focusing on the financial issue, crowdfunding can act as a bridge when public entities fail to mediate promptly with adequate financial resources. Behl and Dutta, 2019 assert that crowdfunding allows mutual collaboration between citizens, firms, non-profit organizations, and government authorities. This mutual collaborative relationship across crowdfunding is recognized in the literature as sustainable humanitarian supply chain management (SHSCM) (Fawcett and Fawcett, 2013; Militello et al., 2007).

However, at the state, the issue of crowdfunding in the crisis period, as the actual one, is still unexplored.

For these reasons, this paper aims to analyze the connection between crowdfunding and the Covid-19 emergency. Particularly the main research questions are:

*RQ1. What are the main thematic areas in the scientific literature on the phenomenon of crowdfunding during the crisis period?*

*RQ2: How is crowdfunding treated in the Covid-19 theme?*

To reach the declared goals, the qualitative methodology of a structured literature review (SLR) was adopted (Paoloni et al., 2020; Paoloni and Demartini, 2016; Massaro et al., 2016).

The results show growing attention from the scholars on the topic of crowdfunding in the time of crises. Particularly the special focus provided on Covid-19 highlights that the cash flow generated from crowdfunding increases the organization's survival likelihood. Moreover, in the crowdfunding campaign during the emergency, the phenomena of social inequity (Igra et al., 2021) and gender inequality (Villaseca et al., 2020) are confirmed.

Particular attention is paid to the components of intellectual capital (structural, human, and relational) considered as key factors for the successful campaign and organizations' sustainability (Brown et al., 2019; Piva and Rossi-Lamastra, 2018; Behl and Dutta, 2019).

The present study contributes to the literature on alternative finance stream, confirming the positive effect of crowdfunding to overcome unplanned periods, as Covid-19.

Limitation of the work concerns the novelty of the theme and the few contributions produced so far. Moreover, the real effect of crowdfunding during the Covid emergency can only be definitively verified when the pandemic ends. In the future, SLR could be replicated enriching the results with new topics analyzed by scholars and, also, it is possible to conduct empirical studies aimed to analyze in detail the topic of intangible resources and organizations' sustainability.

The work is structured as follows: in sections (2) the research methodology was described; in section (3) the SLR's results were explained; section (4) is devoted to discussion and conclusion with particular attention to the Covid-19 issue; in the section (5) the implication of the work was highlighted; finally, limitations and future perspectives were outlined in section (6).

## **2 Research Methodology**

To reach the declared goal the SLR methodology (Paoloni et al. 2020; Paoloni and Demartini, 2016; Massaro et al., 2016) was adopted. This type of qualitative



literature review allows to analyze a corpus of the academic literature to develop insights, critical reflections, future research fields, and research questions.

The database used to extract the information was SCOPUS because it is widely used and the largest available database for the multidisciplinary scientific literature (de Moya-Anegón et al., 2007). The extractions were made on May 25, 2021.

As the protocol suggests, to select relevant documents related to crowdfunding in the Covid-19 era, the authors identified specific keywords. Particularly, the keywords used were "crowdfunding" and "covid-19" or "coronavirus" (to include each result that refers to the pandemic emergency). Without any other limit in the research fields, this investigation produced only 40 results. Considering this number of papers selected not relevant for applying SLR, the authors chose to widen the research field with other similar keywords according to the issue treated. The research was improved with the keywords "disaster\*" and "crisis"; the total of paper extracted is 441. After that, the contributions not related to business, management, and accounting were deleted. By the application of this filter related to the research field, the results were reduced to 235.

Considering the novelty of the topic, the authors do not apply any filters to the stage of documents. In other words, we considered also the results which have not yet reached the last stage of publication.

The final number of the results of the SLR for analysis was 235. Figure 1 shows the process used to identify the eligible research.

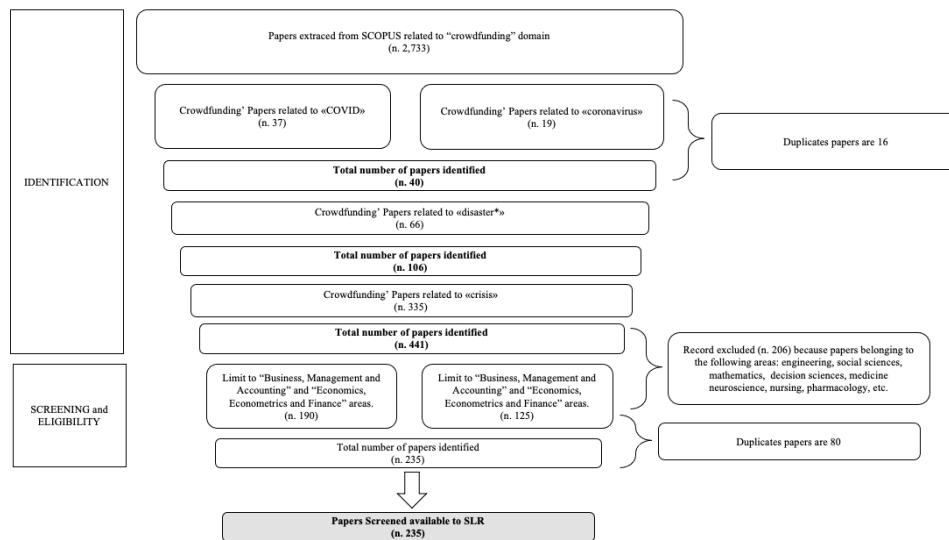


Figure 1 – Procedure to selected the contributions available to SLR

## 2.1 Definition of analytical framework

After reading titles, abstracts, and keywords of papers available to SLR, the authors define the analytical framework useful to classify and analyze all documents (Yin, 2014). According to Paoloni et al., 2020, the authors chose to carry out the papers through the following classification: article focus (A); research method (B), and geographical area (C).

Article focus (A) includes the following classes:

(A1) *Proponent and Output Campaign*: includes all those contributions dealing with crowdfunding in times of crisis, such as Covid's, focusing on the proponent (fundraiser) and aspects related to the characteristics of the campaign project. This category includes, for example, papers that focus on enterprises and organizations or those that deal with particular characteristics of the fundraising campaign output.

(A2) *Platforms*: includes all those contributions that deal with crowdfunding in times of crisis focusing on platforms and their functioning. This category includes, for example, papers that focus on the role of platforms in times of crisis and how they facilitate fundraising activities.

(A3) *Donors, Backers, Investors, and Borrowers*: includes all those contributions that deal with crowdfunding in times of crisis by focusing on the "crowd" and the

various types of actors included in it. This category includes, for example, papers that focus on the role of donors in fundraising.

(A4) *Intangible resources and sustainability*: includes all those contributions that deal with crowdfunding in times of crisis focusing on intangible assets (i.e. intellectual or social capital) and sustainability, meaning the ability of the organizations to overcome the crisis, such as that of Covid. This category includes, for example, papers that focus on intellectual capital in its three components (structural, human, and relationship) and its role in crowdfunding activities, or contributions that examine the critical success factors that ensure the sustainability of organizations and the environment through crowdfunding.

(A5) *Other*: this is a residual category that includes results of the SLR that do not belong to any of the previous categories. It includes research not related to the aim of the present paper and, for this reason, these were considered outside of the focus of the present work.

To classify the papers by research method (B) the authors identify the following classes:

- (1) *Literature analysis*: results of the SLR dedicated to the review of existing literature.
- (2) *Qualitative research*: analysis performed using case studies, experiments, content analysis, surveys through interviews, focus groups, etc.
- (3) *Quantitative analysis*: analysis carried out with statistical tools based on information obtained from databases, questionnaires, or other reports.
- (4) *Research mix*: where more than one method was applied.
- (5) *Theoretical analysis*: conceptual or discursive contributions.
- (6) *Other*: a residual category that includes research written with any method not described above.

Regarding the geographical area (C), we classified the contributions by the author's affiliation.

Following Figure 2 resume the analytical framework described above:

Figure 2 – The analytical framework

A. ARTICLE FOCUS	B. RESEARCH METHOD
A1. Proponent and Output Campaign	B1. Literature analysis
A2. Platforms	B2. Qualitative research
A3. Donors, Backers, Investors and Borrowers	B3. Quantitative research
A4. Intangible resources and sustainability	B4. Research mix
A5. Other	B5. Theoretical analysis
	B6. Other

C. GEOGRAPHICAL AREA	
East Europe	Hungary, Slovenia, Romania, Lithuania, Croatia, Serbia, Macedonia
Middle East	Israel, Lebanon, United Arab Emirates, Jordan, Saudi Arabia, Iran, Iraq, Oman, Kuwait
South and Central America	Argentine, Dominican Republic, Brazil, Jamaica, Mexico, Chile
North America	USA and Canada
Northern Europe	Austria, Belgium, Denmark, Ireland, France, Germany, Netherlands, Scandinavian countries, Switzerland, Poland, Czech Republic, Slovakia
Southern Europe	Italy, Spain, Portugal, Greece, Turkey
Asia	Russia, China, Japan, Korea, Singapore, Sri Lanka, Malaysia, Pakistan, India, Indonesia, Hong Kong, Thailand, Vietnam, Armenia, Nepal, Kazakhstan
Africa	Tanzania, Uganda, Botswana, South Africa, Nigeria, Ethiopia, Zambia, Mauritius
UK	England, Scotland, Wales, North Ireland
Oceania	Australia and New Zealand
Mixed	

Described the protocol used for the analysis, following section shows the results of the SLR.

### 3 Results

#### 3.1 Research focus

After reading the title, abstract, and keywords of each contribution, the first step of SLR was to classify the available paper for article focus. The results show that the relevant focus in which scholars wrote the main contribution is A1 "Proponent and Output Campaign" by 96 papers on 235 (41% of total). Immediately after there are A3 "Donors, Backers, Investors and Borrowers" (35 on 235, 15% of total); A4 "Intangible resources and sustainability" (34 on 235, 14% of total); A2 "Platforms" (20 on 235, 9% of total). Finally, the residual category of "A5. Other" contains 50 papers and represents 21% of the total.

The following figure 3 resumes the article focus' classification of the eligible papers.

Figure 3 – Eligible Papers per article focus (A)

<b>A- Article Focus</b>	
A1. Proponent and Output Campaign	96
A2. Platforms	20
A3. Donors, Backers, Investors and Borrowers	35
A4. Intangible resources and sustainability	34
A5. Other	50
<b>Total</b>	<b>235</b>

Considering that the topics of category "A5. Other" is not inherent to the aim of this research, they will not be considered in the following paragraphs. Therefore, the papers available for SLR are 185.

Analyzing, on the other hand, the scholars' interest in the crisis and crowdfunding, it can be seen that the first contribution was made by class A1 in 2013. The following figure 4 shows a growing interest for the scholars as the number of contributions increases each year.

Figure 4- Article Focus per year

Article Focus /Year	A1. Proponent and Output Campaign	A2. Platforms	A3. Donors, Backers, Investors and Borrowers	A4. Intangible resources and sustainability	TOTAL
2012	0	0	0	0	0
2013	2	0	0	0	2
2014	4	0	0	1	5
2015	7	0	1	3	11
2016	12	1	3	3	19
2017	8	0	5	2	15
2018	18	6	3	6	33
2019	18	9	7	4	38
2020	21	2	8	7	38
2021	6	2	8	8	24
<b>TOTAL</b>	<b>96</b>	<b>20</b>	<b>35</b>	<b>34</b>	<b>185</b>

### 3.2 Research method

Quantitative research (B3) is the most common research method utilized by scholar to analyze the topic of crowdfunding in the crisis context. With 87 papers on 185, it represents 47% of total. After this, the most common method that scholars prefer is qualitative research (B2) with 53 papers (29% of total), follow the research mix method with 25 contributions (14% of total); theoretical analysis with 11 papers (6% of total), literature review method with 7 papers (4% of total) and other method, not included in the above categories, with 2 papers (1% of total).

Following figure 5 resume the above results.

Figure 5- Eligible Papers per Methodology (B)

<b>B - Methodology</b>	
B1. Literature analysis	7
B2. Qualitative research	53
B3. Quantitative research	87
B4. Research mix	25
B5. Theoretical analysis	11
B6. Other	2
<b>Total</b>	<b>185</b>

Analysing the different methodology with the article focus mentioned in the above section (3.1), emerges that the quantitative research is the methodology preferred by scholar to develop the topic of article focus A1, A2 and A3. Only to develop the paper related to intangible resources and sustainability (A4), scholars make more use of qualitative analysis.

Following figure 6 shows the link between article focus and methodologies utilized by scholars.

Figure 6- Link between Article focus and Methodology

<b>(A) Article Focus</b>	<b>(B) Methodology</b>	<b>Total</b>
<b>A1. Proponent and Output Campaign</b>	B1. Literature analysis	5
	B2. Qualitative research	31
	B3. Quantitative research	35
	B4. Research mix	17
	B5. Theoretical analysis	6
	B6. Other	2
	<b>TOTAL A1</b>	<b>96</b>
<b>A2. Platforms</b>	B1. Literature analysis	0
	B2. Qualitative research	7
	B3. Quantitative research	10
	B4. Research mix	0
	B5. Theoretical analysis	3
	B6. Other	0
	<b>TOTAL A2</b>	<b>20</b>
<b>A3. Donors, Backers, Investors and Borrowers</b>	B1. Literature analysis	0
	B2. Qualitative research	2
	B3. Quantitative research	30
	B4. Research mix	3
	B5. Theoretical analysis	0
	B6. Other	0
	<b>TOTAL A3</b>	<b>35</b>
<b>A4. Intangible resources and sustainability</b>	B1. Literature analysis	2
	B2. Qualitative research	13
	B3. Quantitative research	12
	B4. Research mix	5
	B5. Theoretical analysis	2
	B6. Other	0
	<b>TOTAL A4</b>	<b>34</b>
<b>A5. Other</b>	B1. Literature analysis	3
	B2. Qualitative research	20

	B3. Quantitative research	<b>12</b>
	B4. Research mix	<b>7</b>
	B5. Theoretical analysis	<b>4</b>
	B6. Other	<b>4</b>
	<b>TOTAL A5</b>	<b>50</b>

### 3.3 Geographical area of author's affiliations

Most of the documents analyzed were written by authors with affiliations from (C5) Northern European (39 papers, 21% of total) follow (C6) Northern Europe and (C11) Mixed area with an equal number of contributions (31 papers, 17% of total for each area). The peculiarity that emerges from this analysis is that it does not record any contribution on the subject by scholars from the C3 South and Central America area.

Following figure 7 resume the above results.

Figure 7- Eligible Papers per Geographical Area (C)

<b>C - Geographical Area</b>	
C1. East Europe	5
C2. Middle East	2
C3. South and Central America	0
C4. North America	25
C5. Northern Europe	39
C6. Southern Europe	31
C7. Asia	25
C8. Africa	5
C9. UK	18
C10. Oceania	4
C11. Mixed	31
<b>Total</b>	<b>185</b>

Before moving on to analyse the most cited contributions, figure 8 shows all 185 eligible papers linked by article focus, methodology and geographical area.



Figure 8- Eligible Papers linked by article focus (A), methodology (B) and geographical area (C)

(A) Article Focus	(B) Methodology	(C) Geographical Area											Total
		C1. East Europe	C2. Middle East	C3. South and Central America	C4. North America	C5. Northern Europe	C6. Southern Europe	C7. Asia	C8. Africa	C9. UK	C10. Oceania	C11. Mixed	
A1. Proponent and Output Campaign	B1. Literature analysis	0	0	0	0	1	1	0	0	1	1	1	5
	B2. Qualitative research	1	1	0	5	4	6	2	1	5	2	4	31
	B3. Quantitative research	0	0	0	7	8	3	6	0	1	1	9	35
	B4. Research mix	2	0	0	0	6	1	2	0	4	0	2	17
	B5. Theoretical analysis	0	0	0	0	0	0	2	1	1	0	2	6
	B6. Other	0	0	0	0	0	0	1	0	0	0	1	2
	<b>TOTAL A1</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>12</b>	<b>19</b>	<b>11</b>	<b>13</b>	<b>2</b>	<b>12</b>	<b>4</b>	<b>19</b>	<b>96</b>
A2. Platforms	B1. Literature analysis	0	0	0	0	0	0	0	0	0	0	0	0
	B2. Qualitative research	1	1	0	1	3	1	0	0	0	0	0	7
	B3. Quantitative research	0	0	0	3	4	1	0	0	0	0	2	10
	B4. Research mix	0	0	0	0	0	0	0	0	0	0	0	0
	B5. Theoretical analysis	0	0	0	0	2	0	0	0	0	0	1	3
	B6. Other	0	0	0	0	0	0	0	0	0	0	0	0
	<b>TOTAL A2</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>4</b>	<b>9</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>20</b>
A3. Donors, Backers, Investors and Borrowers	B1. Literature analysis	0	0	0	0	0	0	0	0	0	0	0	0
	B2. Qualitative research	0	0	0	0	0	1	0	0	1	0	0	2
	B3. Quantitative research	0	0	0	8	5	4	6	0	2	0	5	30
	B4. Research mix	0	0	0	0	1	1	0	0	0	0	1	3
	B5. Theoretical analysis	0	0	0	0	0	0	0	0	0	0	0	0
	B6. Other	0	0	0	0	0	0	0	0	0	0	0	0
	<b>TOTAL A3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>6</b>	<b>6</b>	<b>6</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>6</b>	<b>35</b>
A4. Intangible resources and sustainability	B1. Literature analysis	0	0	0	0	1	1	0	0	0	0	0	2
	B2. Qualitative research	1	0	0	0	2	3	2	2	2	0	1	13
	B3. Quantitative research	0	0	0	1	1	4	4	0	1	0	1	12
	B4. Research mix	0	0	0	0	1	3	0	1	0	0	0	5
	B5. Theoretical analysis	0	0	0	0	0	1	0	0	0	0	1	2
	B6. Other	0	0	0	0	0	0	0	0	0	0	0	0
	<b>TOTAL A4</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>5</b>	<b>12</b>	<b>6</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>3</b>	<b>34</b>

### **3.4 The most cited research**

To understand the different relevant topics identified (Ardito et al., 2015), the most cited research was considered. To do this, the authors considered the average value of citations. Using average (18.25 citations), the papers to be analyzed are 31, excluding those belonging to the A5 "Other" category.

The results show that most quoted papers belong to class A1 "Proponent and Output Campaign" of article focus (31 contributions).

Many of these refer to the entrepreneurial sphere and companies approaching the world of crowdfunding (Brown et al., 2018; Block et al., 2018; Cumming and Vismara, 2017; Bruton et al., 2015). The most recurrent themes concern the contribution that crowdfunding can give to companies to overcome moments of crisis (Vulkan et al., 2016; Moritz and Block, 2016; Lehner and Nicholls, 2014); the value of communication and information in the project for which the fundraising campaign is being launched (Anglin et al., 2018; Parhankangas and Renko, 2017; Lehner, 2013); the different strategies to be adopted in the crowdfunding campaign (Martínez-Climent et al., 2018; Kraus et al., 2016; Tomczak et al., 2013).

Follow the class of article focus A3 "Donors, Backers, Investors and Borrowers" with 6 contributions, the most recurrent themes analyzed by scholars regard the crowd's behavior (Cumming et al., 2019; Shneor and Munim, 2019; Stanko et al., 2017) and the relevance of information in their decisions (Polzin et al., 2018; Kang, et al., 2016; Morse, 2015).

Focusing on the class of article focus A4 "Intangible resources and sustainability" (5 contributions), the most recurrent themes analyzed by scholars regard the role of social capital in crowdfunding operations (Brown et al., 2019; Piva and Rossi-Lamastra, 2018; Lehner, 2014); the relationship between shareholder structures and firm performance (Walthoff-Borm, 2018b); and the importance of knowledge management capabilities for successful open innovation in crowdfunding for agri-food businesses (Cillo et al., 2019).

Finally, the most recurrent topics analyzed in the class A2 "Platforms" (with only 2 contributions) regard the factors that affect their creation in the European countries (Dushnitsky et al., 2016); and the analysis of its contribution concerning firm's performance (Walthoff-Borm et al., 2018a).

Regarding the research method (B), the most cited research studies mainly used B3. Quantitative research (17 contributions). Many authors have also used B2 Qualitative research (8 contributions), while few have opted for B4 research

mix (3 contributions). Little attention has been paid by scholars to the B1 literature analysis (2 contributions). Other method B6 was used only for 1 contribution. No research fell into the B5. Theoretical analysis.

Regarding on geographical area (C), the most cited research was written by authors with affiliations in C5. Northern Europe (10 contributions). Many authors came from C4. North America, C6. Southern Europe; C9. UK and C.11 Mixed with 5 contributions for each class. From C7. Asia there is only 1 contribution.

#### **4 Discussion and conclusion**

This section is devoted to exploring relevant topics about each class. To address RQ1. (*What are the main thematic areas in the scientific literature on the phenomenon of crowdfunding during the crisis period?*) the following contributions are presented.

The most recurrent research of class A1. "Proponent and Output Campaign" regards crowdfunding as a new instrument to overcome the crisis in the entrepreneurial landscape, the quality of information and communications to attract new funds, and the effect of this innovative financial tool to increase the firm's performance. The contributions of class A2 "Platform" underline that during the uncertain periods, the possibility of raising money from the crowd appears as a "magical cash machine" (Dushnitsky et al., 2016), becoming the "last resort" for the company during the crises (Walthoff-Borm et al., 2018a).

Regarding the class dedicated to the "crowd" (A3. Donors, Backers, Investors, and Borrowers), the main topic that scholars investigate is crowd behavior and the choices made during fundraising activities (Cumming et al., 2019; Shneor and Munim, 2019). In particular, the problem of information asymmetry and the role of communication and information during the campaign were analyzed (Stanko et al., 2017; Polzin et al., 2018). Good information and communications increase the backer's trust degree during the crisis period (Kang, et al., 2016). In this way, a lot of relevance assumes the contributions placed in class A4 "Intangible resources and sustainability". Moving the discussion on the trust, Brown et al., 2019 confirm that one of the main factors that allows the company to raise funds is relational capital, a component of intellectual capital. Particularly, the relationship established by the company with investors during the campaign increase the success likelihood to reach the financial goal. Also, Piva and Rossi-Lamastra, 2018, investigate the signal that attracts the investors during the

campaign. The study highlights a positive role of human capital that is expressed through other information not present in those in the campaign. For instance, promoter information present on social media plays a positive role in fundraising. Focusing on the sustainability topics, the positive role of crowdfunding during the crisis period is confirmed by Kim and Hall, 2021. The study, through a structured model, shows a positive relationship between the risk perception and the desire for participating in crowdfunding for sustainability. The authors assert that perceived risk negatively and significantly leads to crowdfunders' intention to fund sustainability projects.

Before analyzing direct contributions on crowdfunding and covid-19, it is useful to introduce the contribution of Baltas et al.,2021 who studies alternative financing tools, such as crowdfunding, during natural disasters. The authors demonstrate that, within 3 months of the disaster event, the amount of raised funds through alternative financing instruments increases. In this way Behl and Dutta, 2019 fits in, confirming that crowdfunding, combined with corporate social responsibility (CSR), allows the organization to overcome the crisis. According to the authors, crowdfunding acts faster than public entities, connecting citizens, firms, and NGOs. Fundraising implemented through CSR enables the realization of the phenomenon of sustainable humanitarian supply chain management (SHSCM), one of the main collaboration factors in overcoming the crisis and recovery.

#### **4.1 Crowdfunding in the Covid-19 era**

This section is dedicated to in-depth analysis of the issues scholars link between crowdfunding and covid-19. Due to the current nature of the topic, the average citation value could not be considered but the authors selected specific papers on the topic of coronavirus. In this way, the contents of this section are dedicated to answering RQ2: *How is crowdfunding treated in the Covid-19 theme?*

Igra et al.,2021 observe the phenomenon of crowdfunding during the covid emergency through an analysis of charitable campaigns promoted by the GoFundMe platform. The analysis of 175,000 campaigns shows how crowdfunding leads to social inequities during the emergency. Indeed, crowdfunding provides substantially higher benefits in wealthier counties with higher levels of education. People from these areas are more likely to initiate campaigns in response to the adverse health and economic impacts of COVID-19.

Farhoud et al., 2021 introduce the topic of social enterprises in crisis management from Covid-19. According to the authors, the cash flow generated by these enterprises through crowdfunding increases the likelihood of survival of the organizations. Chandler et al., 2021 offer a reflection on three typical moments of the post-crisis phase, identifying them as business resumption, crisis impact analysis, and future evaluation and modification. The authors describe the Covid-19 era as an exogenous shock and therefore draw a post-crisis recovery perspective based on the three moments described above. The recovery starts with the "business resumption" phase according to which entrepreneurs resort to crowdfunding to provide financial relief for their businesses. To realize this first phase, entrepreneurs need to leverage two main concepts: i) consider crowdfunding as a mechanism for continued venture operations, in addition, to a source of new venture funding; ii) explore the merits of crowdfunding as a medium for facilitating founder exit strategies. The second phase "crisis impact analysis" concerns the vehicle through which becomes possible to activate the fundraising activity, i.e. the platforms. According to the authors, in this phase, it is important to carefully observe the platforms available to activate the collection. Frequently moments of crisis, such as the one of Covid-19, encourage fraudulent behaviors and for this reason, it is important to take care of the quality of information to discourage these behaviors and increase the efficiency of the market. The third step "future evaluation and modification" concerns the assumption that once post-crisis survival is achieved, entrepreneurs should not abandon the idea of continuing to use the crowdfunding tool to finance new initiatives. Trusting platforms might open up new opportunities for funding in the future.

Villaseca et al., 2020 provide a gender perspective of crowdfunding during the Covid-19 era. The authors focusing on the financial capacity of start-ups, revealing a potential gender bias both on the supply and the demand side of financing. In this stream, the study confirms previous empirical evidence even in the Covid-19 era, according to which the entrepreneur obtains capital from people rather close to her, like parents or friends.

Finally, the two last contributions on the topic of crowdfunding during coronavirus focusing on the food and agricultural context. Especially, Yu and Khan. 2021, through a game analysis, propose a financing system for green agricultural product supply chain (GAPSC) with agricultural product suppliers as financiers and citizens as investors. proposed However, due to the low cost of

capital, a crowdfunding instrument was preferred. Zhao et al.,2020 investigate the factors that affect a donation-based crowdfunding campaign for coronavirus relief of food donation, analyzing which factors determine the campaign's success. The authors identify the presence of picture and video, an attainable target fund, the presence of project updates, the feedback and the possibility of comments between fundraiser and backers, the presence of external links to the website as factors that have a significant influence on the crowdfunding campaign success.

## **5 Implications**

The present study reveals several theoretical and practical implications. First of all, the work contributes to the literature on alternative finance tools, confirming the positive effect of crowdfunding to overcome uncertain periods, as Covid-19. This research brings to light the contribution of additional factors that fit between crowdfunding and the crisis' issue. Particularly, these refer to the components of intellectual capital, such as structural, human, and relational capital. Several studies confirm their contribution to the achievement of sustainability and recovery of organizations affected by the crisis. Referring to practical implications, this study can provide the base of knowledge to efficiently approach unplanned events. Indeed, several elements, such as CSR and SHSCM, have been identified as success factors.

## **6 Limitations and future perspectives**

The limitations of the present work refer to the novelty of the topic discussed. The still ongoing coronavirus pandemic does not allow for comprehensive knowledge on the issues. In this way, the future lines of research concern empirical studies aimed to know in detail what are the success factors of organizations to overcome the pandemic. With this purpose, this research work will continue with multiple case studies on the topic of intangible resources and organizations' sustainability.

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## The Proposal of a Knowledge Risk Management (KRM) Framework for Healthcare Organizations

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### Abstract

Knowledge generation in healthcare has accelerated in the past years due to the abundance of data captured and information produced. The main reason being the evolvement of the health system into a connected care model which is supported by the advances in medical and other technologies. This accelerated innovation brought more risks related to managing knowledge assets and flows. Extant research suggests that the fields of knowledge risks (KR) and knowledge risk management (KRM) in health has not received adequate attention yet.

This paper aims at developing a KRM framework for healthcare organizations. This framework profiles relevant KR found in healthcare and proposes control measures to mitigate them. It also maps responsible units and personnel for implementing the proposed control measures. The development of the framework builds on recent work by the authors, who developed a knowledge risks (KR) taxonomy for healthcare organizations. This paper provides a basic KRM framework within the healthcare context, which is the first of its kind.

This paper hopes to further promote discourse in KRM literature and raise the awareness and understanding of KRM practices among healthcare researchers and practitioners. Additionally, the proposed framework can have practical implications when applied in healthcare organizations for improving the overall quality of care, efficiency savings and promoting sustainability of health organizations.

**Keywords** – Knowledge risks, knowledge risk management, healthcare, hospital, framework

**Paper type** – Academic Research Paper

## 1 Introduction

The healthcare system is facing multiple challenges to provide quality care including rising costs and limited number of providers (Kyedar et al., 2014), and an aging population (Chouvarda et al., 2015). The situation is unsustainable as around 60% only of healthcare services are provided according to guidelines (Sackett et al., 1995; Braithwaite and Donaldson, 2016), with the waste in treatment and medicine mounting to almost one third of their total cost (Gautam, 2017) and the rate of complications not dropping significantly in the last decades (Braithwaite, 2018), despite the scientific and technological advances.

Recently, the healthcare sector has realized that technology on its own is not enough to guarantee the sustainability of healthcare organizations (Sardi et al., 2020), with the need for more efficient and seamless information flow and knowledge exchange among scientists, researchers and health professionals (Karamitri et al., 2020). Something that is regarded an essential element for the provision of better care to patients (Balas and Boren, 2000). This interactive nature of knowledge synthesis echoes Ferlie et al. (2012) argument that knowledge exploitation has moved beyond the traditional hierarchical and one-to-one exchanges to a more organic and networked model.

Moreover, the collective orchestration, safeguarding and utilization of knowledge are considered the key components of healthcare sustainability. On the one hand, knowledge management applications are synchronous to quality management (Linderman et al., 2004) and were found to greatly improve the quality of care (Hosseini, 2019), when actionable and trusted knowledge is made available to the right health professional at the right time (Bigby and Gadenne, 1996; Karamat et al., 2018). On the other hand, knowledge management strategy and practices are critical to the success of healthcare organizations (Tretiakov et al., 2017) and they are also viewed a source of competitive advantage to medical practices (Stefan et al., 2016; Nonaka and Takeuchi, 2007), as well as the role they play in improving the efficiency and effectiveness of service delivery in health environments (Bose, 2003).

However, knowledge is also considered a source of several risks (Bratianu, 2018; Durst et al., 2018; Olander and Hurmelinna-Laukkanen, 2015) which can disrupt the operations and performance of organizations (Martins and Meyer, 2012; Perrott, 2007). Thus, it is becoming more important than ever that researchers and organizations pay more attention to issues of knowledge risks

(KR) identification and management, regardless of the industry (Temel and Durst, 2020). Healthcare organizations, being knowledge intensive ones (Bose, 2003; Abidi, 2007; Karamat et al., 2018), are objectively more susceptible to knowledge risks and should demonstrate a stronger knowledge risk management (KRM) orientation.

Still, the field of knowledge management is not a familiar discipline among healthcare experts (El Morr and Subercaze, 2010; Karamitri et al., 2020), and only witnessed an increasing attention recently (Kothari et al., 2011; Karamitri et al., 2020). The only real attempt to discuss knowledge risks and develop a taxonomy for them within a healthcare context is the work Hammada and Durst (2021), identifying 23 knowledge risks in healthcare organizations and expounding on their potential impact. This paper aims at building on the taxonomy developed by Hammada and Durst (2021), by providing recommendations and actions that will help healthcare organizations address the identified knowledge risks, thus eliminating or controlling their effects. The following two research questions were formulated to address this purpose:

*RQ1: What are the potential control measures needed to mitigate each of the identified knowledge risks in healthcare organizations?*

*RQ2: Which unit/ department/ personnel is responsible for implementing the proposed control measures?*

This paper is structured as follows. In the next section, we will review extant literature on knowledge risk management in general and knowledge management in healthcare. Then based on our findings and building on the previously conceptualized taxonomy of Hammada and Durst (2021), we discuss the possible measures healthcare organizations can take to eliminate or control those risks. In addition, we map those measures against the departments responsible for their implementation within the healthcare organization. Following that, we discuss the implications of the developed knowledge risk management (KRM) framework on academia and industry, and the limitations of our paper being of conceptual nature. Then, we propose an agenda for advancing research in the fields of knowledge risks (KR) and knowledge risk management (KRM) in healthcare.

## **2 Literature review**

### ***2.1 Knowledge risk management***

Knowledge risk management (KRM) is the process of identifying, analyzing, managing, and controlling risks which are pertinent to the acquisition, storage, exchange, and usage of knowledge and information (Durst and Zieba 2019). In academic literature, KRM act as a common pool which links two separate research streams namely risk management (RM) and knowledge management (KM), according to Massingham (2010). While some researchers seem to regard KRM as a subset of the risk management field (Durst and Zieba, 2020). Akin to its bridging academic nature, knowledge risk management is also a transversal competence in any organization. As Temel and Durst (2020), argue that the different actors and teams within the knowledge organization are affected by one another, they then must contribute collectively to the identification of possible measures to deal with knowledge risks and their implementation.

Research has found that there are several areas that organizations can address to mitigate knowledge risks, such as their processes (Serenko and Bontis, 2016), structures (Agndal and Nordin, 2009), policies, remuneration, and incentives (Lambe, 2013) or improvement of certain parts of the organization (Durst and Zieba, 2019). While Durst (2019) argues that some risks can be removed almost entirely when an organization has the utmost control over them, other risks that fall beyond the full control of the organization are rather hard to eliminate but can still be managed or mitigated. This opinion accords with Massingham (2010) views on risks' manageability; arguing that organizations should be able to predict and control risks, even if they do not have the capacity to rule it out of the equation completely.

KRM was found to be directly linked to an organization's sustainability. Durst et al. (2019) found that there is a positive impact on organizations' innovativeness, agility, sustainability, and growth, as well as their successful digitization (Temel and Durst, 2020). The latter also views KRM essential for successful adoption and implementation of technological innovations. It may also be used as a methodology for bringing together the disparate components of the organization's ecosystem to work collaboratively towards a unified agenda (Durst et al., 2019).

Despite its importance, research on KRM is still nascent (Durst and Ferenhof, 2016). Although it started raising interest among scholars, it still is an underdeveloped area (Aven, 2016). Durst and Zieba (2017) noticed that there are only few studies covering this topic, most of which are disconnected and concluded that there is yet to be an agreement on the definitions, dimensions, and boundaries of this young research field.

## **2.2 Knowledge risk management in healthcare**

In healthcare, even the wider field of knowledge management is under researched and is almost unrecognized among practitioners (El Morr and Subercaze, 2010). So far, there has not been a due focus on knowledge risk management research within a healthcare context, beyond the cyber risk area (Sardi et al., 2020). In recent years, the liberalization of the healthcare industry with the rapid advances in medical technology and information exchange, has intensified competition (Lee and Hong, 2014). This has demanded a focus on better identification and management of healthcare knowledge and its risks, as it constitutes a competitive advantage to medical practices (Karamitri et al., 2017). One use case that demonstrates the pressing necessity for knowledge risk management in healthcare is the World Health Organization (WHO, 2020) recently reporting a five-fold jump in cyberattacks and Sardi et al. (2020) review, finding a staggering increase in the number of cyber-attacks in the healthcare sector.

This resonates with Durst and Zieba (2020), recommendation that future research work on knowledge risk management should consider its application in the different sectors rather than focusing on traditional industries only. Moreover, Temel and Durst (2020) and Martins et al. (2019) urge researchers and all organizations, regardless of their type and sector, to pay careful consideration to knowledge risk management methodologies and their applications.

## **3 Methodology**

To develop the proposed knowledge risk remediation and control strategies and tactics, we did extensive literature review on approaches to knowledge risk management such as Durst and Zieba (2020), who studied knowledge risks from an organizational sustainability perspective and proposed actions to overcome them; Temel and Durst (2020), who followed a similar path but within the small

and medium sized enterprises (SMEs) context with a focus on technology risks; Durst et al. (2019) who conducted an empirical study linking KRM measures to organizational performance; and Massingham (2010) who developed a comprehensive and methodological knowledge risk assessment and management framework building on the risk management theory. The proposed framework is building on the work by Hammoda and Durst (2021), who developed a knowledge risk taxonomy for healthcare organizations. They identified 23 knowledge risks and categorized them into three groups: human, technology and operations. They then explained how these risks could manifest in a healthcare environment and discussed their potential consequences.

Following our literature review, we combined our findings with the authors' insights based on their experience in the health field as practitioners and managers, and used the previously developed taxonomy on healthcare knowledge risks to develop a set of remediation and control measures for each of the 23 identified knowledge risks as explained in the following subsections and in appendices I, II, and III. We then mapped the relevant units and personnel inside a healthcare organization that would typically be responsible for the implementation activities against the recommended control measures for each risk area. We used this mapping to develop a responsibility map, as depicted in Figures 1 and 2.

#### **4 A knowledge risk management (KRM) framework for healthcare organizations**

We propose a framework for managing the 23 knowledge risks identified in healthcare organizations by Hammoda and Durst (2021). These are categorized into three groups: human, technological and operational. We profile each risk and discuss possible control measures that can be implemented by the healthcare organization to overcome it.

##### ***4.1. Human-related knowledge risk management in healthcare***

The attitudes, behaviours, and individual factors of organizational members were seen to constitute a considerable obstacle that must be resolved when applying knowledge management practices in organizations (Robinson, 2004;



Kothari et al., 2011). Hence, identifying them and developing suitable control measures for each is essential to overcome those challenges.

#### *4.1.1 Hiding*

Knowledge hiding occurs when (clinicians or commercial) staff (in hospitals) keep knowledge or learning opportunities to themselves and do not share it with other team members (Connelly et al., 2012). It affects transparency and trust among colleagues and can lead to opportunistic behaviours. Possible measures to overcome this issue could be mandating intra-departmental training activities and including it in the annual appraisal, while providing senior clinicians with more advanced training opportunities. In addition, commercial teams should have a shared file management system for contacts and documents for transparency purposes.

#### *4.1.2 Hoarding*

Senior clinicians keeping training opportunities to themselves and participating in scientific events exclusively, are typical examples of knowledge hoarding in a healthcare environment. Such behaviours can concentrate knowledge and organizational representation in the hands of a few staff members (Webster et al., 2008), thus jeopardizing service continuity and possibly the organization's reputation. To avoid this issue, there should be a clear events and training agenda for each department/ team, made publicly available across the hospital, with each participating member tagged to it.

#### *4.1.3 Attrition / unintentional forgetting*

Infrequent application of certain (diagnostic or surgical) skills and techniques (Bouton, 2000) can lead to clinicians and health professionals losing the grip of them. As a result, the medical practice is forced into referring / losing patients to other providers. In such a case, a possible solution leveraging advanced technology would be making virtual training programmes on procedures not commonly performed available to the medical staff.

#### *4.1.4 Unlearning / active forgetting*

Unlearning refers to (the health professional) being disinclined to replace old and outdated knowledge and techniques and learn new things in its place

(Cegarra-Navarro et al., 2013). Thus, clinicians are rendered unable to perform advanced or up-to-date procedures, which are usually more effective with lesser complications. As a result, patients and corporate clients might shift their attention to other providers who keep pace with advances in clinical practice. Overcoming the unlearning challenge is mainly a task that involves ensuring up-to-date guidelines are being adopted and followed across different medical departments.

#### *4.1.5 Resistance / comfort zone syndrome*

Clinician resisting the different scientific sources and training provided to them are left behind, unable to implement updated techniques or use new technologies and tools. On an organizational level, this leads to lower return on investment (ROI) on new equipment and the rather expensive clinical skills training programmes. Hence, it is essential to involve the departments and teams' leads in designing new service models and the procurement of needed tools, with sufficient onboarding activities conducted amid any new service introduction.

#### *4.1.6 Upskilling / inadequate competences*

Upskilling here refers to the lack of needed competences (Durst and Zieba, 2019), among clinicians and other health professionals to perform necessary procedures and use new tools. Thus, awarding a pressing need to improve their skills. The healthcare organization must regularly audit its skill pool and benchmark it against other providers, to identify missing resources and underdeveloped competences. It also needs to have training and learning plans in place for the entire staff.

#### *4.1.7 Continuity / loss*

In the current hypercompetitive environment, an organization might struggle to keep its most valuable assets (Lambe, 2013). In a healthcare context, this translates to the medical practice's ability to preserve its skilled clinicians and health professionals. Departure of critical resources leaves gaps in the organization's knowledge and skill map, which could be difficult to replace promptly. Thus, healthcare organizations must follow through the implementation of training programmes delivered to existing staff and develop

partnerships with relevant medical and research institutes to ensure knowledge exchange and an uninterrupted flow of new talents and skilled professionals.

#### *4.1.8 Overload*

The inability of clinicians to deal with the fragmented nature and the accelerated pace of scientific knowledge generation and technology advancements (Rebitzer, 2008), can impact their skill level, quality of service provided and innovation process (Kohn et al., 2000). It is important that the healthcare organization supports its clinical staff by promoting and allowing time to participate in medical research and scientific events. It should also provide access to clinical knowledge management systems to equip them with proven and evidence-based clinical knowledge seamlessly at the point of care.

#### *4.1.9 Habituation / application*

Tan et al. (2006) argues that knowledge can become obsolete quickly due to new knowledge being produced. In medical practice, habituation usually happens when clinicians insist on following certain guidelines or treatment modalities, regardless of them being defunct or replaced by updated ones, The main onus of managing this risk pertains to the process of reviewing the guidelines and policies implemented across the medical practice, and ensuring they align with the up-to-date guidance from regulatory and international bodies.

### **4.2 Technology-related knowledge risk management in healthcare**

Information technology is becoming an essential part of health services delivery (El Morr and Subercaze, 2010), with developments in key areas such as clinical data management and diagnostic technologies (Lee and Hong, 2014), and security of patient information (Sardi et al. 2020). In addition to the controversial impact of social media on all industries (Durst and Zieba, 2019). Thus, managing technology knowledge risks is becoming fundamental to safeguard critical functions within a healthcare organization.

#### *4.2.1 Cyber risk*

Hospitals hold sensitive personal information on their patients. Leaked information can jeopardize (patients') safety and affect (hospital) reputation (Kandasamay et al., 2020). It can also lead to incurring heavy fines by regulators.

Healthcare organizations need to pay considerable attention to updating its security software, data flow frameworks, and applications architecture. As well as training its staff on cyber security best practices.

#### *4.2.2 Legacy systems*

This risk emerges from the use of old technologies (Durst and Zieba, 2019), whether hardware or software. Legacy systems do not communicate well with other applications and tend to create blockages in information and process flow charts, thus affecting productivity and users' morale. It is important though for the IT team to prepare and update the digital technology landscape blueprints annually at least, and ensure digital transformation plans are aligned with functional workflows across the hospital.

#### *4.2.3 Digital transformation / digitization*

Given the complexity of hospital systems (Drucker, 2007), using technology to improve how a healthcare organization works is an arduous change endeavour. The chances of disintegrations, bugs, misalignments, and uneven digitization can lead to localized or even hospital-wide system failures. It is important though for healthcare organizations to accurately identify areas of improvement in existing applications' architecture and plan for the required changes thoroughly. Moreover, transformation activities must take in consideration the triad of people, process and technology (Westermann et al., 2014). Examples of control measures are the performance of technical due diligence, involving relevant clinical and commercial personnel in the procurement and implementation phases, reviewing and updating clinical and business workflows to ensure alignment with the new technology architecture, and planning always for a detailed training, stabilization and support phase following implementation of new technologies.

#### *4.2.4 Social media*

Social media platforms facilitate circulation of ungrounded personal opinions (Aula, 2010), which can harm the (clinician or hospital) reputation (Durst and Zieba, 2019). Marketing teams within healthcare organizations must adopt a proactive approach through opening a feedback channel for patients' complaints and addressing them promptly. In addition, they should leverage social media as a tool for enhanced positioning and engagement with the public.

### ***4.3 Operations-related knowledge risk management in healthcare***

Knowledge management activities are crucial in almost all processes and functions of healthcare organizations (Walburg, 2006; Karamitri et al., 2017) as they witness an infinite number of transactions, agents, and networks of dependencies (Zincir and Rus, 2019). Thus, managing operations-related knowledge risks is important to control any effects it might have on the organization's performance and outcomes.

#### ***4.3.1 Articulation / waste***

In healthcare organizations, it is not uncommon to come across disregarded equipment, tools, software applications, or even patents and innovative research. Some of the ignored assets were purchased based on plans that have never materialized, while others have lost their importance with the subsequent emergence of newer knowledge, technologies, and modalities. This represents a classic form of wasting resources and indents the expected returns on investments (ROI) made (Ferenhof et al., 2015). Hospitals must have a cross-disciplinary team, responsible for exploring, creating awareness about, and exploiting those hidden gems. Thus, generating additional revenue streams from previously sunk knowledge assets.

#### ***4.3.2 Gaps***

Perrott (2007) defines gaps as the difference between the knowledge an organization wishes to possess and that it already has. Promising more than what can be delivered can sometimes happen in healthcare settings, as the lines are blurred when it comes to identifying clinicians' level of competence. Hence, hospitals must make sure their promoted range of services and contractual obligations are aligned with their capabilities, and if necessary, cover any temporary or permanent deficiencies through hiring or outsourcing.

#### ***4.3.3 Acquisition***

The inability of a healthcare practice to procure needed assets, be it new diagnostic equipment, an endoscope, or a treatment modality. This can result in delaying or even preventing an organization from achieving its desired objectives (Lambe, 2013). However, reshaping the organization's growth strategy based on realistic expectations with a deliberate orchestration of financial support means

and balancing the in-house provision of services vs outsourcing non-core ones, can prove a successful strategy to mitigate knowledge acquisition risks.

#### *4.3.4 Complexity*

Hospitals are complex organizations (Karamitri et al., 2017) with multitude of inter-reliant services and teams, and an ever-changing guidelines and workflows. The frequent or unnecessary introduction of new technologies or processes can hamper staff ability to cope and might affect seamless service delivery with subsequent patient dissatisfaction. Hospitals need to carefully plan for any changes in its process or architecture, taking a stepwise approach to any transformation initiatives and following them through with adequate training and stabilization phases.

#### *4.3.5 Integration*

As new members of staff would ideally bring valuable insights and skills to the organization pool of resources, their reception of knowledge and proper integration within existing structures is essential to deliver the expected benefits from their hiring (Baroody, 2003; Schneider, 2012). Hence, to ensure a seamless onboarding process, relevant key team members should be involved in the candidates' selection process, and there should be a documented onboarding process whose implementation is followed through by the human resources team and relevant managerial personnel.

#### *4.3.6 Communication / exchange / transfer*

The healthcare ecosystem is rich with knowledge-laden interactions (Abidi, 2007), whether within concerned organizations or among affiliated external networks. Knowledge communication is mainly based on individual exchanges (Tangaraja et al., 2016), and a lack of coordination can build up to become a barrier in delivering combined services that require inputs of multiple teams/ individuals. Organizational involvement is required through clearly communicating a common and shared vision among internal stakeholders, promoting inter-departmental cooperation in the form of regular meetings, and incentivizing collaborative services and activities by setting collective targets. It should also ensure that an accessible and easy to use communication infrastructure is available to all employees.

#### *4.3.7 Equity*

Unequal distribution of valuable resources such as experienced/ senior clinicians, advanced equipment or financial resources among departments can have a negative impact on individual teams. Equity was shown to be essential for developing trust and collaboration (Pearce et al., 2000), and improving organizational performance (Joshi, 1989). The management of the healthcare organization must develop an oversight of resources availability and distribution across different teams, and the human resources department has to ensure that remuneration packages are consistent throughout the organization.

#### *4.3.8 Outsourcing*

Channeling some services to other providers (Tadelis, 2007), such as to specialized medical centres or using locum physicians is common practice in healthcare. However, this carries the risk of knowledge and revenue loss, and possibly customers' (patients') exodus (Durst and Zieba, 2017). For this reason, healthcare organizations should make permanent/ long-term contracts its first choice when hiring physicians and limit outsourcing to those services that are considered auxiliary and non-core. In addition, a well-crafted plan for training existing resources and investing in new productive assets should be prepared.

#### *4.3.9 Relational / leakage / spill-over*

Knowledge leakage could be intentional or unintentional and could result in unauthorized spread of knowledge to other sources inside or outside the organization (Annansingh, 2012). It is inevitable to happen (Inkpen, 2000), particularly given the huge number of interactions in the health ecosystem. Leakage could threaten the (healthcare) organization's competitive advantage, if valuable information is made available to others (Durst and Zieba, 2017; Coraș and Tanțău, 2013). However, healthcare organizations can limit this risk by ensuring that the required legal documents such as NDAs are in place when exchanging commercial and scientific information with external stakeholders. Additionally, it needs to make its clinicians aware of the acceptable level of knowledge they could share with peers during medical events. Furthermore, the legal team should always be ready to assist and guide hospital staff whenever required.

#### 4.3.10 Restructuring / leadership changes

The success of any organizational or ownership change depends on several factors such as the differences in strategies, structures, processes. It is also affected by the opinions and positions of involved stakeholders (Cartwright and Schoenberg, 2006). Losing valuable knowledge assets when going through the restructuring and handover activities is not uncommon but could carry serious consequences on service continuity and finances (Durst and Zieba, 2019). Hence, it is important that the team concerned with leading the change undertakes prior mapping of all knowledge assets and resources likely to be affected by the transition and ensure there is a clear plan for business continuity preserving all necessary resources with minimal service disruption. Additionally, it is advisory to avoid any dramatic changes and always opt for a gradual stepwise transition, whenever feasible.

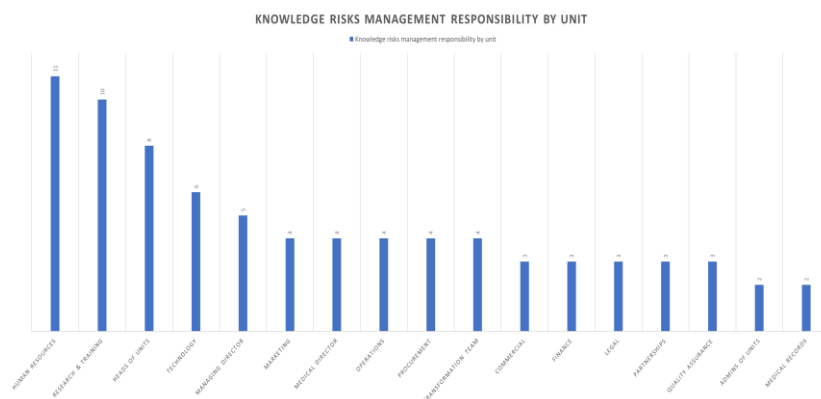


Figure (1) Knowledge risk management responsibility by stakeholder  
Source: Authors

## 5 Discussion and conclusions

Dalkir (2011) argues that healthcare organizations are ideal exemplars for proving the value of knowledge management practices, especially with the explosion in knowledge the healthcare industry is witnessing (Lee and Hong, 2014). Thus, the ability of a healthcare organization to provide quality services and maintain a competitive advantage relies on how effective it is at guarding and leveraging its knowledge assets (Heathfield and Louw, 1999; Bose, 2003; Stefan et al., 2016).



This paper proposed several measures to address knowledge risks identified in healthcare organizations by the authors previously, following their approach which grouped them into 3 categories: human, technology and operations. Some of the most recommended solutions that address multiple risk areas, especially those of individual (human) and operational natures include the improvement of skill levels of incumbent staff through the effective design and delivery of training programmes, subscribing to leading research and skills development platforms; and incentivizing senior staff to pass on their knowledge. Another set of measures aimed at ensuring effective intra and inter-departmental collaboration include holding regular joint meetings, setting collective incentivized targets, and making schedules and events plans publicly available internally. Some measures were developed to address technology risks, ensuring better IT governance such as conducting annual reviews and appraisals of the technology landscape, undergoing thorough feasibility studies and digitization planning, and following through transformation projects with proper training, transition and stabilization phases.

However, as healthcare are complex organizations (Karamitri et al., 2017; Anderson and McDaniel, 2000), there is a shared responsibility among the different units and personnel for the development and effective actualization of knowledge risk management strategies and control measures, as demonstrated in figures (1) and (2). We identified 17 different units and leaders within health organizations who would ideally be responsible for the delivery of the recommended measures. The human resources department is represented the most in the KRM framework, being involved in activities aimed at mitigating 11 risk areas. This is followed by the research and training unit (10 risk areas), the heads of units/ departments (8 risk areas), and the technology / IT department (6 risk areas). Contrary to our prior assumptions before developing the framework, the quality assurance (3 risk areas), legal (3 risk areas), and medical records (2 risk areas) units are among the least involved in the implementation of the proposed knowledge risk management framework in healthcare organizations.

### **5.1 Implications**

As the study of KRM is relatively new (Durst and Ferenhof, 2016) and almost non-existent in the healthcare field (Sardi et al., 2020), the proposed knowledge risk management (KRM) framework represents a first step towards equipping

healthcare organizations, experts and policy makers with a reference tool to address the knowledge risks in healthcare organizations identified by Hammoda and Durst (2021), which are evident in everyday activities in medical practices of all size. Responding to the mounting challenges in the healthcare sector, the mitigation of KR can improve the quality of care provided to patients and their caregivers, drive efficiency savings, and improve performance. Moreover, the proposed KRM framework advances the academic rhetoric bridging knowledge management and risk management research fields (Massingham, 2010), through presenting a fresh perspective into one of the most knowledge-intensive, yet under-researched industries (Abidi, 2007). Consequently, it promotes the discourse in the KM field and offers scholars a ground to build on their research in this nascent area.

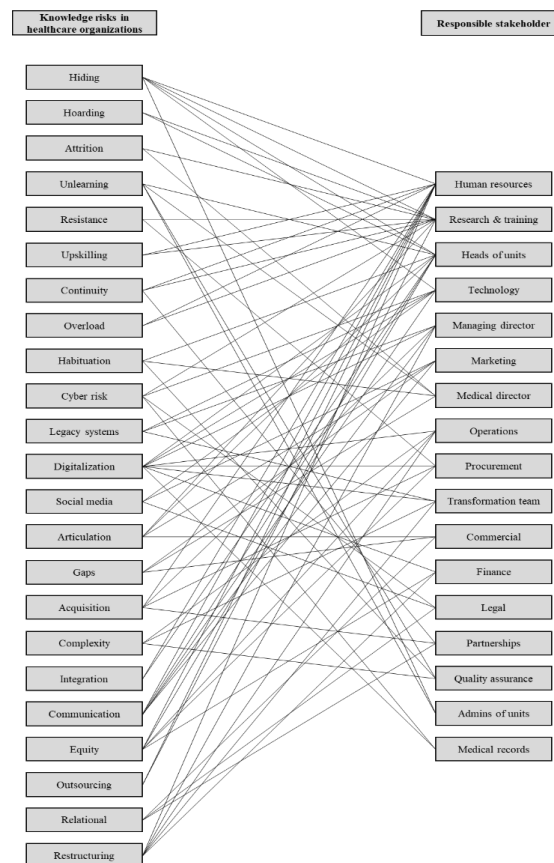


Figure (2) Knowledge risks in healthcare by responsible unit  
Source: Authors

## **5.2 Limitations**

This framework is building on recent work by the authors, producing a taxonomy for knowledge risks in healthcare organizations, explaining their manifestations and impacts (Hammoda and Durst, 2021). In addition, an elaborate review of relevant literature on KRM in general and KM within healthcare was performed. Findings were combined with the authors' experience in the healthcare and knowledge risk management fields to develop the proposed control measures. However, we understand that the resultant framework is a conceptual one, which needs to be empirically validated in a healthcare environment to further refine it.

## **5.3 Future research**

This framework can be leveraged by scholars to advance the research agenda in this increasingly important field of knowledge risks and their management, especially within the knowledge-rich and underrepresented healthcare industry. As the majority of current literature on knowledge risks is of conceptual nature (Durst, 2019), empirical papers are needed and can prove valuable if they manage to harness health experts' and practitioners' insights through interviews, focus groups, surveys and other qualitative and quantitative techniques.

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**Appendix I Healthcare knowledge risks control measures and responsibilities map – Human category:**

<b>Risk #</b>	<b>Human knowledge risk</b>	<b>Control measures</b>	<b>Responsible units</b>
1	Hiding	<ul style="list-style-type: none"> <li>* Mandate intra-departmental training programmes</li> <li>* Include training delivery as part of the job description and evaluation process for senior clinical and commercial staff</li> <li>* Provide senior clinical and commercial staff with more advanced training opportunities</li> <li>* Offer longer-term contracts to clinical and commercial staff</li> <li>* Establish secure team-specific knowledge storage and management repositories</li> </ul>	<ul style="list-style-type: none"> <li>* Human resources</li> <li>* Heads of units</li> <li>* Research &amp; training</li> <li>* Admins of units</li> <li>* Technology</li> </ul>
2	Hoarding	<ul style="list-style-type: none"> <li>* Set a publicly displayed events, activities and trainings master schedule with staff tagged to it across all departments</li> </ul>	<ul style="list-style-type: none"> <li>* Heads of units</li> <li>* Research &amp; training</li> </ul>
3	Attrition / Unintentional forgetting	<ul style="list-style-type: none"> <li>* Subscribe to virtual surgical training programmes</li> <li>* Allow clinical staff to join "scientific workshops" in specialized / tertiary centres</li> </ul>	<ul style="list-style-type: none"> <li>* Medical director</li> <li>* Research &amp; training</li> </ul>
4	Unlearning / Active forgetting	<ul style="list-style-type: none"> <li>* Ensure up-to-date clinical guidelines are regularly reviewed and aligned with regulatory bodies and international standards</li> <li>* Conduct regular clinical quality assurance audits</li> <li>* Open a feedback channel between staff and management</li> <li>* Arrange regular department meetings with minutes recorded</li> <li>* Make workflows and schedules publicly available internally</li> </ul>	<ul style="list-style-type: none"> <li>* Medical director</li> <li>* Quality assurance</li> <li>* Heads of units</li> <li>* Admins of units</li> </ul>
5	Resistance / Comfort zone syndrome	<ul style="list-style-type: none"> <li>* Involve relevant clinical, commercial and managerial staff in service design and procurement activities</li> <li>* Ensure the design and delivery of adequate training and onboarding activities</li> </ul>	<ul style="list-style-type: none"> <li>* Procurement</li> <li>* Research &amp; training</li> </ul>
6	Upskilling / Inadequate competences	<ul style="list-style-type: none"> <li>* Review and audit clinical skills regularly to identify gaps</li> <li>* Ensure the delivery of required training and programmes</li> </ul>	<ul style="list-style-type: none"> <li>* Research &amp; training</li> <li>* Human resources</li> </ul>
7	Continuity / loss	<ul style="list-style-type: none"> <li>* Ensure the delivery of required training programmes</li> <li>* Develop relationships with medical schools and research institutes to ensure access to required skills</li> <li>* Review and adjust your pay and benefits scale to attract and retain skilled staff</li> </ul>	<ul style="list-style-type: none"> <li>* Partnerships</li> <li>* Human resources</li> <li>* Research &amp; training</li> </ul>



8	Overload	<ul style="list-style-type: none"> <li>* Ensure participation in research activities is included in staff job description and schedules</li> <li>* Subscribe to relevant scientific portals to give staff access to up-to-date, trusted and actionable knowledge</li> </ul>	<ul style="list-style-type: none"> <li>* Research &amp; training</li> <li>* Human resources</li> </ul>
9	Application / habituation	<ul style="list-style-type: none"> <li>* Ensure up-to-date clinical guidelines are regularly reviewed and aligned with regulatory bodies and international standards</li> <li>* Conduct regular clinical quality assurance audits</li> </ul>	<ul style="list-style-type: none"> <li>* Medical director</li> <li>* Heads of units</li> <li>* Quality assurance</li> </ul>

**Appendix II Healthcare knowledge risks control measures and responsible units – Technology category:**

<i>Risk #</i>	<i>Technology knowledge risk</i>	<i>Control measures</i>	<i>Responsible units</i>
10	Cyber risk	<ul style="list-style-type: none"> <li>* Mandate regular training of staff on security best practices</li> <li>* Ensure all essential clinical and business applications are available</li> <li>* Ensure staff is trained on the installation, access, usage, basic troubleshooting and error reporting of relevant applications</li> <li>* Ensure security and data management frameworks are up-to-date and activated across all departments</li> </ul>	<ul style="list-style-type: none"> <li>* Technology</li> <li>* Research &amp; training</li> <li>* Legal</li> <li>* Medical records</li> </ul>
11	Legacy systems	<ul style="list-style-type: none"> <li>* Review and regularly update digital landscape blueprints</li> <li>* Prepare the digital transformation/ tech upgrade plan annually, in coordination with clinical, commercial and managerial leads</li> </ul>	<ul style="list-style-type: none"> <li>* Managing director</li> <li>* Technology</li> <li>* Transformation team</li> </ul>
12	Digital transformation / digitalization	<ul style="list-style-type: none"> <li>* Identify gaps in the digital landscape blueprint and ensure these gaps are addressed in the annual tech upgrade plan</li> <li>* Ensure the digital transformation/ tech upgrade plan guarantees operational equity among departments, taking into considerations the feasibility of different projects and their timeline</li> <li>* Ensure digital transformation best practices are followed throughout implementation</li> <li>* Apply stepwise transformation methodology</li> <li>* Perform technological and financial due diligence for each application during the procurement process</li> <li>* Involve relevant clinical, commercial and managerial staff in the procurement and deployment phases</li> <li>* Review and adapt clinical and business workflows in line with the new enterprise architecture</li> </ul>	<ul style="list-style-type: none"> <li>* Managing director</li> <li>* Technology</li> <li>* Procurement</li> <li>* Transformation team</li> <li>* Heads of units</li> <li>* Medical records</li> <li>* Finance</li> <li>* Operations</li> </ul>

		<ul style="list-style-type: none"> <li>* Ensure vendors and service providers contracts include detailed and proofed implementation, integration, testing, training, and post-go-live support clauses</li> <li>* Archive and document paper medical records properly</li> <li>* Create backups of electronic medical records on separate and secure servers</li> </ul>	
13	Social media	<ul style="list-style-type: none"> <li>* Ensure involvement of relevant clinical and business staff in drafting and when required, executing digital marketing and social media plans</li> <li>* Ensure a customer feedback system is in place, on-site and online</li> <li>* Ensure proactive, swift and two-way communication is ingrained in the social media/ digital marketing team practices</li> <li>* Orient clinical staff on best practices to avoid reputation issues</li> <li>* Train legal staff on managing social media inflections</li> </ul>	<ul style="list-style-type: none"> <li>* Marketing</li> <li>* Legal</li> <li>* Technology</li> </ul>

**Appendix III Healthcare knowledge risks control measures and responsible units – Operations category:**

<i>Risk #</i>	<i>Operational knowledge risk</i>	<i>Control measures</i>	<i>Responsible units</i>
14	Waste / articulation	<ul style="list-style-type: none"> <li>* Dedicate a team to create awareness and commercialization plans for leveraging internal knowledge assets</li> </ul>	<ul style="list-style-type: none"> <li>* Research &amp; training</li> <li>* Heads of units</li> <li>* Marketing</li> <li>* Commercial</li> </ul>
15	Gaps	<ul style="list-style-type: none"> <li>* Ensure accreditations, contractual agreements and marketing collaterals are aligned with available capabilities</li> <li>* Cover temporary deficiencies by hiring covering (locum) staff or outsourcing services to other providers</li> </ul>	<ul style="list-style-type: none"> <li>* Medical director</li> <li>* Marketing</li> <li>* Commercial</li> <li>* Human resources</li> </ul>
16	Acquisition	<ul style="list-style-type: none"> <li>* Prepare regular business plans for needed staff and assets</li> <li>* Establish and maintain a network of creditors and investors</li> <li>* Adjust growth strategy and projections to the new reality</li> <li>* Cover staff and services deficiencies by hiring covering (locum) staff or outsourcing services to other providers</li> </ul>	<ul style="list-style-type: none"> <li>* Managing director</li> <li>* Finance</li> <li>* Procurement</li> <li>* Partnerships</li> <li>* Human resources</li> </ul>
17	Complexity	<ul style="list-style-type: none"> <li>* Conduct impact analysis before adopting new tools</li> <li>* Apply stepwise transformation methodology</li> </ul>	<ul style="list-style-type: none"> <li>* Quality assurance</li> <li>* Operations</li> </ul>

		* Ensure delivery of adequate training and onboarding activities with improvement and transformation projects	* Transformation team
18	Integration	* Involve key relevant departments' members in the recruitment and onboarding process * Review and ensure onboarding activities are followed properly, and given adequate time and attention	* Heads of units * Human resources
19	Communication / exchange / transfer	* Ensure hospital vision, mission and goals are clearly articulated and regularly communicated * Ensure departments and teams' plans are aligned to the overarching hospital strategy * Include KPIs based on inter-departmental activities * Ensure cross-departmental meetings are held regularly * Ensure necessary communication applications are available and accessible to all staff	* Managing director * Marketing * Human resources * Heads of units * Technology
20	Equity	* Map skills pool and available equipment and systems across departments on regular basis. * Review remuneration and promotion policies on annual basis and ensure consistency across departments	* Heads of units * Human resources * Operations * Procurement * Finance
21	Outsourcing	* Hire full-time staff whenever possible and feasible * Limit outsourcing to additional and temporary coverage * Ensure the delivery of required training programmes	* Human resources * Research & training
22	Relational / spillover / leakage	* Ensure proper legal documents are available to staff * Mandate sign-off of external activities and interactions * Make legal team available to staff	* Legal * Commercial * Partnerships
23	Restructuring / leadership change	* Mapping affected incumbent knowledge assets, services in the early stages of any change programme * Apply stringent risk control and business continuity plan * Apply stepwise transformation methodology	* Managing director * Operations * Human resources * Transformation team * Finance

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## Knowledge Behaviors and Commons: What We Learn from the Covid-19 Crisis

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### Abstract

How do people's beliefs on the likely system-level consequences of circulating a certain piece of knowledge influence those people's knowledge behaviors? To address this question, we leverage the most recent developments of the theory of the commons as learning systems. According to this theory, people are strongly responsive to perceived threats to the commons they (may) benefit from, and strive to learn and respond accordingly. Through this theoretical lens, we analyze thick qualitative data (January-April 2020) from the Covid-19 crisis, which resulted in unprecedented visibility of commons-related knowledge behaviors. The contribution of this inductive study is fourfold. First, we identify a new emerging taxonomy of knowledge behaviors, including knowledge unleashing and knowledge curbing behaviors. Second, we identify a new emerging taxonomy of commons-related postures, that is, specific cognitive and behavioral attitudes that an individual may display about a certain commons. Third, we identify interesting

emerging regularities in the relationships between specific commons-related postures and specific knowledge behaviors. Fourth, we show that the empirical data, analyzed in the light of the theory of the commons, strongly suggest disentangling knowledge behaviors from their consequences: for example, knowledge withholding proved far from being “intrinsically” counter-productive. We argue that these results open up promising research paths and opportunities for new knowledge management approaches in a wide range of organized and self-organizing contexts, such as innovation ecosystems, sustainability transitions, open innovation, or crisis management.

**Keywords** – knowledge sharing, system resilience, common good

**Paper type** – Academic Research Paper

## 1 Introduction

In the last years, knowledge management (KM) scholars have highlighted the key role of the processes through which people share knowledge, not only in individual organizations but also in wider, boundaryless contexts, such as communities of practice or virtual wikis (Rice et al., 2019). In most of these studies, knowledge sharing is viewed as an intrinsically positive behavior (Zhu et al., 2018) that is key to enabling other processes that are also understood as intrinsically positive, such as knowledge creation and knowledge use (Baskerville & Dulipovici, 2006). Other behaviors that influence knowledge flows, such as knowledge seek (Case & Given, 2016), knowledge hiding (Serenko & Bontis 2016), or knowledge sabotage (Serenko, 2019), are mostly viewed either as complements of knowledge sharing, and then intrinsically good, or as opposites of knowledge sharing, and then intrinsically counterproductive.

On the other side, some studies delineate a more complex picture. The smooth knowledge circulation and use resulting from knowledge sharing may have unintended consequences, even regardless of whether that knowledge is “wrong” (e.g., Lin & Wang, 2020). As early as in 2002, Schultze and Leidner’s seminal paper suggested that KM scholars need “a stronger theoretical base that includes both favorable and unfavorable consequences of knowledge” (p. 231). Several studies do investigate how the expected consequences of knowledge circulation and use influence people’s decisions as for knowledge behaviors (Wang & Noe, 2010). According to these studies, people make decisions on their knowledge behaviors based on their will to achieve (tangible or intangible) personal advantages for

themselves or their individual friends, and/or harm or punish individual rivals (Wang et al., 2019; Serenko, 2019).

Nevertheless, knowledge behaviors may also depend on the expected consequences at the system level (rather than the individual level) of knowledge circulation and use. For example, knowledge sharing may be hindered by concerns over the greater good, such as concerns over harmful collective panic, or unaffordable time waste (Trusson, et al., 2017), which may result from knowledge sharing. In other words, there is a political dimension of knowledge behavior motives, that complements the individual dimension. People may prefer a specific knowledge behavior for the (perceived) sake of their firm's work climate, industrial sector's viability, or social movement's credibility, for example. Hyper-connection amplifies the consequences of each knowledge behavior today. Perhaps, the time is now ripe to investigate the relationship between knowledge behaviors and their (expected) system-level consequences.

How do people's beliefs on the likely system-level consequences of circulating a certain piece of knowledge influence those people's knowledge behaviors? To address this question, a theory that links motivation, individual knowledge behaviors, and the common good is needed. For example, Rice et al. (2019) propose a public goods approach to investigate behavior in an online knowledge sharing portal. We go further up this road and leverage the more recent developments of the theory of the commons, based on systems thinking, as a lens to enable our investigation (Ricciardi et al., 2020). Even if the first seminal studies on the commons focused on traditional common pool resources (Ostrom, 1990), such as fisheries and grazing lands, the commons are everywhere, ranging from communities of practice to global climate or Wikipedia (Ansari et al., 2013). Businesses, too, can be viewed as commons, or key actors in larger commons. In fact, business organizations (may) provide internal and/or external communities with resources that are available on a collective basis, and can only be protected through a collective sense of the common good.

The literature on the commons as social-ecological learning systems (Armitage et al., 2008) highlights that people may have different attitudes towards a certain commons. For example, a person may value a certain commons, be aware of its fragilities, and believe that abiding by a certain set of existing rules is necessary to protect and develop the commons' capacity to (re)generate resources for the common good. This attitude influences that person's knowledge behaviors, for example, his or her decisions to share or hide specific pieces of knowledge. On

this basis, it is possible to argue that people's attitudes towards a commons translate into commons-related cognitive postures that shape their beliefs on the possible consequences of knowledge circulation and use and, consequently, their knowledge behaviors.

In this study, we adopt the theory of the commons as learning systems as a lens to inductively investigate a colossal systemic change, which has provided unprecedented opportunities to observe commons-relating knowledge behaviors in action. In the first months of 2020, the Covid-19 contagion spread from China to the entire world. Italy was the first Western country that was dramatically impacted, with overwhelmed hospitals, dramatic surge of victims, and strict, traumatic lockdown policies enforced. In a few weeks, more than half the world's population was involved in different forms of pandemic control measures. The Covid-19 pandemic and its consequences suddenly impacted innumerable commons at all levels. Many commons were severely disrupted or shaken to their foundations. For example, some excellent health care systems, like Italy's, suddenly lost their taken-for-granted capability to provide all patients with best-practice care. Liberal democracies lost to a significant extent their capability to guarantee personal and enterprise freedom. Small and micro-businesses lost their capabilities to provide decent jobs, cross-generational perspectives, and local, adaptive responses to market needs. The school system lost its capability to allow parents to work during school hours. Tourism destination systems collapsed, as well as most charity systems. On the other hand, however, the Covid-19 pandemic resulted in a previously unthinkable strengthening of other commons. Carbon emission collapsed, reinvigorating the hopes of climate activists. Natural ecosystems were relieved from the human burden throughout the world. Many organizations that had prohibited any remote way of working for years suddenly wiped out any resistance and became capable of smart working. At the time of writing, in May 2020, the long-term consequences of the Covid-19 pandemic are imponderable yet; however, the empirical material collected for this study from January 20th to April 20th, 2020 (about 1,500 pages from a wide range of sources, in Italian and English) allowed a thick observation of knowledge behaviors and the commons-related postures associated to those behaviors.

In this study, we leverage the Covid-19 crisis as an extreme-intensity case study to inductively develop a framework of how commons-related postures influence knowledge behaviors. Our findings allow us to identify six commons-related postures (which we conceptualize as recognizing the commons, adapting it,

contributing to it, depleting it, invading it, and stranding it). Our findings also suggest that these six commons-related postures influence knowledge behaviors (which we cluster around six categories: knowledge intake, search, sharing, withholding, hijacking, and neglect) in complex, intertwining ways. Last but not least, our findings show that knowledge behaviors that the literature would traditionally consider as positive, such as knowledge sharing, may have counterproductive consequences indeed (and vice versa) from the standpoint of a certain commons' cherishers.

Therefore, this study proposes to include commons-based cognitive postures among the factors explaining knowledge behaviors and to overcome the traditional classification of knowledge behaviors into good or counterproductive per se. Our empirical data suggest to disentangle knowledge behaviors from their consequences and to cluster knowledge behaviors into knowledge unleashing behaviors (which include knowledge intake, search, and sharing) and knowledge curbing behaviors (which include knowledge withholding, hijacking, and neglect).

## **2 Background**

### ***2.1 Knowledge behaviors in the KM literature***

In the KM literature, scholars have devoted great attention to the processes through which knowledge flows between and across individuals (Paulin & K. Suneson, 2012). In this respect, most of the research has focused on knowledge sharing. Some scholars have tried to narrow the concept of knowledge sharing distinguishing it from similar concepts such as knowledge exchange and knowledge transfer. Wang & Noe (2010), for instance, distinguished knowledge sharing from knowledge exchange, claiming that the former refers to providing knowledge to others without others explicitly seeking for knowledge, while the latter includes sharing and seeking knowledge simultaneously. In a similar vein, Chhim et al. (2017) pointed that the concept of knowledge transfer is more general than knowledge sharing since it involves both prior and subsequent aspects that range from developing, searching, and locating, through validation, application, and reuse. However, many authors understand knowledge sharing as "the exchange between a contributor and a seeker" (Mirzaee & Ghaffari, 2018, p. 501).



Knowledge flows are today viewed as essential for improving individual and group decision making, increasing organizational performance through creativity and innovativeness, and fostering adaptability to respond to environmental changes (Rice et al., 2019; Mirzaee & Ghaffari, 2018). Consistently, the concept of knowledge sharing has developed over the last years in KM literature, including studies not only in intra-organizational but also in inter-organizational and community contexts (Rice et al., 2019; Forliano et al., 2020).

The expansion of the areas of investigation led to deeper investigations of the knowledge behaviors influencing knowledge flows. Therefore, besides knowledge sharing, the scope of KM scholars' inquiries has embraced new perspectives, introducing the so-called counterproductive knowledge behaviors (Serenko & Bontis, 2016) such as knowledge hiding, knowledge hoarding, knowledge withholding, knowledge sharing ignorance, and knowledge sabotage (Serenko, 2019; Connelly et al., 2012; Israilidis et al., 2015). More recently, some studies have highlighted that considering behaviors such as knowledge hoarding and knowledge hiding as antithetic to knowledge sharing represents an over-rational view of how people think and act. Other scholars have challenged the common assumption that knowledge sharing is essentially virtuous. For example, Trusson et al. (2017), have pointed out that knowledge hoarding behavior is not necessarily dysfunctional as, for instance, in time-pressured and highly contingent environments it might be more pro-organizational than knowledge sharing.

To understand the dynamics of knowledge flows among individuals, KM studies have identified different antecedents such as social norms, organizational incentive structure, job design, and individual traits and motivations (Foss et al., 2009; Xiong et al., 2019; Witherspoon et al., 2013). The theories that are most frequently used to explain the motives of knowledge behaviors are the psychological ownership theory, the theory of planned behavior, the self-efficacy theory, and the social exchange theory (Xiong et al., 2019; Witherspoon et al., 2013). Attempts have been carried out to understand knowledge behaviors and dynamics using the lens of the public goods theory (e.g., Rice et al., 2019), but the more recent development of the theory of the commons, which are based on systems thinking, have been overlooked by the knowledge management literature so far, despite its potential in explaining the processes through which individual and collective knowledge are recursively and dialectical constituted (Paulin & K. Suneson, 2012).

## ***2.2 The commons as a fragile learning system***

In light of systems thinking, a commons is a very particular type of system. It is capable of (re)generating resources for a certain community's collective use and benefit, but its capabilities to (re)generate such resources are vulnerable to its very beneficiaries' misbehaviors, such as over-exploitation or carelessness (Ricciardi et al., 2020).

When people believe that a certain system benefitting them is a commons (i.e., it is vulnerable to beneficiaries' behaviors and/or carelessness), people likely become strongly interested in learning about the state of the system, understanding what behaviors should be collectively adopted/avoided to avert the collapse of the system, and spreading knowledge and social control about these behaviors (Ricciardi et al., 2020; Ostrom et al., 2007). Strong social and emotional rewards reinforce these attitudes, thus supporting the theory of commons-enabling behaviors as hard-wired in human nature (Fehr & Gintis, 2007; Sigmund et al., 2010; Henrich et al., 2010). These dynamics are present in innumerable contexts, spanning from social movements to communities of practice and business organizations (Rossignoli et al., 2018; Hess, 2008).

True, commons-enabling behaviors are not always for the greater good: for example, they may reinforce a predatory commons, such as a group of bullies. True, commons-enabling behaviors may fail to spread to a critical threshold, for example, because they are perceived as unsustainable by most beneficiaries, or because an epidemic of opportunism occurs. However, despite contrarian predictions by classical economics (Hardin, 1968), wide empirical evidence has accumulated that innumerable successful commons exist (including, for example, innovation ecosystems and scientific communities), and some of them are probably the most powerful learning systems that human beings can develop.

Since the 1990s, when the most important studies by Nobel laureate Elinor Ostrom were published, Ostrom (1990), the research on the commons as learning- and interaction-based social-ecological systems has advanced significantly (Dietz et al., 2003; Berkes, 2009). More recent publications converge in identifying poor management of knowledge processes as the key factor for the failure of complex commons (Armitage et al., 2008). These studies converge in identifying resilience as the key purpose of systems governance, management, and learning. This approach is attracting growing attention in organization and management studies, especially in the light of the impending sustainability

challenges (Barnett & King, 2008; Plummer & Armitage, 2007; George et al., 2016).

### **3 Methodology**

To create the empirical base for this inductive study (Bryman & Bell, 2011; Eisenhardt, 2016), we engaged in intense qualitative data collection of newspaper articles, online discussion excerpts, newsletters, blogs, online forums, social media posts, interview transcripts, talk show transcripts, radio broadcasting transcriptions, institutional communications, instant books, and reports, in Italian and English, around the Covid-19 pandemic. Overall, the empirical material resulted in about 1,500 pages available for analysis. The collected sources span a period from January 20th to April 20th, 2020: three months during which the Italian scenario changed from a collective perception that the new Coronavirus was just a Chinese problem to traumatic tragedies, severe lockdowns, and economic disruption.

Like all systems, the commons become much more visible in times of systemic change. When people feel that one or more commons they rely on are under threat, their knowledge processes tend to be monopolized. The pandemic made this phenomenon incredibly intense and wide-spread, and the media made the explosion of the relating knowledge flows visible to an unprecedented extent. Therefore, the Covid-19 crisis provided an unprecedented opportunity to observe knowledge behaviors when the commons are at stake. The data gathering process was an exhausting and inevitably subjective effort, since for the last seven weeks of our observation period, up to 90% of the contents provided by all the media we leveraged as sources had to do with the Coronavirus crisis.

Besides, since universities were closed at the time of data analysis and we could not access any software for qualitative data analysis, we conducted coding with the aid of online calls and a word processor.

In the first phase, we coded for commons-related postures. In a pilot exploration of the empirical material, we identified 1,000 situations (corresponding, for example, to an online post or a TV interview) in which an actor clearly had a specific objective, preoccupation, or attitude towards at least one commons (e.g., the public health system, a tourism destination, Italy's reputation). Then, we clustered these commons postures into categories through

bottom-up coding and collaborative discussion. A taxonomy emerged of six types of commons-related postures.

In the second phase, we analyzed the knowledge behaviors of the 1,000 selected contexts of analysis. Then, we clustered these knowledge behaviors into categories through bottom-up coding and collaborative discussion. A taxonomy emerged of six key types of knowledge behaviors, each associated with at least one commons-related posture as for at least one commons. In some cases, two knowledge behaviors were observable contemporaneously in the same situation, therefore 1,022 coded behaviors resulted from the analysis. In some cases, the actors talked about others' or their own previous behaviors that, out of an emergency, are difficult to observe, such as knowledge hiding. In this phase, we also evaluated the expected consequences of each knowledge behavior on the resilience of the relevant commons.

In a third phase, we analyzed and compared the emerging associations between each of the six commons-related postures and each of the six knowledge behaviors.

## **4 Findings and discussion**

### ***4.1 An emerging taxonomy of commons-related postures***

Our work contributes to the theory of the commons by identifying six specific commons-related postures affecting people's cognitive and behavioral attitudes (Fig. 1).

Three out of these six postures reflect attitudes that the literature has already investigated. "Depleting the commons" corresponds to the cheating behavior predicted by classical economics (Hardin, 1968). "Contributing to the commons" corresponds to the conforming behavior predicted by neo-institutionalism (Immergut, 1998). "Adapting the commons" corresponds to the experimentation and adoption of technologies, rules, and beliefs that seem to better protect the commons; this process has been investigated by social-ecological systems (Armitage et al., 2008), and the literature on institutional work (Barnett & King, 2008).

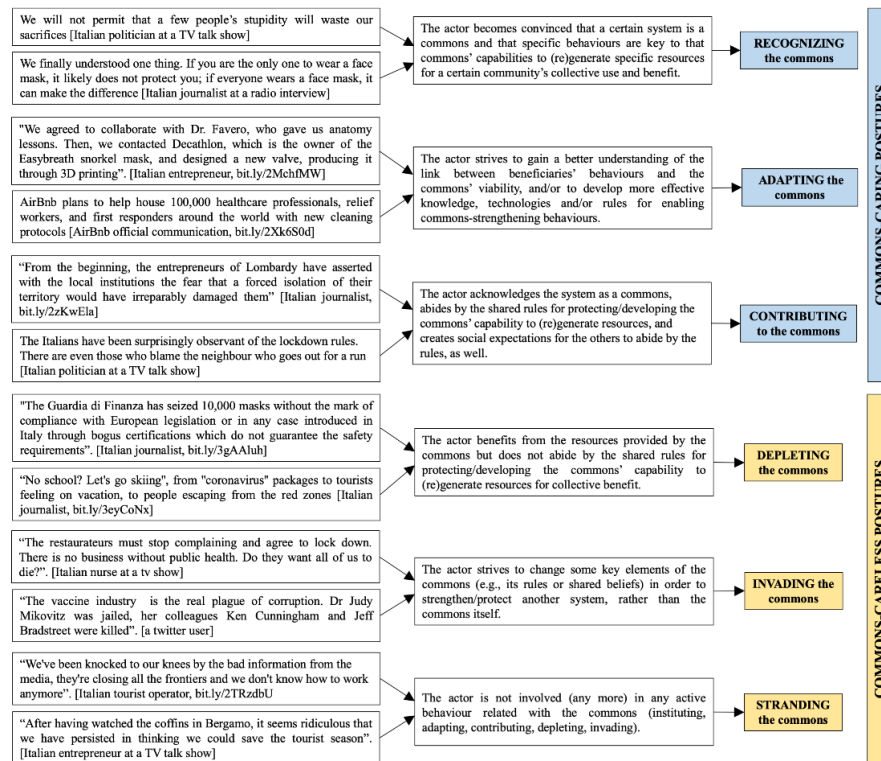


Fig. 1. How the taxonomy of commons-related postures emerged from the empirical material (illustrative quotes).

On top of these three already established phenomena, we identify three further commons-related postures. The first one regards "recognizing the commons", through which the actor acknowledges the commons-like nature of a system and particularly is dependent on beneficiaries' behaviors. For instance, before the pandemic, the Italians did not consider the health system as a commons, but during the crisis, the Italians realized that they had to make sacrifices, such as staying at home and wearing masks in public to protect the health care system's capability to save lives.

A second commons-related posture that emerges from the empirical material but, to the best of our knowledge, has not been investigated so far is the one we labeled as "stranding the commons". When a commons is perceived as losing its capability to provide a certain person with (significant) resources and/or requiring unacceptable sacrifices, it may be abandoned. In that case, the person simply

stops from contributing and from getting anything from that commons, sometimes temporarily, sometimes permanently.

For example, when the magnitude of the crisis became clear, several owners of hotels and restaurants, after engaging for a while for fighting collective panic, declared that they would abandon their business, activity sector, and in some cases, even their country.

Also, the attitude that we labeled as “invading the commons” has not been investigated so far. We found that this cognitive and behavioral posture is typical of actors who feel threatened by a certain commons’ success. In this case, they attempt to undermine and/or delegitimize knowledge, technologies, and rules of the opponent commons. Some exponents of anti-vaccination groups, for example, attacked the vaccine industry accusing it of being responsible for having supersized the C-19 phenomenon to gain economic benefits. In other words, and quite interestingly, the dynamics of a commons and the behaviors it requires can be perceived as detrimental to other personal and/or collective interests. Our context of analysis has allowed us to observe live these “clashes between commons”, which so far have not been investigated accurately by literature.

#### ***4.2 An emerging taxonomy of knowledge behaviors***

Our findings led us to identify six categories of knowledge behaviors. We found that knowledge sharing played a key role in the context under study. However, our empirical analysis shows that knowledge search can occur regardless of whether the knowledge searched for has already been shared. In other words, people may seek knowledge that no one has created and shared yet. Intense knowledge search behaviors, in these cases, may trigger knowledge sharing, rather than resulting from them. The rapid spread of Covid-19, for instance, triggered colossal collective information search on the modes of transmission of the virus causing Covid-19 and the possible causes of immunity even when there was not established knowledge available on that. This also resulted in counter-productive knowledge sharing because this “information appetite” encouraged opportunistic behaviors on the part of some individuals who pretended to be experts, taking on an important role in conveying information whose scientific evidence was not proven.

Furthermore, individuals are not only involved in knowledge search but also in knowledge intake behavior as the process through which individuals absorb

information according to their cognitive frames and inner motivations. For instance, at the beginning of the pandemic, the actors who were recognizing the tourism destination system as the reference commons tended to rely on and process the institutional information aimed at reassuring people that Italy was a safe country.

On the other side, people tend to discard a significant amount of available knowledge as false, useless, or not accessible. The previous literature highlighted that knowledge neglect can derive from evaluation but also overload and ignorance (Israilidis et al., 2015; Peters & Maruster, 2010); however, we found that knowledge neglect is often due to individuals' commons-related posture. For example, knowledge whose perceived implications are negative for the relevant commons (like "let us be realistic: the virus is already here even if we have not found it yet") are likely neglected.

We realized that many behaviors that significantly influenced knowledge flows could not be described with the categories already present in the literature. For instance, an Italian politician engaged in public handshaking in Milan in February 2020 to make the point that there was nothing to be scared of and the economy should not stop because of the virus. We labeled this as a knowledge hijacking behavior from the perspective of the health system as a commons. Knowledge hijacking includes, but is not limited to, the phenomenon of knowledge sabotage introduced by Serenko (2019) since it includes all those behaviors in which one person actively behaves to curb a certain knowledge flow. It is a broad group of knowledge behaviors that have been quite overlooked by knowledge management so far, ranging from purposefully creating fake news to the debunking of conspiracy theories. We found that knowledge hijacking, like all the other knowledge behaviors, may have both positive and negative consequences from the standpoint of a certain commons' cherishers.

Lastly, we identify knowledge withholding as a key knowledge behavior. Depleting the commons or contributing to the commons are important reasons to hide knowledge. In the first case, knowledge withholding assumes its traditional meaning and takes the form of detrimental social behavior such as social loafing and free-riding (Lin & Huang, 2009). In the second case, knowledge withholding behavior assumes a new and under-investigated role of protection of the commons' capability to (re)generate resources. For instance, at the beginning of the pandemic, most scientists encouraged the population to handle information with caution since there was still high uncertainty and limited

knowledge regarding the characteristics of the virus. In this case, they just wanted to protect the members of the commons from possible misunderstandings of complex and contradicting information.

We found that knowledge sharing, search, and intake complement each other in unleashing knowledge flows but are clearly distinguishable from each other since they evolve at different paces and may diverge. On the other side, knowledge neglect, withholding, and hijacking complement each other in curbing knowledge flows. Besides, one of the most remarkable results of our study is that, from a certain commons' standpoint (i.e., a region's health care system, a certain tourism destination, as well as a certain company), knowledge behaviors that KM traditionally considered as positive, such as knowledge sharing, can have negative consequences, and vice versa. Therefore, we refrain from clustering knowledge behaviors into positive/counterproductive, and rather propose to cluster the six knowledge behaviors emerging from the as knowledge unleashing/knowledge curbing behaviors.

#### ***4.3 The influence of commons-related postures on knowledge behaviors***

Our research findings may provide scholars with a comprehensive theoretical framework to examine knowledge behaviors in the light of commons-related postures. We found that each specific commons-related posture may leverage each of the six knowledge behaviors, namely knowledge intake, search, sharing, withholding, hijacking, and/or neglect. We also found that what is beneficial for a commons can be detrimental to other commons. This suggests that the (expected) consequences of each knowledge behavior may be perceived as positive or negative depending on the cognitive and behavioral attitudes of the actors, which in turn are strongly influenced by their commons-related posture. The analysis of our empirical material, however, has revealed particularly strong links between specific commons postures and specific knowledge behaviors. More specifically, "recognizing the commons" is more strongly associated with knowledge intake than all the other knowledge behaviors. Similar stronger associations emerged between "adapting the commons" and knowledge search; between "contributing to the commons" and knowledge sharing; between "depleting the commons" and knowledge withholding; between "invading the commons" and knowledge hijacking; and between "stranding the commons" and knowledge neglect.



## 5 Implications and future steps

Since most organized and self-organizing contexts may be considered as commons, this study provides a complementary lens to address knowledge management challenges in these contexts. For example, while confirming the central role of knowledge sharing (which is the knowledge mechanism that is more frequently adopted to people with the pro-social “contribute to the commons” posture, according to our findings), our results suggest that all of the six categories of knowledge behaviors, including those that have been overlooked by the literature so far (such as knowledge hijacking) deserve attention and may result in positive consequences.

On the other side, our main contribution to the theory of the commons resides in the observations of three commons-related postures that have not been investigated by the literature so far. Last but not least, the cross-fertilization between KM and the literature on the resilience of the commons may provide the latter with concrete management tools that were lacking so far.

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## The Fragility of SMEs' Supply Chain Risk Management – Insight from six European Countries

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### Abstract

COVID-19 has shown how fragile our societies and economies are. Supply chains have particularly been affected. We all had to learn again that the basic supply of some goods is not as crisis-proof as we thought. Moreover, the strong division of labour and the concentration on a few companies in certain areas present considerable weaknesses in case of a new external crisis such as COVID-19; a crisis that is dynamic and whose end is not yet in sight. Small and medium-sized enterprises (SMEs) have been affected by the current pandemic, particularly as they are highly sensitive to external threats. Using data that was collected between December 2020 and January 2021 through semi-structured interviews conducted with owners and/or managers of SMEs located in six different European countries, the paper aims to provide fresh perspectives about how SMEs address supply chain risk management in times of an external and dynamic crisis.

**Keywords** – Supply chain, Supply chain risk management, Risk management, Risks, SMEs

**Paper type** – Academic Research Paper

## 1 Introduction

COVID-19 has shown how fragile our societies and economies are. Supply chains have particularly been affected (Guan et al., 2020). We had to learn again that the basic supply of some goods is not as crisis-proof as we thought. Moreover, the strong division of labour and the concentration on a few companies in certain areas present considerable weaknesses in case of a new external crisis such as COVID-19; a crisis that is dynamic and whose end is not yet in sight.

All companies have been affected to a certain extent by the current pandemic. Small and medium-sized enterprises (SMEs), however, face particular challenges as they are highly sensitive to external threats (Doern et al., 2019; Herbane, 2019). And even though no one was, or could be prepared for the current crisis and its magnitude (Durst and Henschel, 2021), the weaknesses of the crisis and risk management approaches utilized in these companies quickly became apparent, namely being primarily based on known and past data. At the same time, in such an uncertain environment, firm-specific resources are likely to be further dispersed when different types of disruptions caused by a crisis occur simultaneously (Osiyevskyy et al., 2020), which in turn further restricts the possible scope for action.

Against this background, the authors of the proposed paper see a clear need for advancing our understanding of how SMEs cope with the current uncertain, but at the same time, very dynamic time. More precisely, the particular interest is in obtaining an understanding of how SMEs handle their supply chains in increasingly uncertain times. Even before the crisis, supply chains were exposed to a great number of risks; these being triggered by a manifold of developments, such as the increasing digitalization and connectivity of supply chains, but also by political instability and the aggressive actions of big players in the market. Making both supply chains and the risks associated with them very promising and timely research subjects. Regarding the latter, supply chain risk management is intended to reduce an organization's vulnerability from risks (Wieland and Wallenburg, 2012).

Thus, the paper aims to provide fresh perspectives about how SMEs address supply chain risk management in times of an external crisis. Data for this paper was collected between December 2020 and January 2021 through semi-structured interviews conducted with owners and/or managers of SMEs located in

six different European countries (i.e., Austria, Estonia, Germany, Greece, Italy, and Portugal). The SMEs involved cover different company sizes and industries. Considering this variety, the paper provides insights into differences and similarities between the SMEs involved.

The paper is organized as follows. In the next section, the relevant literature is outlined. This is followed by a section that presents and describes the methodology chosen. Then the findings are presented and discussed. The paper terminates with a conclusion section.

## **2 Literature background**

Recent literature regarding SMEs' supply chain risk management (SCRM), indicates that the increasing fragility of SMEs' supply chains and SCRM is one of the dominant topics (e.g., Campos et al., 2019; Fischer-Preßler et al., 2020; Hoek, 2020; Ivanov and Das, 2020). As reasons the increased organizational and geographical complexity of supply chains (e.g., increasing number of partners/interactions and locations) as well as intensified inter-organizational sharing of digital data and imbalanced bargaining power for SMEs in (global) supply chains are named. Furthermore, increasing political and economic uncertainty, which is influencing SMEs' SCRM in general is mentioned (e.g., Ferreira de Araújo Lima et al., 2020). While Chowdhury et al. (2021) found that the global pandemic has further enforced the anyway increasing number of supply chain risks, in particular for SMEs.

The increase in risks relates to all kinds of risks, such as human risks (e.g., missing/inadequate competencies of employees or managers), technological risks (e.g., risks related to cybercrime or digitalization risks in general), and operational risks (e.g., relational risk due to dissatisfactory cooperation by supply chain partners) (see Durst and Zieba, 2019). Additionally, also the classical market (e.g., strong supply and/or demand fluctuations), financial (e.g., payment loss/delay) and geographical long-distance supply chain risks have overall increased (e.g., Campos et al., 2019; Grondys et al., 2021).

Compared to the past, the more recent SCRM literature stresses differences regarding increasing risks in relation to national and industrial context as well as SME firm size (micro, small, medium-sized) (Păunescu and Mátyus, 2020; Chowdhury et al., 2021). The national context, e.g., SCRM regulations of a given country, can influence SME supply chain risks. At the same time, a too strong

dependence of SMEs from international import and/or export of goods and services can further aggravate the situation. The Industry context refers to industry specific regulations and risks. There are clear signs that the market and financial risks for SMEs have developed very differently between industries in the last years.

Despite the afore-mentioned, research on SCRM in SMEs is limited. Furthermore, the few studies available mostly do not differentiate between micro, small and medium-sized enterprises. The study by Grondys et al. (2021) can be named as an exemption. Using an SME survey data from Poland it is stressed that "risk management requires from these entities the awareness, identification, planning, and counteracting threats, which they have not dealt with so far" (p. 16). The authors further point to the assumption (e.g., as a starting point for further research) that in medium-sized enterprises, more "detailed management processes concerning risk are carried out" (p. 15), while smaller SMEs rather follow a more pragmatic, short-term oriented approach.

In the overall picture, financial aspects regarding risk management seem to be more important for micro companies than for small and medium-sized enterprises.

In regard to technological risk management, Fischer-Preßler et al. (2020) stress as one central result from their literature review that the role of IT in identifying, analysing and monitoring supply chain risks is neglected so far in the literature. Regarding operational risk management, Li et al. (2015) identified "risk information sharing and risk sharing mechanism" in SME supply chains as crucial factors for successful supply chain cooperation. These two factors are closely related to a trustful relation between supply chain partners as precondition for sharing critical risk-related information about possible vulnerabilities of the supply chain as a whole or of single SME supply chain partners.

### **3 Methodology**

Considering the underdeveloped research on SCRM in SMEs, a qualitative research approach appears to be appropriate. A qualitative approach allows researchers to get closer to the participants and their way of thinking to scrutinize the entire research problem in depth (Maykut and Morehouse, 1994).

The present study is part of an ongoing Erasmus + project called "SMEs: Be Prepared for Supply Chain Risks" that aims to better prepare SMEs for identifying

and handling supply chain risks. This project consists of six partner countries namely Austria, Estonia, Germany, Greece, Italy and Portugal. In total, 28 small firms have been involved in the study (Table 1).

Table 1. Overview of companies involved in the study

<b>Interview N</b>	<b>Company size</b>	<b>Industry/Sector</b>	<b>Country</b>
Company 1	Medium	Software engineering and consulting	Austria 1
Company 2	Small	Medical equipment (R&D)	Austria 2
Company 3	Medium	Measurement technology	Austria 3
Company 4	Small	Trading company	Austria 4
Company 5	Small	Security service provider	Austria 5
Company 6	Micro	Food production	Estonia 1
Company 7	Micro	Packaging	Estonia 2
Company 8	Medium	Retail solutions	Estonia 3
Company 9	Micro	Steel production and sales	Estonia 4
Company 10	Medium	Retail	Germany 1
Company 11	Medium	Retail	Germany 2
Company 12	Medium	Logistics	Germany 3
Company 13	Medium	IT Services	Germany 4
Company 14	Medium	Clothes manufacturing	Germany 5
Company 15	Medium	Producer of industrial sensors	Germany 6
Company 16	Small	Logistics	Greece 1
Company 17	Medium	Logistics	Greece 2
Company 18	Small	Wholesale	Greece 3
Company 19	Micro	Construction/ Building renovation and refurbishing	Italy 1
Company 20	Micro	Construction	Italy 2
Company 21	Small	Event management	Italy 3
Company 22	Medium	Sanitary ceramic	Italy 4
Company 23	Medium	Sanitary ceramic	Italy 5
Company 24	Small	Paper transformation	Portugal 1
Company 25	Small	Engineering/Plastic injection moulding	Portugal 2
Company 26	Small	Transport consulting	Portugal 3
Company 27	Small	Wastewater treatment	Portugal 4
Company 28	Medium	Moulding and Plastic Injection	Portugal 5



Table 1 underlines that a heterogeneous sample of SMEs in terms of size and industry was involved in this study, thus displaying the reality found in the countries and with SMEs.

Data was collected via semi-structured interviews that have been conducted with the managing directors or owners of the firms. An interview guide supported the interview process. The guide focused upon the following points: some general facts about the companies and their operations and some more specific issues about the companies and their approaches to SCRM. The data was collected online between December 2020 and January 2021. Thus, data was collected during a period when the majority of the participating countries were experiencing lockdowns of varying degrees.

We utilized the tenets of thematic analysis as detailed by Fereday and MuirCochrane (2006) to analyse the collected data. According to these authors, thematic analysis is searching for the primary themes that seem to be most important, after an initial analysis. This analytical approach is appropriate to segment, categorize, and summarize relevant ideas within the dataset as well (Ayres, 2008).

## **4 Findings and discussion**

This section presents and discusses the approaches to/practice of SCRM of the SMEs studied. The section is organized as follows. It is started with the supply chain risks the SMEs were exposed to at the time of the investigation. This is followed by the relevance of SCRM in the firms and the firms' approaches to SCRM.

### ***4.1. Supply Chain Risk Exposure***

Considering the period of data collection, the general risk exposure among the interviewees was focused on COVID-19-related risk. Moreover, the findings suggest that the perception of conventional risks was magnified by COVID-19.

The risks reported by the interviewees are summarized in Table 2.

Table 2. SMEs' risk exposure

Type of risk	COVID-19 related New COVID-19-related Supply Chain risks reported by interviewees.
Financial risk	Sharp decline of profit (Interviewees 6, 8, 9, 16, 18, 19, 21) due to industry freeze (HORECA, tourism, event management, etc.)
	Risk of non-collection of customers' payments that restrict business operations (Interviewees 8, 9, 18)
	Risk of bankruptcy/loss of potential investor (Interviewee 1)
Market risk	Sharp decline in demand (Interviewees 4, 9, 6, 21)
	Raw material price fluctuation (Interviewees 22, 23) due to unstable and unpredictable supply
	Risk of losing major client(s) became more crucial for business sustainability during the pandemic (Interviewees 4, 9, 21, 24)
	Strong(er) price competition (Interviewees 22, 23, 24)
Operational risk	High dependency on resellers and lack of ability to contact/influence end consumers (Interviewees 22, 23)
	Lack of personnel critical for maintaining operations: availability and health safety (Interviewees 6, 9, 18, 19, 24)
	"Flawed" communication within company as well as within supply chain due to lack of personal contact (Interviewees 7, 8, 19, 21, 28)
Supply chain risk	Significant delays in supply or supply disruptions (Interviewees 4, 2, 10, 11, 12, 15, 19, 20)
	Increasingly complicated and costly logistics (Interviewees 7, 11)
	Keeping stock in "equilibrium": problems with "overstocked" warehouses because clients were not able to pick up their orders due to mobility restrictions (Interviewees 16, 17) or problems with receiving enough supplies (Interviewees 2, 4, 7, 11, 12, 19, 20)
	Unsatisfactory quality of supply; has become an even bigger problem due to mobility restrictions (→ no possibility to physically evaluate the quality of products (Interviewees 7, 8, 19)
Regulatory risk	New regulations and restrictions that affected operations to a differing extent: from limiting operations to full stop of business activities (Interviewees 8, 15, 16, 17, 18, 21)
Knowledge risk	Risk of unintentional "knowledge" spillovers due to remote work and communication via social media (Interviewee 3)
	Low level of internal knowledge sharing became clear when companies started considering job rotation due to lack of workforce (Interviewees 1, 28)
Digital risk	Increased "sensitivity" to cyber security risks due to increased number of digital operations (Interviewees 4, 5, 24, 28)
	Integration problems between different data management software became more visible due to increased number of digital operations (Interviewee 25)
	Reliability of IT infrastructure to handle new tasks become an issue (Interviewee 24)

Exposures that were apparently common for all types of SMEs were concerns regarding supply and demand volatility (e.g., customer demand, stocking challenges) and supply chain disruption (e.g., logistics problems, raw material price fluctuation). Some examples are provided below:

*There are a lot of suppliers from abroad... and you have to be able to deliver relatively quickly and in the time like now, when a part is missing, then production is at a standstill and that is of course very critical for the company. (Interviewee 2)*

*We try to avoid being short on stock... On average suppliers take one day to accept the order. Nowadays, they also take three days to send the order. It is a standard time now. It happens due to COVID. (Interviewee 20)*

*The main vulnerability is that the origin of most of our raw materials is outside Italy. That exposes us to the risks of price fluctuations, as well as of potential disruption in the value chain. Moreover, raw materials must show a specific quality, otherwise the quality of the final products will be influenced. Our production plant works on a continuous cycle, and a shortcoming of raw materials, or even a reduction of quantities available, increases the risk of not fulfilling the demand, or of running out of budget for the production." (Interviewee 22)*

Otherwise, some types of risk seem to be more dependent on factors such as geography and size of enterprise. For example, policy-related risks varied according to the regulations and restrictions of a given country. In some countries where restrictions were minor (Estonia, Germany, and Austria), the regulatory risks were considered as low. In countries where a complete lockdown was introduced (Greece), regulatory risk was a dominant factor.

*During the pandemic period, the company was closed for more than 3 months. The clients completed their orders only online. The warehouse of the company until now is full because the delivery company cannot plan and organise the distribution. The company has stopped online orders until the warehouse can host more goods. We are waiting for new regulations from the ministry about how we can proceed with the delays." (Interviewee 18)*

Regarding specific industries, companies involved in the international trade of medical and cosmetics products were affected by new COVID-related regulations (e.g., Germany, Italy).

*We organise events (for medical personnel), and they were forbidden by the government from the very beginning of the lockdown in March. Plus, most - if*

*not all - of our events were targeted for doctors and half of them used either hospitals or hotels and conference centres. However, governmental rules change too often - due to the trends of the pandemic - and they are very complex to interpret. We have to become familiar with the COVID safety protocol for our events. However, the number of exceptions in the planning phase of events increased dramatically. (Interviewee 21)*

Overall, when detailing supply chain risk exposure, the owners/managers of micro companies tended to focus on a short-term perspective, i.e., maintain their operational routine and immediate financial liquidity. For the small and medium-sized firms, on the other hand, the focus appears to have shifted to strategic issues and a long-term perspective (e.g., new competitive and sourcing strategies as well as the consequences of new laws and regulations).

#### **4.2. Supply Chain Risk Management and its position/relevance in the firm**

Based on the findings, the overall approach among the companies to SCRM can be divided into two forms: simple and sophisticated. The simple approach is characterized as an ad hoc approach. Thus, preventive measures to prepare for operational delays and problems are not there but initiated once an issue occurs. By contrast, the sophisticated approach, which is more common among medium-sized companies, utilized an organized and dedicated set of policies, rules, and guidelines, which were prepared in advance to handle different business challenges.

The person or unit in charge of identifying and analysing risks is also heavily influenced by the size of the company. In micro-enterprises, risk was assessed directly by the owner (Interviewees 6, 7, 9, 19, 20). In small companies, that task was conducted by partners/co-owners or board members (Interviewees 2, 4, 5, 16, 18, 21, 24, 25, 27), while in medium-sized companies, risk assessment was handled by management, i.e., by owners/managers and heads of departments, collectively (Interviewees 1, 3, 8, 10, 11, 12, 13, 14, 15, 17, 22, 23, 28).

The major distinction of small and micro-enterprises regarding the relevance of SCRM was that these smaller companies considered a systematic approach unnecessary. Bearing in mind the limited financial and human resources and low probability of re-occurrence of the same types of risk, the owners/managers of these firms preferred to take quick responsive measures to handle the risk, rather than to have them prepared in advance (Interviewees 4, 6, 7, 10, 11, 19, 20). As

one Interviewee described it, "We are not practicing crisis scenarios. If something happens, we will decide what to do in order to maintain operations" (Interviewee 6).

Not surprising, medium-sized enterprises employed more developed forms of preventive risk measures, including risk maps and signalling systems to visualize and systematically assess risks and their relevance, impact, and probability (Interviewees 1, 9, 13, 14, 24, 25). For those companies which followed ISO standards, this approach was determined by adherence to those standards. The following statement may illustrate the approach typical for companies following ISO standards:

*To ensure high quality of services and to be prepared for risks, the company is certified according to several standards (e.g., ISO 9001, ISO 27001) and has developed its own risk management system inspired by ISO 31000 with a business continuity logic. The firm has a risk board which meets monthly. Members are the managing director, head of quality management, heads of units, and an external consultant. The board systematically identifies business risk including supply chain risks, carries out a business impact analysis, and prepares measures. (Interviewee 13)*

#### **4.3. Approaches to Supply Chain Risk Management**

As indicated before, the approach to SCRM differed according to company size. The majority of medium-sized companies had a systematic approach to SCRM (Interviewees 1, 3, 12, 13, 14, 15, 22, 23, 28). By contrast, the majority of micro and small companies seem to have adopted a "problem-solving" (ad hoc) approach (Interviewees 2, 4, 5, 6, 7, 8, 16, 18, 19, 20, 21, 25). It seems that the latter utilized risk management techniques according to the primary business challenges at hand. The chief similarities between the SMEs seem to be found regarding securing trustworthy and stable supply chain relationships, as well as ensuring safe and secure business operating environments. Table 3 details the steps that were taken by the firms studied to handle different types of SC risks.

Table 3. Risk management in SMEs

Initiatives	Specific Steps	Interviewee Examples
Develop a strong and reliable network within the supply chain	Careful selection of suppliers and partners: preference for suppliers with similar values and long-term relationship strategy (Interviewees 14, 19, 20, 21, 22)	A major SC risk is the loss of, or dependency on, a supplier. Therefore, the firm selects (potential) suppliers very carefully and regularly visits them. Policy is a long-term collaboration, and the management looks for family-owned businesses with similar values. (Interviewee 14)
	Establish trust and mutual support with suppliers to minimize risks and financial losses (Interviewees 19, 21, 22, 23)	Experience and a good relationship with our historical business partners helps in reducing these risks. In particular, communication with business partners is crucial to be aware of potential risks and avoid them as much as possible. (Interviewee 21) Reputation of suppliers is another positive factor. With "trusted" suppliers we know we can work timely and with a high-quality standard. (Interviewee 19)
	Increasing share of local or short-distance suppliers (Interviewees 7, 11)	To reduce dependency on suppliers, e.g., for whiteboard production..., we are aiming to bring back as much of production to Germany as economically feasible, working with long-term contract manufacturing partners. (Interviewee 11)
	Enforcing a code of conduct and overall quality and sustainability strategy (Interviewee 14)	The fashion firm has defined a Code of Conduct binding all business partners, which defines requirements for suppliers and partners... Among other things, the Code of Conduct contributes to compliance with social and ethical standards, sustainable environmental protection, and ensures fair working conditions. (Interviewee 14)
	Implementing suppliers' check-ups: quality assurance and process improvement (Interviewees 7, 14)	We perform regular quality checks and audits of suppliers. (Interviewee 14)
Taking measures to ensure continuous	Ensuring stock safety: redundancy strategy for suppliers of important products,	In parallel with these measures, the firm develops alternative vendors for critical products or prospects for possible alternative suppliers. (Interviewee 14)

operation	extra stocking to avoid out-of-stock situations (Interviewees 10, 11, 12, 13, 14, 15, 20)	We try to maintain our own buffer stock to ensure close to 100% availability. (Interviewee 10) We buffer stock in decentralized offices and in central warehouse and have a dual vendor strategy for important parts. (Interviewee 13)
	Setting up “loose” delivery dates for end-customers to compensate logistics delays (Interviewee 8, 19)	A good scheduling of the project and a good planning of extra time helps to compensate potential suppliers’ shipment issues. (Interviewee 19)
	Organizing in-house delivery services to ensure delivery of parts in time (Interviewee 13)	We organized parts delivery to the offices by own vehicles and drivers. (Interviewee 13)
Taking actions to mitigate financial risks	Diversify the client pool to decrease dependency on a single client/industry (Interviewees 6, 15, 28)	As every company in plastic injection, there is considerable dependence on the automotive industry, but we have been trying to diversify the customer base to decrease a high customer concentration risk. (Interviewee 28)
	Concluding NDA contacts with suppliers (Interviewees 2, 15, 27)	Even if the machines are patented, certain information should not spill over to competitors, especially process knowledge which is difficult to patent. All possible agreements (e.g., NDAs) are made with the respective suppliers to prevent unwanted spillover or leakage. (Interviewee 2)
Taking steps to develop a risk-aware culture and organizational defence	Organizing training for the staff in the following domains: quality standards (Interviewee 16, 18); ethical standards (Interviewee 3); process improvement (Interviewee 7); “sensitive data” protection (Interviewee 3)	It is important for the employees and the company to follow the technology and methodologies of the supply chain and address the risks. (Interviewee 18)
	Organizing risk awareness events: risk	There have been regular awareness training sessions for employees at least once a year

	evaluation and mitigation training (Interviewees 1, 3, 12); risk mitigation brainstorming (Interviewee 17)	for new employees when they were hired and then regular updates every year. There have been repeated mailings to the employees, such as newsletters, which summarized some of the most diverse risks. (Interviewee 1)
	Developing personalized data access, i.e., linked to employee profile and functional responsibilities (Interviewees 5, 25, 28)	These days every employee has a profile that allows him to access only what he supposed to for performing his function. (Interviewee 28)
Taking actions to protect data	Multiple encryption solutions (Interviewee 5) and multi-factor authentication (Interviewees 5, 24, 25, 26) and various email protection systems, certificates of emails, backup systems, and VPN tunnels for remote access (Interviewees 1, 5, 27)	We have processes in a quality management system for the archive of projects. Some of the projects are stored in a vault with very strict access. They are very cautious with the application of GPRD. Increasingly, projects are subjected to NDAs. (Interviewee 26) Technologically, several things are used to protect the data and the customers' data. Classification, multiple encryption solutions, multiple multi-factor authentication, different email protection systems, certificates of the emails, backup systems and multiple locations of the backup systems and the data. (Interviewee 5)
Taking measures to protect intellectual property	Concluding NDA with employees and suppliers (Interviewees 2, 15, 25, 27, 28) and patenting newly developed technology (Interviewee 25, 27)	Unwanted knowledge spillover can happen all the time in SCs. Legal measures are difficult to enforce, especially for SMEs and in foreign countries and it takes time to build a sufficient level of trust. (Interviewee 2) When having developed something really innovative, the company patents it before going to the market." (Interviewee 25)

From the table above, one can conclude that a larger share of companies adopted initiatives that ensure stable SC and continuous operations. To a lesser extent, instances in which companies took specific steps to handle financial risks, promote a more risk-aware organizational culture, and secure data/IP in increasingly remote working environments were identified.



## 5 Discussion and conclusions

The aim of the paper was to provide some fresh insights into how SMEs address supply chain risk management in times of an external crisis. Linking the empirical findings with the relevant literature, one can conclude the following.

First, the present study clearly confirms that the global pandemic enforced the already existing and in the last years increasing fragility of SMEs' SCRM for all types of investigated risks. Furthermore, inter-organizational trust has become even more important for SMEs' SCRM management during the pandemic (e.g., Grondys et al., 2021).

Second, the findings allow to draw a more differentiated picture of supply chain risk exposure and SCRM in different groups of SMEs, compared to the small stock of relevant literature. Such differences refer in the first place to the identification of a simple, more ad hoc SCRM approach without preventive measures in micro and small enterprises versus a sophisticated and more organized approach, which is more common in medium-sized enterprises. In this context of different SME size groups, the findings also stress that there is not something like a 'generic SCRM toolbox' for SMEs (c.f., Durst, 2012). The findings rather showed that tailored SCRM approaches are needed that consider both the internal environment like ownership and management structure as well as the skills and competences (e.g., Păunescu and Mátyus, 2020) and the external environment such as the institutional setting (Thukral, 2021) of the respective SMEs.

Regarding the latter, the present study further detailed and illustrated the importance of specific national and industry contexts for SCRM in SMEs. These contexts do not only comprise governmental regulations (e.g., legal or administrative rules). It can also be influenced by the increasing importance of voluntary environmental, social and ethical standards for SCRM in SMEs (see, e.g., Ferreira de Araújo Lima et al., 2020).

In sum, from a theoretical point of view, the present study provides fresh insight into the practice of supply chain risk management in SMEs located in six different European countries. The findings demonstrate how the decision-makers of these firms perceive the current developments triggered by the ongoing pandemic and their possible implications on the companies' supply chain operations. By having involved SMEs not only from different industries and countries but also of different size, similarities and differences regarding SMEs

risk management practices, their fragility or even their absence, can be shown. From a practical point of view, SME managers/owners may learn from the practices presented in the paper to improve their own approach to SCRM considering the company's internal and external environments. Additionally, they can also learn, in case of absence of these practices, about the risks inherent from not having in place such risk management practices and thus the increased fragility of the firms' SCRM and possible consequences for their business operations.

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## Knowledge Risks in the COVID-19 Pandemic

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### Abstract

This conceptual paper aims to identify, present, and analyse potential knowledge risks organizations face in external and dynamic crises such as the COVID-19 pandemic. Until only recently, many researchers and practitioners have perceived knowledge primarily as something positive. This view has changed recently with a growing number of studies highlighting risks related to knowledge. The on-going COVID-19 pandemic can be seen as an additional triggering point which has brought several new knowledge risks. Research on knowledge risks, their consequences and potential ways of handling them is still only in its beginning and consequently rather fragmented. To address this situation, this paper is aimed to provide some theoretical insights into knowledge risks and their possible implications organizations are exposed to in an external and dynamic crisis such as the COVID-19 crisis. To reach this aim, this paper presents a continuation of the research by Durst and Zieba from 2018 related to knowledge risks and their potential outcomes. This present study reviewed the up-dated literature on knowledge risks and uses the taxonomy proposed in the paper by Durst and Zieba to identify and analyse knowledge risks organizations are exposed to in the COVID-19 pandemics. Hence, the paper does not only offer fresh food for thought for researchers dealing with the topic of knowledge risks in the COVID-19 crisis and ways of handling them, it also expands the knowledge risks

taxonomy proposed by Durst and Zieba; thereby showing both the taxonomy's dynamic character and usefulness.

**Keywords** – knowledge risks, risk management, knowledge management, knowledge risk management

**Paper Type:** Academic Research Paper

## 1 Introduction

This conceptual paper aims to identify, present, and analyse potential knowledge risks organizations face when exposed to external and dynamic crises such as the COVID-19 pandemic. Until only recently, many researchers have perceived knowledge as something positive that has to be shared and disseminated to improve organizational performance (Durst and Edvardsson, 2012; Massingham, 2010). However, this has changed recently with a growing number of studies related to knowledge perceived as a risk, e.g. Durst et al., 2018; Temel and Durst, 2020; Zieba and Durst, 2018. An additional factor that has triggered more knowledge risks is the still on-going COVID-19 pandemic. This crisis represents a new form of an external crisis; one that is dynamic and no end in sight yet (Rapaccini et al., 2020). This new situation has not only forced organizations to rearranging their operations, moving to online work and initiating changes in their normal functioning (Kramer and Kramer, 2020; Mollenkopf et al., 2020; Waizenegger et al., 2020). It has also brought several new knowledge risks. For example, there is a risk of knowledge cherry-picking (some people may select evidence or statistical data so that the information presented agrees with the beliefs of the person making the process). Another example is the risk of deliberate isolation, when a remote employee can naturally lock themselves in their silo, isolate from colleagues, focus on their tasks and not get involved in teamwork, and hence increasing the likelihood of knowledge hiding. There is also the risk that employees are breaking security rules while 'left on their own' (some companies still don't have any special policies for remote workers and there is nothing stopping employees from printing sensitive data from their computers or email files to their private devices). Additionally, many managers and company owners often do not possess skills and tools to accurately assess, examine and manage risks in general (Durst et al., 2021) and knowledge risks in particular. Generally, the research on knowledge risks, their consequences and

potential ways of handling them is only in its beginning and consequently rather fragmented (Durst and Zieba, 2019). To address fill this situation, this paper is aimed to provide some theoretical insights into the knowledge risks and their possible implications organizations are exposed to in an external and dynamic crisis such as the COVID-19 crisis.

To reach this aim, this paper presents a continuation of the research by Durst and Zieba that has started in 2017 related to knowledge risks and their potential outcomes. It uses the taxonomy proposed by Durst and Zieba to identify and analyse knowledge risks organizations are exposed to in the COVID-19 pandemic. Hence, the paper does not only offer fresh food for thought for researchers dealing with the topic of knowledge risks in the COVID-19 crisis and ways of handling them, it also expands the knowledge risks taxonomy proposed by Durst and Zieba; thereby showing both the taxonomy's dynamic character and usefulness.

The paper continues as follows. First, knowledge risks are briefly presented. This is followed by a presentation and discussion of knowledge risks triggered or amplified by the pandemic. The paper terminates with a conclusion section.

## **2 Knowledge risks – theoretical background**

To get deeper into knowledge risk, it is worth getting acquainted with the already developed knowledge risk taxonomy or concept maps. The benefits of concept maps were highlighted by Trochim (1989), it includes expressing the given framework in the language of participants instead of the language of science, which makes the participants more encouraged and helps them to remain on task. A graphic or pictorial product that expresses all major elements and their interrelations is comprehensible to all, it can be presented to the audiences relatively easily and interpreted relatively quickly (Trochim, 1989). Thus, there are also several advantages of creating and analyzing knowledge risks concept maps, reasoned as follows by Durst and Zieba (2019): they are very helpful in visualizing risk, thereby increasing awareness of the knowledge risks and emphasizing their importance, also, concept maps help to understand at what levels in the organization risk is present and how it is related to each other, therefore the holistic view of knowledge in the organization is presented. The map proposed by Durst and Zieba (2019) illustrates the various knowledge risks

that organizations may face and their interlinkages. On the mentioned map, risk has been classified into three categories: human, technological, and operational.

The human risk category includes the following: “knowledge hiding, knowledge hoarding, unlearning, forgetting, missing/inadequate competencies of organizational members” (Durst and Zieba, 2019, p. 2). Another risk that may fall into this category is the loss of knowledge. Organizations experience a loss of knowledge when a key part of the team leaves the company and takes their experience and expertise with them (Brătianu *et al.*, 2020). All mentioned risks are associated with the individual's behaviors, decisions, intentions, ego, inabilities to learn, forgetting, or missing competencies. The risks associated with technology mapped by (Durst and Zieba, 2019) include “cybercrime, old technologies, digitalization, social media”. Ten years ago, only some of the companies relied on the Internet and technology for their business operations, today everyone and every business rely on technology (*The Cost of Cybercrime. Ninth Annual Cost of Cybercrime Study*, 2019), that is why hacker attacks, data theft, old incompatible programs, overreliance on technology, and all dangers related to social media like spreading fake news or trolling accounts are increasing. In the last category, the largest one, the following risks were recognized: “knowledge waste, risks related to knowledge gaps, relational risks, knowledge outsourcing risks, risk of using obsolete/unreliable knowledge, risk of improper knowledge application, espionage, continuity risks, communication risks, knowledge acquisition risks, knowledge transfer risk, and merger & acquisition risks.” (Durst and Zieba, 2019, p. 5). This is a very wide category and all the operational risk are still very actual, because even if organizations once implemented knowledge management processes and systems over the past, they may still face operational risks, as it is not enough to coordinate operational knowledge but to identify and manage potential operational risks (Neef, 2005).

### **3 Knowledge risks in the COVID-19 pandemic**

The COVID-19 pandemic has brought enormous challenges to all kinds of organizations. They suddenly faced the need to adapt rapidly to a new work environment and many of them also to remote work. This changed reality has also brought several new knowledge risks. When working remotely, employees are very task-oriented, such a tendency is effective from the point of view of productivity, however, loneliness and the lack of a common work environment



lead to a decrease in employee engagement and motivation (Mukhopadhyay, 2020). While working remotely many organizations start to experience some form of 'silos' or already existing silos become even worse. The term "silos" refers to grain silos that separate different types of grain from one another, and therefore is a metaphor for separating different parts of an organization. Moreover, when working from home employees can naturally lock themselves in their silo. According to De Waal, Weaver, Day, & van der Heijden (2019) "the concept of a silo refers not so much to the existence of boundaries, but to the mentality through which those boundaries shape behaviors and ways of working that hinder cross-boundary cooperation and collaboration" (p. xxx). Such 'silo-mentality' even more increases the likelihood of knowledge hiding.

The Covid 19 outbreak, the increased number of persons working from home, and thus the increased internet use have also heightened the risk of cybercrime (Wiggen, 2020). E-mail, social media, video conferences, cloud storage, etc. - all of these have been the order of the day in many companies, but the transition to 100% remote work made that all these tools are used even more and more intensively. Technology remains the key when offices are closed, but it is important to ensure that every employee can access and use the technology properly as much as it is needed for a given workload level (Mukhopadhyay, 2020). Not all employees have been adequately trained on Internet security issues, the risk that employees, due to lack of knowledge, break security rules when left on their own increases even more. Home networks, private IT devices, software, and antivirus programs are generally less secure. Overall, it can be concluded that the increasing use of the Internet while working remotely and the growing number of new inexperienced users who have been transferred to the home office suddenly create even more opportunities for criminal activity than before (Wiggen, 2020).

The hurry triggered by the pandemic to switch to home office and remote work has also led to the situation that outdated and underdeveloped IT infrastructures and IT systems clashed with very sophisticated cyber-attacks; thus, technological knowledge risks. This situation has made it even easier for certain individuals/organization to hack themselves in the organizations IT systems to leak sensitive information and knowledge. Given the sophistication of these attacks, many organizations may still have not noticed them. Thus, this situation suggests the presence of both risks related to old technologies and risks of hacker attack (Durst and Zieba, 2018). At the same time, COVID-19 has shown

that risk management skills are underdeveloped in the majority of organizations (Durst et al., 2021). As a consequence, the initiated responses might have been quick but not decisive.

When considering knowledge risk taxonomy, it can be very useful in the analysis of the present COVID-19 situation in companies.

Beginning with the analysis of the first category – human knowledge risks in the context of the COVID-19 situation, we can notice that some of the threats are more serious than before. For example, knowledge hiding during e-work is even easier, there are less personal contact, face-to-face meeting, and the relation between colleagues are getting worse. There occurs also the risk of deliberate isolation and selfish behaviors of employees. Remote work favors isolation, and remote employees may naturally lock themselves in their comfort zone, focus on their tasks and stop being involved in teamwork and knowledge sharing. Companies are trying hard to bring newer and newer innovations in communication technologies that could have the potential to increase knowledge sharing among co-workers, however, the practices of hiding the knowledge remain prevalent in organizations (Connelly *et al.*, 2019). The same applies to unlearning and forgetting, which have become greater threats in times of remote work. They are more common due to a lack of real contact with co-workers. When a worker does not know something or does not remember, he needs to find out the way to contact somebody who can share the knowledge with him. The whole process of finding out the right person, writing an e-mail, calling someone, or even planning the meeting in advance takes very limited time. Missing/inadequate competencies of organizational members to deal with the new situation is also present in the context of COVID-19. Ignorance of safety rules by employees when working at home can have very negative consequences, such as knowledge losses and leaks.

The next category in the taxonomy is technological knowledge risks, risks that have become even more severe during a pandemic. Beginning with the risk of cybercrime which heightened due to people working at home and using a less secure internet connection or generally speaking less experienced users who break security rules. Moreover, some companies did not have enough time to implement special policies for the remote workers, who may not be aware of special rules and may undertake dangerous actions like printing sensitive data from their computers or sending files to their private devices. Less secured devices and less experienced users can easily be caught by phishing attacks, and

are a good target for criminal and malicious actors (Wiggen, 2020). The other risks that companies may face are related to old technologies. Some employees may use computers with outdated programs, which means that the program is no longer eligible for producer security updates. For example operating system Windows 7, which Microsoft ended to support at the beginning of the year 2020 is still in use by millions of users (Wiggen, 2020).

Operational knowledge risks are a broad category when considering the knowledge taxonomy. We can also find some examples of this risk in the context of COVID-19. Knowledge transfer is more difficult when limiting to online tools only. Potential gaps when transferring the knowledge can also pose another risk which is improperly applying knowledge. This risk is also affected by missing face-to-face mentoring, difficulties with a concentration of employees, and facing distractions when working at home. The other risk which occurred recently when working remotely is the "silo mentality". Employees when working from home sometimes lose their organizational culture and are not eager to share skills, knowledge, or information with other peoples, teams, or departments, or even to act as "one company"(de Waal *et al.*, 2019). Lack of proper knowledge sharing and information flow may also increase knowledge waste.

Present COVID-19 situation in companies heightened some of the knowledge-related risks in each category of taxonomy.

#### **4 Conclusions**

From a theoretical point of view, this study provided evidence of the power and usefulness of knowledge risk map taxonomy proposed by Durst and Zieba. Focusing on knowledge risks triggered by an external crisis, i.e. a pandemic, the taxonomy has shown its dynamic character which can be applied to different scenarios/situations.

From a practical point of view, the study provides useful insight for managers and owners of companies who have understood that any organization is fragile with regard to their knowledge and risks related to it. The recommendations may be useful for business professionals to better handle risks related to knowledge, i.e. to eliminate or alleviate the influence of knowledge risks in the COVID-19 era.

At this stage of development, the proposed study is of theoretical character. This limitation will be addressed in future research activities involving a large

sample of organizations from various countries and sectors to validate the risks identified or amend them if necessary.

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## COVID-19 and Crisis Management in Business: A Symbolic Bibliometric Data Analysis

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### Abstract

During COVID-19, it has been common practice for governments to suspend non-essential business activity as a precautionary measure temporarily. As a result, economic activity has slowed in some parts of the world, and businesses in the economic sector are not operating at their maximum capacity. Regularly maintaining the current knowledge management database and methodologies is essential to improving one's ability to handle information and knowledge. In this sense, the bibliometric analysis as a suitable quantitative method in knowledge management can be combined with big data and symbolic data analysis relevant insights. Bibliometric analysis may also analyze semantic cores, revealing other intriguing correlations between the most frequently cited terms in the considered literature and their network location. These strategic responses take various approaches, for example, for family businesses, such as perseverance during the crisis and a short-run strategy based on an adjustment of the business model. The study shows the importance of collaboration and coordination between the various national and international authorities to share pertinent information relevant to disaster mitigation.

**Keywords** – COVID-19, Crisis Management, Bibliometric Analysis, Symbolic Data Analysis, Community Detection

**Paper type** – Academic Research Paper

## **1 Introduction**

Individuals have been affected by the COVID-19 virus pandemic, but the virus has spread around the world. It wreaked havoc on people's lives in all nations and communities. It harmed global economic development in 2020 that was exceptional in more than a hundred years (Jackson et al. 2021). Throughout the world, as COVID-19 spreads, a frequent public policy in response to the pandemic has been to impose a temporary halt to non-essential commercial operations (Cowling et al. 2020). The result is that economic activity is down in some regions of the world, with firms in the economic sector not working at their full potential. However, as the COVID-19 develops into a global economy, this is becoming less of an issue. In some nations, governments have subsidized a portion of the salary income of employees who have been forced to take time off, or they have expanded their welfare programs to include recently laid-off workers or the owners of small businesses (Cowling et al. 2020). In this context, the role of knowledge management cannot be undervalued. It is necessary to consider a context in which it is possible to create and adapt the different companies to accommodate new working methods and collaborate through knowledge management techniques (O Dell and Hubert 2011).

In this sense, effective time management methods increase the company's ability to anticipate what is needed to improve performance. In this respect, managing knowledge within a project is a critical factor. Social networking can be a method of collaboration available which can be helpful in a business strategy. It is necessary to increase knowledge management skills by regularly keeping the knowledge management database and techniques up to date.

## **2 The Research Problem**

The COVID-19 indeed claims a very complex task for businesses nowadays and their decision-making capacity (Dwivedi et al. 2020). COVID-19 requests for every business quick responses to face the crisis. It is necessary to start from disaster management and planning to a mitigation strategy of the damages in practice. Finally, it is necessary to plan a reaction and prepare for economic recovery (Hao 2020). Big data (see, for instance, Chen et al. 2014) can help detect the best intervention strategies and approaches to the crisis. In particular, bibliometric databases, which are typically big or large datasets for the amount of research

produced every year, need to be carefully analyzed to determine a synthesis of the research outcomes (Parlina et al. 2020 Drago and Hoxhalli 2020 Drago and Amidani Aliberti 2018). In this respect, the research question is collecting and synthesizing this research input to obtain the most relevant policy outcomes. In this sense, the approach is to collect and synthesize the existent information on the literature results and obtain new insights. In this respect, the bibliometric techniques can be considered entirely relevant to knowledge management because they allow discovering the contents and the resulting outcomes from the research and the international cooperation between researchers in business that work on a specific topic (Raghu and Vinze 2007). This knowledge can be relevantly considered as an essential basis from the businesses.

A relevant point here that needs to be emphasized is that it is possible to use many different techniques in helpful bibliometric analysis to analyze and evaluate the different patterns on citations and scientific articles, useful to extract relevant scientific insights (see Ponce and Lozano 2010). Moreover, these insights can be very relevant for the business processes (Bhatt et al. 2020).

The development of information markets is one strategy for ensuring the long-term viability and high-quality research outputs. Furthermore, the knowledge market may be a long-term source of funding for advancing knowledge research and a motivator for businesses to collaborate on research projects (on knowledge markets and businesses see Hamet and Mitchel 2019).

### **3 Methodology and Results**

#### **3.1 The Methodological Approach**

We propose an approach helpful to face big data as symbolic data analysis (Billard and Diday 2003 and 2006 Drago 2016 with applications to network analysis and community detection). Every symbolic data is based on an extensive network and a community detection helpful approach to identifying the relevant "semantic cores" of literature (Drago 2019, Drago and Bertelli 2021). So we started collecting scientific works related to these terms: ("covid-19" AND "crisis" AND "management" AND "business") refining the search in the Business, Economics, Social Science area in order to select the most relevant works. We start from co-occurrence terms undirected network (Pons Latapy 2005):

$$G = (V, E)$$



V is related to a vertex as a term, and E is an edge (or link) as a scientific work containing both the terms. The analysis aims to identify a partition P on the network (Pons and Latapy 2005), identifying the "semantic cores" (Drago and Gatto 2021) as part of the partition:

$$P = \{C_1, \dots, C_k\}$$

[2]

From the "semantic cores" as a community in the network, the bibliometric analysis, we can discover relevant approaches that businesses are explicitly considering to face with COVID-19. More specifically, we start by identifying the relevant literature considering the relevant keywords ("crisis," "management," "business," "COVID-19"). We construct a bibliometric database containing all the research articles considering these keywords. We determine the co-occurrence network from the original data, representing the literature and the relationships between the themes (represented by the nodes). From the network obtained (see fig. 1 the 15 most central concepts in the literature regrouped into relevant clusters visualized by the different colors), we can extract the relevant information as communities using the walk trap algorithm (Pons Latapy 2005), which is helpful to identify clusters of nodes maximally connected each other but also feebly connected with nodes of the other clusters (Fortunato 2010). The relevant group of nodes identified are the "semantic cores" of the literature and usually identify the relevant themes and the relevant ideas, synthesizing the underlying scientific works. Following Wasserman Faust (1994), in order to adequately interpret each core, we compute statistical measures of network centrality as the betweenness for each node i

$$C_B(p_i) = \sum_{k=1}^N \sum_{j=1}^{k-1} b_{kj}(p_i) \quad (3)$$

(see Marsden 2002). Betweenness is relevant to measuring the global centrality of the concepts in the literature. And then, for each community, we compute the interval. Finally, bibliometric analysis can adequately identify key scientific works and interpret the semantic cores showing other interesting relationships between the most cited terms in the considered literature and their network position. Semantic cores are represented as interval data which can quantify their relevance as relevance on the bibliometric network.

### **3.1 The Results**

In this sense, in the analysis, we identified three crucial elements not only on interpreting the semantic cores but also on the entire literature considered: risk management and viral disease, decision-making, and information management. In this sense, we can analyze possible crisis management strategies and economic responses. These strategic responses consider various approaches, for instance, for family firms, as the perseveration during the crisis (Kraus et al. 2020), but also a short-run strategy based on an adjustment of the business model but also on a long run approach based on the innovation of the business model (see also Wensel et al. 2020). Additionally, our approach shows the importance of risk management (see in the tourism sector Richie and Jiang 2019). At the same time, the relevant literature shows that there is the need for collaboration, but also coordination between the different national and international authorities in order to share the relevant information applicable to mitigating the disaster (crisis reports, for instance) and also identify relevant responses and actions (see Goniewicz 2020 in the context of the tourism industry see Wen et al. 2020). At the same time, there could be an opportunity for a greener sustainable economy (see Ioannides Gyimothy 2020). Our results show that careful risk management of the viral disease, appropriate decision-making, and efficient information management can be reliable tools and instruments for a solid response to the greatest challenge of the COVID-19.

## **4 Conclusions**

A typical public policy reaction to the epidemic as COVID-19 spreads has been to temporarily cease any commercial activity that is not necessary for survival (Cowling et al. 2020).

It is impossible to overstate the importance of knowledge management in this environment. Social networking may be a way of cooperation that is readily available and beneficial in developing company strategies. At the same time, a very relevant tool in modern knowledge management is the use of the scientific literature to enforce strategic decisions in business. In this work, we have considered a bibliometric analysis useful to detect specific insights and discoveries for the business world. In this sense, we have synthesized the relevant literature on the sector, and we have obtained some relevant essential results.

In the investigation, we discovered three components that were critical not only to the interpretation of the semantic cores but also to the interpretation of the entire literature under consideration: risk management and viral illness, decision-making, and information management. These strategic solutions take into account various techniques, such as the perseverance of family businesses during a crisis, for example (see also Kraus et al. 2020). At the same time, the pandemic may present a chance for a more environmentally friendly and sustainable economy (see also Ioannides Gyimothy 2020)

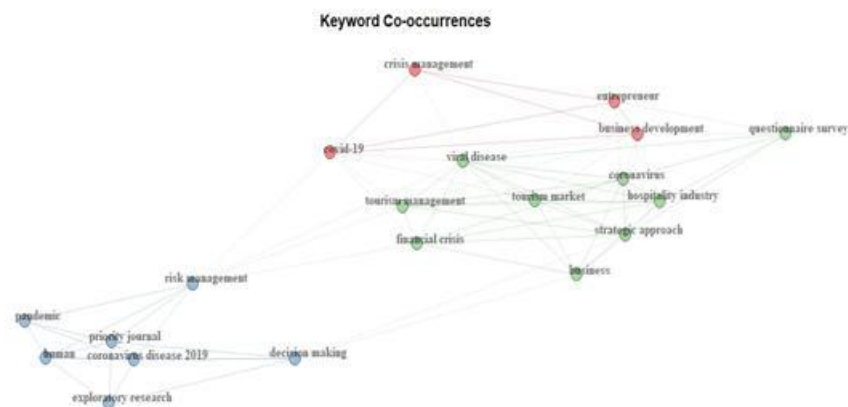


Fig. 1 The most central nodes of the network and their communities

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## **Green Consumer Behaviour during Covid-19 Pandemic: a Survey of Italian Consumers**

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### **Abstract**

Since the beginning of 2020, the world has been hit by the SARS CoV-2 virus that causes Covid-19. To hamper its spread, policy makers of many countries have put in place strong countermeasures, including lockdowns, that have led to significant changes in people's lifestyles and daily routines. The literature highlights that the Covid-19 pandemic has impacted several behavioural aspects. Despite the research on the changes in consumer behaviour due to the Covid-19 pandemic has been rapidly increasing, the study of this phenomenon remains an urgent issue to deepen. Further, the literature on the topic suggests the need to investigate from multiple perspectives the impact of Covid-19 on sustainability.

In this context, this paper aims at assessing the changes in green consumer behaviour in Italy caused by Covid-19. A survey was conducted on 1.535 Italian consumers between December 2020 and January 2021. Respondents have been asked to assess the extent to which their consumption behaviour related to several categories of products (eco-

sustainable, organic, fair-trade, locally produced, made in Italy, sold by neighbourhood stores) has changed due to the pandemic, as well as the extent to which the pandemic has impacted on many other aspects, including their environmental awareness and purchase behaviors.

The results show higher levels of consumption of eco-sustainable, organic, and fair-trade products, as well as of goods sold by neighbourhood stores, produced locally and made in Italy. For these product categories, it is also reported an increase in the consumers' sense of moral duty to purchase and in the willingness to pay a premium price. Further, results show that consumers are more aware of the extent to which their consumption behaviour can have economic, social, and environmental impacts. Consumers have also changed their purchasing habits. Further, this study's findings reveal that the extent of change is strongly affected by socio-demographic variables, such as gender, age, income, and education.

Changes reported in green consumer behaviour suggest implications on multiple levels. These are of great importance to guide marketers to respond promptly and effectively to the new challenges and to guide scholars to extend knowledge on this topic.

**Keywords** – Sustainable consumer behavior, green consumer behavior, sustainable products, green products, sustainability, Covid-19.

**Paper type** – Academic Research Paper

## 1 Introduction

Since the early stage of 2020, humanity has started to be threatened by the SARS-CoV-2 virus, which causes Covid-19. Its contagiousness, its high mortality rate, especially for elderly, and the need for hospitalization and intensive care for the most serious cases led policy makers of many countries to take a number of countermeasures: social distancing, wearing protection masks, restrictions that involve non-essential activities (e.g., restaurants, non-grocery shops), partial or total lockdowns, among others. Together with the fear of the new virus, which has caused severe impacts on the global economy (Brewer and Sebby, 2021), these countermeasures have led to significant changes in people's lifestyles and daily routines (Kirk and Rifkin, 2020; Zwanka and Buff, 2021). Many studies in the literature have been conducted to investigate how and the extent to which consumer habits and behavior can be affected by particular (unexpected) events, such as natural disasters – e.g., hurricanes (Sneath et al., 2009), earthquakes (Forbes, 2017), and terroristic attacks (Baumert et al., 2020; Herzenstein et al., 2015). In line with this literature, research on the impact of Covid-19 on consumer behaviors has been rapidly growing. This topic has been analyzed from different

perspectives, such as consumers' food consumption habits (Coulthard et al., 2021; di Renzo et al., 2020; Murphy et al., 2021), shopping behavior (Moon et al., 2021; Safara, 2020; Wang et al., 2020), mobility patterns (Anke et al., 2021; Nouvellet et al., 2021), physical activity (Faulkner et al., 2020; Martínez-de-Quel et al., 2021), and tourism (Miao et al., 2021). It has been highlighted that consumers constantly change their behavior in response to policies developed by governments to address the health emergency (Yang et al., 2020), suggesting the relevance of studying the impact of the pandemic on consumer behavior. Indeed, understanding changes in consumer behavior is of great importance to guide marketers and policymakers to respond promptly and effectively to these changes (Kirk and Rifkin, 2020). Despite the literature on the topic has been growing and the phenomenon has been studied from different points of view, research on the influence of Covid-19 on consumers behavior is still at a nascent stage (Qi et al., 2020) and remains an urgent issue (Borsellino et al., 2020). Further, the literature recognizes the need to investigate the impact of Covid-19 on sustainability from multiple perspectives (Sarkis et al., 2020).

In this context, this paper aims at assessing the extent of changes in sustainable consumer behavior caused by Covid-19 in Italy. Specifically, this study investigates the extent of changes generated by the pandemic in sustainable consumer behavior under multiple perspectives. Further, the change in consumer behavior for the following six categories of sustainable products is analyzed: organic, eco-sustainable, fair-trade, made in Italy, local, and products sold by neighbourhood stores. Organic and eco-sustainable products are related to the environmental dimension of sustainability. Fair-trade products are related to the social and economic dimensions of sustainability. Made in Italy and local products positively contributes to all three dimensions of sustainability - being produced in Italy or locally, there is a reduced environmental impact due to transportation, as well as a positive impact on Italian/local economy and employment levels). Products sold by neighbourhood stores contribute to the social and economic dimensions of sustainability, due to their impact on the local economy and employment levels.

To measure the extent of changes in consumer behavior, a questionnaire was developed and administered to a sample of 1.535 Italian consumers. Specifically, we asked whether the pandemic has increased consumer awareness (related to environmental problems and the impact of individual behaviors and purchase choices on the environment, society, and economy). Further, we asked whether



the pandemic has increased the consumer sense of moral duty to purchase different categories of sustainable products. Then, we asked whether the pandemic has impacted on the consumer purchase frequency and willingness to pay for the above-mentioned products, as well as and whether the pandemic has affected several consumer purchase behaviors. Differences among the answers provided by groups with different socio-demographic characteristics (i.e., gender, age, income, and education) have been investigated.

The paper is organized as follows. In Section 2, we explain the methodology used and describe the characteristics of the sample. In Section 3, we describe and discuss the results. Finally, in Section 4, we report the implications and conclusions of the study.

## **2 Methodology and sample**

A structured questionnaire was developed to collect data for this research<sup>1</sup>. The *first section* included two questions. A five-point Likert scale was used to measure how much Covid-19 pandemic increased (from “not at all” to “extremely”) consumers’ levels of awareness and moral duty. Specifically, Q1 evaluated, through eight items, the impact of Covid-19 on the increase of respondents’ awareness on the effect of human activities on environmental degradation, as well as the influence of Covid-19 on the increase of respondents’ awareness about the impact of their purchasing decisions on the natural environment, society, and economy (two items from BCG (2020), six items adapted from Kang et al., 2013). Q2 measured, through six items, the changes due to Covid-19 in respondent’s sense of moral duty to purchase different product categories (Sold by neighbourhood stores, Made in Italy, Local, Fair-trade, Organic, Eco-sustainable).

The *second section* included three questions. A five-point Likert scale was used to measure the change, due to the Covid-19 pandemic, in the frequency of different types of actions (from “I do it a lot less often” to “I do it a lot more often”). Specifically, Q3 investigated, through six items, how much the frequency of purchase of different product categories (Sold by neighbourhood stores, Made in Italy, Local, Fair-trade, Organic, Eco-sustainable) has changed due to the pandemic (three items from BCG (2020), three items self-developed). Q4 evaluated, through six items, how much the frequency of carrying out several

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<sup>1</sup> In this paper a shorter version of the full questionnaire is presented.

purchase behaviors has changed due to the pandemic (two items adapted from BCG (2020), four items self-developed). Q5 investigated the changes due to Covid-19 in respondents' willingness to pay a premium price for five product categories (Made in Italy, Local, Fair-trade, Organic, and Eco-sustainable) (adapted from Moser 2015)<sup>1</sup>. A five-point Likert scale was used (from "greatly decreased" to "greatly increased").

The *third section* included questions on socio-demographic characteristics of respondents (gender, age, education, net monthly household income).

The questionnaire also included some other questions, but in this paper, it was decided to focus only on certain aspects: awareness, moral duty, purchase frequency and behaviours, and willingness to pay.

The developed questionnaire was pre-tested with a sample of 40 people. As a result, small changes were done to improve the clarity of some questions.

The questionnaire was administered through the Qualtrics survey platform. The survey was spread to people living in Italy between December 2020 and February 2021 through multimedia channels (e.g., social networks and instant messaging clients). The final sample is made of 1.535 respondents. The socio-demographic characteristics of the sample are reported in Table 1.

Table 1: Socio-demographic characteristics of the sample.

Variable	Group	Frequency	Percentage (%)
Gender	Male	668	43,52
	Female	867	56,48
Age	18 – 24	347	22,61
	25 – 34	480	31,27
	35 – 44	215	14,01
	45 – 54	235	15,31
	55 – 65	198	12,90
	> 65	60	3,91
Education	Middle school or lower	84	5,47
	High school	563	36,68
	Bachelor's master's degree	705	45,93
	Postgraduate course or	183	11,92
	PhD		
Net monthly household	< 1.500	258	16,81

<sup>1</sup> Products sold in neighbourhood stores have not been included in this question since, differently from the other considered categories, their sustainability only derives from the place where they are sold rather than from clearly recognizable intrinsic product characteristics.

income (euros)	1.500 - 3.000	789	51,40
	3.001 - 4.500	325	21,17
	> 4.500	163	10,62
<i>Total</i>		<i>1535</i>	<i>100</i>

### 3 Results and discussions

In this section, results from data analysis are reported. For each question, results are provided first on the whole sample of responses, then for different groups of respondents, defined according to socio-demographic characteristics. In order to investigate the differences among groups, the nonparametric Kruskal-Wallis test was performed, followed by a Post Hoc test comparing pairwise via Dunn procedure with Bonferroni adjustment.

#### **3.1 Awareness of environmental problems and of the impact of consumer purchasing choice and behaviors**

The results show that the pandemic caused an increase in consumer awareness related to all the considered aspects (Figure 1a). Results show a moderate or extreme increase in awareness of the effect of environmental problems (over 55% of respondents), in the awareness that individual purchasing choices can have a significant impact on the economy and that consumer behavior can make a significant difference in mitigating environmental problems (over 40% of respondents). Concerning the other aspects, over 30% of the answers are on the last two anchors of the Likert scale.

The level of awareness increased for all the socio-demographic groups. Women report significantly higher values than men for all the statements (Figure 1b). Concerning *age groups*, the group "25-34" shows a lower increase in the awareness compared to groups "18-24", "45-54", and "55-65" on multiple statements (Figure 1c). Regarding the *household income*, no significant differences can be noted among groups, except for the statement A (Figure 1d). Respondents belonging to the "1.500 - 3.000" group have increased their level of awareness about the threat by environmental degradation significantly more than the group "3.001 - 4.500". Significant differences are found among *education groups* on multiple statements (Figure 1e). Respondents belonging to the two highest education levels have a lower increase in the level of awareness for environmental problems compared to other groups (statements A and B). For the statements C,

E, and F the "High school" group has significantly higher values than the "Bachelor's or master's degree" and "Postgraduate course or PhD" groups.

### **3.2 Moral Duty to purchase sustainable products**

Results show that consumers' moral duty to purchase the considered product categories is increased due to the pandemic (Figure 3a). The sense of moral duty to purchase Local products moderately or extremely increased for over 50% of respondents, whereas the sense of moral duty to purchase Made in Italy products and Products sold by neighbourhood stores moderately or extremely grew for over 40% of respondents.

The moral duty to purchase increased for all the considered groups. Women report significantly higher values than men for all the product categories (Figure 3b). Significant differences are found among *age groups* for each product category (Figure 3c). Respondents belonging to the group "25-34" increased their moral duty significantly less than respondents belonging to other groups for multiple types of products. On the contrary, the group "55-65" shows higher values than other groups. Results reveal significant differences among *household income* groups only for Organic products (Figure 3d). The "3.001 - 4.500" group shows a lower increase in the level of moral duty to purchase Organic products compared to the "< 1.500" group. Concerning *education*, significant differences among groups are found on Made in Italy, Fairtrade, Organic, and Eco-sustainable products: respondents with the lowest education level report a higher increase in their sense of moral duty to purchase these products (Figure 3e).

### **3.3 Purchase frequency**

Results show that more than 50% of respondents increased the frequency of purchase related to Made in Italy and Local products, around 50% of respondents increased the frequency of purchase products sold by neighbourhood stores, while more than 20% of respondents increased the frequency of purchase of Fair-trade, Organic, and Eco-sustainable products (Figure 4a). These results are consistent with those of the Coop Report (2020) and Severo et al. (2021), which show how the pandemic increased sustainable consumption.

The purchase frequency increased for all the socio-demographic groups. Women increased their purchase frequency for all categories of products

significantly more than men (Figure 4b), consistently with the study by Witek and Kuźniar (2021). Concerning the *age groups*, results do not reveal significant differences among groups (Figure 4c). Regarding the *household income* groups, significant differences are found only for Organic products, where the "< 1.500" group has a significantly higher value than the "3.001 - 4.500" group (Figure 4d). This may be related to the fact that the "< 1.500" income range has a significantly greater moral duty to purchase Organic products than the "3.001 - 4.500" income range, as well as more concern for environmental issues. With respect to *education*, no significant differences are reported (Figure 4e).

### **3.4 Purchase behaviors**

Results show several changes in the purchase behaviors (Figure 5a). More than 50% of respondents increased the frequency of purchasing products online, consistently with other recent studies (Alaimo et al., 2020; Moon et al., 2021; Principato et al., 2020; Wang et al., 2020). Around 50% of respondents avoided, more often, the purchase of non-essential products, in line with Mehta (2020). Similarly, around 50% of respondents limited the number of times they shop in physical stores buying large quantities at a time, consistently with Wang (2020). Conversely, around 25% of respondents decreased the frequency of shopping in large stores. Finally, around 30% of respondents increased the frequency of reading the product labels.

Concerning the results related to the specific groups, it can be noted that women reported significantly higher values than men for all the purchase behaviors, except for Purchasing products online and Shopping in large stores (Figure 5b). Results reveal significant differences among the *age groups* on items B and C (Figure 5c). Respondents under 45 have increased the frequency of shopping online significantly more than older respondents. This result might be due to higher familiarity of young people with online platforms. Respondents over 35 have reduced the frequency of shopping in large stores significantly more than the younger respondents, probably because they are more vulnerable to Covid-19 and shopping in large stores is perceived as a situation characterized by potential infection risks. Regarding the *household income*, no significant differences can be found among groups, except for Purchasing products online (Figure 5d). Respondents with a net monthly household income higher than 3.000 euros increased the frequency of online shopping significantly more than other

respondents whose net income is lower than 3.000 euros. This result may be linked to the greater economic availability and ease of access to e-commerce for the high-income people. Relating to *education*, respondents belonging to the “Middle school or lower” group increased the frequency of online shopping significantly less than the other respondents (Figure 5e). The “High school” group increased the frequency of checking the ingredients or materials used on the product labels significantly more than the “Postgraduate course or PhD” group.

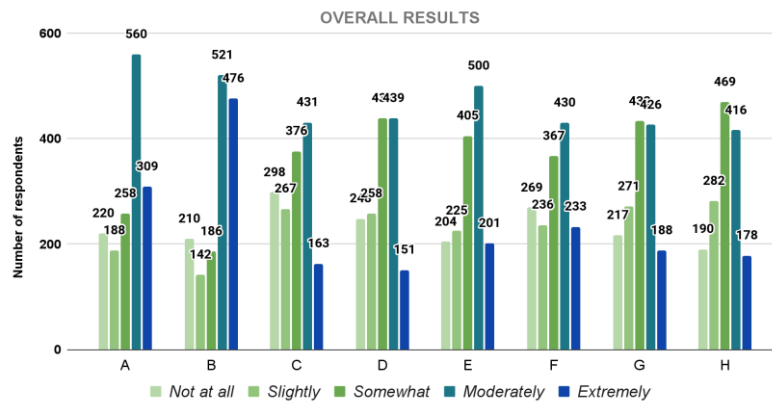
### **3.5 Willingness to pay**

Results show that, depending on the specific category of sustainable product, between 20% and 45% of the respondents indicated an increase in the willingness to pay a premium price due to the pandemic (Figure 7a). Alternatively, between 3% and 6% of respondents decreased their willingness to pay.

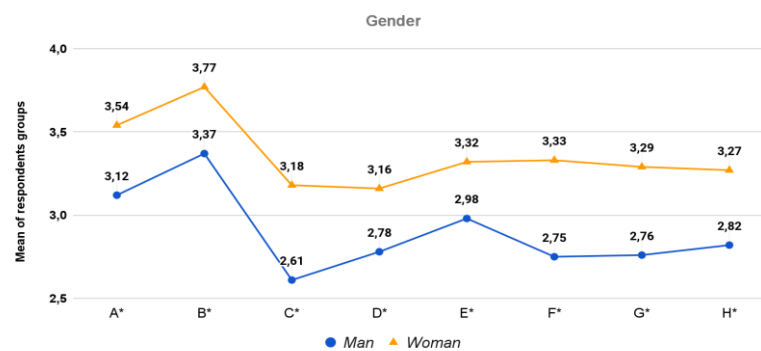
The willingness to pay a premium price increased for all socio-demographic groups. Significant differences between men and women are found only for two product categories, i.e., Made in Italy and Organic products, for which women reported a significantly higher increase in the willingness to pay a premium price (Figure 7b). This could be related to the fact that women increased the frequency to read product labels more than men. This result is consistent with Shahsavar and Kube (2020). No significant differences among the *age groups* are found (Figure 7c), as well as among the *household income* (Figure 7d) and the *education* (Figure 7e).

**Q1 - Please indicate how much the Covid-19 pandemic has made you more aware of the following aspects: [from 1 = "not at all" to 5 "extremely"]**

- A. Humans can be threatened by environmental degradation
- B. The climate is threatened by human activities
- C. My purchasing choices can have a significant impact on the environment
- D. My purchasing choices can have a significant impact on society
- E. My purchasing choices can have a significant impact on the economy
- F. My behavior can make a significant difference in mitigating environmental problems
- G. My behavior can make a significant difference in mitigating social problems
- H. My behavior can make a significant difference in mitigating the economic problems of my territory



a



b

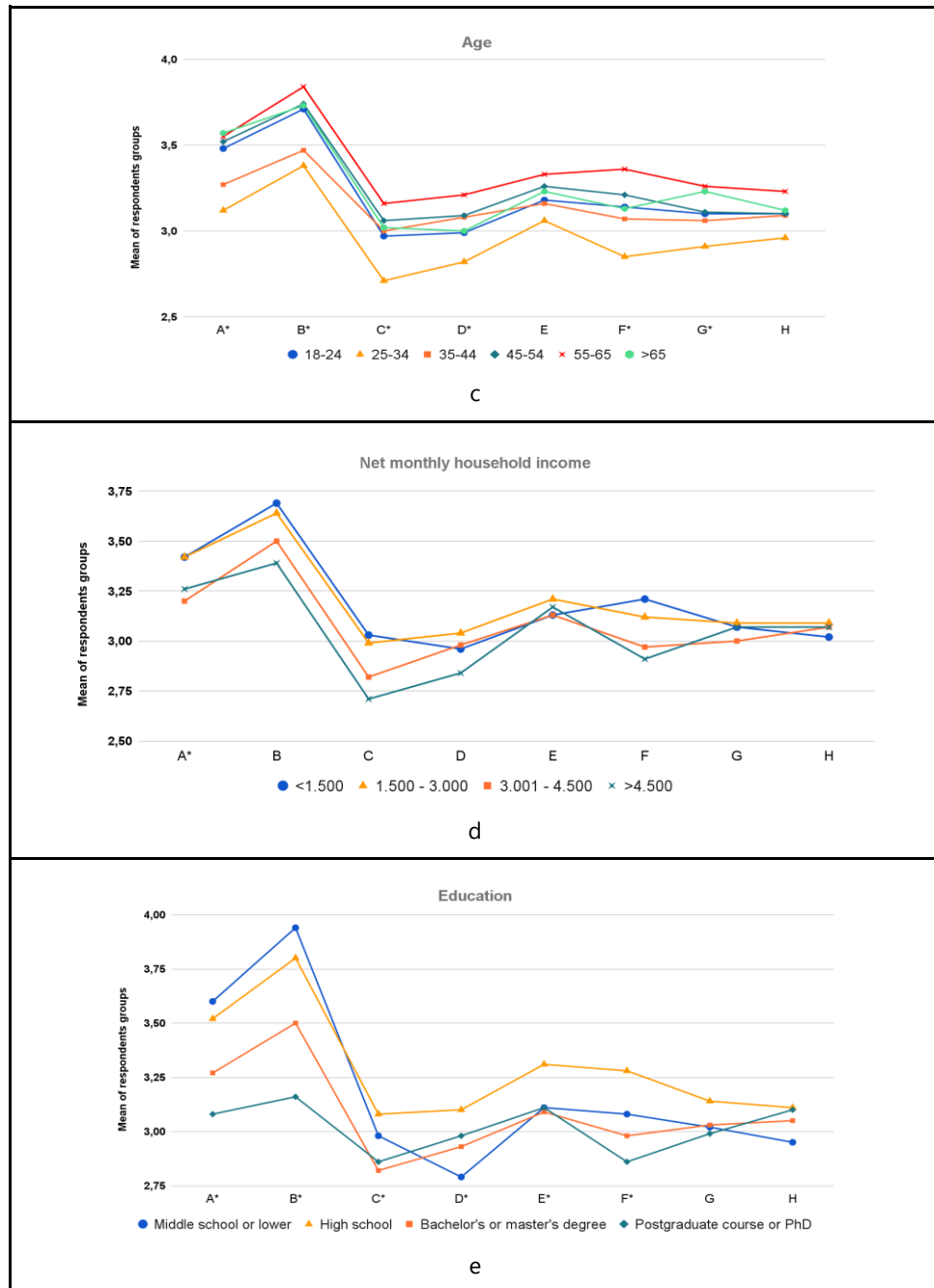
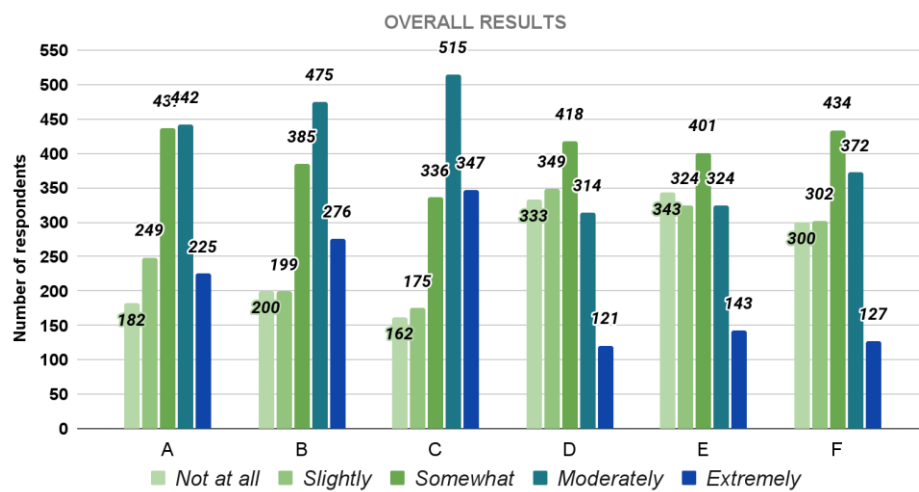


Figure 1. Increase, due to Covid-19 pandemic, in the level of awareness of environmental problems and of the impact of consumer purchasing choice and behaviors. (a) Overall results; (b) Gender; (c) Age; (d) Household income; (e) Education. \* means that significant differences exist among groups.

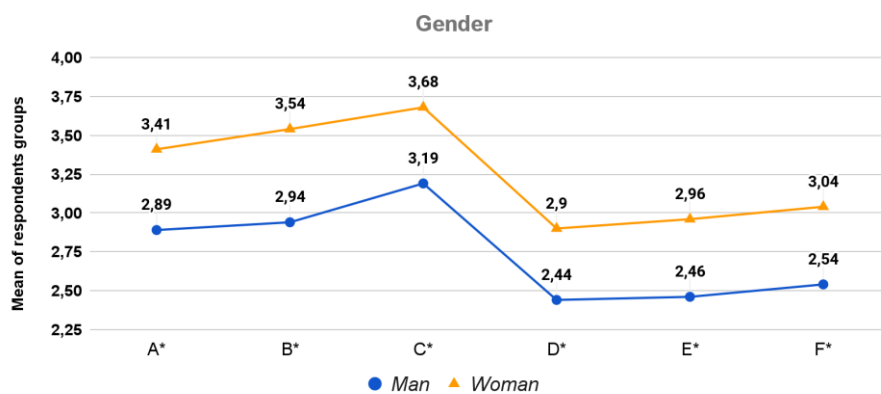


**Q2 - Please indicate how much, following the Covid-19 pandemic, your sense of moral duty to purchase the following products has increased: [from 1 = "not at all" to 5 "extremely"]**

- A. Products sold by neighbourhood stores
- B. Made in Italy products
- C. Local products
- D. Fairtrade products
- E. Organic products
- F. Eco-sustainable products



a



b

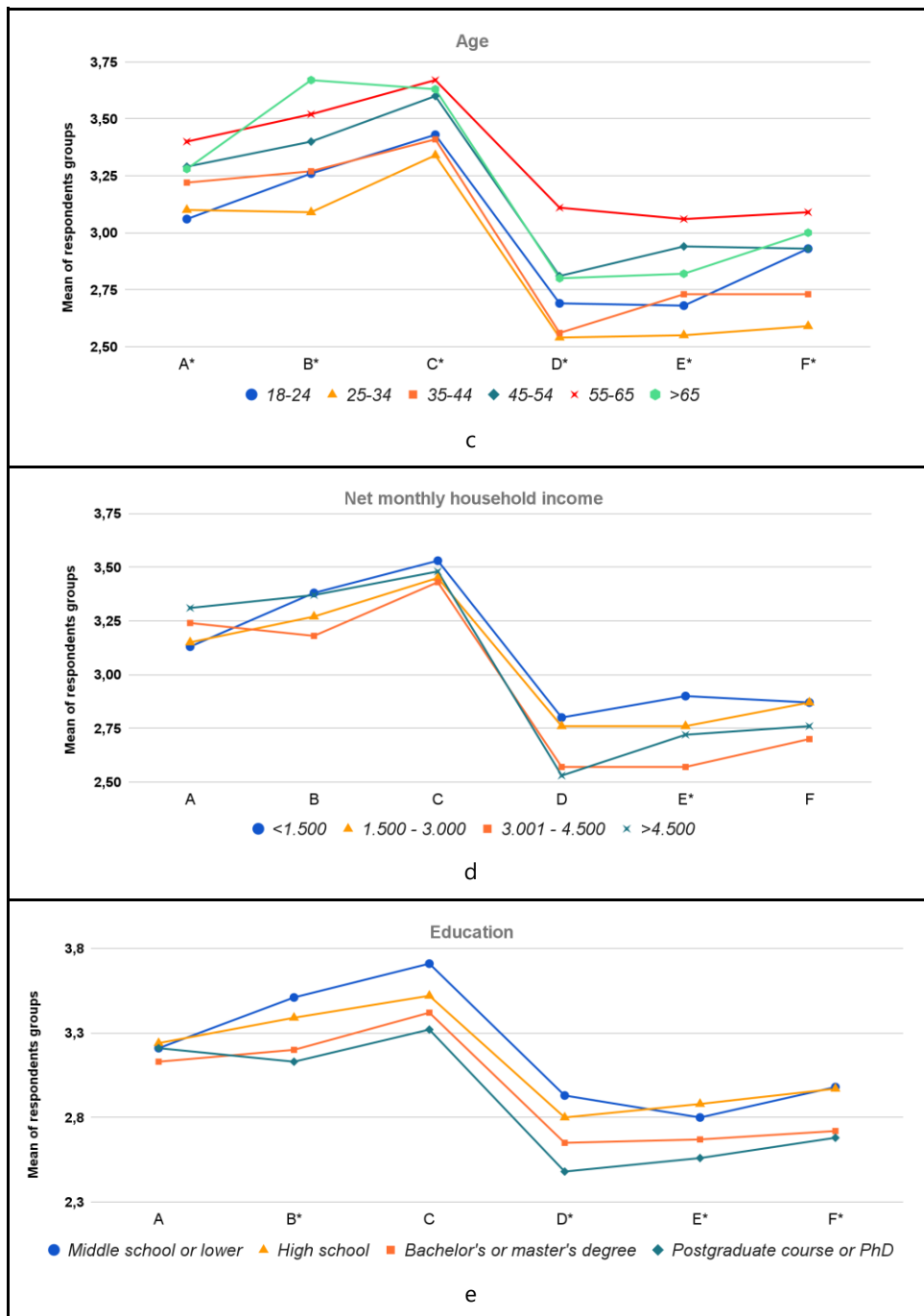
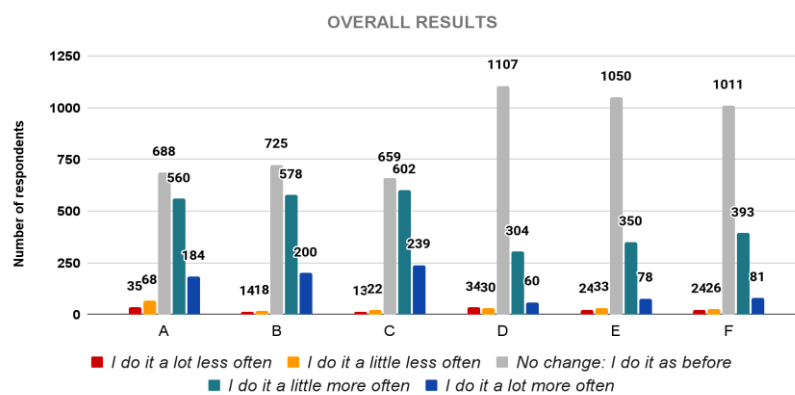


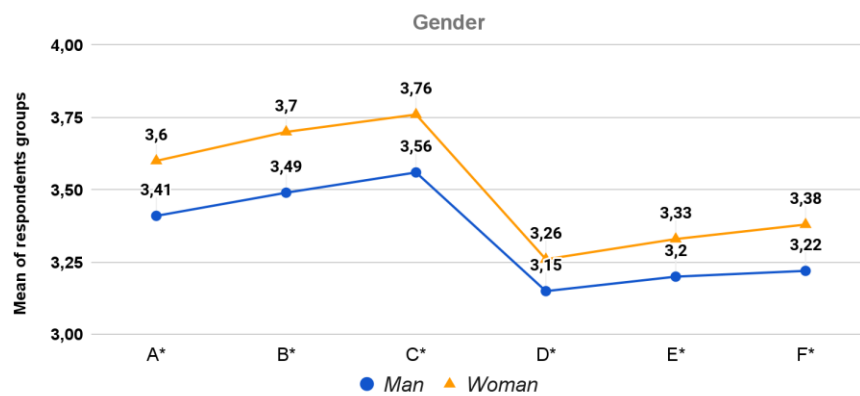
Figure 2 - Increase in the level of moral duty to purchase specific categories of products due to the Covid-19 pandemic. (a) Overall results; (b) Gender; (c) Age; (d) Household income; (e) Education. \* means that significant differences exist among groups.

**Q3 Product type-** Please indicate how much the frequency of your actions has changed as compared to before the Covid-19 pandemic: [from 1 = "I do it a lot less often" to 5 "I do it a lot more often"]

- A. Purchase of Products sold by neighbourhood stores
- B. Purchase of Made in Italy products
- C. Purchase of Local products
- D. Purchase of Fairtrade products
- E. Purchase of Organic products
- F. Purchase of Eco-sustainable products



a



b

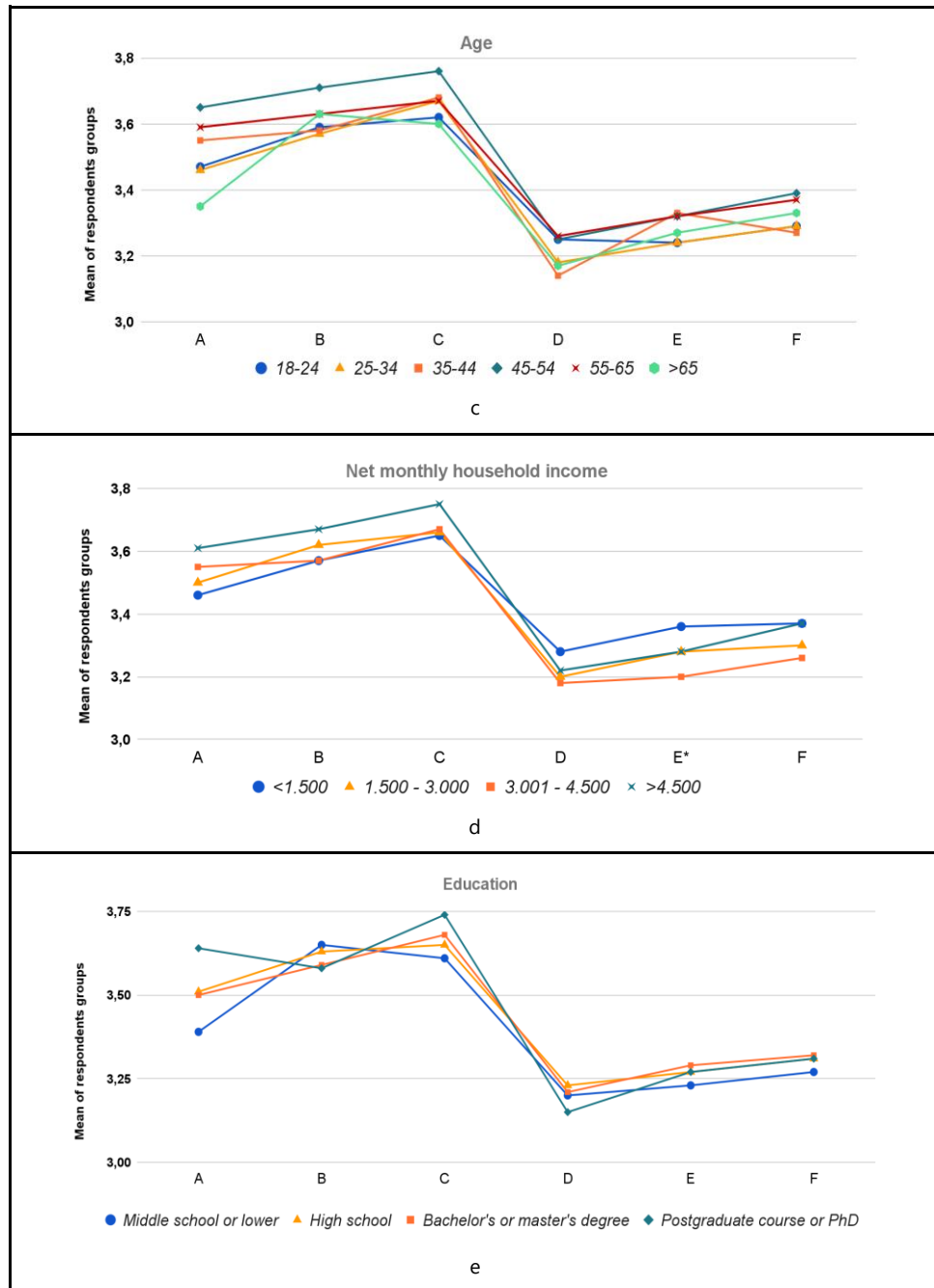
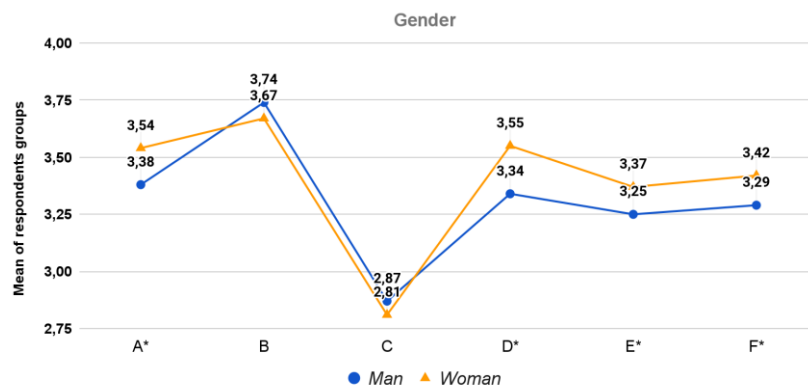
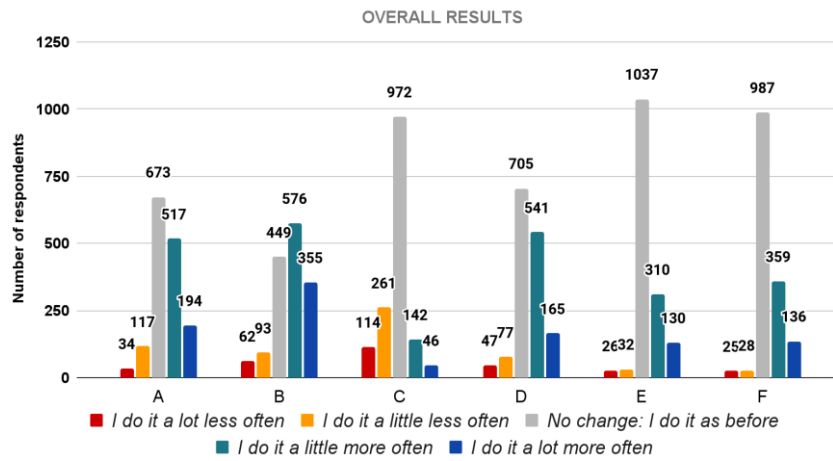


Figure 3 - Change in the frequency of purchase of sustainable products due to Covid-19 pandemic. (a) Overall results; (b) Gender; (c) Age; (d) Household income; (e) Education. \* means that significant differences exist among groups.

**Q4 Purchase Behaviors - Please indicate how much the frequency of your actions has changed as compared to before the Covid-19 pandemic: [from 1 = "I do it a lot less often" to 5 "I do it a lot more often"]**

- A. Avoiding the purchase of non-essential products
- B. Purchasing products online
- C. Shopping in large stores
- D. Limiting the number of times you shop in physical stores buying large quantities at a time
- E. Reading product labels about the ingredients or materials used
- F. Reading the product labels to verify the place of production



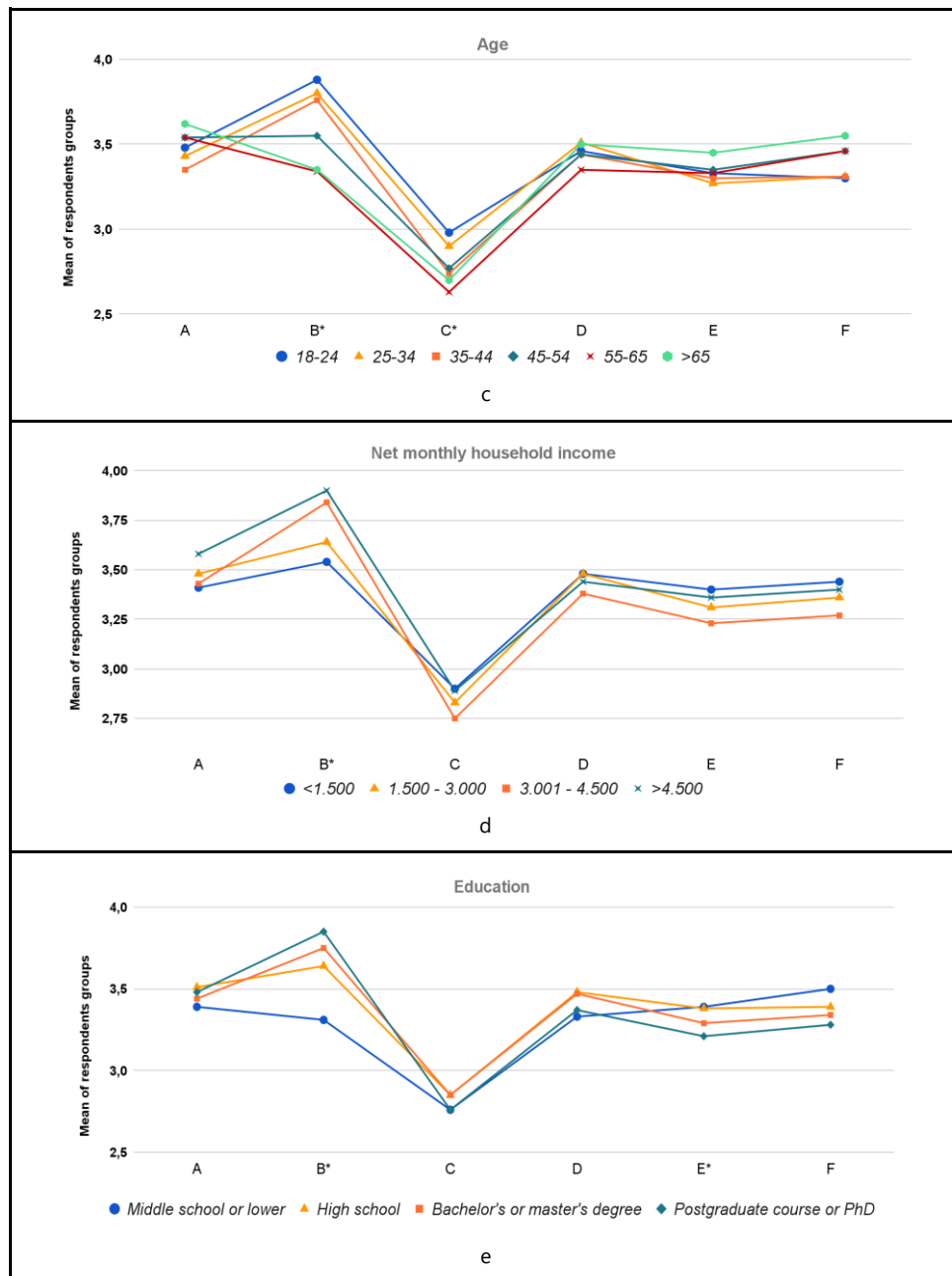
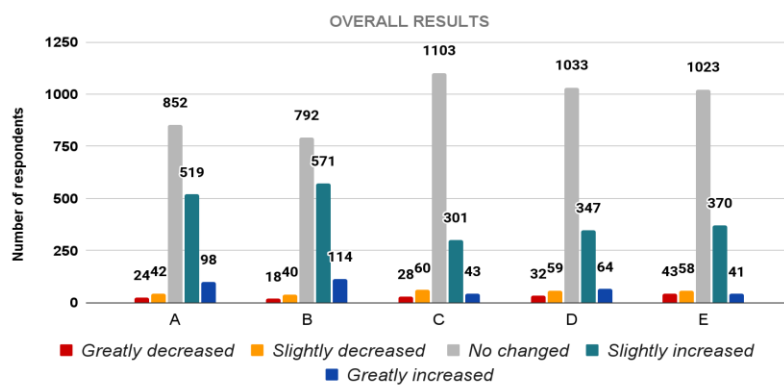


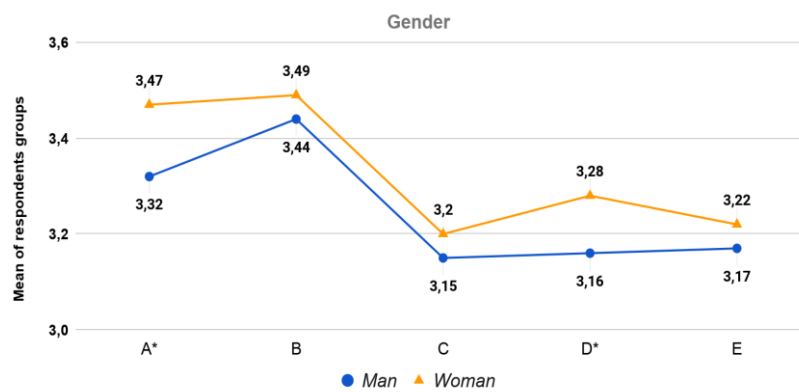
Figure 4 - Change in purchase behaviours due to Covid-19 pandemic. (a) Overall results; (b) Gender; (c) Age; (d) Household income; (e) Education. \* means that significant differences exist among groups.

**Q5 - Please indicate how much, compared to before the Covid-19 pandemic, your willingness to pay a premium price for the following product types has changed: [from 1 = "Greatly decreased" to 5 "Greatly increased"]**

- A. Made in Italy products
- B. Local product
- C. Fair trade products
- D. Organic products
- E. Eco-sustainable products



a



b

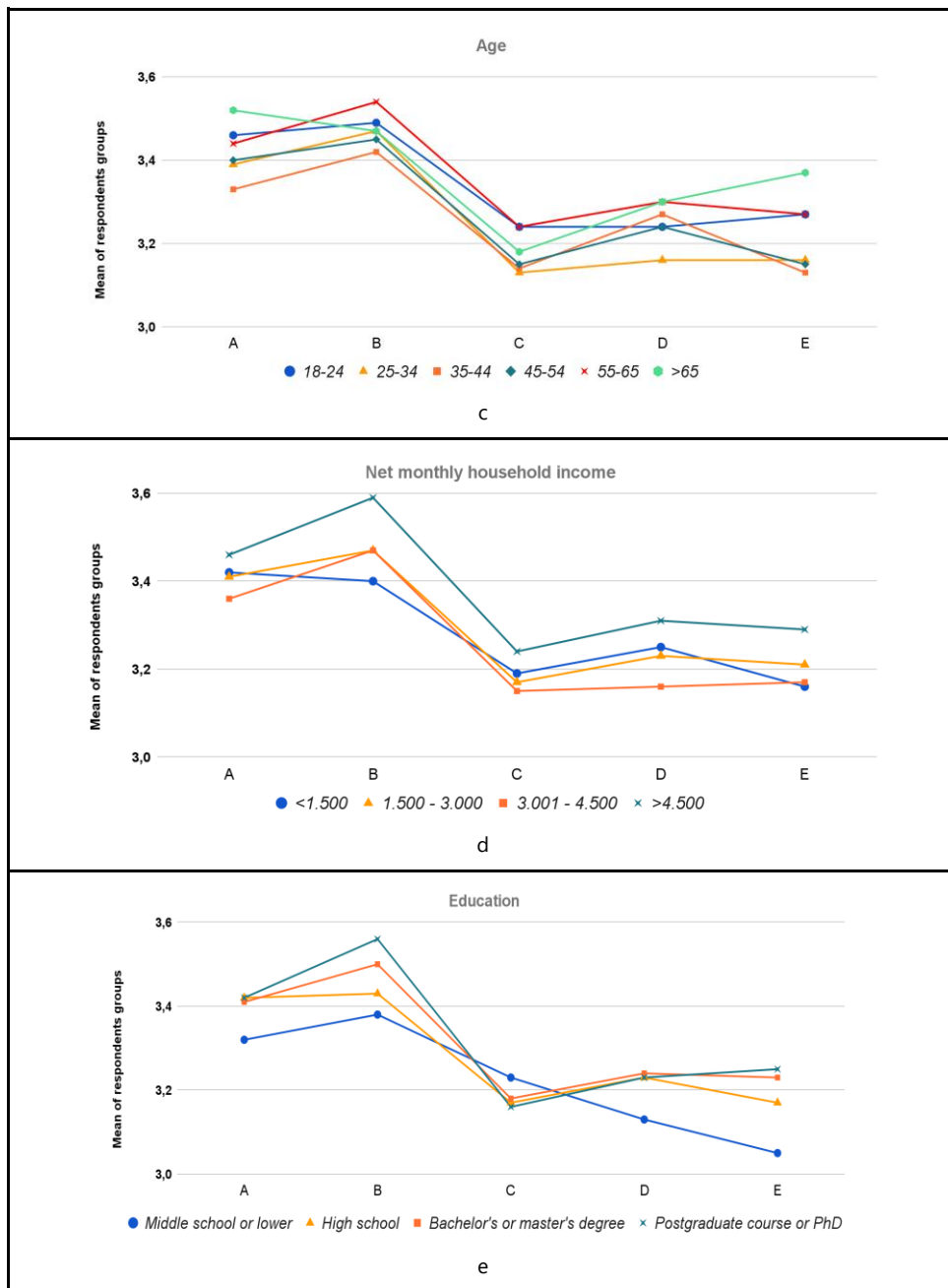


Figure 5 - Changes in the willingness to pay a premium price for sustainable products due to Covid-19 pandemic. (a) Overall results; (b) Gender; (c) Age; (d) Household income; (e) Education. \* means that significant differences exist among groups.



## 4 Implications and conclusions

This paper investigated the extent of changes in sustainable consumer behavior caused by the Covid-19 pandemic in Italy. Results demonstrated that the Covid-19 pandemic has indeed caused several changes in sustainable consumer behavior and that these changes are different according to socio-demographic characteristics of respondents.

Based on the obtained results, several implications can be developed for both theory and practice.

In terms of theoretical implications, this study contributes to the consumer dynamics literature (Zwanka and Buff, 2021; Baumert et al., 2020) and to the green/sustainable consumer behavior literature (Borsellino et al., 2020; Jian et al., 2020; Qi et al., 2020; Severo et al., 2020) by assessing the influence of an unexpected and disruptive event, such as the Covid-19 pandemic, on sustainable consumer behavior. This study considers the economic, environmental, and social dimensions of sustainability simultaneously, by including different product categories (i.e., Sold by neighbourhood stores, Made in Italy, Local, Fairtrade, Organic, and Eco-sustainable products) related to the three above-mentioned aspects of sustainability. This is a novelty compared to previous studies. This study offers elements of novelty also with regard to the context in which it has been carried out. Actually, previous research conducted on the Italian context on the impact of Covid-19 pandemic on consumer behavior is quite limited and focused on very specific aspects, while our study considers multiple aspects of consumer behavior. Furthermore, our results also show how the changes in consumer behavior can be different according to socio-demographic characteristics of respondents, as significant differences emerged among gender, age, income, and education groups.

Several implications for companies can be derived from this study's results. Specifically, our results show a general increase in both the frequency of purchase and the willingness to pay more for several categories of sustainable products. These changes in consumer behavior highlight growing opportunities for companies to embrace sustainability into their strategies, position themselves as sustainable firms and develop sustainable products. Further, the increase in the frequency of purchase and willingness to pay more for made in Italy and local products may let companies change their production strategies or better promote these characteristics. Moreover, the differences emerged among the

different socio-demographic groups highlight that specific marketing mixes should be developed for each category.

In conclusion, this research offers a general picture of the changes in sustainable consumer behavior that occurred in the Italian context due to the Covid-19 pandemic. Results have shown that this catastrophic and unexpected event led consumers to be more concerned about environmental problems and more aware of individual impacts, and to have a more sustainable purchase behaviour.

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## Products from Industrial Symbiosis: a Survey of Consumer Perceptions and Purchase Intention

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### Abstract

This paper is aimed at analyzing the consumers' perception toward products from Industrial Symbiosis (IS) processes (hereafter mentioned as "IS products"), as well as their purchase intention and willingness to pay a premium price for them. IS is one of the key strategies supporting the transition towards the circular economy: accordingly, wastes produced by a company can be used as production inputs by other companies or be exploited to produce new products. Specifically, this paper investigates the consumers' perception of two IS products: (1) electronic products, whose shell is made by industrial plastic wastes, and (2) electronic products, whose battery contains substances extracted by wood wastes. A survey was conducted on 1.224 Italian consumers, aimed at assessing risks and benefits perceived by them, related to the above-mentioned IS products. Results show that consumers do not perceive IS products as risky; alternatively, they perceive several benefits in terms of the quality and functionality of these products. Furthermore, consumers are aware that IS products can contribute to preserving the natural environment. Finally, most consumers declare a purchase intention of the investigated IS

products and are willing to pay a premium price for them. The results of this paper highlight that potential markets for IS products currently exist and suggest companies to include IS products into their product portfolio.

**Keywords** – Industrial Symbiosis, Consumer Behavior, Green Products, Survey Research.

**Paper type** – Academic Research Paper

## 1 Introduction

The last global environment outlook accurately describes how climate change poses a serious challenge to economic development, creating risks to natural systems and human society (Ekins et al., 2019). Alongside the climate change problem, the consumption of natural resources and the production of wastes is becoming increasingly alarming, due to the population growth and the increase in per capita consumption rates (World Bank, 2019).

Consequently, the traditional production and consumption model must evolve from a linear to a circular one, able to reduce the inputs of raw materials to the economic systems and close the resource loop to minimize waste production (Korhonen et al., 2018). In this regard, industrial symbiosis (IS) is one of the most impactful strategies able to support the transition towards the circular economy (Domenech et al., 2019). IS deals with replacing – totally or partially – raw materials and production inputs with wastes produced by other companies (Chertow, 2000). By implementing IS relationships, companies can achieve economic benefits from the reduction in their production costs and create environmental benefits for the society, simultaneously (Taddeo et al., 2017). Driven by these potential benefits, the attention received in the literature by IS has drastically increased in recent years (Mallawaarachchi et al., 2020). So far, the literature has analyzed IS from the company perspective, e.g., analyzing case studies – aimed at highlighting the benefits from IS – (Neves et al., 2020), drivers and barriers to the IS implementation (Mortensen and Kørnø, 2019), as well as investigating the impact of operational (Fraccascia, 2019) and social issues (Hewes and Lyons, 2008) on the IS practice. However, scant attention has been devoted so far to investigating IS from the perspective of consumers, i.e., who is going to buy goods produced via the IS approach.

This paper contributes to this research topic via investigating the consumer perceptions towards IS products, as well the purchase intention and the

willingness to pay a premium price for these products. Although many studies in the literature exist that address consumer behavior towards many product categories, including green products (e.g., Dangelico et al., 2021), there are no studies that specifically address IS products. In particular, two categories of IS products have been considered: (1) electronic products (e.g., laptops, smartphones, tablets) whose shell is made by industrial plastic wastes – in the remainder referred to as “IS plastic products” – and (2) electronic products whose battery contains substances extracted by wood wastes, which replaces chemical substances – in the remainder referred to as “IS wood products”. To this aim, a survey has been conducted on 1.224 Italian consumers between November 2020 and February 2021.

The remainder of the paper is organized as follows. Section 2 presents the theoretical background. Section 3 addresses the methodology. Section 4 presents the results. The paper ends with discussion and conclusions in Section 5.

## **2 Theoretical Background**

To investigate consumers’ perceptions towards IS products, along with their purchase intention and willingness to pay a premium price for them, we have referred to the theory of the decision-making process (Engel et al., 1968). This theory is based on the concept that, during the purchasing decision process – i.e., when the consumer is assessing whether to buy the product and how much he/she is willing to pay for it – consumers balance risks and benefits related to purchasing that product (Hamzaoui-Essoussi and Linton, 2010; Mugge et al., 2017).

Risks can be categorized in terms of inherent risk – i.e., those reflecting the consequences of a purchase (Taylor, 1974) – and psychological risk – i.e., the discomfort coming from anticipated post-behavioral reaction (Perugini and Bagozzi, 2001). Nevertheless, the most popular taxonomy comes from Mitchell (1992), who has identified six types of risks: social, financial, physical, performance, time, and psychological. The perceived risk depends on the product characteristics and related available information (Hwa-Wu et al., 2015).

Concerning IS plastic and wood products, consumers may primarily associate a *contamination risk*, if they perceive the product as dirty or unsanitary. Another relevant risk relates to the *perceived safety*, since consumers could perceive the product as not safe. Alongside these two types of risks, the *performance risk* can

be considered through the consumers' expectations on the quality and functionality of the product. The *quality* of a product is the utility resulting from the expected performance, in terms of reliability and degree of customization, as well as freedom from defect, and is affected by the conformance to customer requirements and specifications (Hur et al., 2014; Johnson and Ettlie, 2001). Environmentally friendly products can be perceived as less attractive than traditional products (Micklethwaite, 2004) and consumers may associate a lower quality to them (Magnier et al., 2019; Wang et al., 2013). The *functionality expectation* is related to consumers' perceived utility of a product and their perception of receiving the maximum benefit, in terms of physical attributes, performance, and functionality (Gonçalves et al., 2016; Hur et al., 2014). The quality and functionality knowledge are the main components of the perceived overall value of the product (Churchill and Surprenant, 1982; Hur et al., 2014; Singhal et al., 2019; Wang and Hazen, 2016), having a positive impact on purchasing behavior (Chang and Fong, 2010; Cronin et al., 2020; Styliadis et al., 2020). Finally, it is important to consider the *green perceived utility*, i.e., the environmental benefit of the product perceived by the consumer. Consumers are more likely to purchase environmentally friendly products when they are aware of the related environmental benefits (Magnier et al., 2019).

### **3 Methodology**

#### **3.1 Sample and Procedure**

Primary data was collected through a survey addressed to Italian consumers between November 2020 and February 2021. Two identical questionnaires were developed, aimed at collecting data on the consumer behavior, purchase intention, and willingness to pay a premium price for two different products, i.e., electronic products including parts made of recycled wood (IS wood products) or plastic (IS plastic products), respectively. The questionnaires were validated through a pre-test conducted on a sample of 20 consumers, aimed at highlighting whether the questions were clear enough to respondents, as well as to test the time required to complete the questionnaire. Only small changes were made after the pre-test. The questionnaires were distributed online using social networks, instant messaging clients, and e-mails. The final sample of respondents



was made by 1.224 consumers, 605 for the survey related to IS plastic products and 619 related to IS wood products.

### **3.2 Measures**

The questionnaires were divided into two parts: the former consists of several questions based on the theory of consumers' decision-making process, while the latter focuses on socio-demographic characteristics of respondents.

Each construct in the first section was measured through a multi-item 5-point Likert scale. Each scale ranges from 1 = "strongly disagree" to 5 = "strongly agree", except the scales measuring the *quality expectation*, ranging from 1 = "much lower" or "very low" to 5 = "much higher" or "very high". *Contamination risk* scale is made of three items (Magnier et al., 2019; Argo et al., 2006), *perceived safety* scale of three items (Magnier et al., 2019), *quality expectations* of two items (Boulding and Kirmani, 1993), *functionality expectations* of three items (Magnier et al., 2019; Homburg et al., 2015), and *green perceived utility* of three items (Magnier et al., 2019; Chang, 2011). *Purchase intention* is assessed through three items (Bamberg, 2003; Gleim et al., 2013) and *willingness to pay* is assessed through two items (Magnier et al., 2019). Table 2 in the Appendix displays all the scales analyzed in this paper, with source, mean and standard deviation of each variable.

The second section includes questions about socio-demographic characteristics of respondents: gender (a dummy variable with 0 for male and 1 for female), age (from 1="18-24" to 6="over 65"), education (from 1="Middle school or lower" to 5="Doctorate"), and monthly household net income (from 1= "less than 1.500 €" to 4= "over 4.500 €").

## **4 Results**

### **4.1 Description of the sample**

From a demographic point of view, the sample is mostly made by young and highly-educated people. Actually, more than 50% of respondents are younger than 35 years old; 25% of respondents have a bachelor's degree and 34% have a master's degree. 36% of respondents are male and 64% are female. Around 24% of respondents declared a net monthly household net income lower than 1.500

euros, 42% between 1.500 and 3.000 euros, 19% between 3001 and 4.500, and 15% higher than 4.500 euros.

#### 4.2 Descriptive analysis

Figure 1 displays the assessment of *green perceived utility* for IS wood products (Figure 1a) and IS plastic products (Figure 1b). It can be noted that, for both products, more than 60% of respondents agree that these products protect the environment and can contribute to effectively reduce pollution and problems related to landfill saturation.

Concerning the *perceived risks* by consumers (Figure 2), the majority of respondents perceive both these products as not-risky: almost 90% of respondents do not consider them as contaminated, unsanitary, or dirty, regardless of the type of recycled material used – results for IS wood products are shown in Figure 2a, results for IS plastic products are shown in Figure 2b.

Table 1. Socio-demographic characteristics of the sample.

	Frequency (percentage)
Gender	
Male	445 (36.36%)
Female	779 (63.64%)
Age	
18-24	335 (27.37%)
25-34	380 (31.05%)
35-44	158 (12.91%)
45-54	150 (12.25%)
55-65	159 (12.99%)
over 65	42 (3.43%)
Educational level	
Middle school or lower	37 (3.02%)
High school	426 (34.80%)
Bachelor's degree	312 (25.49%)
Master's degree	421 (34.40%)
Doctorate	28 (2.29%)
Household net income	
< 1.500	291 (23.77%)

1.500 - 3.000	519 (42.40%)
3.000 - 4.500	232 (18.95%)
> 4.500	182 (14.87%)

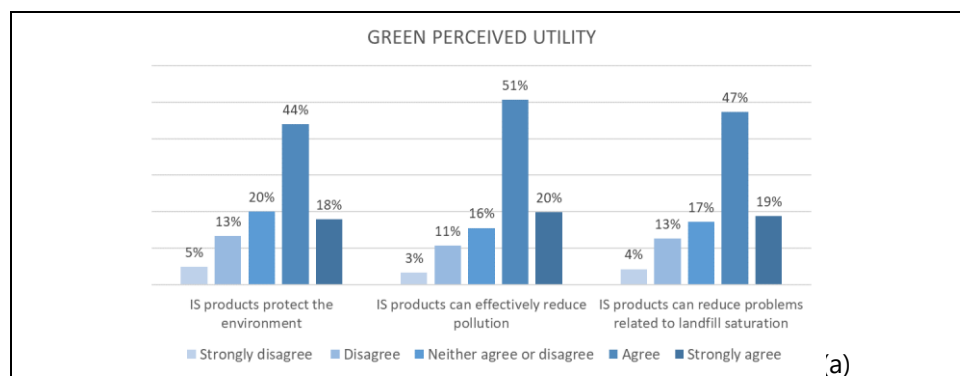
Concerning the *perceived safety* (Figure 3), approximately 85% of respondents declared to perceive those products as not dangerous. Nonetheless, safety is perceived slightly higher in the case of IS plastic products – results for IS wood products are shown in Figure 3a, results for IS plastic products are shown in Figure 3b.

Concerning the *functionality expectations* (Figure 4), more than 90% of respondents think that IS products are capable of performing well, doing their job, and being functional. Even in this case, the perceived functionality is slightly higher in the case of IS plastic products – results for IS wood products are shown in Figure 4a, results for IS plastic products are shown in Figure 4b.

Concerning the *quality expectations*, it can be noted that almost 85% of consumers expect that the quality of IS products is equivalent to or higher than that of traditional products. Almost all respondents perceive the quality of these new products as acceptable or high (Figure 5).

Concerning the *purchase intention* (Figure 6), more than 60% of respondents state that they would consider buying IS plastic or IS wood products.

Finally, concerning the *willingness to pay* a premium price (Figure 7), more than 40% of respondents declared that they would pay a premium price for IS products, for both the types of product.



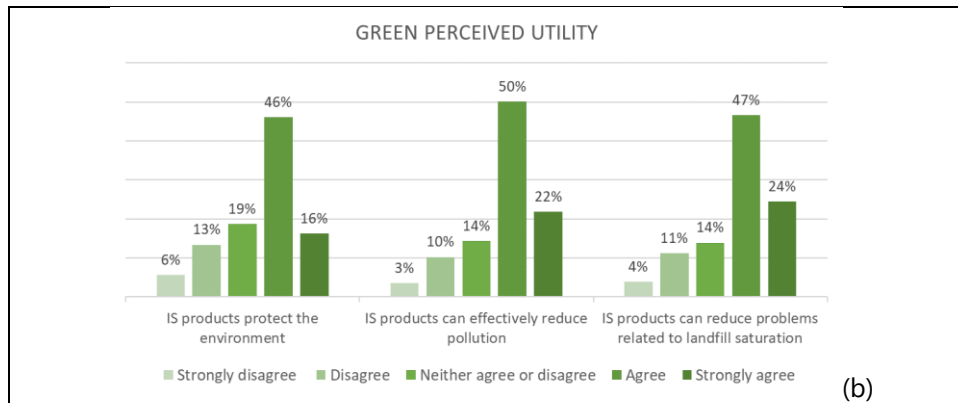


Figure 1. Results on green perceived utility for IS wood products (a) and IS plastic products (b).

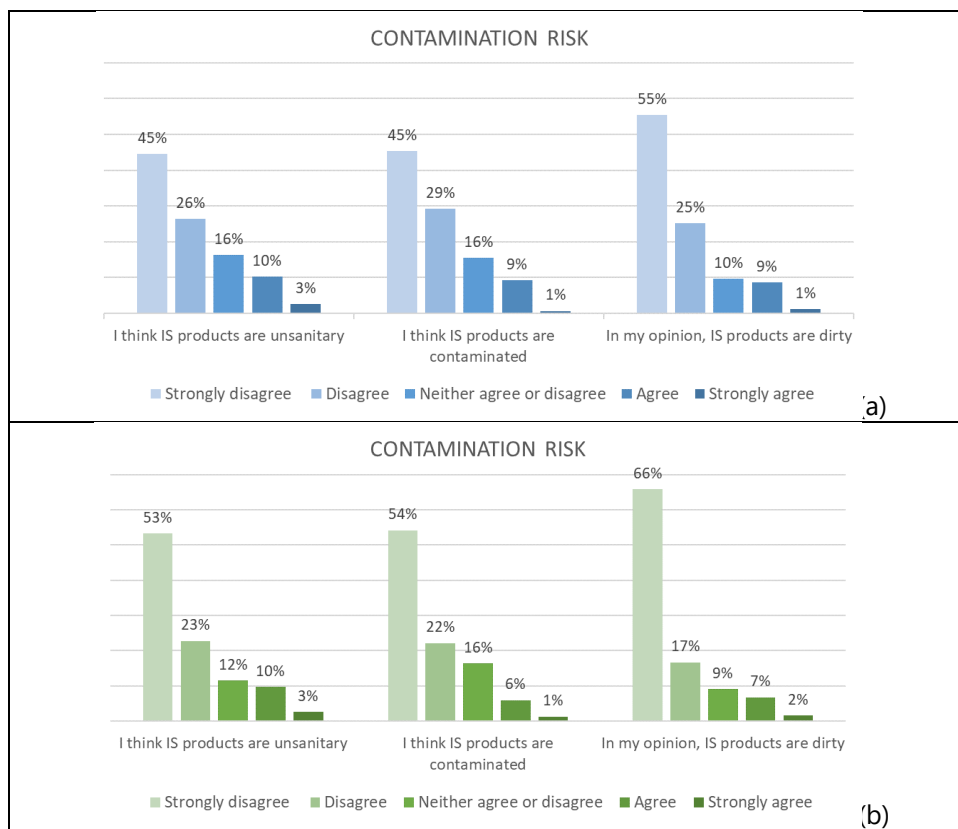


Figure 2. Results on contamination risk for IS wood products (a) and IS plastic products (b).

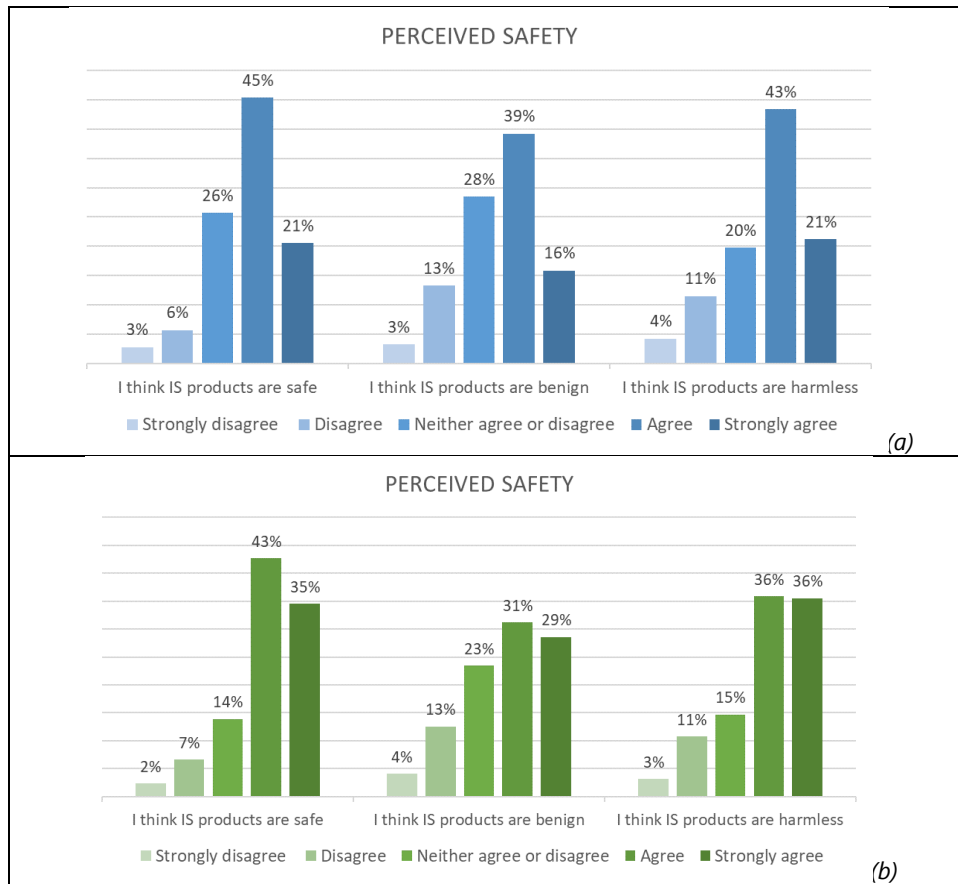
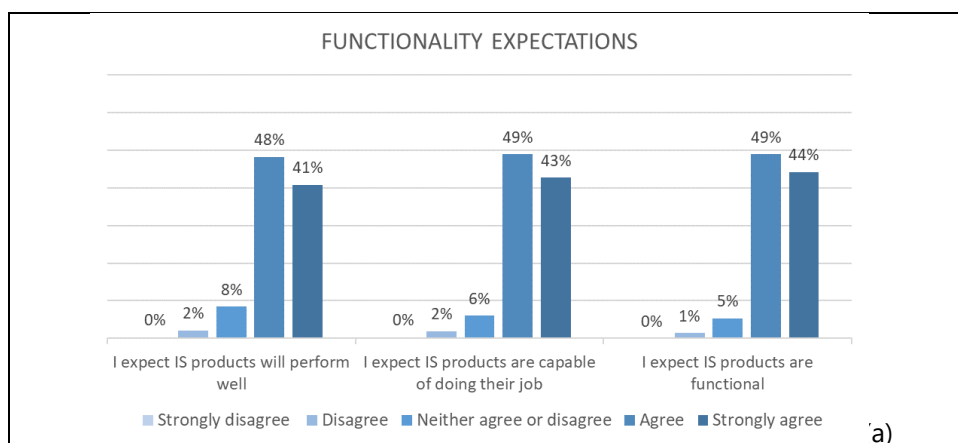


Figure 3. Results on perceived safety for IS wood products (a) and IS plastic products (b).



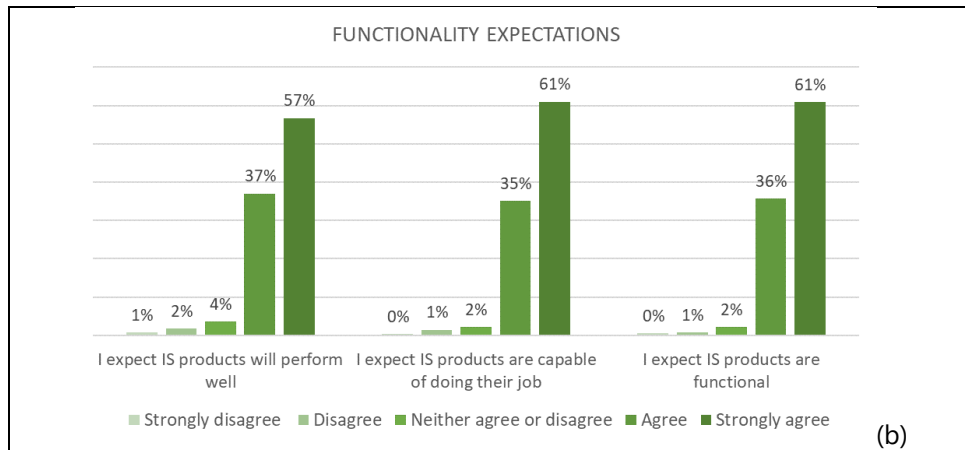


Figure 4. Results on functionality expectations for IS wood products (a) and IS plastic products (b).



Figure 5. Results on quality expectations for IS wood products (a) and IS plastic products (b).

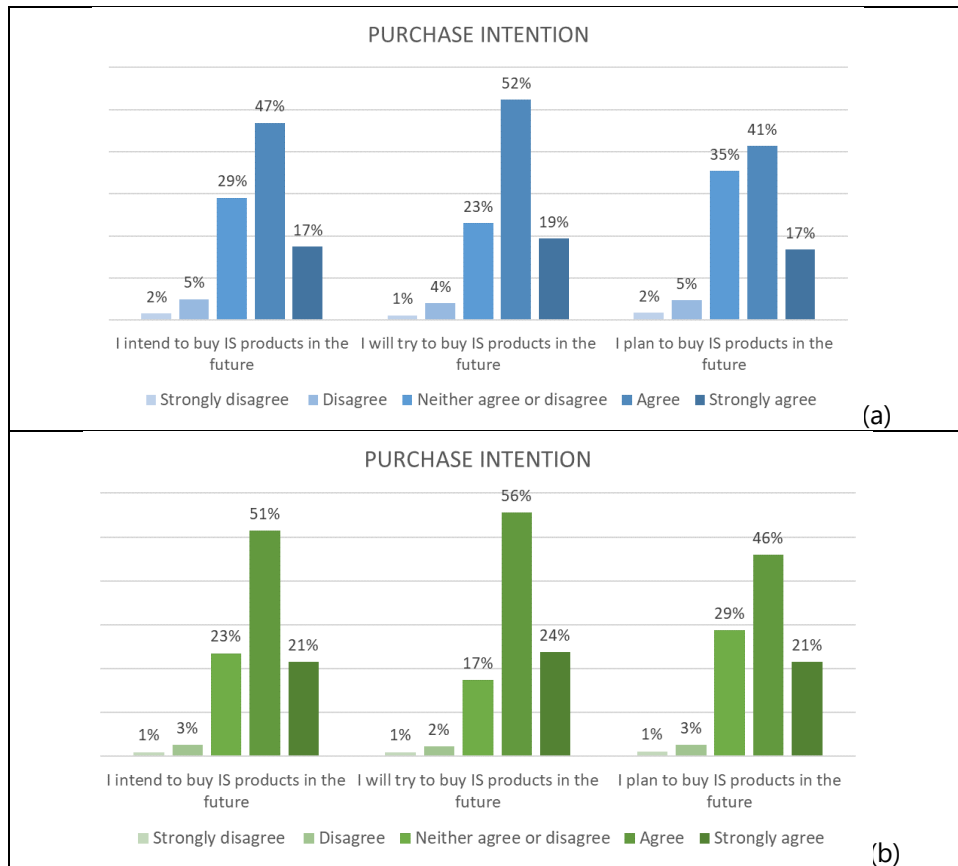
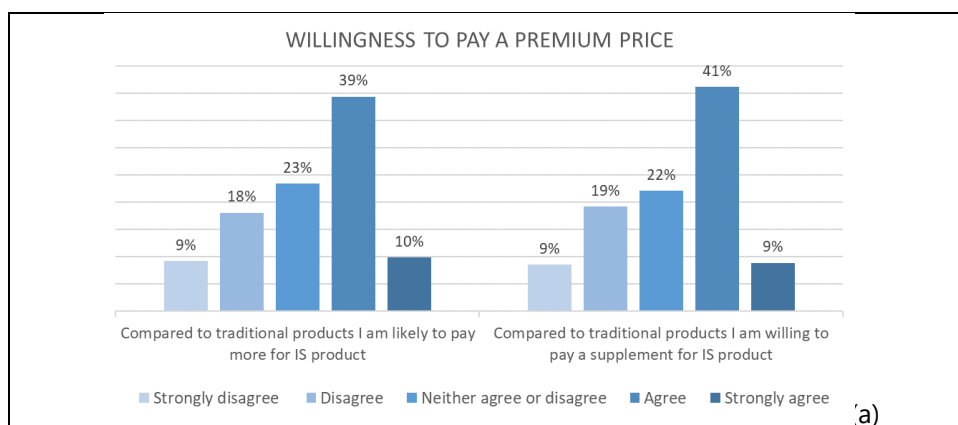


Figure 6. Results on purchase intention for IS wood products (a) and IS plastic products (b).



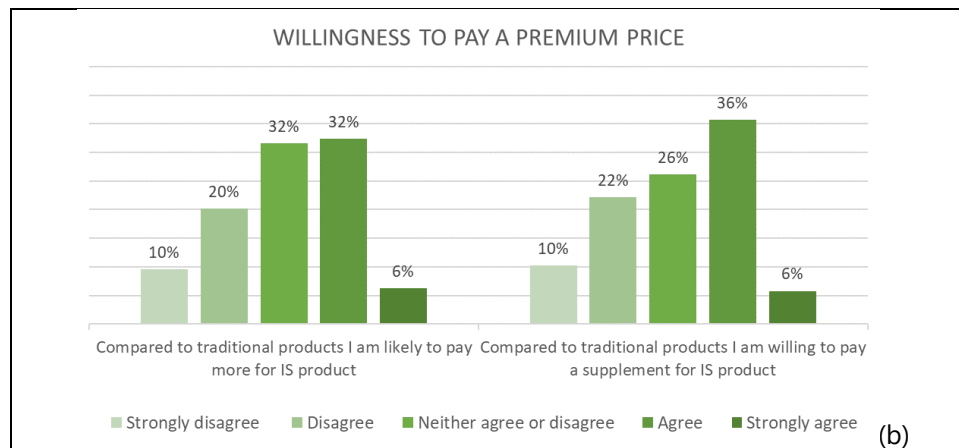


Figure 7. Results on willingness to pay for IS wood products (a) and IS plastic products (b).

## 5 Discussion and conclusion

This paper aims to analyze consumers' perception towards IS products, together with their purchase intention and willingness to pay a premium price for them. The theory of the decision-making process has been adopted, in order to study consumers' perception related to products with parts made of recycled wood or plastic (IS wood and plastic products), considering risks that might be perceived by consumers. Since the perceived risk is considered as a potential loss, it could have a negative impact on consumers' purchase intention and willingness to pay a premium price (Baxter et al., 2017; Featherman and Paul, 2003; White et al., 2015). In this paper, contamination and safety risks have been explored, together with the analysis of the performance risks and the study of the green perceived utility as a benefit.

In the literature, the existence of the perception of contamination has been demonstrated for several products. For instance, the packaging of a bottle of water is perceived as less shiny and clear (Laville and Taylor, 2017) or the recycled textile fiber is believed to have an unpleasant smell (Rucker, 2009). Nevertheless, this study shows that consumers do not perceive IS products as dangerous or dirty/unsanitary. Respondents also have good perceptions and very high expectations of the products' quality and functionality. This result is consistent with the results of Hamzaoui-Essoussi and Linton (2010) and Magnier et al. (2019).

Concerning the green perceived utility, respondents of this study believe that IS products can be useful and effective to protect the natural environment. This is an



important result because several studies demonstrate that the more consumers are concerned about the environment and aware of the utility of green products, the higher the likelihood they purchase them (Alhosseini Almodarresi et al., 2019; Choi and Kim, 2005; Kilbourne and Pickett, 2008; Laroche et al., 2001).

Results of this study show that consumers would like to purchase IS products and they would pay a premium price for them. According to the literature, consumers are more likely to purchase recycled products and are more willing to pay a premium price when they perceive a low risk of contamination or safety (Magnier et al., 2019; Michaud and Llerena, 2010), and when they have high quality and functionality expectations about the product (Baker and Crompton, 2000; Chang and Fong, 2010; Hamzaoui Essoussi and Linton, 2010; Magnier et al., 2019).

The results can be useful for companies and policymakers. Companies should take into account that, since consumers have good perceptions related to IS products and are willing to buy them, new markets for these products might exist. Hence, companies should devote attention to explore these new markets. In-depth research should be conducted on clustering (potential) customers of IS products. Since IS products can contribute to creating environmental benefits, policymakers could develop ad-hoc policies to support the development of IS products, such as incentives to companies producing them and customers buying them (Fraccascia et al., 2017; Tao et al., 2019).

Although this study considers several variables concerning risks and benefits related to IS production, it does not investigate the (potential) impact of these variables on the consumers' purchase intention of IS products, as well as the willingness to pay a premium price. Hence, future research is recommended to fill this gap.

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## Appendix

Table 2 - Scales with source, mean, and standard deviation for each type of product.

CONSTRUCTS AND ITEMS	Source	Mean wood	Mean plastic	Std dev wood	Std dev plastic
Green perceived utility					
These products protect the environment.	(Magnier et al., 2019; Chang, 2011)	3.57	3.54	1.08	1.09
These products can effectively reduce pollution.		3.73	3.77	1.00	1.02
These products can reduce problems related to landfill saturation	Self-developed	3.64	3.77	1.05	1.06
Contamination Risk					
I believe these products are unsanitary	(Magnier et al., 2019; Argo et al., 2006)	2.00	1.86	1.12	1.12
I think these products are contaminated		1.90	1.78	1.01	1.01
In my opinion, these products are dirty		1.75	1.62	1.02	1.01
Perceived Safety					
I think these products are safe	(Magnier et al., 2019)	3.75	4	0.94	0.98
I think these products are benign		3.51	3.68	1.01	1.14
I think these products are harmless		3.66	3.90	1.06	1.10
Quality Expectations					
Compared to traditional products, I expect the quality of these products to be: much lower, lower, equivalent, higher, much higher	(Boulding and Kirmani, 1993)	2.96	3.05	0.67	0.63
I expect the quality of these products to be: very low, low, acceptable, high, very high		3.51	3.62	0.70	0.67
Functionality Expectations					
I expect these products will perform well	(Magnier et al., 2019; Homburg et al., 2015)	4.27	4.47	0.73	0.73
I expect these products are capable of doing their job		4.32	4.45	0.70	0.65
I expect these products are functional		4.36	4.56	0.65	0.63
Willingness to pay a premium price					
Compared to traditional products I am likely to pay more for these products	(Magnier et al.,	3.23	3.06	1.14	1.08

Compared to traditional products I am willing to pay a supplement for these products	2019)	3.23	3.05	1.12	1.10
<b>Purchase intention</b>					
I intend to buy these products in the future.	(Bamberg, 2003, Gleim et al., 2013)	3.74	3.90	0.86	0.80
I will try to buy these products in the future		3.85	3.99	0.82	0.77
I plan to buy these products in the future		3.67	3.84	0.87	0.83

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## **The Impact of Food Waste Treatment Claims on Consumer Attitudes and Behavioural Intentions**

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### **Abstract**

Food waste is a global problem, affecting all areas of sustainability, that has already triggered various calls for actions via research, public, societal and private initiatives. The goal of this research was to analyse the impact of on-package food waste treatment claims on the consumer attitude and behavioural intentions toward the presented food company. A positive correlation between the communication of food waste measures and consumer attitude and behavioural intentions can motivate further activities against food waste.

A digital survey was structured and conducted with an online survey tool in order to measure the major constructs, regarding the attitude towards the company, the purchase

intention, and the willingness to pay premiums. All participants were first randomly presented a fictitious food product with a description about a food waste treatment claim and afterwards they completed the questionnaire. The answers of 256 participants have been analysed.

Food waste treatment claims were found to have a significant influence on the attitude towards the fictitious company in three out of four cases. The influence on the purchase intention was only measured to be significant in one case. On the contrary, we found a significant influence on the willingness to pay premiums for the products in all experimental conditions.

The results of this research demonstrated that descriptions, including the topic of food waste, can have a positive impact on consumers attitude and behavioural intentions. This offers empirical evidence that consumers see an additional benefit in buying products from companies that proactively engage in actions against food waste. Additionally, the coherence of sustainability strategies of companies was pointed out as a key element in creating competitive advantages.

**Keywords** – Food waste, food marketing, green consumerism, food waste strategies

**Paper type** – Academic Research Paper

## 1 Introduction

Food waste is a global problem that affects all of sustainability, generating negative environmental externalities (Campoy-Muñoz et al., 2017), with an annual global loss of three trillion dollars including social and environmental costs (Gustavsson et al., 2011). The issue of food waste has already triggered various calls for actions via research, public, societal and private initiatives (Aschemann-Witzel et al., 2017).

This study focuses on the processing and packaging stage of the food supply chain. Managers of food manufacturing companies apply different strategies to cope with food waste. The most common strategy is delivering potentially to-be-wasted food to non-profit organizations and food banks (Muriana, 2017). With consumers getting more aware of the impact of food production and consumption, as well as the climate change problem (Gadema & Oglethorpe, 2011), corporate social responsibility (CSR) has a crucial role in improving the reputation and trust among those consumers (Carroll & Shabana, 2010). CSR activities differentiate a company from the competition in the market (Vahdati et al., 2015), have the potential to influence consumer behaviour, and can lead to rewards from stakeholders (Hartmann, 2011).



To communicate CSR activities to consumers, companies mainly rely on the internet and the display in corporate reports (Wanderley et al., 2008). However, only a small segment of conscious consumers retrieves information from various sources to be highly informed about corporate activities. Other consumers rely on information at the point of sale (Walther et al., 2010). To reach their consumers at the moment of purchase (Chandon, 2013), companies can display information on food products depending on the type of packaging and label. It is an effective instrument to communicate with consumers (Stanton & Cook, 2019), can involve messages or claims (Biondi & Camanzi, 2020), and can lead to competitive advantages (Ballco et al., 2019). However, only a limited number of articles focus on the CSR information on packaged foods. One example is the study by Wei et al. (2018), which examines the effect of on-package CSR claims on the consumer perceptions of health benefits, taste, and attitude, as well as behavioural intentions toward the food company. Nevertheless, Willersinn et al. (2017) underline the importance of evaluating the perception of consumers towards food waste measures undertaken by companies.

Hartmann (2011) points out the lack of information for a clear answer on 'when, how and why' consumers are responding to CSR. Additional research is needed to better understand the impact of CSR information at the point of purchase on the food choice of consumers (Loose & Remaud, 2013).

The goal of this research is to analyse the impact of on-package food waste treatment claims on the consumer attitude and behavioural intentions toward the food company. Specifically, the following research question is investigated: To what extent do food waste treatment claims on packaged foods influence consumer behaviour? In this research, food waste treatment claims are statements on how companies deal with the issue of food waste. To answer the research question, the impact of food waste treatment claims on the consumer attitude toward the food company, the consumer purchase intention, and the willingness to pay a premium price for the product have been tested. To this aim, a survey has been conducted on 256 consumers between July and September 2020.

This research contributes to the academic literature in getting insights on consumer reactions towards the communication of several food waste measures, as well as to the academic literature on consumer insights by better understanding consumer perceptions of food waste measures.

Moreover, the practical contributions of this research help improving organizational decision making. Managers are expected to focus their environmental actions on areas where they can gain competitive advantage and base their strategies on solid justifications (Orsato, 2006). Richter and Bokelmann (2016) state that companies do not see the potential competitive advantage of differentiating themselves from the competition by food waste reduction in the production process. The findings of this study can help company managers to improve strategic decision making by analysing consumer perceptions and behaviours associated with corporate food waste activities.

## **2 Theoretical Framework**

### **2.1 Food waste**

Consumers have a large impact with their choices on the type of foods produced and the production methods, via supporting different products and brands (Grunert, 2011). Cecchini et al. (2018, p. 554) describe the post-modern consumer as driven by "more responsible and exigent buyer behaviour, increasingly providing attention to the 'mode of production' of food." In this study, the term "food waste" is used in compliance with the definition used by the High Level Panel of Experts (HLPE) on food security and nutrition (2014, p. 22): "Food loss and waste (FLW) refers to a decrease, at all stages of the food chain from harvest to consumption in mass, of food that was originally intended for human consumption, regardless of the cause."

### **2.2 Attitude towards the company**

The attitude of a consumer is the positive or negative feeling about an action in general and indicates the assessment of emotions and the interest or reluctance towards a specific idea or product (Kordnaeij et al., 2013). Therefore, attitude can be described as the cognitive and emotional overall assessment of a concept (Bem, 1970; Monirul & Han, 2012).

The spending patterns of many consumers show that they want brands to 'go green', believing in a better and healthier life for this and future generations (Yazdanifard & Mercy, 2011). If consumers can identify their own beliefs in the

actions of a company, this is expected to influence positive attitudes towards this company and resulting positive behaviours (Lech, 2013).

Regarding CSR, researchers already pointed out a positive relationship between the CSR initiatives and the attitude of consumers towards respective companies (Sen et al., 2006; Trudel & Cotte, 2009; Vahdati et al., 2015).

Based on these discussions, the following hypothesis was derived:

*H1. There is a positive relationship between food waste treatment claims on packaged foods and consumer attitudes towards the company.*

### **2.3 Purchase intention**

Prior studies had inconsistent findings regarding the relationship between CSR and financial outcomes for the companies. While some researchers found a weak or no relationship between CSR and financial outcome (Sen et al. 2006), others found the potential of proactive CSR - ethical and discretionary activities that exceed legal demands - to positively influence financial performance (Brown & Dacin, 1997; Kim, 2017). The study of Kim (2017) showed the positive intent of respondents to support and purchase from companies engaging in proactive CSR initiatives and Wei et al. (2018) stated a positive effect of on-product CSR claims on consumer purchase intentions.

Despite the inconsistent findings, CSR initiatives are expected to have the potential to change consumer buying behaviour, rewarding and/or punishing companies based on their responsible or irresponsible activities (Trudel & Cotte, 2009). Moreover, according to consumer inference-making theory, if a company is perceived as responsible by a customer, the positive inference of products or services are likely to lead to a purchase intention (Lech, 2013).

Vahdati et al. (2015) confirmed an indirect impact of CSR on consumer buying behaviour through the attitude towards the company in their study, while a direct impact of CSR on buying behaviour has been rejected. Empirical findings support the effect of attitude as a precursor to the formation of a corporate image, favourable behavioural intentions, and the establishment of relationships with stakeholders (Kim, 2017).

Based on these discussions, the following hypothesis was derived:

*H2. There is a positive relationship between food waste treatment claims on packaged foods and the consumers' purchase intention.*

## 2.4 Willingness to pay premiums

Today in western Europe, environmental-conscious consumers can actively transfer their beliefs through purchases of environmentally friendly products into corresponding actions reducing their environmental footprint (Moser, 2016). Even though White et al. (2012) showed that consumer purchasing behaviour does not have to correspond with positive attitudes towards certain food products, a positive willingness to pay for products with environmental, social, and ethical certifications has been approved in several studies (Cecchini et al., 2018; Loose & Remaud, 2013).

The results of Cecchini et al. (2018) point out that consumers are willing to pay a premium price (between 13 and 50%) for products with an environmental certification compared to similar products without such certification. Several studies pointed out an increased willingness to pay of consumers regarding CSR claims, sustainability labels or waste prevention labelling on food products (Del Giudice et al., 2016; Sammer and Wüstenhagen, 2006; Wei et al., 2018).

Based on these discussions, the following hypothesis was derived:

*H3. There is a positive relationship between food waste treatment claims on packaged foods and the willingness to pay a premium price for the product.*

Figure 1 shows the conceptual framework considered in the paper.

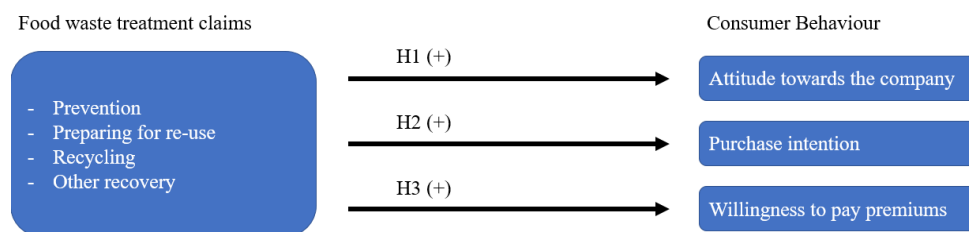


Figure 8 Conceptual framework

## 3 Methodology

This research was conducted via a structured survey distributed via online channels and online survey communities. The participants were randomly assigned to a questionnaire including a fictitious food product with a description about a food waste treatment claim out of one of the four management options

'prevention', 'preparing for re-use', 'recycling', and 'other recovery'. The description for the control group did not include a food waste treatment claim. The questionnaire is presented in Section 3.2. To formulate the food waste treatment claims, a pilot study was conducted, presented in Section 3.1.

### **3.1 Pilot study**

The waste hierarchy was applied for the pilot study in order to select a diverse set of strategies for treating food waste.<sup>1</sup> The participants were asked to rank different strategies out of the management options, according to how they would want a food manufacturing company to prioritize their actions against food waste. Additionally, participants were asked to list their five most frequently bought packaged groceries. This grocery was then used in the final questionnaire to present a fictitious food package with a fictitious company name and a randomly assigned food waste treatment claim. For the control group, a typical consumer service information was included instead of the food waste treatment claim.

The data of 52 participants of the pilot study was further analysed. The strategy out of the management option 'prevention' that was ranked highest was: "Preventing food waste through the application of eco-design (the systematic integration of environmental aspects into product design with the aim to improve the environmental performance of the product throughout its whole life cycle)." Out of the management option 'preparing for re-use', participants wanted food manufacturing companies to focus on: "Redistribution to people, re-using surplus food for human consumption for people affected by food poverty, through redistribution networks and food banks, or donations made to non-profit organizations." The strategy of the management option 'recycling' that was ranked highest was: "Recycling food waste by reprocessing food for human consumption (for example, making food products out of food waste)." These three strategies were further included in the final questionnaire.

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<sup>1</sup> Strategies to tackle the issue of food waste are numerous. The food waste hierarchy was used in this research to select a diverse set of strategies for treating food waste as a food manufacturing company. One strategy out of each management option was selected for the final questionnaire to consider strategies that have a low similarity. Strategies referring to the management option 'disposal' were not considered as disposal represents the least desirable management option, since the biodegradable organic material of the food waste does not return to its original state (Fehr et al., 2002) and is therefore solely wasted.

The strategies found for 'other recovery' in academic literature were mostly focused on recovering energy from food waste (for example, through generating biofuel and bioenergy from food waste). Therefore, the food waste treatment claim about 'other recovery' was formulated accordingly.

Regarding the most frequently bought packaged groceries, the most stated grocery was "pasta" with 20 mentions followed by "cheese" (17 mentions). The food product "pasta" was included in the final questionnaire.

### **3.2 Questionnaire**

The aim of the questionnaire is to test the hypothesis regarding the three factors of 'attitude towards the company', 'purchase intention', and 'willingness to pay premiums'.

To present the food waste treatment claims, a fictitious food package was designed under the name "Pastolli", which is shown in Figure 2. The picture presented was the same in all versions of the questionnaire, only the description shown below all pictures were changed.



*Figure 9 Fictitious food product "Pastolli"*

To ensure comparability between the descriptions of the strategies for treating food waste in the questionnaire, they were all formulated following the same

structure. All strategies are based on the findings of the pilot study and formulated as CSR claims, as presented in Table 1. For the control group, a general description of the ingredients and the description of how to prepare the pasta was presented, formulated based on existing food product descriptions.

Table 6 Food waste treatment claims

Management option	Description used in the questionnaire
<i>Prevention</i>	<p><u>Pastolli</u></p> <p>Food waste is a global problem that affects all of us, generating high costs, negative environmental effects, as well as major social problems.</p> <p>At Pastolli, we minimize our food waste through the application of eco-design. This way, we design our products ecologically and directly integrate environmental aspects. Our aim is to improve the environmental performance of our products throughout its whole life cycle. We make our products more efficient, use fewer resources and generate less waste and emissions.</p> <p>Thank you for supporting our actions by choosing our products.</p>
<i>Preparing for re-use</i>	<p><u>Pastolli</u></p> <p>Food waste is a global problem that affects all of us, generating high costs, negative environmental effects, as well as major social problems.</p> <p>At Pastolli, surplus food does not go to waste. We redistribute our surplus food to people affected by food poverty, through redistribution networks and food banks, or donations made directly to non-profit organizations.</p> <p>Thank you for supporting our actions by choosing our products.</p>
<i>Recycling</i>	<p><u>Pastolli</u></p> <p>Food waste is a global problem that affects all of us, generating high costs, negative environmental effects, as well as major social problems.</p> <p>At Pastolli, surplus food does not go to waste. We reprocess our surplus food for human consumption. With our circular approach, we transform wastes or surplus ingredients, obtained during the manufacturing of other foods, into new food products under our high-quality standards. This way, we decrease the amount of food waste generated and improve our environmental performance.</p> <p>Thank you for supporting our actions by choosing our products.</p>

Management option	Description used in the questionnaire
<i>Other recovery</i>	<p><u>Pastolli</u></p> <p>Food waste is a global problem that affects all of us, generating high costs, negative environmental effects, as well as major social problems.</p> <p>At Pastolli, surplus food does not go to waste. We turn it into energy! The food waste gets treated in order to produce biofuel and bioenergy from it. Residues from biofuels production can be further used as soil fertilizers.</p> <p>Thank you for supporting our actions by choosing our products.</p>
<i>Control Group</i>	<p><u>Pastolli</u></p> <p>Pastolli spaghetti are made from durum wheat semolina from controlled production.</p> <p>To prepare the spaghetti, boil 80g per portion in 1 litre of boiling, slightly salted water (1 teaspoon = 5g of salt per 1 litre of water). After about 7 minutes, pour the spaghetti into a sieve and let it drain. Now just put it on a plate and serve with the sauce of your choice. Bon appetite!</p>

In the main part of the questionnaire, the participants were asked several questions to test the hypotheses. To assess the attitude toward the food company, three items from Kozup et al. (2003) were measured using a five-point Likert scale. The purchase intention was also assessed using three items from Kozup et al. (2003). The willingness to pay premiums was assessed using three items from Perrini et al. (2010) into the questionnaire. All items were previously included in a questionnaire by Wei et al. (2018) in a related field. Participants were asked to indicate the ease of understanding of the food waste treatment claim, using one item previously applied by Wei et al. (2018). All items were modified in wording or characteristics of the Likert-scale, to fit this research.

### 3.3 Analysis

To analyse the effects of the different food waste treatment claims on the "attitude towards the company", "purchase intention" and "willingness to pay premiums" of the participants, the method of Univariate Analysis of Covariance (ANCOVA) was conducted. To show direct comparisons between the groups, the Bonferroni post-hoc test was applied.



The factor analysis was used to uncover the underlying structure of the analysed concepts and the covariates. The internal reliability was then evaluated by calculating the Cronbach's alpha coefficient for each factor.

In the analysis, next to the demographic information (such as gender, age, ethnicity, income, and education), - following Wei et al. (2018) and based on prior studies by Raju et al. (2015), Chandon and Wansink (2007), Irmak et al. (2011) and Creyer (1997) - subjective nutrition knowledge, the nutrition involvement, diet restraint behaviour, the perception of the importance of a firm's CSR activities and the liking of food were used as covariates to incorporate their potential influence on the variables of interest and test the impact of food waste treatment claims.

## 4 Results

Participants were asked to indicate the ease of understanding of the respective description that was shown for each of the groups on a scale from 1 ("Very difficult") to 5 ("Very easy"). The highest mean indicating the understandability was calculated for the description of 'preparing for re-use' (mean=4,04), followed by 'other recovery' (mean=3,60), 'recycling' (mean=3,48), and 'prevention' (mean=3,35). The control group, which only included a basic product description and no food waste treatment claim, was the easiest for participants to understand (mean=4,09).

### 4.1 Demographics

The gender distribution was almost equal, with a total of 134 female and 122 male participants. The most important demographics measured can be seen in Table 2.

Table 7 Demographics

Measured value	Frequency	Percent
Age: Younger than 18	7	2,7
Age: Between 18 and 24	69	27,0
Age: Between 25 and 34	128	50,0
Age: Between 35 and 44	14	5,5

Age: Between 45 and 64	34	13,3
Age: 65 or older	4	1,6
Country of residency: Germany	217	84,8
Region of residency: DACH	235	91,8
Net income: < 1,000€	95	37,1
Net income: €1,000 - €1,500	51	19,9
Net income: €1,500 - €2,000	29	11,3
Net income: €2,000 - €2,500	24	9,4
Net income: €2,500 - €3,000	16	6,3
Net income: over €3,000	41	16,0
Profession: Students	116	45,3
Profession: Workers or employees	118	46,1
Highest obtained school leaving certificate: University of applied sciences degrees, degrees from universities or scientific colleges	171	66,8

## 4.2 Covariates

The covariates used in the questionnaire were all previously applied by other researchers and modified to fit this research. For assessing whether the modifications changed the functionality of the scales, the items were tested by means of exploratory factor analysis.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy ( $KMO=.824$ ) and the Bartlett test ( $\text{Chi-square}(190)=2316,384$ ,  $p<.001$ ) indicated that the variables are suitable for factor analysis. The principal component analysis with Varimax rotation was performed and the loadings of the different factors were in accordance with the previous studies. Cronbach's Alpha was further calculated for all covariates and was above 0,8 for all factors.

All covariates were further included in the Univariate Analysis of Covariance (ANCOVA) and the two-way ANOVA to test the four hypotheses.

### **4.3 Hypotheses testing**

The items used in the questionnaire to measure the attitude towards the company, consumer purchase intentions, and the willingness to pay premiums, were all taken from studies by Kozup et al. (2003), Perrini et al. (2010) and Wei et al. (2018) and modified to fit this research.

An exploratory factor analysis and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy ( $KMO=.887$ ) and the Bartlett test (Chi-square (36) = 1580,739,  $p < .001$ ) indicated that the variables were suitable for factor analysis and the principal component analysis with Varimax rotation confirmed the factors in accordance with previous studies. The means of the four different groups with food waste treatment claims were always higher than the corresponding mean of the control group.

#### **4.3.1 Testing hypothesis 1: Attitude towards the company**

The first hypothesis was "There is a positive relationship between food waste treatment claims on packaged foods and consumer attitudes towards the company." The Cronbach's alpha coefficient indicated an internal reliability of 0,865.

The result of the ANCOVA showed a statistically significant difference between the groups in the test of between-subject effects after controlling for the included covariates.

Pairwise comparisons between the groups regarding 'attitude towards the company' pointed out a significant difference at the 0,05 level in the means of the control group and the group 'preparing for re-use', between the control group and the group 'recycling' and between the control group and the group 'other recovery'.

The positive relationship between food waste treatment claims on packaged foods and consumer attitudes towards the company was confirmed for the claims of three out of the four groups, except for the claim presented for the group 'preparing for re-use'. H1 was partially confirmed.

#### **4.3.2 Testing hypothesis 2: Purchase intention**

The second hypothesis was formulated as follows: "There is a positive relationship between food waste treatment claims on packaged foods and the

consumers' purchase intention." The internal reliability of the factor was tested using Cronbach's alpha coefficient, with a result of 0,862.

The ANCOVA showed a statistically significant difference between the groups in the test of between-subject effects after controlling for the included covariates.

The results for the comparisons between the groups with regard to 'purchase intention' pointed out a significant difference at the 0,05 level in the means of the control group and the group 'preparing for re-use'.

With only one out four food waste treatment claims resulting in a significant difference between the control group, H2 was rejected.

#### *4.3.3 Testing hypothesis 3: Willingness to pay premiums*

The third hypothesis was: "There is a positive relationship between food waste treatment claims on packaged foods and the willingness to pay a premium price for the product." The internal reliability of the factor was tested using Cronbach's alpha coefficient (Cronbach's alpha=0,896).

The factor 'willingness to pay premiums' met the homogeneity of variances assumption and was tested for normality with two tests and confirmed a normal distribution of the data.

While all calculated means decreased, comparing the means per group for the variables of 'purchase intention' and 'willingness to pay premiums', the means of the control group decreased most drastically for the dependent variable 'willingness to pay premiums'.

The result of the ANCOVA showed a statistically significant difference between the groups in the test of between-subject effects after controlling for the included covariates.

The pairwise comparisons between the groups regarding the variable of 'willingness to pay premiums', pointed out a significant difference at the 0,05 level in the means of the control group and the groups 'prevention', 'preparing for re-use', 'recycling' and 'other recovery'. Therefore, H3 was confirmed.

## **5 Discussion**

The global problem of food waste needs to be addressed simultaneously at all stages of the food supply chain. Increasing the understanding of the influences on consumer attitudes and behavioural intentions through the communication of

food waste measures was the goal of this study, wherefore three hypotheses were analysed.

### **5.1 Attitude towards the company**

The first hypothesis was formulated to analyse the impact of on-packaging food waste treatment claims on the attitude towards the company of the consumers.

Pairwise comparisons pointed out a significant difference between the control group and all groups except the group 'prevention'. This might have been impacted by the lower ease of understanding for the description of the group 'prevention'. With the lowest mean out of the four groups with food waste treatment claims, participants might have had struggles understanding the impact of the described solution and its impact on food waste.

The highest difference in means was measured between the control group and the group 'preparing for re-use'. It was again in line with the results of the ease of understanding. This was a very interesting finding, as a direct influence of the understandability of the claims on the level of influences was not mentioned in any of the cited literature but turned out to match the findings of this research.

With a significant influence of on-packaging food waste treatment claims on the attitude towards the company, the hypothesis was partially confirmed, and held true for statements regarding 'preparing for re-use', 'recycling' and 'other recovery'. The findings of this research are in line with prior studies by Sen et al. (2006), Trudel and Cotte (2009) and Vahdati et al. (2015), who pointed out the positive impact of various dimensions of CSR on the attitude of consumers. In their study, Vahdati et al. (2015) included social, environmental and moral aspects into CSR and approved the impact on the consumer attitude. The results of this research demonstrate that a distinction between different food waste treatment claims is crucial; accordingly, communication must be targeted to consumer groups and the topic of food waste cannot be generalized.

### **5.2 Purchase intention**

Prior studies have analysed and approved the influence of the attitude of consumers on their desires, intentions, and behaviour (Trudel & Cotte, 2009). Therefore, with a partially confirmed hypothesis about the influence of food waste

treatment claims on consumer attitudes, this was further expected to influence the behaviour of the consumers.

In the pairwise comparisons, the significant difference between the control group and the group 'preparing for re-use' was demonstrated as the only significant difference.

The level of purchase intention for the control group indicated a general buying intention of the participants, which can be a result of appealing packaging design or a tendency to give generally more positive answers. As a result, the differences between most groups with food waste treatment claims were not significant. The hypothesis of food waste treatment claims, in general, having a positive influence on the purchase behaviour of participants was rejected, but was approved for the group 'preparing for re-use'. In the study by Vahdati et al. (2015), a distinction between the direct and indirect impact of CSR on buying behaviour led to the approval only of the indirect impact through the attitude towards the company, which was also indicated in the results of this work. Other empirical studies by Jaafar et al. (2012), Kim (2017), and Trudel and Cotte (2011) underline the effect of the attitude towards a company as a precursor of behavioural intentions, such as purchase intention.

Jaafar et al. (2012) stated that to change the behaviour of consumers, the attitude should be changed first. Therefore, the analysed positive impact of food waste treatment claims on the attitude towards the company can have an impact on consumer buying behaviour in the future.

### **5.3 Willingness to pay premiums**

A comparison of the measured means for 'willingness to pay premiums' distinguished by groups showed a large difference to the means for purchase intention. According to the results of this research, participants in the control group were not willing to pay premiums for the presented food product, participants in the group 'prevention' were neither more nor less willing to pay premiums and the three other groups with food waste treatment claims were on average willing to pay premiums.

A significant difference between all groups with descriptions about food waste measures and the control group was presented in the results. These results indicated that participants in the control group did not see a benefit in paying more for this product compared to similar products. The presence of food waste

treatment claims in the description from all four groups significantly increased the willingness to pay of participants and showed the opinion of consumers that companies tackling the issue of food waste are worthy of financial support. This finding is in line with the work by Wei et al. (2018), where they approved the significant impact of on-package CSR claims on the willingness to pay premiums of consumers. This gave an indication that food waste treatment claims also might have a stronger impact on the general purchase intention of consumers as measured in this research, as the significant impact on the willingness to pay premiums for a product incorporates a preceding purchase intention.

## **6 Conclusion**

The aim of this study was to deepen the understanding of communicating measures taken by food manufacturing companies against the issue of food waste, on food packaging and how this influences the consumers at the point of sale.

Following the questionnaire, one issue arose from the feedback of participants. The packaging used for the fictitious food product in the questionnaire was, based on the looks on the picture, made from plastic, with no further information provided. Even though the issue of food waste was important for these participants, the plastic packaging of the presented food product was not appealing which negatively affected the answers given regarding the studied factors. Kotler and Keller (2006) indicated the importance of consistency to create and support a brand value that customers associate with a company. It has to be based on thoughts, feelings, images and beliefs that are in line with each other in order to achieve competitive advantages (Kotler & Keller, 2006). The results of this research might have been even more significant if the image of the fictitious food product would have complied with state-of-the-art eco-friendly food packaging.

One important aspect of this research that has to be taken into consideration is the applicability and the degree of sustainability of the different presented strategies. The participants of this survey were at no point informed about the degree of environmental sustainability of the presented measure against food waste. Moreover, not all solutions are always applicable for all companies.

The findings of this research can also lead to another sustainable impact. Consumers are responsible for the highest amount of food losses in the food

supply chain (Scherhauser et al., 2012). Food recovery at this stage could result in a worthless activity, as the food is highly spread across households with little quantity, which makes a recovery economically unfeasible (Muriana, 2017). Increasing the communication of the importance of the topic of food waste might have an educational impact on consumers. Most of the food waste at the domestic level is avoidable (Beretta et al., 2013) and creating awareness of food waste is a prerequisite for tackling this issue (Aschemann-Witzel et al., 2015).

The results of this study demonstrated the potential of the communication of actions against food waste to consumers, to positively influence consumer attitudes towards the company and behavioural intentions. Companies can create competitive advantages from tackling the issue of food waste and communicating their efforts to consumers. Rundh (2009) argues that companies should include customers in developing successful packaging designs, in order to result in an increased purchase intention and reinforcement of the brand name, for which this study can serve as a basis.

The finding of the measure of food donations as the food waste measure with the most significant impacts on the variables is in line with current food waste treatment measures of food manufacturing companies (Muriana, 2017).

To the best of our knowledge, there is a lack of research on consumer perceptions of food waste activities of food manufacturing companies. Most of the academic research focuses on the relationship between consumer perceptions and activities of retailers (Aschemann-Witzel et al., 2015; Hermsdorf et al., 2017; Topolansky Barbe et al., 2017).

Only a limited number of strategies for food waste treatment were taken into consideration for this research. Significant differences between the strategies were identified in this research, which underlines the importance of distinction between the various strategies and points out the need for future research regarding other strategies.

The selection of the food product pasta was based on a limited number of participants and only represented one type of food. Future research is needed to understand the role of the food product on the findings.

For future studies, also personal interviews, especially at the point of sale, would be of high relevance to understand the underlying reasoning. This could result in a better understanding of consumer behaviour regarding the information on food packaging, as this research was based on the assumption that consumers would read the whole description on a food package.



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## **An Empirical Investigation of the Enablers for Circular Economy Business Models in the Agri-Food Sector**

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### **Abstract**

The concept of circular economy has recently gained prominence in the management research and the adoption of circular economy principles in companies has highlighted peculiar managerial practices that can be implemented in their business models. Existing research still falls short to describe in sufficient detail the enablers of these practices for a circular business model design. This issue is particularly interesting in the agri-food sector, and especially in rural areas, characterized by enormous sustainability challenges, including food production and waste, food packaging, transportation, consumer habits and behavior. The paper takes stock of this gap through the analysis of the enablers of managerial practices in a company that has designed its own circular business model and operating in the agri-food sector of a rural area. The case reveals interesting evidence in terms of relationships between enablers, managerial practices, and circular economy outcomes.

**Keywords** – Circular Economy, Enablers, Business Model, Agri-food

**Paper type** – Academic Research Paper

## 1 Introduction

The field of circular business models has recently emerged as a new one within the broader circular economy literature (Centobelli et al., 2020; Linder & Williander, 2017; Baldassare et al., 2017), with the aim to deepen the managerial practices that companies can implement in their business model to transform their linear business into a circular one (Bocken et al., 2019). Managerial practices represent the way top management, usually in charge of defining and modifying over time the strategy of the company, makes the transition to a new, circular, business model (Ünal et al., 2019). In the case of circular economy adoption in business models, for example, managerial practices can be related to the way companies use energy, materials, and resources, as well as how they reduce the environmental impacts of their activities. At the same time, companies can be required to maintain the properties of products, as well as of their components, while customers acting “mostly” as users, thus managerial practices can be related to the re-use or re-manufacturing of resources, as well as to maintenance activities (Tukker, 2015; Tukker & Tischner, 2006).

Although several studies have proliferated in the last years to deepen the transition of companies’ business model from linear to circular (Pieroni et al., 2019; Lüdeke-Freund et al., 2019; Garza-Reyes et al., 2019), much more theoretical and empirical effort is however needed to analyze what are the enablers of managerial practices for a circular business model design (Hussain & Malik, 2020; Ranta et al., 2018), intended as those factors that enable and encourage the implementation of circular economy-driven managerial practices in companies’ business model (Panwar & Niesten, 2020; De Jesus & Mendonça, 2018; European Commission, 2015). In this paper, we take stock of the research on the enablers and go into the detail of the factors that allow companies to implement managerial practices for circular economy adoption in their business model (Urbinati et al., 2021; Hussain & Malik, 2020).

The design of circular business models is particularly interesting to analyze from the point of view of the agri-food sector that is characterized by enormous sustainability and circular economy challenges, including food production and waste, food packaging, transportation, consumer habits, and behaviour (Testa et al., 2020). The relevance of the circular economy transition into the agri-food sector is due to the complexity characterizing this sector in terms of larger and differentiated nature of productions, the challenges of the deterioration and

shelf-life, the impact of weather and geographical condition, the need to guarantying safety and quality to the consumers, the commoditization of the productions (Lehmann et al., 2012). The focus on the agri-food industry is also relevant for what concerns the harmonization of development patterns between urban and rural areas, and it assumes a challenging meaning for this last one, where the primary sector plays a more critical role in terms of employment, infrastructures, market sophistication, and research orientation (Eurostat, 2021; Nicolosi et al., 2021).

Accordingly, a research avenue lies in the research stream of circular business models in the agri-food industry of a rural area, to better understand the enablers that allow agri-food companies in a such context to adopt circular economy principles in their business model (Barth et al., 2017). However, the debate on the enablers of managerial practices for a circular business model design in this sector of activity is still in its infancy and much more effort is required from a theoretical and a managerial perspective. To address this research gap, we leverage a single case study analysis of Fiusis, an innovative Italian company operating in the field of the energy production for agri-food systems and located in a small Apulian town in the South of Italy and awarded in 2019 as “the best business model in the rural area” by the European Commission.

The paper is organized as follows. After the Introduction, Section 2 presents the conceptual development of our study, i.e., a review of the existing research at the intersection between circular business models and the agri-food sector. Then, whereas Section 3 highlights the rationale of the methodology we used for the research, Section 4 points out the main results deriving from the empirical analysis. Finally, Section 5 summarizes the concluding remarks, including the main implications and limitations of the paper, as well as some avenues for future research.

## **2 Literature Background**

### ***2.1 Circular Economy Business Models: enablers of managerial practice***

Circular economy is an innovative industrial approach that has gained importance in the last decades, as the traditional “take, make, dispose”, linear, economic model, has become unable to manage the demand and supply balance in consumption of natural resources (Goyal et al., 2018). According to Mathews et

al. (2011), circular economy can be defined as a closed-loop system, characterized by (i) the reduction of the consumption of non-renewable sources and non-environmentally friendly raw materials; (ii) the reuse of the products and services, which have been specially designed for being reused; and (iii) the recycling of the waste products into new resources for further use and consumption in the same or other supply chains.

From a micro-level perspective, circular economy requires companies to reflect on changing their traditional business model into a new, circular, one, by significantly rethinking the anatomy of their business model, as well as their supply chain and supply chain's collaborations, and strategic positioning (Lüdeke-Freund et al., 2019; Choi, et al., 2018; Schoenherr & Talluri, 2012). In addition, as far as the value transfer is concerned, companies may leverage peculiar practices to share and promote their circular value proposition, such as a direct involvement of clients and customers in their activities or an extensive communication through different channels, such as in-store advertising, website, and sales personnel (Shao & Ünal, 2019; Linder & Williander, 2017). Again, relevant practices that could be adopted by companies for value capture, i.e., for gathering the value generated and converting it into revenues streams, cost savings and value preservation, are represented both by the pay-as-a-service mechanisms (Tukker, 2015; Williams, 2007), and the take-back systems or product-service systems (PSSs) (Kjaer et al., 2019).

While analyzing the managerial practices for a circular business model design, existing research has also paid the attention to the factors that can enable and encourage the implementation of these practices for the circular economy adoption in companies' business model (De Jesus & Mendonça, 2018; European Commission, 2015). Several enablers have been identified in the existing research that seem particularly promising, such as supply chain interactions (Albino et al., 2016), business model innovation (Antikainen & Valkokari, 2016), (green) technological innovations (Dangelico, 2016), values & culture, governmental policies (van Keulen & Kirchherr, 2021), and servitization & platformization (Konietzko et al., 2020; Ciulli et al., 2020), i.e., how firms can organize social and economic interactions through online platforms to achieve greater circularity, for example through dedicated sharing platforms (Fraccascia, 2020). Such enablers can support the design of circular business models in terms of, for example, supply chain contracts for reverse logistics and closed-loop supply chains (Govindan et al., 2015; Savaskan et al., 2004), industrial symbiosis (Chertow, 2000),



design for disassembly and recyclability (Boothroyd, 1994; Kuo et al., 2001), green product design and environmental innovation (Baumann et al., 2002), and innovation ecosystems (Del Vecchio, et al. 2020).

## ***2.2. Circular Economy in agri-food industry: challenges and opportunities***

Although the interesting research in the field of circular business models (Urbinati et al., 2017; Hussain & Malik, 2020; Ranta & Saari, 2019; Ranta et al., 2018), however, only limited progress has been accomplished so far regarding the enablers of managerial practices in circular business models in the agri-food sector, and especially in contexts of rural areas. Again, even though a high number of guidelines for governments and policymakers as enablers of circular economy are currently available (e.g., Ellen MacArthur Foundation, 2015), existing research still falls short to provide a systemic direction of how the enablers of managerial practices for a circular business model design can support companies into this aim and especially in rural areas (Lahane et al., 2020). Therefore, the aim of this paper is to increase knowledge and understanding about the enablers of circular economy-driven managerial practices experienced by agri-food companies in rural areas when adopting circular economy principles at the core of their business model.

In the agri-food sector, circular business models can play an important role both for decision makers and companies in supporting, the former, to develop new sustainable strategies and, the latter, to conduct their business responsibly (Muscio & Sisto, 2020). The relevance of the agri-food industry into the debate on sustainable growth and circular economy has been recently highlighted by several studies in terms of contribution to the preservation and enhancement of natural capital (Ciccullo et al., 2021; Pagotto & Halog, 2016). The transition of the agri-food sector towards the paradigm of circular economy has been enhanced by the larger adoption of advanced technologies, customer centric strategic approaches, as well as by the need to make sustainable the supply chains (Kumar et al., 2021) and it is recognized as a concrete opportunity for addressing the patterns of sustainable development in the rural areas as well as for the harmonisation and the reduction of the development gaps between urban and rural areas (Eurostat, 2021; Nicolosi et al., 2021). Furthermore, as argued by Jurgilevich et al. (2016), the food sector is characterized by growing population and increased demand for food, inefficient use of food resources and food distribution, and high levels of

wasted food. Especially in the agri-food sector, the main issues to be solved are related to reducing food waste and emissions in food production, including greenhouse gas emissions, recycling of food packaging materials and plastic, and cascading use of food products, including the use of fertilizing products, using them as inputs of new products (Cingiz & Wesseler, 2019; Borrello et al., 2017). In a recent study on circular economy in agricultural waste, Donner et al. (2021) have identified a critical set of success and risk factors that may support the design of circular business models for companies in the agri-food industry. These factors consist in technology and logistics, economic, financial, marketing, and organizational setting, institutional and legal frameworks, environmental, social, and cultural features. All these factors assume a more critical configuration in the context of rural areas, where the primary sector plays a more critical role in terms of employment, infrastructures, market sophistication, and research orientation (Eurostat, 2021; Nicolosi et al., 2021). In this context, the effectiveness of a circular economy adoption is largely depending by several features, including the cross-sectorial dependencies and intersections, the institutions and the larger community of stakeholders populating the area.

### **3. Methodology**

The paper adopts the methodology of a single case study as suitable investigative methodological approach for the analysis of a contemporary phenomenon in its natural setting (Yin, 1994, 2003), by leveraging on collection of data from various types of multiple sources (Eisenhardt, 1989). Consistently with the qualitative research approach described by Strauss and Corbin (1990) and Yin (1994, 2003), case study methodology has been preferred since the boundaries between the phenomenon and the context are not clear (Glaser and Strauss, 1967; Miles and Huberman, 1984).

The empirical context of the research has been identified on Fiusis, an innovative small Italian company operating in the field of the energy production in the agri-food sector and located in Calimera, a small Apulian town, in the South of Italy. The company counts 6 permanent employees operating in the energy plant, 10 permanents and 5 seasonal employees in pruning harvesting and transporting. The company has realized a small-scale power plant (1 MWe) for producing electricity exclusively from olive tree pruning. The plant consumes from 24 to 28 tons of pruning daily. Fiusis indeed is a critical and extreme case

(Eisenhardt, 1989; Yin, 1994) of an innovative company who challenged the opportunity to design a circular business model in attempting to close the loop in the agri-food sector in a rural area.

By benefiting from programs of public funds for the installation of new industrial plants and thanks to the national laws on the introduction of the produced energy in the national distribution system, Fiusis works in a supply chain populated by a largely distributed basis of suppliers (mainly for the woods, but also producers of tools, plants, and oil) and by two main customers, who are Fiusis itself, with the two plants for the production of energy and bio-pellet, and the national energy system.

Data collection and analysis were carried out using multiple data sources and ensuring triangulation of information (Eisenhardt, 1989). The combination of different investigative techniques has been embraced to reduce the bias of a single observation and to enhance data credibility (Patton, 1990). Data collection has been performed by integrating primary and secondary sources. About the first, several interviews and follow-ups have been conducted with the founder and CEO at Fiusis, the purchasing manager, and the responsible of the energy production plant.

All the gathered information has been integrated with data resulting from secondary sources and specifically the company's website and accounts on social networks, interviews and press releases available online, financial reports, and official documents related to the business competition in which the company has been awarded from the European Commission. We stopped interviewing, meeting people, and scrutinizing secondary sources, when the possibility for us to obtain additional new information was attained (thematic saturation), and further coding was no longer feasible (Fusch & Ness, 2015).

Finally, as suggested by Eisenhardt (1989), a further series of iterations between empirical data and literature review analysis has been conducted to identify the enablers of managerial practices for the circular business model design of Fiusis, as well as to better identify the theoretical foundations and implications of the research. The developed findings from the empirical analysis of the case have been discussed with the key informants for their final approval.

#### 4. Findings

Fiusis is an innovative company operating in the field of energy production from olive tree pruning and plantation removal. The company has started in 2010 by Marcello Piccinni, the founder and CEO. Fiusis works on a volume of 8.000 t/y and the coverage of an area of 10 kms. Fiusis is located in a rural area, traditionally vocated to the agriculture and characterized by the limited specialization of tertiary sector and the presence of urban areas of small dimensions. As highlighted during the interviews, the volume of the produced energy can satisfy the nightly need of electricity of the small town of Calimera. The innovativeness of Fiusis business model is clearly linked to the area. As highlighted during the interviews with the CEO, while the production of biomass energy was already diffused in the north of Italy and in other European countries, as they are characterized by high level of development, in the context of the province of Lecce it represents a meaningful innovation. As for the plant exclusively based on the olive tree pruning, the company has initially worked for assuring the procurement of this raw material. Despite its abundance in the area, at the beginning the number of farmers collaborating with Fiusis was very limited (only 12 in 2010).

Instead, the area is characterized by very small and fragmented farms with limited portions of fields. Currently, more than the 60% of the local farms of the area collaborates with Fiusis. In collecting pruning for Fiusis, farmers have the benefit of cleaned fields. This also allows to reduce the costs of cleaning and to reduce of a meaningful percentage the environmental pollution due to the burning. In the most recent years, the area has been interested by the emergence of Xylolla, which has impacted on the overall landscape and has enhanced the quantity of wood and pruning of olive tree available in the area. Despite this, the interviews with the company's founder and CEO have allowed us to comprehend how the most important challenge was to convince local farmers to abandon their well-established habits of burning branches in their fields. At this purpose, several meetings either with single local farmers or consortia have been promoted to illustrate them some scenarios of collaboration and mutual benefits.

Logistics and collection activities are also very critical in the Fiusis supply chain. Accordingly, after a first phase in which Fiusis collaborated with external contractors for the collection and harvesting of pruning, in 2014 Fiusis has created a "newco" (named Ligna). The activities of Ligna were aimed to perform a

new strategy of logistics' management and consisting in services of messaging and geo-localizations that are useful for the coordination of the supply chain, and that have a positive impact on the network of suppliers in terms of better organization of their single supplies, cultural spillovers, and cultural catching up. As highlighted during the interviews, the creation of Ligna has allowed to optimize the operational processes of the company. Accordingly, the company collects through Ligna the requests from the farmers by registering all the data necessary for both the traceability of the pruning and the effectiveness of the logistics.

In addition, as far as the new plant for producing the bio-pellet is concerned, also in this case, Fiusis leverages on the local farmers to work only olive wood. In addition, this plant is nurtured by the energy produced by the energy production plant of Fiusis and without the usage of chemicals that normally are used for producing pellet.

From the analysis of Fiusis' business model, it emerges how collaborations along the supply chain play a pivotal role to facilitate inter-organizational cooperation between the company and each stakeholder. The design of Fiusis' circular business model has indeed implied the design of a collaborations' network with some key actors operating in the same supply chain of Fiusis. This relevant aspect of the company's business model is deepened in the following section.

The analysis of Fiusis from the perspective of the enablers of managerial practices for a circular economy adoption in companies' business models can be summarized as in the following Table 1.

Table 1. enabling factors, the enabled managerial practices, and the circular economy outcomes characterizing the circular business model of the company.

<b>Enablers</b>	<b>Managerial practices</b>	<b>Circular economy outcomes</b>
National and supranational laws for the green energy production	Fiusis has implemented a production plant to produce biomass energy according to the national and supranational laws related to the green energy and CO <sub>2</sub> reduction	Image of a green and sustainable company with a higher commitment with the local community
Public funds for the installation of new industrial plants	Fiusis has accessed public programs supporting the development of new industrial plants	Lower direct investments by the company, fiscal benefits, and advantaged conditions for loans

Waste Management and Energy Efficiency	Fiusis value creation derives from the usage of pruning as raw material, the usage of energy produced for self-feeding, the attempt to use also the ashes resulting from the production for fertilizing fields	Value creation in coherence with the principles of circular economy and according to a strategic model that works for closing the loop and reintroduce equilibrium in the local ecosystem
Supply contracts with local farmers	Fiusis has developed a structured contractual system to have the raw material for producing energy. The recent introduction of the Ligna newco has allowed to structure the network of suppliers	A well-established network of suppliers that guarantees the raw materials by avoiding the problems of storage and management of the inbound flows of pruning.
Supply contracts with the national energy system	Fiusis introduces into the national distribution system all the energy exceeding the power of its plants for producing energy and bio-pellet	Certainty of the outbound flows with fixed economic conditions and access to a relatively protected market
Business and Technological Innovation	Fiusis continues to look for new entrepreneurial opportunities. Several innovations have been introduced during the last years, as initiatives to improve the competitiveness of company's core business, as in the case of Ligna, or to promote a diversification strategy, as realized with the new plant for producing the bio-pellet	Competitiveness and growth, higher employment rate, and larger value creation process

## 5 Conclusions

The present research was aimed to analyze the enablers of managerial practices in circular business models operating in the agri-food sector in the context of a rural area; an interesting research issue that has recently emerged in the existing fields of circular economy and circular business models. The paper has tackled this objective by leveraging a single case study analysis of Fiusis, a small company located in a rural area of the southern Italy operating in the field of the energy production from olive tree pruning and recently involved into the production of bio-pellet.

The anatomy of Fiusis business model reveals interesting evidence for the comprehension of the relationships between enablers, managerial practices, and

circular economy outcomes. First, the mechanisms of value creation, transfer, and capture in Fiusis are affected by the political and institutional environment, identifiable into the favorable policies that have allowed the creation of the company at the beginning of its story, but also standards for environmental safety that have made Fiusis able to reduce the CO<sub>2</sub> emissions in the atmosphere. Second, Fiusis has implemented core activities in the direction of a sustainable networking, affiliation of local farmers, traceability of their production, creation of a new culture of sustainability, and green behaviours into farmers and customers, as well as into the employees' mindset. Third, through the analysis of Fiusis circular business model and supply chain collaborations it is possible to identify several insights in terms of re-design of the traditional process of management of fields, change into the conception of waste usage for a new production process, and implementation of new forms of collaborations with a vast array of supply chain stakeholders. Finally, the case of Fiusis provides interesting evidence for the advancement of the academic debate in the field of circular economy, and especially at the intersection between circular business models, agri-food sector, and development of rural area.

The paper has of course some limitations that deserve a further examination. First, the paper does not analyze the barriers associated to the implementation of Fiusis managerial practices in its business models, but only the enablers that have pushed the company to design a circular business model. Another limitation is mostly related to the kind of the methodology we used for conducting the empirical analysis. Indeed, the single case study methodology does not allow for cross-case comparison or statistical generalizations. Other agri-food businesses who are adopting circular economy for a circular business model design could be investigated to reinforce the "analytical" generalization of the obtained results).

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## The Peculiarities of Equity Crowdfunding for Cultural Heritage: a New Approach to Innovation

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### Abstract

This paper addresses the topic of alternative financing for the cultural heritage sector, investigating equity crowdfunding as a potential means to increase financial resilience. Indeed, the allocation of funds to the cultural heritage sector has progressively decreased over the last fifteen years, making traditional financial models for cultural heritage no longer maintainable especially in times of crisis and economic downturn (Jelinčić and Šveb, 2021). As a result, both academics and practitioners have called for a higher degree of differentiation of sources of funding, that include also the exploration of crowdfunding as a promising funding means (Dalla Chiesa and Handke 2020; Rykkja *et al.*, 2020; Zhao and Shneor, 2020). However, this funding tool is just partially used in the cultural and creative sector, especially in its most innovative models such as equity crowdfunding (Massolution, 2015; Rykkja *et al.*, 2020). This paper aims to fill this research gap: it questions equity crowdfunding as a viable tool to finance cultural heritage interventions and explores the success factors and peculiarities of equity crowdfunding campaigns for cultural heritage. By means of a QCA -Qualitative Comparative Analysis, the research indicates that equity crowdfunding could raise considerable amounts of funds as those needed in heritage interventions. Moreover, it points out that equity crowdfunding campaigns for cultural heritage differ from traditional equity crowdfunding campaigns of other sectors, since it privileges signals related to emotional aspects and social and community values rather than those related to financial aspects.

**Keywords** – equity crowdfunding, innovative financing, cultural heritage innovation, crowdfunding

**Paper type** – Academic Research Paper

## 1 Introduction

Over the last fifteen years, the allocation of funds to the cultural heritage sector has been gradually questioned (Jelinčić and Šveb, 2021), making the financing mechanisms for cultural heritage no longer sustainable. This issue has increased during the recent COVID-19 pandemic, adding new problems to traditional financial difficulties (FINPIEMONTE, 2020; Jelinčić and Šveb, 2021). As a result, both academics and practitioners have called for a higher degree of differentiation of sources of funding for the cultural heritage field. In this framework, crowdfunding has emerged as an innovative participatory way of financing, that could contribute to sustainability in the long term (Dalla Chiesa and Handke 2020; Zhao and Shneor, 2020). Although the cultural heritage sector is still reluctant to use it, crowdfunding has been considered a promising new way of financing cultural projects while at the same time promoting innovation (Rykkja *et al.*, 2020). The research on crowdfunding for cultural heritage has underlined several similarities with other sectors (Borin and Crepin, 2019; Rykkja *et al.*, 2020; Zhao and Shneor, 2020) and has pointed out that the community orientation of cultural heritage organizations could work as a strong catalyst for using crowdfunding initiatives (Tosatto, Cox, & Nguyen, 2019). However, most crowdfunding campaigns for cultural heritage (that are for the most using a donation or reward crowdfunding model) are collecting relatively small amount of money (De Voldere and Zeqo, 2017; Massolution, 2016) that are useful but not enough for often costly heritage interventions. Equity crowdfunding could represent an exception; in few cases, it has indeed proved a good means not only to raise considerable amounts of money for cultural heritage, but also lead to innovative and participatory models of cultural heritage governance and management. This research aims at investigating equity crowdfunding potential for cultural heritage, answering to the following research questions:

- What are the success factors for equity crowdfunding campaigns in the cultural heritage sector?
- What are the peculiarities of cultural heritage's equity crowdfunding compared to other sectors?

The paper is structured into five main sections. After this short introduction, a literature review on equity crowdfunding and crowdfunding for cultural heritage is carried out in section two. Section three presents the research design and methodology, while section four illustrates and discuss the results of the empirical

investigation. Section five presents some concluding remarks on the research and underlines the limitations and potential for future investigations.

## 2 Literature review

Over the last two decades, the cultural heritage sector has increasingly experienced a decrease of funding (Borin, Donato and Sinapi, 2017; Martin, 2010), that has pushed the organizations in this field to rethink their funding model and find new innovative funding streams that could ensure financing without compromising preservation and representation of cultural values. In this scenario, although cultural heritage professionals are still hesitant to use it, crowdfunding has emerged as new complementary method of financing (De Voldere e Zeqo, 2017; Massolution, 2015). Crowdfunding, described as a fundraising tool based on the online collection of small amounts of money from a wide number of people, has its roots in several fundraising campaigns for charity, political purposes, and arts (Kuppuswamy and Bayus, 2018; Ordanini *et al.*, 2011; Short *et al.*, 2017). The crowdfunding innovation consists mainly in the use of internet platforms as intermediaries that connect campaign's proposers with potential backers, notwithstanding their geographical distance (Ordanini *et al.*, 2011). Crowdfunding disrupts traditional financing mechanisms as it has the potential to call for the help of online communities leaving banks and traditional financing organisms outside the transaction. There are five main crowdfunding models (Giudici *et al.*, 2012; Harrison, 2013; Battisti *et al.*, 2020): donation-based, reward-based, royalty-based, lending-based, and equity-based crowdfunding. *Donation-based* crowdfunding is really similar to traditional fundraising in which the donors do not expect anything in return; whereas in *rewards-based* crowdfunding, rewards (such as free or discounted products or services) are offered in exchange for the donation. *Lending-based* crowdfunding is defined as crowdlending or peer-to-peer lending and works as a loan from the backers to the project proposers. In *royalty-based* crowdfunding a project is financed by the crowd in return for a share of the profits. Finally, *equity-based* crowdfunding is a form of crowd-investing in which the backers receive a percentage ownership in the company.

The research on crowdfunding has focused on the different aspects of this phenomenon, focusing also on the factors that might influence the success of a crowdfunding initiative (Gerber *et al.*, 2012; Zheng, Li and Xu, 2014). This stream of research has highlighted that donation, reward-based and peer-lending

crowdfunding campaigns mainly base their appeal on emotional and social/community aspects (Belleflamme, Lambert and Schwienbacher, 2014). The majority of these analyses do not consider the peculiarities of the equity crowdfunding. Indeed, research on equity crowdfunding is still considered at an initial stage (Lukkarinen et al., 2016). Nevertheless, so far equity crowdfunding investigations has peculiarities that are more related to an investing framework (Ahlers et al., 2015), where the backers are basically investors that could claim administrative and capital rights. As a result, equity crowdfunding is one of the most complex crowdfunding models, requiring *ad-hoc* legal schemes (investments are generally regulated by national securities exchange commissions; Cholakova and Clarysse, 2015) and agreements (Ahlers et al., 2015). The signals of potential success are mainly factors related to financial aspects, even if equity crowdfunding investors are often less experienced in investment, prone to herding behaviours and showing lack of due diligence (Block, Hornuf and Moritz, 2018). Emotional and social/community signals are considered significant but less important (Block, Hornuf and Moritz, 2018b; Wald, Holmesland and Efrat, 2019; Wuillaume, Jacquemir and Janssen, 2018 and 2019), whereas factors related to the quality and characteristics of financial investments are determining (Mochkabadi, and Volkmann, 2020). Several papers identify success factors and signals related to: *human capital*, interpreted as entrepreneurs and management education and experience (Ahlers et al., 2015; Vismara, 2016; Piva and Rossi-Lamastra, 2017; Nitani and Riding, 2017; Giga, 2017; Angerer et al., 2017); *equity retention*, considered as percentage of equity offered to investors (Ahlers et al., 2015; Vismara, 2016; Nitani and Riding, 2017); *social capital of the entrepreneurs*, defined as the number of social network contacts (Vismara, 2016; Nitani and Riding, 2017; Wald, Holmesland, Efrat, 2019); *validation of the project by third parties*, coming in the form of grants, intellectual property rights, professional investors as partners, product certification, social proof, prominent affiliates (Ralcheva and Roosenboom, 2016; Bapna, 2017); and last but not least, *active communication during the campaign* (Block et al., 2018).

There is however still a gap in the research on equity crowdfunding for specific sectors (Mochkadadi and Volkmann, 2018). Among these sectors, we can also include the cultural heritage sector, that has so far been kind of reluctant in using this crowdfunding model (Borin and Rossato, 2020; Massolution, 2015). This reluctance could be due to diverse factors: first, whereas equity crowdfunding in other sectors may be very profitable for investors, in cultural heritage the

prospective profits are rather unpredictable, and this may hinder the potential attractiveness of equity crowdfunding initiatives for cultural heritage (Borin and Rossato, 2020). Second, there might be concerns related to ownership, value preservation or governance issues.

However, the often-consistent amounts of money raised to equity crowdfunding could represent an interesting opportunity to deal with the inner traditional financial fragility of cultural heritage organizations (Grefe, 2010; Konrad, 2017; Perry and Beale, 2015; Tosatto, Cox, & Nguyen, 2019;). In addition, the typical community orientation of the cultural and creative sector (Konrad, 2015), the prevalence of small and medium size enterprises (Borin, Donato and Sinapi, 2017) or the desire for independence in the artistic production could work as a strong incentive in using this type of financing tool (Tosatto, J., Cox, J., & Nguyen, T. 2019). It seems therefore relevant to further investigate equity crowdfunding for cultural heritage and understanding its peculiarities and success factors, which is the aim of this research.

### **3 Research design and methodology**

In order to investigate the topic mentioned above, a qualitative empirical research was carried out on the signals/ factors of success at the basis of equity crowdfunding campaigns in the cultural heritage sector.

This study decided to focus on equity crowdfunding in France as this country seemed particularly relevant: not only because of its richness in cultural heritage (UNESCO, 2020) but also because it has been among the countries in which equity crowdfunding has been developing the most (Massolution, 2015). Moreover, French government has widely encouraged the development of blended finance models, for example supporting European initiatives such as the EIC - European Innovation Council or pushing for equity driven investments on cultural heritage.

The authors decided to use a QCA – Qualitative Comparative Analysis approach (Ragin, 1987). QCA is a research methodology aiming at investigating new phenomena and focusing on the theory of change. It is composed by six main steps: 1) Develop a theory of change; 2) identify cases of interest; 3) Develop a set of factors; 4) Score the factors; 5) Analyse the dataset; and 6) Interpret the findings and revise the Theory.

Since the geographical domain of the research was France, the case studies were selected in the most important French crowdfunding platform specialized in cultural heritage, which is *Dartagnans*. Over the last 10 years, in this platform five equity crowdfunding campaigns were launched, and all of them were successful, all dedicated to purchases or interventions on historical French castles. More specifically, these campaigns were related to the Castle of La Mothe Chandeniers (in Les Trois Moutiers), one campaign related to the Castle of Fort De L'Ebaupinay, and one to the Castle of Vibrac. These five equity crowdfunding campaigns constitute the research sample of the QCA analysis. In terms of key factors, they were selected according to the factors and signals identified in accordance with the ones highlighted in the literature review and divided in seven main domains: financial factors, equity retention factors, human capital factors, emotional factors, social-capital factors, factors related to active communication, and validation by third parties.

For each case study, the factors were scored according to a crisp set analysis (the score is always either '0' or '1' meaning absence or presence, respectively) using FsQCA, a specific software for QCA analysis. Finally, the results were critically analysed and referred to the initial research questions regarding the peculiarities and success factors of equity crowdfunding for cultural heritage, allowing the authors to get interesting insights on the topic.

#### **4 Results of the empirical research**

The results of this research reveal that equity crowdfunding could represent a viable source of external capital within the cultural heritage sector especially when a substantial amount of capital is needed.

Indeed, the findings of this analysis (Figure 1), show that all five campaigns were successful and able to raise even more than the targeted amount (75% or even 555% more). In this regard, the results of the theoretical model developed by Miglo (2016) show that entrepreneurs tend to choose equity crowdfunding if more substantial amount of capital is needed. Extending these results within the cultural heritage sector based on the findings of this research, can be argued that equity crowdfunding could be a sensible choice, outside the traditional finance, that can be pursued to raise considerable amount of funds needed to carry out preservation, restoration and/or enhancement works. Moreover, the choice of alternative sources of finance, such as equity crowdfunding, can be influenced by



factors like perceived lack of funding alternatives, which is the scenario that has been characterized the cultural heritage sector in the latter fifteen years (Brown et al., 2015).



*Figure 10 - Percentage of funded amount*  
(Source: authors' elaboration based on data from Dartagnans)

Furthermore, in order to identify the peculiarities of equity crowdfunding in the cultural heritage sector within the region of France, this study carried out a QCA - quantitative comparative analysis as explained above.

From the QCA's truth table and the intermediate solutions – Figure 2 - it can be stated that signals of potential success of equity crowdfunding campaigns within the cultural heritage sectors are mainly factors related to emotional signals. Indeed, each campaign included expression and images that encouraged the emotional component which seemed prevailing in comparison to other information provided. Starting from the motto used in all the campaigns where people were asked to contribute to the initiative as thanks to their donation, they could have been able to "*Devenez co-chatelain*", co-owners, of the Castle. Moreover, have been used images of volunteers taking active part of the castle's preservation and restoration and picture of them visiting the site, to show to the potential investor, what could have meant taking part of this initiative.

These results are in contrast with previous research that investigated equity crowdfunding success, as they identified to be the financial signals the key drivers (Block, Hornuf and Moritz, 2018). That difference could be because of the sector under analysis. Previous crowdfunding research within cultural heritage showed that a key factor of their success was the emotional and or social/community side

of it (Belleflamme, Lambert, and Schwienbacher, 2014) rather than the financial side.

Therefore, it can be concluded that equity crowdfunding initiatives for the cultural heritage sector differ from traditional equity crowdfunding campaign but are aligned with the main motivations that characterize crowdfunding campaigns for cultural and creative projects, such as their link with emotional aspects and social and community values typical of the cultural and creative sector.

FS_1	FS_3	ER_1	ER_2	HC_1	HC_3	ES_1	ES_3	SCS_1	SCS_2	AC_1	AC_2	VTP_1	VTP_3	number	outcome	raw consist.	PRI consist.	SYM consist.
1	0	1	1	1	0	1	1	1	1	0	1	1	0	2	1	1	1	1
1	0	1	1	1	0	1	1	1	1	0	1	0	0	1	1	1	1	1
1	0	1	1	1	0	1	0	1	1	1	1	0	0	1	1	1	1	1
1	1	1	1	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1
100%	25%	100%	100%	100%	0%	100%	75%	100%	100%	25%	75%	50%	0%					

```

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1
consistency cutoff: 1
Assumptions:

```

	raw coverage	unique coverage	consistency
FS_1~FS_3*ER_1*ER_2*HC_1~HC_3*ES_1*ES_3*SCS_1*SCS_2*~AC_1*AC_2*~VTP_3	0.6	0.6	1
FS_1~FS_3*ER_1*ER_2*HC_1~HC_3*ES_1~ES_3*SCS_1*SCS_2*AC_1*AC_2*~VTP_1*~VTP_3	0.2	0.2	1
FS_1*FS_3*ER_1*ER_2*HC_1~HC_3*ES_1*ES_3*SCS_1*SCS_2*~AC_1*AC_2*VTP_1*~VTP_3	0.2	0.2	1
solution coverage: 1			
solution consistency: 1			

Figure 11 - Truth table and intermediate solutions  
(Source: author's elaboration)

Table 1 – Results of the signals' analysis (source: authors' elaboration)

<b>Code</b>	<b><u>Financial signals</u></b>	
<b>FS_1</b>	- <b>The project outline how the funds are used</b>	<b>100%</b>
<b>FS_3</b>	- Tax relief	25%
	<b><u>Equity retention</u></b>	
<b>ER_1</b>	- <b>The indication of % of equity offered to investors were clear and explicit</b>	<b>100%</b>
<b>ER_2</b>	- <b>Shareholders can contribute to the project in the steering committee</b>	<b>100%</b>
	<b><u>Human capital</u></b>	

HC_1	- The project highlights the competences in the field of cultural heritage, cultural heritage preservation and enhancement (with specific reference to castles) of the project proposers	100%
HC_3	- There is senior recognition of the importance of digital skills	0%
	<b><u>Emotional signals</u></b>	
ES_1	- The campaign included expression and images that encouraged the emotional component of the campaign	100%
ES_3	- Possibility to enter into contact with the castle	75%
	<b><u>Socio-capital signals</u></b>	
SC_1	- The promoters based the campaign on the use of their social media and social contacts	100%
SC_2	- The bakers were international (not just French)	100%
	<b><u>Active communication</u></b>	
AC_1	- The success of the campaign is due also because of the interviews	25%
AC_2	- The success of the campaign also is due based on the number of posts on Dartagnan	75%
	<b><u>Validation by third parties</u></b>	
VTP_1	- The campaign received support of several partners involved in the cultural heritage intervention	50%
VTP_3	- The campaign received support from financial institutions	0%

## 5 Conclusions

This research aimed at investigating the success factors for equity crowdfunding campaigns in the cultural heritage sector and the peculiarities of cultural heritage's equity crowdfunding compared to other sectors.

From the literature review, it emerged that success factors in equity crowdfunding campaigns are generally identified mainly in financial factors such as shared information related to financial characteristics of the project, equity retention, with other significant but not determining factors represented by human capital signals, emotional signals, social capital signals, active communication factors, and validation by third parties.

Starting from these literature findings on factors and peculiarities of equity crowdfunding in general, this paper focus on the specific cultural heritage sector. It investigated successful campaigns of equity crowdfunding for cultural heritage, selected among the equity crowdfunding projects launched on the specialized website *Dartagnans* and analysed through a QCA methodology. The findings demonstrated that equity crowdfunding campaigns within the cultural heritage sector have been able to raise considerable amount of funds, thus representing a valid path to increase financial sustainability for this type of organizations. Moreover, results demonstrate that the traditional factors of success of equity crowdfunding campaigns are partially met also in those for cultural heritage, but the sector presents some peculiar characteristics. Indeed, within those signals, those related to emotional identification with the initiative and social and community values are more relevant, while financial factors or traditional equity retention information seems to have less importance.

The research contributes to the academic literature on the peculiarities of equity crowdfunding for specific subsectors and on the broader reflection on the opportunities of crowdfunding for the cultural heritage field. Furthermore, it could provide interesting insight to policy makers and managers who are interest in exploring new ways to increase the financial sustainability of their institution.

However, the limited research sample and geographical area of the campaigns call for further investigations based on a broader sample and international comparative approaches.

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## **Transform Knowledge Assets into Reality: How the Purposeful Combination of Knowledge Activities Enables Organisations to Channelise the Knowledge Flow in Software Engineering Development**

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### **Abstract**

**Purpose** — Knowledge Activities like acquiring, codifying, storing, maintaining, transferring and creating knowledge, can be seen as what constitutes Knowledge Management in an organisation. Executing knowledge activities should ideally come at no additional cost and blend well with the respective organisation's business. Being a highly knowledge-intensive discipline, software engineering becomes an interesting testbed for this approach. This study aims to identify existing connections between knowledge activities and some frequently used software team practices or measures, establish their relations and investigate their suitability as tools for implementing knowledge management.

**Methodology and approach** — In accordance with the research questions, this study used a qualitative research approach. Using a questionnaire, practitioners such as software developers and team leaders were asked to provide feedback on a set of previously selected team practices and measures typically used in software engineering projects and to assess their relation to the activities of acquiring, codifying, storing, maintaining, transferring and creating knowledge. The obtained results were analysed using frequency analysis and the comparison of summarised agreement vs. disagreement related to typical software development team practices and measures.

**Findings** — The results show that meetings and team processes like code reviews or pair programming come with intensive knowledge transfer while knowledge is acquired through activities involving client contact. New knowledge is created in a large number of team processes, often along with other knowledge activities. In addition, the inquiry revealed that the selection of team practices and measures are both relevant and considered important for managing knowledge in software teams. This indicated that



activities that are already part of the software engineering process in many organisations can be facilitated to trigger particular knowledge activities.

**Practical implications** — The study clearly shows the relevance of practices and measures well-accepted in software engineering for implementing knowledge management in software development teams. Based on a systematic analysis it establishes their correspondence with particular knowledge activities thus allowing practitioners to assess or create the prerequisites for knowledge creation in their teams along with existing workflows. Project and team leaders, and ultimately the whole organisation benefit from a tool enabling them to improve both flow and creation of knowledge within and between teams strengthening expertise and sustainability in the particularly knowledge-intensive software market.

**Keywords** – Knowledge Creation, Knowledge Activities, SECI Model, Software Engineering, Development Team Practices

**Paper type** – Academic Research Paper

## 1 Introduction

Due to the nature of what it produces and the work involved to create it the software industry had to find ways of dealing with knowledge at a time when knowledge management as a scientific discipline had not yet evolved. After theories on systematic knowledge creation and knowledge management, Nonaka's SECI model (Nonaka and Takeuchi, 1995) and first notions of knowledge activities (Pentland, 1995; Andersen, 1996) surfaced in the 1990s, blending practitioners' best practice and researchers' findings became possible. This led to considerable research focusing on the particularities of knowledge in software engineering as well as the introduction of some of the newly established terminology and methodologies such as knowledge transfer and storage. Some researchers focused on technology commonly used in the software industry like Wikis and issue trackers to support knowledge transfer, maintenance and storage (Dingsøyr and Conradi, 2002; C. Khalil and S. Khalil, 2019; Sungkur and Ramasawmy, 2014; Abdur *et al.* 2015). Others, like Dissanayake *et al.* (2013), conclude that knowledge management key concepts as described by Nonaka and Konno (1998), Nonaka, Toyama, and Byosièrè (2003), and Nonaka and von Krogh (2009) are already present in agile software development methodologies.

However, while the combination of knowledge management and software engineering as a field of interest for researchers has now been around for at least two decades, a separation between the two camps is still noticeable and calls for

a more holistic approach trying to connect knowledge management to existing elements of software development teams' work. This research aims to fill this gap by investigating a selection of software development team practices, measuring their relevance to team knowledge and establishing their relation to six knowledge activities as proposed by Heavin and Adam (2012) thus enabling software project leaders to more consciously involve the concept of knowledge when designing team processes.

The paper is organised as follows: In section 2 relevant existing research is reviewed, followed by two research questions. The research method used in this study is outlined in section 3 The results are presented in section 4 followed by the conclusion in section 5.

## **2 Literature Review**

### **2.1 Knowledge Creation**

The fundamental concepts of what is known today as Knowledge Management and Knowledge Creation have been created and further developed since the 1990s, and a vast amount of relevant research on how to implement KM in — usually large scale — enterprises exists (Nonaka, 1991; von Krogh, Ichijo, *et al.* 2000; Ichijo and Nonaka, 2008). Nonaka (1994), defines knowledge as 'justified true belief' held by individuals. In order to qualify as knowledge rather than just information a "clear understanding of information and their associated patterns" is an additional important requirement (Bierly *et al.* 2000, p. 600). Knowledge is also the actuality of skilful action and/or the potentiality of creating situations to permit (skilful) action (Nonaka and von Krogh, 2009).

Nonaka (1991) points out that there is a distinction between explicit and tacit knowledge. Tacit knowledge comprises information that is difficult to express, formalize or share. It resides within people and according to Stenmark (2000) it can neither be documented in a manual nor be explained in words to others. Hence this kind of knowledge requires involving the knowing one and transferring the knowledge via periods of practices where experiences are shared through actions. In other words, knowledge needs to be transmitted from person to person (Grover and Davenport, 2017). Nonaka and Toyama (2003) reinforce Stenmark's idea of tacit knowledge by stating that the only way to acquire tacit knowledge is through shared direct experience by spending time together.

Thereby, tacit knowledge often takes the form of narratives, analogies or metaphors in order to give insight into the 'why' and 'how' something is done the way it is (Holste and Fields, 2010). From a practical standpoint this means after writing down the narrative, it is read by another group of people in the company and should be discussed afterwards. The analysis of the narrative will help making better decisions in the future. However, the ability to amplify tacit knowledge is limited.

When focusing on an entrepreneurial environment, making tacit knowledge explicit carries the risk of losing sustainable competitive advantage. Tacit knowledge transformed to explicit and having left the original company may become industry best practice (Lubit, 2001). In opposition to tacit knowledge, explicit knowledge can be transmitted by using strings, i.e. interaction between physical objects, in the right circumstances (Collins, 2010). It can be codified and/or verbalized (Nonaka and Toyama, 2003; Grover and Davenport, 2017) and expressed by data numbers, formulas, pictures, manuals, patents (Holste and Fields, 2010). Both explicit and tacit knowledge can be passed on and converted using appropriate methods and with varying degrees of difficulty or required effort. The resulting four possible transitions — tacit-to-tacit (Socialisation), tacit-to-explicit (Externalisation), explicit-to-explicit (Combination) and explicit-to-tacit (Internalisation) are the pillars of the SECI model, according to which organisational knowledge creation evolves from a spiral out of continuously transforming and transferring explicit and tacit knowledge between individuals (Nonaka and Takeuchi, 1995).

Since the beginning of the SECI model's development, a broad academic debate has arisen, mainly around the distinctions between the different conversion processes, the relationship between the explicit and tacit levels and its possibilities related to cultural differences. The adoption and application of the SECI model is under continuous consideration and development (von Krogh, Nonaka, *et al.* 2012; C. S. Lee and Kelkar, 2013; Nezafati *et al.* 2009; Tee and S. S. Lee, 2013). KM practitioners soon learnt that a lot of important knowledge is not explicit. Only discussion, probing, reflection and conversion of tacit knowledge can bring out valuable explicit knowledge. The four conversion modes of tacit in tacit, tacit in explicit, explicit in explicit and explicit reversed in the form of new tacit knowledge constitute an approach to support the exchange and creation of knowledge. The SECI model is widely accepted but varying contents and perceptions regarding the importance of particular aspects of the knowledge

creation model exist, such as cultural aspects, the practical implications of the transformation of knowledge and the role of management (Kahrens and Früauff, 2018).

An important extension, the concept of Ba (Japanese for 'space'), introduced by Nonaka and Konno (1998) and Nonaka and Toyama (2005), stating that in order for the SECI model's transitions to take place an enabling context is necessary. The four pillars are complemented by four types of Ba: Originating Ba (face to face) for Socialisation, Interacting Ba (peer to peer) for Externalisation, Cyber Ba (group to group) for Combination and Exercising Ba (on the site) for Internalisation. The concept of Ba stresses how important relationships and interactions between peers are for the process of knowledge creation, and the environment needs to provide psychological safety and care (von Krogh, Ichijo, *et al.* 2000). Besides the already mentioned creation of the appropriate enabling Ba, fostering organisational knowledge creation can be supported by targeted management decisions. Knowledge transfer and knowledge creation best prosper in micro-communities of small to medium size and changing membership over the years, and sources of innovation, like e.g. R&D departments need to be organised (Ichijo and Nonaka, 2008) accordingly. Teece (2010) points out that in tech companies (e.g. Intel), innovation already originates from development and production without even the need for dedicated R&D departments.

Knowledge sharing, depending on the flow of information, plays a central role here. Inside an organisation, decentralised decision-making and reduced formalisation are preferred as they encourage initiative and participation (Saifi *et al.* 2016). When dealing with peers outside the respective organisation, similar principles apply. Building communities with them enables tacit knowledge sharing through co-experience and shared praxis (Sapir *et al.* 2016; von Krogh, Ichijo, *et al.* 2000; Nonaka and Toyama, 2005; Ichijo and Nonaka, 2008). While the SECI model starts from the point where individuals already carry knowledge to enter the knowledge creation spiral, the idea of distinguishing between embodied and not-yet embodied ('self-transcending') tacit knowledge is introduced in Scharmer (2001). Scharmer address the question for the driving force behind the knowledge spiral, stressing the importance of appropriate enabling contexts and the necessary conversational complexity in communication. In the future, the application and extension of the SECI model are expected to be leaner in structures and more digitised concerning knowledge creation and sharing (Kahrens and Früauff, 2018).

The SECI model has also been subject to criticism, a.o. for being too vague in its recommendations and its perception of both, tacit and explicit knowledge (Schreyögg and Geiger, 2003; Schreyögg and Geiger, 2004; Lin, 2010), also for being deeply rooted in Japanese culture and hence not sufficiently considering cultural differences as possible obstacles to its application (Andreeva and Ikhilchik, 2011). Nevertheless, this research will consider the basic concept of the SECI model when assessing typical meeting structures in software development projects to improve the exchange among team members and thereby increase learning and knowledge.

## **2.2 Knowledge Management in Software Development**

It is a common understanding that software engineering and development is a highly knowledge-intensive discipline, and various aspects of it have attracted the interest of researchers in knowledge management (Rus and Lindvall, 2002; Kavitha and Irfan, 2011; Vasanthapriyan *et al.* 2015; Shongwe, 2017). In terms of the taxonomy proposed by Earl (2001), knowledge management strategies are usually closely related to the technocratic schools for traditional software development and more to the behavioural schools for agile approaches (Bjørnson and Dingsøyr, 2008). Rus and Lindvall (2002) exemplify the need for knowledge management in software engineering by the different dimensions of knowledge involved in it:

- Process and product knowledge is concerned with how the development of a particular project should be approached.
- Domain knowledge is related to what a software system is developed for, like e.g. accounting or space shuttles.
- Technological knowledge includes programming languages, tools, libraries selected and used for implementation.
- Knowledge of local policies covers amongst others conventions existing in development teams.
- Also, it is important to know who the bearer of specific knowledge in the organisation is.

Hegde and Walia (2014) note that generally the different involved forms and dimensions of knowledge have a significant impact on the developers' creativity.

An early study based on 'lessons learnt' reports from eight software companies (Dingsøyr and Conradi, 2002) shows that employees are interested in this field

and also willing to invest in it, e.g. by developing supporting tools. From analysing knowledge flows involved when creating source code Sandhawalia and Dalcher (2010) conclude that the activities of knowledge creation, learning and reflection clearly play an important role in uncovering and reviewing mistakes and mismatches. Similarly, Ward and Aurum (2004) find that knowledge management helps appreciate the challenges and complexities inherent in software development with employees being able to identify activities related to knowledge management in their organisations. However, the same research also reveals that employees found the helpers, techniques and methodologies in use for the software development process inadequate to support the intended knowledge management.

A significant number of studies stresses the importance of software tool support. The use of knowledge repositories (e.g. Wikis, databases etc.) is considered a central element of knowledge management in software organisations (Dingsøyr and Conradi, 2002; C. Khalil and S. Khalil, 2019). However, this term is a bit misleading as persisted knowledge becomes *information* and needs to be transferred back to *knowledge* when consumed by others. Bjørnson and Dingsøyr (2008) confirm a tendency to over-emphasise the role of technology by finding that some software engineering organisations focus on storage and retrieval of knowledge at the cost of knowledge transfer, application and creation. In particular collaborative software tools already popular in software development environments, like issue trackers and the already mentioned Wikis, are useful, e.g. for externalisation of knowledge (Sungkur and Ramasawmy, 2014; Abdur *et al.* 2015).

Because of their strong reliance on team processes, agile methods already contain various elements of what is known from the SECI model as is shown in the mapping of agile practices to characteristics of Ba in Dissanayake *et al.* (2013). Similarly, Abdur *et al.* (2015) find processes and tools common in agile methods beneficial for knowledge creation. These findings are confirmed by an investigation in large French companies conducted by C. Khalil and S. Khalil (2019) who based on a theoretical model of knowledge management in agile environments and interviews with employees from 12 French companies conclude that agile practices contribute to the creation of a knowledge-intensive culture. But what makes agile methods so interesting from the knowledge management perspective is their team dynamics and the flow of information they bring along. These contribute to competitiveness and more or less come automatically in small

or medium-sized enterprises (Basri and O'Connor, 2011; Shongwe, 2017; Heavin and Adam, 2014). Even larger organisations can benefit from it since agile teams are usually kept small on purpose: e.g. Scrum recommends teams of three to nine people (Sutherland and Schwaber, 2010).

Elements fostering open discussion or collaboration have a strong influence on team knowledge. One is the Retrospective in Scrum where team members gather after each sprint reflecting on what did not go well in the finished iteration and which measures should be taken to prevent it from happening again (Viana *et al.* 2013). Similarly in projects based on the waterfall model lessons learnt meetings take place after milestones. Another example is Pair Programming where two developers share the same screen while composing source code together (Kavitha and Irfan, 2011).

### 2.3 Knowledge Activities

While knowledge clearly plays a crucial role in software engineering, still some measures are required in order to achieve or design a systematic process of knowledge creation. For this, researchers propose the definition of Knowledge Activities (KA) — transactions or manipulations of knowledge where the knowledge is the object, not the result (Jetter *et al.* 2006; Kraaijenbrink *et al.* 2006). The term Knowledge Activity is fairly generic, hence several different interpretations are in use. Table 1 provides a selection of variations to the concept.

Table 1: Variants to the concept of Knowledge Activities

Authors	Name	Activities
Holsapple and Joshi (2004)	Knowledge Manipulation Activities	Acquiring, Selecting, Internalising, Using, Externalising, Generating
Ward and Aurum (2004)	KM Activities	Application, Distribution, Organisation, Adaptation, Identification, Acquisition, Creation
Costa and Monteiro (2017)	Knowledge Management Processes	Acquisition, Storage, Codification, Sharing, Application, Creation
Kraaijenbrink <i>et al.</i> (2006)	Knowledge Activities	Elicitation, Codification, Detection, Assessment, Transfer (of knowledge), Transfer (of knowledge holder), Nurturing, Motivation
Heavin and Adam (2012)	Knowledge Activities	Acquire, Codify, Store, Maintain, Transfer, Create

Heavin and Adam (2012) derive a list of six Knowledge Activities — acquire, codify, store, maintain, transfer, create — from the definition provided by Holsapple and Joshi (2004) conducting an investigation of KA application in five Irish software SMEs finding a dominance of knowledge and an underrepresentation of knowledge creation (Heavin and Adam, 2012; Heavin and Adam, 2014). Ward and Aurum (2004) focus on seven separate activities — knowledge application, distribution, organisation, adaptation, identification, acquisition and creation — finding them used and evolving with technology, organisational culture and practises. In a subsequent study, the same group of researchers investigate how and whether all these activities are executed by looking at four projects in two software companies and linking them to typical project lifecycle stages: Requirements Gathering, Analysis & Design, Building & Development, Testing and Deployment (Aurum *et al.* 2008). Their findings indicate that while the KAs are executed, this often happens implicitly, i.e. without having been identified as KAs by developers. Although there clearly is a common understanding of the concept behind knowledge activities, there are differences in detail e.g. Costa and Monteiro (2017) refer to knowledge sharing and application instead of transferring and maintaining.

Hence it can be concluded that the concept of knowledge activities (or KM activities or knowledge management processes) is recognised as a relevant element in implementing knowledge management. To a far lesser extent, the question has been addressed which software development practices actually result in executing which KAs. Sungkur and Ramasawmy (2014) refer to such activities as building blocks for knowledge management processes to which technical tools are linked in order to show which aspects of knowledge management they support. In their survey on knowledge management in software engineering, Vasanthapriyan *et al.* (2015) go through the software development life cycle and analyse its stages for their relation to the teams' knowledge, while employees from small South African software companies comment on their experience regarding KAs in Shongwe (2017). Examples for such mappings, while not actually focused on, can be found in some other works, like Sandhawalia and Dalcher (2010) and Abdur *et al.* (2015).

Mapping of some team processes and measures to knowledge activities can be found as side products in some of the abovementioned studies, like e.g. Pair Programming, Daily Scrum, rotation/visit in Abdur *et al.* (2015), or design, test, implementation, document, development in Aurum *et al.* (2008). However, a



systematic analysis of how elements of software development workflows and management measures relate to knowledge activities would be of value to both researchers and practitioners, which is why this research is dedicated to this aspect.

## **2.4 Research Questions**

The purpose of this study was to develop a holistic concept of implementing knowledge activities in the context of software engineering organisation.

Therefore, the overarching research question for this qualitative exploratory study was:

**RQ1.** *Which knowledge activities are related to which team practices and measures?*

*A subordinate research question to support the analysis and interpretation of primary data was:*

**RQ2.** *How should team practices and measures be combined in order to support a mixture of knowledge activities suitable for effective knowledge management in software engineering organisations?*

## **3 Research Method**

### **3.1 Qualitative Research**

In accordance with the proposed research questions, this study used a qualitative research approach. Although such a kind of qualitative research allows for observing a phenomenon in-depth (Eisenhardt and Graebner, 2007) and case study research seems to be appropriate, the authors of this paper decided to take a broader view that is not bound to a single case organization.

Specific contextual problems are related to software development and delivery that create general challenges in relation to knowledge management in projects. In terms of complexity, these challenges are related to the complexity of software development projects consisting of complex interactions among project members internally and externally. Qualitative research methods are helpful to analyse abstract constructs of observable phenomenon (Creswell, 2014).

This study is concerned with analysing how knowledge activities and their structured and purposeful implementation benefit software engineering

organizations. The underlying assumptions of this research were based on a partially phenomenological stance. According to van Manen (2007), a context-sensitive form of interpretive inquiry, the phenomenology of practice, is well suited to serve practitioners who in their day-to-day practice may be unaware of the depths of people's experiences. By constructing the realities related to knowledge activities in developing and programming software solutions in projects with multiple perspectives this qualitative empirical method composed summaries of lived experience and asked a group of experts to assess these practices. Thereby, the underlying patterns and structures of meaning can be drawn when a central feature of the phenomenon is considered (van Manen, 2016). The interpretive findings of this research may serve as the foundation for future empirically conducted researches aiming to measure the degree to which knowledge activities applied in software engineering projects contribute to the organizational knowledge base.

### ***3.2 Sampling and data collection***

Several factors contribute to the success of knowledge management activities within organisations including the firm's objectives, the enabling conditions and the environment, the knowledge processes including the dialogue between individuals and the individual's experiences (Nonaka and von Krogh, 2009). The implication here is that knowledge activities are best examined within the context where they take place. A key advantage of qualitative research is that the researchers are free to choose from multiple sources while still incorporating one's know-how to extract understanding.

In this research, data was collected through questionnaires. The study population included managers, project managers, developers, and other experts involved in software development projects for internal organizational purposes or for external client-related purposes.

The sampling strategy for the data collection followed the principle of convenient purposive sampling that requires recruiting from a group or organisations with a close perspective on the research phenomenon of interest from a group or organization (Creswell, 2014). In the case of the questionnaire, the convenient purposive sampling took place by posting the questionnaire on online research platforms (SurveyCircle) and social media (LinkedIn) approaching special expert group related to software project management, agile

methodologies. Although convenience sampling strategies do not allow generalising the findings due to the unknown population, it plays a prominent role in the field of business and management (Bryman and Bell, 2007). The expectation was to reach 50 participants with a self-administrated internet-mediated questionnaire. Table 2 illustrates the composition of the participants.

Table 2: Composition of the participants

<b>Role</b>	<b>Team Lead</b>	<b>Developer</b>	<b>Architect</b>	<b>Other</b>	
	40.48%	30.95%	5.95%	22.62%	
<b>Organisation employees</b>	<b>1 ... 10</b>	<b>11 ... 50</b>	<b>51 ... 250</b>	<b>251 ... 500</b>	<b>over 500</b>
	10.71%	7.14%	30.36%	12.50%	39.29%
<b>Organisation core business</b>	<b>Standard Software</b>	<b>Individual Software</b>	<b>Products incl. software</b>	<b>Services incl. software</b>	<b>Others</b>
	3.57%	19.64%	26.79%	26.79%	23.21%

In this research, RQ1 and RQ2 served as a guide for the review of the questionnaire data which was analysed by frequency analysis and the comparison of summarised agreement vs. disagreement to statements related to typical software development team practices and measures.

## 4 Results and Interpretation

### 4.1 Various companies' approaches to software development

Through the questionnaire responses were obtained from practitioners working for companies of 5 different scales. The vast majority of these companies develop individual software, software as part of a service or software as part of a product. Almost all of them use some mixture of software development methodologies while a significantly smaller number focuses on a single dominant one (used by more than 75%). While still 45% use the waterfall model to some degree, a vast majority uses an agile methodology (58%) or a mix of agile and traditional (54%).

### 4.2 How Team Practices and Measures correspond with Knowledge Activities

In the questionnaire, practitioners were asked to 'tag' team practices and measures with knowledge activities executed or fostered by them. The result can be seen in figure 3 where the respective bar lengths indicate relevance.

Part 1: Meetings	Acquire	Codify	Store	Maintain	Transfer	Create
Daily standups	■	■	■	■	■	■
Recurring longer meetings	■	■	■	■	■	■
Client Meetings	■	■	■	■	■	■
Retrospectives	■	■	■	■	■	■
Part 2: Development	Acquire	Codify	Store	Maintain	Transfer	Create
Design software	■	■	■	■	■	■
Write Code	■	■	■	■	■	■
Code Reviews	■	■	■	■	■	■
Pair Programming	■	■	■	■	■	■
Test each others' features	■	■	■	■	■	■
Part 3: Planning	Acquire	Codify	Store	Maintain	Transfer	Create
Collaborative Release Planning	■	■	■	■	■	■
Epics/Stories Reviews	■	■	■	■	■	■
Joint estimate software features	■	■	■	■	■	■
Part 4: Organisation	Acquire	Codify	Store	Maintain	Transfer	Create
Bring in new staff	■	■	■	■	■	■
Onboarding / Mentoring	■	■	■	■	■	■
Team assignment changes	■	■	■	■	■	■
Rotate responsibilities in the team	■	■	■	■	■	■
Cross-disciplinary task forces	■	■	■	■	■	■
Part 5: Learning & Documentation	Acquire	Codify	Store	Maintain	Transfer	Create
Contribute to documentation	■	■	■	■	■	■
Give presentations or training	■	■	■	■	■	■
Engage in Special Interest Groups	■	■	■	■	■	■
Attend Conferences	■	■	■	■	■	■
Part 6: Other	Acquire	Codify	Store	Maintain	Transfer	Create
Informal exchange in the kitchen	■	■	■	■	■	■
Informal gathering after work	■	■	■	■	■	■
Part.in Open Source projects	■	■	■	■	■	■
Part. in cross-disciplinary exchange	■	■	■	■	■	■

Figure 3: Team practices and Knowledge Activities

Generally, knowledge activities were found to correspond with the 6 parts categorising practices and measures:

- The four kinds of meetings show relevance in maintaining and transferring knowledge while client meetings also help to acquire and create knowledge. Retrospectives even relate significantly to all knowledge activities with the only exception of acquiring knowledge.
- Development exhibits an emphasis on codifying, transferring and creating knowledge.
- Collaborative planning helps in transferring, also to a lesser degree maintaining and creating knowledge.
- Organisational measures leading to permanent or temporary changes in team composition emphasise knowledge transfer, acquisition and creation.
- Learning measures and documentation cover all 6 knowledge activities to different degrees.
- Informal exchange and participation in external activities are helpful for acquiring, transferring and creating knowledge.

The above results, in particular the findings displayed in figure 3, answer RQ1.

#### **4.3 Most effective Team Practices and Measures**

Finally, RQ2 asks how team practices and measures should be combined in order to achieve a mixture suitable for effective knowledge management in software engineering organisations. While figure 3 already gives a good indication of how particular activities can be fostered, some team practices and measures were found to be of particular value because of their high relevance for some specific knowledge activities, like onboarding and mentoring (acquire and transfer knowledge), team membership changes (transfer and create knowledge). Others are attractive because of their versatility, like contributing to documentation, Retrospectives and Pair Programming.

This indicates that for instance Retrospectives should take place because of their correspondence with 5 out of 6 knowledge activities. While they are usually compulsory for Scrum teams this is not the case for many others, hence introducing them and making sure they are always held could be helpful in this context. Pair programming can give a boost when needed, even if there are reasons not to use it by default. Finally, in general, teamwork is beneficial not only for knowledge transfer, ideally while making changes to the team composition from time to time.

Of course, it needs to be understood that just introducing the above will hardly trigger an automatism not requiring any further steering or management: once a tool's potential is understood it should be introduced and then applied in a purposeful way allowing it to fulfil its potential.

### **5 Discussion and Conclusion**

Based on the responses obtained from practitioners using an online questionnaire, team practices and measures were investigated on their relation to six knowledge activities. The clearness with which connections to knowledge activities were identified indicates their applicability as a tool for decision making by project leaders in software engineering.

Most of the practices and measures originate from agile software development methodologies and are widely in use in the software industry, even in organisations not considering themselves as 'agile'. This is significant because it shows that development teams will usually not need to start from scratch or

sacrifice productivity for the sake of knowledge management. On a side note, this also corresponds with other researchers' findings of agile software development methodologies being more suitable for knowledge management because of their focus on communication and collaboration (Dissanayake *et al.* 2013; Heavin and Adam, 2014; C. Khalil and S. Khalil, 2019).

The findings highlight some particular practices' and measures' versatility in terms of knowledge management indicating their potential to add value to software projects. Hence team leaders do not even need to rely on a large number of them in order to achieve the desired mixture of knowledge activities. An organisation does not have to be 'agile' in order to benefit from this: elements like Daily Scrums or Retrospectives either have their equivalents in traditional methodologies or can be easily integrated.

Software project work is frequently subject to enormous time pressure. Teams dealing with knowledge efficiently have an advantage here, while unfortunately systematic knowledge management usually does not promise immediate return on investment. This is why blending well with existing work procedures and not coming at an additional cost are critical requirements. Relying on commonly-used procedures with some direct value to the software development process while understanding their potential in knowledge management fills this gap.

These outcomes may already sound familiar to experienced practitioners, however, increased attention, a more substantiated understanding of processes and measures and their relationship to knowledge-related aspects can contribute significantly to more sustainable team development with little or no overhead.

Future research will continue exploring the application of knowledge management in software engineering by investigating the here presented team practices and measures on their importance and software teams' proficiency in applying them and how this relates to organisations' characteristics like scale or preferred development methodology.

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## **Blockchain-Driven Process Innovation in Healthcare Ecosystems: a Business Process Management Capabilities Analysis**

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### **Abstract**

The Blockchain potential in enabling and boosting business process innovation in the Healthcare industry is a hot topic. However, the realization of such a potential is hampered by two hindrances. First, healthcare business processes are inherently complex. This implies additional difficulties in managing and innovating them. Second, the digitalization trend has entailed relevant changes in the capabilities needed to manage and innovate business processes. Yet, to our best knowledge, such changes have not been empirically

investigated to understand context-specific factors in driving digital innovation. Accordingly, this research aims at figuring out which may be the main Business Process Management capabilities needed to carry on Blockchain-driven Healthcare business process innovation. To fill this gap, we developed two exploratory case studies in the healthcare sector – one for probing a case of incremental business process innovation (BPI) and another one for investigating a case of radical BPI. The cases focused on the business process redesign phase of the BPM lifecycle.

This working paper illustrates and discusses the preliminary results of the incremental BPI case, which concern an Italian project of Blockchain-driven innovation of the national drug logistics process. The findings suggest that the Process Portfolio Management, Process Data Governance, and Multi-purpose Process Design BPM capabilities should be prioritized. Furthermore, they highlight that a new BPM capability – Process Risk Assessment – may be strongly relevant in the healthcare context. These preliminary results integrate the BPM research stream and provide practitioners with actionable insights.

**Keywords** – Blockchain, Business Process Management, Business Process Innovation, Drug Logistics, Healthcare.

**Paper type** – Academic Research Paper

## 1 Introduction

The digitalization trend is increasingly challenging Business Process Management (BPM) (Baiyere et al., 2020; Lederer et al., 2017). In light of the innovation potential brought by digitalization, BPM can no longer be conceived only as the classic notion of reaction-based, problem-driven analysis and incremental enhancement of already adopted business process configuration (Dumas et al., 2018). Instead, it has to harness the generative capacity of the new digital-driven opportunities and the radical Business Process Innovation (BPI) it may enable (Berger et al., 2018; Eck et al., 2015; Kohlborn et al., 2014; Mendling et al., 2020; Tilson et al., 2010). Rosemann (2014) formalized this change in the ambidextrous BPM concept, described as the combination of "exploitative BPM" (i.e., the traditional BPM conception, which is associated with incremental BPI) and "explorative BPM" (i.e., the exploitation of digital-based opportunities to carry on radical BPI).

In the current digital technology landscape, Blockchain has been largely proffered as an enabler of incremental and radical innovation of inter-organisational business processes (Chang et al., 2019; Holotiuk et al. 2019; Mendling et al., 2018). Although the financial service industry had initially

monopolised the exploration of the Blockchain innovation potential (Swan, 2015), other industries, e.g., Insurance, Logistics, Agriculture and Food, Energy Management, have turned their attention on this topic (Al-Jaroodi et al., 2019). In this regard, Healthcare is getting the lion's share because Blockchain may tackle notorious issues that characterise this sector, such as data security and privacy (Esposito et al., 2018), lack of trust in sharing information among stakeholders (Tandon et al., 2020), supply control over cold chain interruption and drug counterfeiting and recall (Singh et al., 2020; Tseng et al., 2018), cross-institutional and cross-border data sharing (Omar et al., 2019).

Yet, while Blockchain may unfold and boost BPI in Healthcare ecosystems, harnessing its potential may be hampered by two hindrances. First, Healthcare business processes are complex because they: are knowledge-intensive; involve several heterogeneous business and medical functions; encompass medical practices that change and evolve over time; and are patient-dependent, i.e., each process instance exhibits specific – often unique – patterns/traces and highly variable control parameters (Antonacci et al., 2018; Reed et al., 2018). This complexity may make BPI harder to pursue because it entails not-to-underestimate difficulties in generating easy-to-interpret process models, analysing process performance and conformance, and orchestrating and coordinating concurrent processes and actors that use shared resources (Mans et al., 2015; Rebuge and Ferreira, 2012). However, most Management academics analysed drivers, limitations, and social and technical challenges of adopting Blockchain in Healthcare services (Khezzr et al., 2019; Pandey and Litoriya, 2020; Tandon et al., 2020; Tripathi et al., 2020). Thus, Blockchain-enabled BPI in Healthcare is a little-investigated topic.

Second, the changes brought by digitalization have deeply affected the capabilities needed to carry on BPM and to pursue BPI. This update concerns almost all the BPM capabilities (cf. de Bruin and Rosemann, 2007), particularly the cultural, individual, methodological, and Information Technology ones (Kerpedzhiev et al., 2021). This is not surprising, since digitalization is a socio-technical phenomenon involving a deep transformation in technological and behavioural aspects (Bockshecker et al., 2018). Yet, this shift in BPM capabilities has not been empirically investigated in depth and calls for further analysis in different contexts (Kerpedzhiev et al., 2021).

In light of digitalization, BPI in Healthcare is thus a worthwhile albeit challenging endeavour. Nonetheless, to the best of our knowledge, the BPM

capabilities needed to conduct Blockchain-enabled BPI are little known and largely unaddressed. Accordingly, we aim at answering the following Research Question:

*"What are the main BPM capabilities necessary to carry on Blockchain-driven Healthcare business process innovation?"*

In answering the Research Question, we focused on the business process redesign phase of the BPM lifecycle (Dumas et al., 2018). From a scientific perspective, this may contribute to the BPM research stream by pinpointing the main capabilities and challenges needed to innovate Healthcare business processes through Blockchain. In addition, it is an attempt to combine typical BPM approaches with empirical field work to advance the understanding of context-specific factors in driving digital innovation (Mendling et al., 2020). From a practitioner perspective, embedding the Healthcare ecosystem complexity in the technology-driven innovation initiative may be beneficial to a deeper exploitation of the Blockchain innovation potential. In doing so, the findings may provide managers with actionable insights on which BPM capabilities should be prioritised.

To pursue our research objective, we conducted two exploratory case studies in the Healthcare industry. The first one focused on the drug logistics process to investigate a scenario of incremental innovation, meant as improved data exchange integrity. The second one concerned the home care process to probe a scenario of radical innovation, intended as the development of unprecedented forms of process choreography hardly achievable by other technologies. This working paper focuses on the incremental innovation case study, expounding and discussing its preliminary results.

The remainder of this work is as follows: Section 2 illustrates the research design; Section 3 presents the results; Section 4 discusses them; Section 5 concludes the paper.

## **2 Research design**

Two exploratory, single-case studies were developed according to the guidelines by Pan and Tan (2011). The case study research method was chosen because it is suitable for studying a phenomenon in real-life settings when no control over behavioural events is required to the investigator(s), the phenomenon focuses on contemporary events, and when capturing the context

of the phenomenon is of utmost importance (Cavaye, 1996; Yin, 2013). The selected case type was exploratory because it fits the exploratory nature of our research question (Tellis, 1997). Furthermore, it is suitable for the situations in which an intervention or a phenomenon – the Blockchain-enabled BPI – has multiple, no clear outcomes (Baxter and Jack, 2008; Yin, 2013). The case design was single-case because our case studies are revelatory in nature, i.e., they investigate a rather unexplored phenomenon and aim at being an unprecedented source of insight on it (Yin, 2013). Indeed, the BPM capabilities for digital innovation have been more theorised rather than being actually explored. In addition, single cases may lead to a deeper understanding of the exploring subject (Dyer and Wilkins, 1991).

This working paper focuses only on one of the case studies, whose research design is detailed in the following. The case study investigated a national Italian project that aims at achieving incremental Blockchain-enabled BPI in a national drug logistics process. The objective of the project is to facilitate accurate information sharing regarding drug inventory across the national pharmaceutical supply chain to guarantee drug availability and compliance. The unit of analysis is thus the overall drug logistics process, including its innovation goals and its information and resource needs. We chose this project as an exploratory example of business process incremental innovation because carrying drug logistics out in the best possible way is critical to healthcare ecosystems for three reasons. First, it guarantees drug supply continuity to avoid supply starvation. Second, it is essential to preserve the quality of the drugs until their storage in their final destination. Third, it may cope with the well-known inefficiency of pharmaceutical supply chains (Papalexi et al., 2020).

The objectives of the case are to contextualize the project and to collect the necessary data to:

1. Model the drug logistics process before the Blockchain implementation, i.e., the as-is business process, and the re-designed process needed to introduce the Blockchain, i.e., the to-be business process.
2. Identify which BPM capabilities are needed to enable BPI through Blockchain.

The case data were collected by semi-structured interviews. The data collection started with a kick-off meeting with the Project Manager of the project to obtain an overview of the whole initiative and its objectives, phases, milestones, and challenges. During this meeting, the key informants were jointly identified

according to the following criteria: representativeness of the main project stakeholders; commitment to and sponsorship of the project; knowledge about the drug logistics process, the requirements according to which to re-design the process, and the resource and information needs. The interviews with the key informants (Table 1) were carried out until saturation, for a total of eighteen interviews. Further minor information exchange regarding additional details on quantitative aspects was arranged by additional video conferences and phone calls.

Table 8. Detail of the semi-structured interviews

Key informant	Timeframe
Project Manager	A first 2-hour meeting; a second 1-hour meeting
IT manager of the project	Two 2-hour meetings
International primary distributor	One 1.5-hour meeting
Two national primary distributors	Three 1-hour meetings per person
Supply Chain manager from three different regional purchasing bodies	One 1.5-hour meeting per person
One pharmacist from ten hospitals	One 1.5-hour meeting per person

The design and development of the question set followed the three steps recommended by McIntosh and Morse (2015). First, in line with the research question, the domain of the topic under investigation was defined and bound by analyzing the pertinent BPM and BPI literature and leveraging the authors' background, as suggested by Rabionet (2011). Second, in line with the case objectives, two categories were identified to develop the questions: "logistics process" and "BPM capabilities". The "logistics process" category includes all the main components of a business process, i.e., activities, relations among activities, resources, information flow, boundaries, and procedures (Dumas et al., 2018). The "BPM capabilities" category covers the five BPM capability clusters specified in the framework by Kerpedzhiev et al. (2021), i.e.: Strategic Alignment, Governance, Methods and Information Technology, People, Culture. For further detail on the BPM capabilities, please refer to the original manuscript. Third, the question stems were developed for both the categories. The questions were refined by a pilot test (Adams, 2015) conducted with the Project Manager. The interviews were



conducted from January to June 2021 and were recorded, transcribed, and enriched by field notes. The interview data were complemented by the analysis of project documentation and archival records. All the case data were arranged in a case archive (Yin, 2013).

The main case evidence was reviewed with the key informants. The case data were synthesized and coded into themes by the three-column approach by Saldaña (2015). The coding procedure was driven by the research question, with particular attention to informants' responsibilities, project drivers and objectives, Supply Chain configuration, and technological context (cf. Saldaña, 2015). The authors were split into two groups that concurrently carried out the coding procedure manually in two steps, which are detailed in the following:

- From raw data to preliminary codes. The chunks of raw data were analyzed to elicit the "preliminary codes". A preliminary code is the conceptual units representing the main concepts expressed by one or more consecutive sentences. This first step reduced the amount of data to manage by focusing on the most essential concepts expressed by the data.
- From preliminary codes to final codes. Based on a conceptual homogeneity criterion, the preliminary codes related to each question were gathered and synthesized into analytical categories (Schmidt, 2004), called "final codes". The final codes from each verbal interchange were compared to each other to remove any duplication.

After each step, the outcomes from the two groups were discussed jointly to reach consensus. The synthesized data were arranged according to the "logistics process" and "BPM capabilities" categories and steered the development and the discussion of the case findings.

### **3 Case study findings**

This section presents the preliminary case study results. In the first part (Section 3.1), it illustrates the drug supply chain in which the logistics process is put in place. In the second part (Section 3.2), it details the process incremental innovations that the Blockchain project aims at achieving. In the third part (Section 3.3), it expounds the most important BPM capabilities to enable the Blockchain-driven incremental innovation.

### 3.1 The drug supply chain

The supply chain is complex and illustrates different stakeholders:

- *Manufacturer.* The manufacturer purchases the drug raw materials (active ingredients) from the supplier and processes them in the manufacturing plant to produce the desired prescriptions. The produced drugs are then sold or delivered to the distributor, who further retails them to the downstream stakeholders.
- *Primary Distributor.* Primary distributors hold and distribute medicinal products to secondary distributors and to hospitals and territorial retailers, such as pharmacies, on behalf of manufacturers. Therefore, they do not have ownership of the medicinal products. They also offer a variety of specialized services such as specialty drug distribution, packing, and repackaging of drugs.
- *Secondary distributor.* Secondary distributors have ownership of the medicines they distribute. They purchase medicines from manufacturers and resell them to hospitals and territorial retailers, such as pharmacies.
- *Hospital System.* In Italy, the hospital system is managed centrally or in a decentralised manner depending on the region/area. In the first configuration, manufacturers and/or secondary distributors ship their products directly to a central hub. In this central logistics centre, shipments are broken down into smaller units, repackaged, stored, and then directly delivered to the hospital wards (Azzi et al. 2013). The hospital pharmacies have the role of validating ward requests, sharing information, etc. On the contrary, in the decentralised configuration, manufacturers and/or secondary distributors ship their products, through eventually intermediaries, directly to the hospitals' warehouses, which store the products until they were needed.
- *Pharmacy.* They purchase drugs from manufacturers and/or secondary distributors and sell them to end consumers (patients).
- *Patient.* The patient can be a part of the pharmaceutical supply chain as it buys the medicines directly from the pharmacy or it receives them during his hospitalization.
- *Drug Regulatory Authority.* The role of the drug regulatory authority includes checking and maintaining the quality, safety, efficacy, and availability of pharmaceutical products.

Fig 1 shows the structure of the pharmaceutical supply chain, highlighting both physical and information flows.

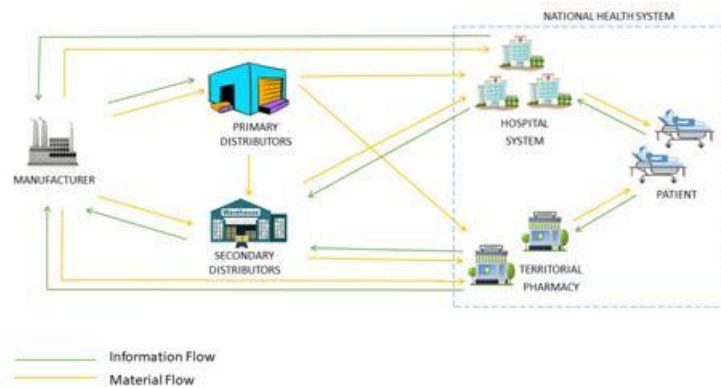


Figure 12. The drug logistics Supply Chain

More in detail, the downstream process begins with the doctor prescription based on the drug therapy defined for a specific patient. Such prescription is sent to the nurse, who verifies the drugs availability and administers the therapy to the patient in accordance with the prescription.

At fixed intervals and independently by the prescription, the nurse checks the drug inventory, manage drug's expiration dates, and quantify the drug needs. Based on the control, the nurse prepares a Refill Request (RR) to the hospital pharmacy or to the central hub, depending on the organizational model. The RR can be regular or urgent based on the in-stock situation. Once a RR is received and validated, it is processed by the warehouse workers and the related documentation prepared. The central warehouse outsources delivery to wards, while hospital pharmacies manage it in-house.

Based on the replenishment policy, the hospital pharmacy/central hub periodically prepares a Purchase Order (PO) to the manufacturer and/or the secondary distributor. The former assigns the PO management to the primary distributor, generally a third part, who prepares and packages medicinal products according to the PO and ships them to hospital warehouses and/or central hubs. The latter sells and ships medicinal products directly to the central hub/hospital pharmacy. Delivery is outsourced in both cases. The same process is followed by territorial pharmacies.

### 3.2 Use cases of Blockchain-driven process improvement

#### 3.2.1 Shipment traceability

The pharmaceutical supply chain is generally a cold chain, in which the temperature of the medicines should be maintained in a specified range throughout the journey (Sunny et al., 2020). Accordingly, such supply chain is inherently vulnerable to many critical points at various stages. Specifically, the temperature and humidity should be maintained both in the storage areas of the warehouse and during the transit as per the specifications. However, currently, the shipment is not monitored in real time and thus it is difficult to trace and certify the party who violated the specifications. As a consequence, any non-conformities may only be detected at the time of delivery or may not be detected at all. Figure 2 shows the as-is scenario. The actors are: distributor, carrier, and receiver.

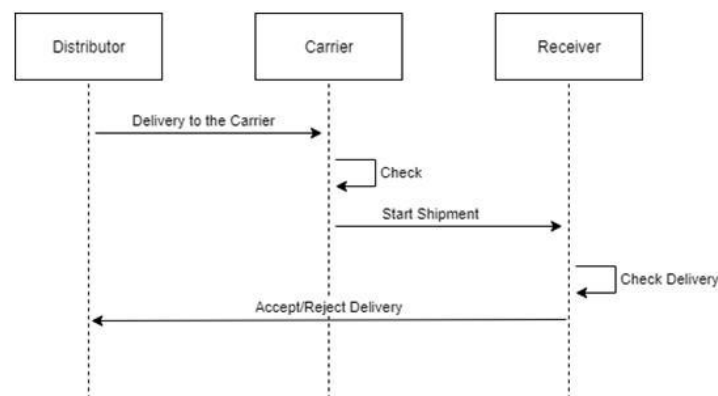


Figure 13. As-is scenario of drug shipment traceability

More in details, the distributor packages the drugs and delivers them to the carrier. The container is equipped with a data log that collects data on the status of the delivery (localisation, temperature). Before departure, the carrier checks the status of the truck's refrigerators to avoid nonconformities. Once delivered, the receiver verifies the accordance between the package, the purchase order, and the delivery note. He also checks the integrity of the package through the data recorded on the data log. In case of non-compliance, the shipment is refused. The combined use of an IOT sensor embedded in the container and a blockchain-

based logistics platform can enable a real-time monitoring of the shipment and allow to certify the responsibility of the actions. In Fig. 3, we present three different to-be scenarios, including a blockchain-based system, with and without temperature violations during the shipment. The main actors are: distributor, carrier, IOT sensor, blockchain-based logistics platform, and receiver.

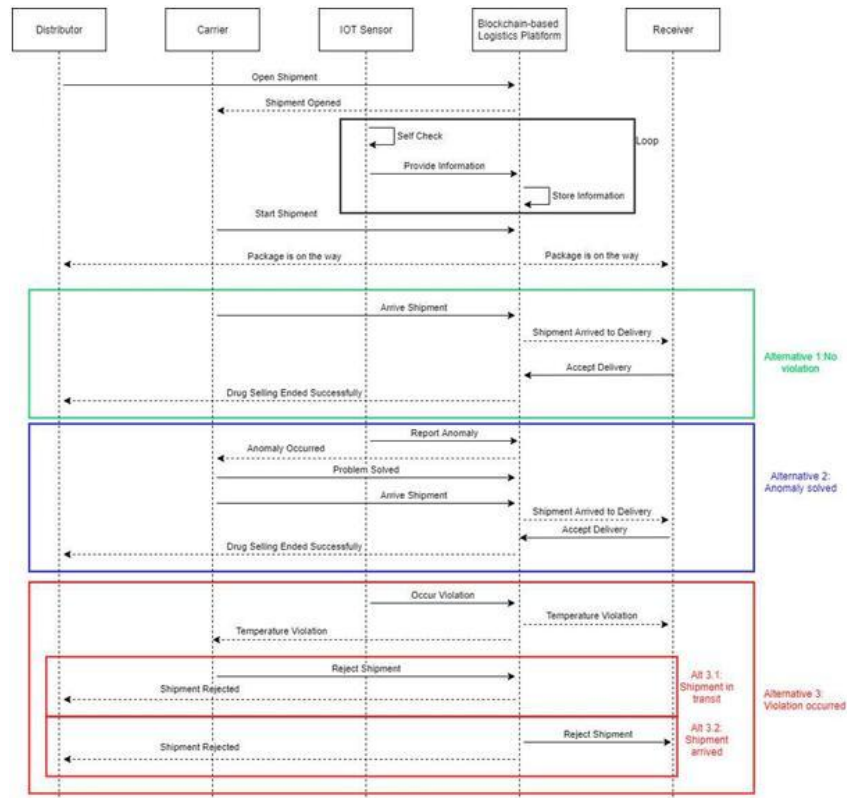


Figure 14. To-be scenarios of drug shipment traceability

Firstly, the distributor adds shipment information on the platform, including drugs to be delivered (e.g., type, lot number and expiration date, quantities, etc.), the place of departure and of delivery, the receiver, and shipment conditions (temperature, humidity, etc). Then, the IOT sensor starts to measure and record temperature and other parameters (geographic location, unexpected container opening, etc.) in real time and provides them to the platform, until the end of the ship. This enables to check whether the shipment conditions are in accordance

with the agreed terms during the transit of the container. At the same time, the carrier notifies to the platform the start of the shipment. If no violations have occurred (see alternative 1 in Figure 3), the shipment is accepted by the receiver. Alternatively, if any anomaly has occurred, the platform alerts the carrier, allowing him to solve the problem, before the arrival of the shipment (see alternative 2 in Figure 3). Finally, in case of any agreed parameters have been violated, the platform notifies the situation to the carrier or to the receiver (see alternatives 3.1 and 3.2 in Figure 3), and the shipment is aborted. In so doing, the system can allow the shipment to be stopped as soon as the violation occurs, without necessarily waiting for the end of the delivery.

### 3.2.2 Information sharing

The unavailability of medicines is a critical issue involving all actors in the pharmaceutical supply chain. This is aggravated by the current lack of information sharing on stock levels between them.

More in details, Figure 4 shows the as-is scenario with no information sharing between the actors upstream and downstream in the supply chain. In the first case, the main actors are: distributor, carrier, and receiver; while, in the second case, are central hub, carrier, and hospital ward.

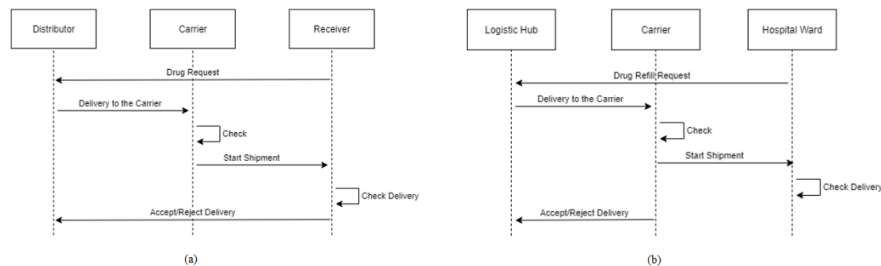


Figure 15. As-is scenario of drug information sharing

Once a PO or a RR is received, the package is prepared and delivered to the carrier, who will hand it over to the receiver (or hospital ward). At the end of the delivery, the receiver may accept or, in case of non-compliance, reject it. Up-to-date stock information are only used by the distributor or by the central hub to manage the warehouse and plan orders to the manufacturer.

The use of blockchain can enable the actors upstream and downstream in the supply chain to know the stock levels of products and their actual availability in

each area (regions or sub-regions), guaranteeing the privacy and anonymity of the information.

Figures 5 and 6 show the to-be scenarios, including a blockchain-based system, with information sharing between the actors upstream and downstream in the supply chain. The main actors are: manufacturers, distributors, central hubs, blockchain-based platform, hospital wards, and Drug Regulatory Authority.

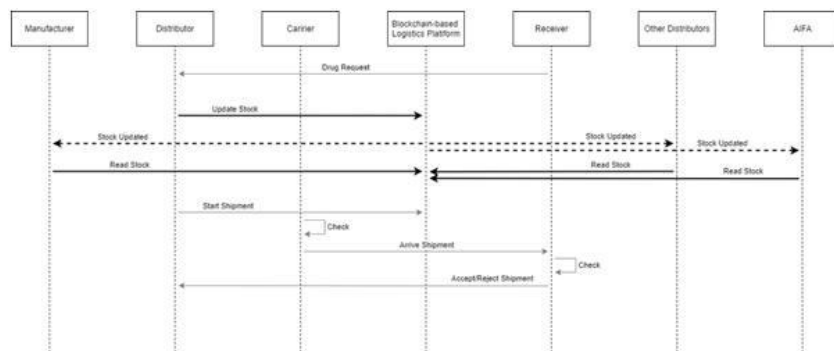


Figure 16. To-be scenario of drug information sharing among Supply Chain actors upstream

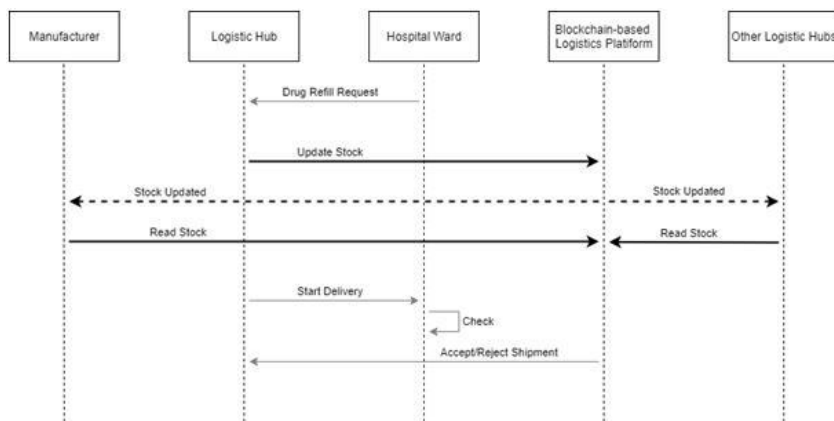


Figure 17. To-be scenario of drug information sharing among Supply Chain actors downstream

Once a PO or a RR is received, the package is prepared and delivered to the carrier. At the same time, stock updates are sent to the blockchain platform, which verifies that the required information are inserted on time by the

authorised actors. Then, such platform processes stock information, aggregated for example by geographical area, and shares it with the other actors in the supply chain. In so doing, as shown in Figure 5, upstream in the supply chain, both manufacturers and the drug regulatory authority can be able to see actual stock levels in the different areas, while distribution-side nodes can be able to see warehouse information (in terms of ID and distributor/logistic hub). On the contrary, as shown in Figure 6, downstream in the supply chain, central hubs can have visibility on the stock levels and on the availability of expiring drugs in the national territory. In this way, they can be able to better manage urgent situations or unexpected shortages. subsequently, as in the AS-IS scenario, the carrier delivers the package to the receiver/hospital ward, who verifies its quality and compliance with the order. In case of non-conformity, the delivery is refused.

### **3.3 Priority BPM capabilities**

The evidence obtained with the interviews highlights that 3 out of 5 capability clusters specified in the framework by Kerpedzhiev (2021) are of greater relevance in case of incremental BPI: Strategic Alignment, Governance, and Methods & Information Technology. Specifically, the first group of capabilities allowed to define the expected process improvements guaranteeing the lining up between the project goals and the aims of the involved organizations. These capabilities were particularly important in the process under analysis due to the high number and heterogeneity of the participating subjects (i.e., manufacturer, primary distributor, pharmacy, drug regulatory authority, etc.). Governance cluster capabilities led the actions of the project team during the process redesign activities through the definition of appropriate standards and guidelines. For example, the definition of privacy and cybersecurity guidelines prompted the devising of implementation logics of the blockchain-based system. Methods & Information Technology capabilities were also important, in particular for driving the most operative activities of the innovation implementation – e.g., specific requirements were identified for the integration of the existent IT systems with the new blockchain system since the presence of numerous different information systems.

The minor relevance of the two remaining clusters, People and Culture, appears to be related to the incremental nature of changes implemented, which are expected to slightly affect working practices and stakeholder relationships.



Analysing in detail each capability in the framework by Kerpedzhiev (2021), the preliminary results show that three capabilities – Process Portfolio Management, Process Data Governance, and Multi-Purpose Process Design – are of the greatest importance during the blockchain project under analysis. The Process Portfolio Management capability allowed to take into account effectively dependencies among inter and intra-organizational processes during the devising of the BPI. This element revealed to be crucial as the drug logistics process involves multiple functions and, most of all, several organizations which therefore imply the handling of many interactions. The evidence about Process Data Governance is related to both the process characteristics and the technology exploited. Indeed, the healthcare processes, and the drug logistics one is no exception, need to have very high reliability in the data produced and exploited. In parallel, blockchain-based systems can adequately meet this requirement but they require the definition of standards and guidelines for managing the process data, identifying the sources of data –for example in terms of actors – and the users of data. Multi-purpose process design capability revealed to be critical because it permitted to manage the process fragments in which the drug logistics process is divided and to obtain a unified process design, keeping into account the main decision points in the process and the operational needs of all subjects involved.

In addition to these three capabilities, the case study underlined a further essential element, the Process Risk Analysis. This capability, which appears to be quite overlooked by the framework of Kerpedzhiev (2021), was very useful because it allows to carry out an effective analysis of the main critical points for the correctness and cybersecurity of the data along the drug logistic process. The significance of Process Risk Analysis is linked to the nature of the blockchain technology, since it is usually employed to certify the correctness of the information, and the characteristics of the healthcare field, where the reliability of the information must be maximum given the potential serious side effects on patients.

#### **4 Discussion**

The project we analyzed exploited Blockchain to enable incremental BPI in the drug logistics process. The innovation did not require a significant process re-design. Indeed, the to-be processes show a re-design of the information flow only. Thus, the project intends to introduce Blockchain to enable new

functionalities (e.g. advanced traceability and information sharing) without entailing significant deep changes in the process flow.

In this regard, the risk assessment capability is of the utmost importance. This assessment should be carried out on the process events to figure out which data the Blockchain should certify to guarantee the requested performance, e.g., to assure that the right drug stocks are stored in the supply network or that the cold chain is not interrupted. Without this risk analysis, the selected event data may be less than necessary. This may jeopardize the achievement of the objective for which the Blockchain is developed. In other cases, the selected event data may be more than necessary. This may widen the scope of the Blockchain implementation, entailing additional unnecessary costs and managerial efforts.

The Process Portfolio Management capability is needed to prioritize the business processes to innovate. Indeed, the data that the Blockchain may certify are generated by different business sub-processes. These sub-processes should be correctly identified within the process portfolio according to the purpose of the Blockchain initiative. This process-driven approach is consistent with the well-acknowledged nature of the Information Systems implementation, which should be steered by process requirements and not by technological requirements (e.g., Arif et al., 2005).

The Process Data Governance capability should define standards and guidelines for data management. In particular, these standards should stress privacy and security aspects. Although Blockchain is largely proffered as a solution to privacy and security issues in information sharing, only a small set of blockchain platforms can actually cope with them (Zhang et al., 2019). These issues are even more felt in the Healthcare context because healthcare data include personal and private data that have to be correctly managed (Yüksel et al., 2017). Furthermore, for the Blockchain to work, information integration and interoperability among the stakeholders that participate in it must be guaranteed.

The Multi-purpose Process Design capability suggests leveraging process fragments to design business processes in a collaborative way (Kerpedzhiev et al., 2021). This is particularly relevant for healthcare ecosystems, in which business processes are often inter-organizational. In this context, the data that a Blockchain may certify are generated by several business processes. This certification may be conceived as a proxy business process built by means of different process fragments that are combined and integrated with each other by

the Blockchain. Without the Blockchain, it would be pretty challenging to reconstruct a single process instance referring to a unique process pattern.

## 5 Conclusions

This research aims at answering the following Research Question: "*What are the main BPM capabilities necessary to carry on Blockchain-driven Healthcare business process innovation?*". To do so, we developed two exploratory case studies in the healthcare industry. The cases investigated the re-design phase of the business process management lifecycle. This working paper presented the preliminary results from the first case. This case focused on the Blockchain-driven incremental innovation of the drug logistics process.

The results showed that the Process Portfolio Management, Process Data Governance, and Multi-purpose Process Design capabilities, defined in the BPM capability framework by Kerpedzhiev et al. (2021), should be prioritized over other BPM capabilities. In addition, we found that a new unprecedented capability, i.e., Process Risk Assessment, may be fundamental to enable Blockchain-enabled incremental BPI.

These outcomes may integrate the BPM research stream by responding to the call by Kerpedzhiev et al. (2021) to analyze which BPM capabilities may be relevant in specific contexts. In so doing, we did a first step in answering the call by Mendling et al. (2020), which stressed the need to combine typical BPM approaches and empirical field work to advance the understanding of context-specific factors in driving digital innovation. Furthermore, from a managerial perspective, our findings suggest prioritizing four specific BPM capabilities to conduct a Blockchain-driven incremental BPI initiative in the healthcare context.

However, this working paper is not free from limitations. First, it presents only the preliminary results of our research. Thus, further reflection on the outcomes is definitely needed. Second, the single case study may limit the external validity of our conclusions. Third, the detected capabilities cannot be interpreted as Critical Success Factors because we limited our inquiry to the re-design phase of the drug logistics process.

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## Does Culture Impact the Inversion of the Flow? National Culture and the Reverse Innovation

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### Abstract

In the recent years, a new typology of innovation emerges in the global innovation literature: i.e., the Reverse Innovation. The term was introduced by Immelt, Govindarajan and Trimble (2009) to refer to innovations that are originated in emerging countries and later launched in advanced economies. This phenomenon has been mostly neglected by scholars and it misses a complete understanding of which are the potential drivers and obstacles. The aim of our work is to understand if and how cultural factors could impact the inversion of the flow, increasing or slowing the process. A cross-cultural approach to the Reverse Innovation is totally absent and could help scholars and managers in understanding how to implement it successfully, even in culturally distant context. The study focuses on two different types of barriers: cognitive - more relevant in the mature economies - and operational (in terms of infrastructure) - crucial in the emerging countries-. This theoretical paper presents six propositions, elaborated on the Hofstede's cultural dimensions of Power Distance, Individualism and Uncertainty Avoidance.

**Keywords** – Reverse Innovation; diffusion; process, cognitive barriers, operational barriers, culture; Hofstede

**Paper type** – Academic Research Paper

## 1 Introduction

Considering the uncertainty coming from the actual pandemic situation, the traditional innovation paradigms could change even faster than how we think. Thus, what if innovation comes from unexpected areas? Although innovation, in terms of product, service or process, is generally considered as costly, path dependent, and risky (Zanello, Fu, Mohnen, & Ventresca, 2016), nowadays it is no more a distinctive and exclusive feature of developed countries. Indeed, a new phenomenon is arising within the global innovation literature: Reverse Innovation (RI). The term was firstly introduced recently in 2009 by Immelt, Govindarajan and Trimble: while discussing about the GE handheld electrocardiogram device and the PC-based ultrasound machine, the authors proposed the term Reverse Innovation as “the opposite of the *glocalization* approach that many industrial goods manufacturers based in rich countries have employed for decades” (Immelt, Govindarajan, & Trimble, 2009, p. 3). According to the authors, indeed, the *glocalization* approach allows multinationals to create high performance product/service in and for their home market, and further spread them globally, adapting the innovation to the local context. By contrast, Reverse Innovation entails “creating fundamentally different products to meet the needs of people in these markets” (Govindarajan & Euchner, 2012, p. 13), without necessarily lowering the price. Surely, as the authors explain, affordability is a reality to face in emerging countries, since people will have a different purchasing power. Moreover, Reverse innovation, following an inverted flow of diffusion is not a necessity-driven strategy aimed at overcoming challenges and increasing competition, but rather it is a planned opportunity-based diffusion process. Thus, we consider the Reverse innovation as a process in contrast with the well-known Theory of the product life cycle Theory of Vernon, according to which firms flow internationally only in the third phase of the product’s life, i.e., the maturity (Vernon, 1966).

The focus on the emerging context as areas of origin for innovations is due to a change of perspective: nowadays, emerging economies have become the “hotbeds of innovation” (Petrick & Juntiwarakij, 2011, p. 24; Hadengue, de Marcellis-Warin, & Warin, 2017) in different sectors, from healthcare to transportation and “the new epicentre of global growth” (Shan & Khan, 2016, p. 1). This represents a serious challenge for western firms, to whom will be



demanding for a complete rethink of the innovative strategies (Petrick & Juntiwassarakij, 2011).

Although RI has several practical and empirical implications, the phenomenon, because of its newness, has not been deepened enough. In order to fill this gap, and provide useful insights, this theoretical paper adopts a cross-cultural approach, aimed to theoretically explore the role of national cultures in potentially inhibiting or incentivizing the diffusion of a Reverse Innovation by raising or lowering barriers to the process of moving an innovation from an emerging market to an advanced economy.

Specifically, our study focuses on two types of barriers that might be influenced by national cultural traits: (a) cognitive barriers, which may influence perceptions about Reverse Innovation and affect its diffusion; (b) operational barriers, which may either drive or inhibit initiative to promote RI diffusion. The first types of barriers may be particularly relevant in mature economies, since RIs from less advanced markets may be perceived as inferior and thus not easily accepted in some nations. The operational barriers, though, will be more impactful and challenging in the emerging, where lack of resources, infrastructure and entrepreneurial initiative could strongly discourage the inversion of the flow.

## **2 Literature review: the impact of culture on the traditional diffusion**

To the best of our knowledge, within the existing emerging literature of Reverse Innovation, it is completely missing a strand investigating the impact of culture (both in terms of national and organizational) on the inversion of the flow. Therefore, to fully understand this reversed flow, we referred to the established literature on the traditional diffusion process. The term “diffusion” expresses the process thanks to which innovations are used by different members of a social system over the time (Rogers, 2010; Zhang & Vorobeychik, 2019); while “innovation” indicate not only new technological product or service but also to “the spread of ideas and practises” (Zhang & Vorobeychik, 2019, p. 2)

Several studies have shown that, among different theoretical perspectives, such as those related to the nature of innovation (Rogers, 2010; Zanella, Fu, Mohnen, & Ventresca, 2016), relevant insights can come from institutional theory. This theory postulates that how an innovation diffuses in a market (Peres, Muller, & Mahajan, 2010) depends on three pillars, namely the cognitive pillar, the

regulatory pillar, and the normative pillar (Scott, 2007). The regulatory pillar, arising from economic studies, relies on sanctions and conformity, which act as guidelines. The normative pillar consists of organizational and individual behaviour model, which depends on what is socially expected for an institution. The third and last pillar is designed according to rules and beliefs at the individual level, that build the individual behaviour (Scott, 2007). Together, all these factors potentially influence the diffusion of an innovation, but the first pillar seems to be the most influential and relevant (Bruton, Ahlstrom, & Li, 2010). Indeed, scholars argued that cultural values deserve special attention for their role in the diffusion process (Takada & Jain, 1991; Zanello, Fu, Mohnen, & Ventresca, 2016; Yaveroglu & Donthu, 2002; He & Lee, 2020).

The previous mentioned scholars agreed on suggesting the extension of the classical diffusion models, such as the Bass model (Van den Bulte & Stremersch, 2004; Peres, Muller, & Mahajan, 2010) which studies the shape of the diffusion curve under certain starting conditions, or the agent-based model, which is essentially related to individual perceptions or user adoption behaviour (Desmarchelier & Fang, 2016; Zhang & Vorobeychik, 2019). Further, they argue that adopting a country-level perspective (Peres, Muller, & Mahajan, 2010; Desmarchelier & Fang, 2016) and including culture as an uncontrollable factor influencing innovation diffusion can expand our understanding of the phenomenon (Takada & Jain, 1991).

Scholars have focused specifically on various typology of cultural traits: some refers to cultural dimensions identified by Hofstede and have analysed how these traits are responsible for increasing or slowing the diffusion of innovation. Based on Hofstede's definition, we can define culture as "the collective programming of the mind that distinguishes the members of one group or category of people from others" (Hofstede, Hofstede, & Minkov, *Culture and organizations: software of the mind, intercultural cooperation and its importance for survival*, 2010, p. 6) and cultural dimensions as "an aspect of a culture that can be measured relative to other cultures" (Hofstede, 2011, p. 7). Others, for instance Takada et al. (1991), by means of Hall's concepts of high or low context, hypothesized and proved a country effect on the rate of adoption of consumer durable goods. According to the authors, in high context culture the rate of adoption is faster (Takada & Jain, 1991). Thus, several studies show how specific traits of national cultures affect the diffusion of innovation differently. For example, Dwyer (2005) shows how cultures that avoid uncertainty hinder the diffusion process of an innovation. In the same

vein, Tellis et al. (2003), Yaveroglu and Donthu (2002), and He and Lee (2020) show how uncertainty avoidance is negatively related to innovation diffusion in the early stage. In contrast with the previous, Desmarchelier and Fang (2016), in their simulations, demonstrate a positive influence of the uncertainty avoidance dimension on the cross-border diffusion rate of innovations. Further, Yaveroglu and Donthu (2002) and later He and Lee (2020) elaborate on this topic by investigating the role played by the dimensions of individualism and power distance on the early stage of innovation diffusion. Their results demonstrate that where there is high individualism and low power distance, there will be a high innovation rate (Yaveroglu & Donthu, 2002). Adopting a different approach, He and Lee (2020) explore how individualism and power distance impact on the speed of diffusion in the early stage: the first dimension is positively related, while the second is negatively related. In agreement with Van den Bulte and Stremersch (2004), individualism is shown to have a positive effect, while power distance a negative effect. In fact, the measures of individualism are also found to be correlated with the national innovation rate by Taylor and Wilson (2012). The authors, nonetheless, pointed out that different types of collectivism, such as patriotism, could enhance the innovation rate at national level "when it encourages society-wide efforts to develop scientific and technological solutions to national problems" (Taylor & Wilson, 2012, p. 245). According to Yaveroglu (2002), however uncertainty avoidance and power distance will both have a positive relationship in the post-initial stage of diffusion.

While the majority of scholars agree on the positive effect on individualism, Desmarchelier and Fang (2016) found out a negative influence of the dimension on the cross-border diffusion rate of innovations.

As showed above, although hugely discussed, different results are discussed in the extant literature: particularly, the most ambiguous dimension seems to be the uncertainty avoidance, which represent a challenge also in other strand of the literature. Nevertheless, these studies on the interaction between culture and innovation diffusion are entirely focused on the usual/traditional diffusion flows, where innovation starts in mature markets and then moves to the emerging. Meanwhile, studies aimed at exploring how culture can influence the diffusion of Reverse Innovation are still very few, generally the literature is still fragmented and almost based on anecdotal evidence (von Zedtwitz, Corsi, Sørberg, & Frega, 2015) and success stories (Hadengue, de Marcellis-Warin, & Warin, 2017). The cross-cultural approach to Reverse innovation is completely missing.

### **3 Methodology**

In order to theoretically explore how national culture affects the inversion of the flow in the diffusion process, we adopt a cross-cultural point of view, whose purpose is to empathize to which extent the Hofstede's dimensions of Power Distance, Uncertainty avoidance and Individualism could increase or lower the cognitive or operational barriers.

As mentioned before, generally the literature on Reverse Innovation is quite poor and there are just few researches studying the cultural effect on the inversion. Therefore, to reach our goal and to answer to our research question, we rely on the diffusion innovation literature to derive some theoretical propositions. We adopt a deductive reasoning, that starting from the existing literature allows us to build six propositions.

#### **3.1 The propositions**

We leverage the Hofstede's model (particularly the first three dimensions discussed above) to advance specific propositions concerning the cultural traits that can foster and discourage the acceptance of a Reverse Innovation. Firstly, we discuss how cognitive barriers could impact in the advanced economies; meaning how culture shapes the acceptance of these innovation in the host markets. Secondly, we examine the extent by which operational barriers work in the emerging economies, considering the Hofstede's dimensions as factors affecting the emergence of entrepreneurial initiative.

Regarding the Individualism dimension, main scholars agree on having a positive effect on the traditional diffusion (He & Lee, 2020; Yaveroglu & Donthu, 2002; Van den Bulte & Stremersch, 2004; Taylor & Wilson, 2012). However, the Individualism dimension, while boosting for personal creativity and promoting the generation of new ideas (Shane, 1993; Tian, Deng, Zhang, & Salmador, 2018), concerns mostly the individual and the personal achievement. Therefore, our first proposition states:

- P1: Advanced countries with high IDV will have a lower acceptance of RIs.

According to Hofstede, "high Power Distance nations are more autocratic, and individuals are more willing to accept differences in power and wealth" (Rinne, Steel, & Fairweather, 2012, p. 96). In the diffusion innovation literature, this dimension is found to have a negative relation: indeed, in high Power Distance

cultures, people feel superior to others and tend to reject opinions or suggestion from the outside. Our second proposition states:

- P2: Advanced countries with high PD will have lower acceptance of RIs.

The third and last dimension is Uncertainty avoidance, for which diverse results are reached in the diffusion innovation literature. Some authors prove a negative effect (Dwyer, Mesak, & Hsu, 2005; Tellis, Stremersch, & Yin, 2003; Yaveroglu & Donthu, 2002; He & Lee, 2020); while others a positive (Desmarchelier & Fang, 2016). In our opinion, within high uncertainty avoidance context, people will easily feel anxious about innovations' origins and quality. Thus, we formulate as follow the third proposition:

- P3: Advanced countries with high UA will have lower acceptance of RIs.

Thereafter, we consider operational barriers which may be relevant in emerging countries where innovations take advantage of less efficient infrastructures and resources. Thus, culture may play a relevant role in stimulating the entrepreneurial initiative to support the diffusion process or, on the contrary, in preventing the start of these initiatives. Accordingly, based on the Hofstede's model and on the innovation diffusion literature, we formulate three propositions for each cultural dimension considered.

Firstly, we assume that individualism push people to be free (Rinne, Steel, & Fairweather, 2012) and encourage the innovative initiative. Hence, our fourth proposition affirms:

- P4: Emerging countries with high IDV are more likely to spread RIs.

Regarding Power Distance, the typical strict hierarchy could hinder the diffusion. Consequently, we formulate the fifth proposition as follow:

- P5: Emerging countries with high PD are less likely to diffuse RIs.

Lastly, we focus on the Uncertainty avoidance: despite innovations represent always important challenges, launching an innovation from an emerging to an advanced economy represents an even more risky choice, due to all the potential conflict of rejection, the negative country of origin effect or even market share issues. Based on these assumptions, our last proposition is the following:

- P6: Emerging countries with high UA are more likely to inhibit the diffusion of RIs.

## 4 Conclusions and implications

One of the main issues concerning a Reverse Innovation is how it is perceived in the advanced markets: usually, people from the west are quite sceptical towards innovations coming from less advanced context, specially within the healthcare sector. This is due probably to the prejudice of emerging context having less capabilities and less resources, which brings people to think of dealing with second-rate products. Although the resources are still fewer if compared to the wealth of the advanced economies, their capabilities are quickly growing, challenging the advanced multinationals and firms. Indeed, innovations coming from the emerging context are not necessarily low-quality standard. Moreover, in this scenario, culture play an important role in shaping people perceptions and in facilitating the inversion of the flow.

This theoretical paper is intended to provide a starting point for future academic empirical study, and effectively test the elaborated propositions. This research aims to offer scholars and managers a conceptual framework to better understand how Reverse Innovation spreads across culturally distant countries.

In line with our goals, this work presents interesting implications from the theoretical point of view, enriching the fragmented literature related to Reverse Innovation and practical implications stemming from the possibility to successfully implement a Reverse Innovation. Concerning the latter, if innovations are coming from the emerging context and are also able to spread globally, there will be an increase in the innovations flowing around, with an expansion of the effective number of innovations working.

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## **Noto: The Day of Fear (1693). A VR Immersive Project about the Legacy of Resilience**

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### **Abstract**

Experiences of cultural heritage and tourism have been enhanced by the development of digital technologies. In light of this, this paper focuses on the importance of immersive storytelling experiences to encourage visitors' engagement through VR and the evocative and emotional storytelling of events and contexts.

After an introduction to the best practices from Italy and abroad in recent years, the paper focuses on the VR immersive storytelling of the 1693 earthquake, which destroyed 70 cities in south-eastern Sicily. The survivors, revealing great resilience, soon rebuilt their cities. The well-known Baroque city of Noto, a UNESCO site since 2002, was rebuilt on another site, so abandoning the destroyed one (Noto Antica).

Through an immersive film in VR (25 min.), commissioned by the Noto Municipality, the last moments of the city are recounted, creating a "digital bridge" between generations to regain awareness of their ancient roots. The VR project stands out for its participatory production process involving a commission of experts and 3D casting of its modern citizens, and the tragic nature of the event, recounted through the emotional and evocative account of a recent earthquake and the solution adopted following the COVI-19 pandemic (in situ, on YouTube VR and Vimeo).

**Keywords** – Digital Storytelling, Virtual Reality Experience, Immersive Storytelling, Digital ethnoanthropology, 3D Historic Environmental reconstruction

**Paper type** – Practical Paper

## 1 Introduction

The diffusion of new technologies has given rise to the spread of information and improvement in quality as well as evolving the way people enjoy museums, culture and cities, by enhancing their experience, also in a mobile way (Ciasullo et al., 2016; Fernandez Vaz et al., 2018; Liang et al., 2017).

New technologies, which range from social media (Hays et al., 2013; Lund et al., 2018) to digital participatory platforms (Bonacini and Giaccone, 2018; Nisi et al., 2015) and serious games (Paliokas and Sylaiou, 2016; Sánchez Mateos 2018; Paliokas 2019; Bonacini and Giaccone, 2021) to virtual reality (VR) and to augmented reality (AR) technology (Atembe, 2015; Huang et al., 2016; Pietroni, 2012; Tussyadiah et al., 2018), are improving both cultural and tourist strategies and people's enjoyment of cultural opportunities such as museums, archaeological sites and art collections and, in general, culture. As they have created new cultural experiences for end-users enhancing their emotional aspect, they have become considered as a marketing tool for tourism (Huang et al., 2016; Li and Chen 2019).

AR and VR applications and experiences are among the most popular and innovative audience engagement solutions and their use has recently increased. Within the context of cultural and tourist attractions, organizations are searching for new ways to exploit the potential of these technologies to enhance the visitor's experience from home or in situ. While scholars are investigating how virtual and augmented installations are enhancing visitors' experiences and the impact they have on them (Errichello et al., 2019; Fernandez Vaz et al., 2018; Hopf et al., 2020; Tanasi, 2017), the COVI-19 pandemic has brought about incredible advances in the development of VR in the simulation of real-life experiences (Sarkady, Neuburger and Egger, 2021).

Within this framework, story-based narratives provide experiences which let users understand both cultural heritage and history thanks to more stimulating cognitive and emotional processes (Gabellone et al., 2017; Gabellone, 2020; Jung et al., 2016; Tussyadiah, Jung and tom Dieck, 2017; Tussyadiah et al., 2018). Digital storytelling has therefore been considered very useful in the enhancement and fruition of a cultural heritage and visitors' engagement (Alexander, 2017; Bonacini, 2020; Handler Miller, 2020; Schoenau et al. 2015).

In the light of this consideration, this paper focuses on the importance of VR storytelling experiences in Italy and abroad, to encourage visitors' engagement

not only through VR reconstructions (such as those tourism experiences literally exploited following the COVI-19 pandemic) but also on the evocative and emotional storytelling of events and contexts. In particular, after presenting some best practices (which have been extensively discussed in Bonacini 2020: 176-216), this paper focuses on the VR immersive storytelling movie of the 1693 earthquake in the Southern part of Sicily, focusing on Noto's last moments.

## 2 VR immersive storytelling

If the archaeological field is where scholars have demonstrated the greatest skills and competences in virtual reconstructions [by applying the *London Charter* (2006-2009) and the *Seville Charter* (2012) principles, regarding the application of scientific, transparent and verifiable methodologies], we agree with Gabellone's *active immersion* definition, achieved with VR viewers who are able to enter the virtualized environment in which the realism and the almost physical interaction with the 3D elements produces a natural and direct understanding of the architectural, figurative and spatial elements (2020: 125).

Many projects of immersive experiences can be cited, all dated to 2017, such as the *Domus Aurea Experience* in Rome; the *Jheronimus Bosch e Venezia* exhibition; *Nuragica* in Sassari. All these are strictly VR immersive experiences, but without a true, more involving storytelling, employing characters and/or narrating voices.

In recent years, in fact, increasing interest has brought about the creation of a real *immersive storytelling*, not limited to 3D reconstructions and music, but with a real script for digital characters with narrating voices. According to scholars, an immersive storytelling could be defined as:

*"Digital storytelling type based on a blurring of borders between fiction and reality. The putting into narrative is operated continuously and puts the user in a particular situation, in which the difference between the story told and the experienced reality becomes more and more tenuous. The narrative universe defines the experience in which the user is immersed"* (Brouillard, Loucopoulos, Dierickx, 2015: 37).

The descriptive style in a story, as Pietroni states, is less emotionally impactful than the narrative one; the storytelling itself, thanks to evocation and dramatization, has an enormously greater impact than description, able to *"create an emotional involvement and an expectation in the visitors, that throw a bridge between past and present"* (2019: 22).

This is the reason why we are going to describe some of the most important immersive storytelling experiences, useful to introduce the Noto VR movie.

## **2.1 An overview on immersive storytelling experiences**

Some projects deserve to be mentioned for their quality as benchmarks in the defined framework, based on mixing different techniques, such as traditional and stereoscopic filming, three-dimensional reconstructions, computer graphics, digital character animation.

### *2.1.1 Italian best practices*

The very first examples are those of *Apa* (2012) and *Ati* (2014) immersive storytelling projects (Guidazzoli, Liguori, Delli Ponti, 2012; Guidazzoli et al., 2014). Produced by the CNR of Rome, they are stereoscopic 3D movies, made in a cartoonish computer graphic style to connect, through immersive storytelling, the history of Northern Etruria (Bologna) with the Southern part of the region (Rome).

*Siracusa 3D reborn* (2013), realized in order to create a tourist attraction with a solid scientific base and a real tool for education and awareness for Syracusan citizens (Gabellone, Tanasi, Ferrari, 2014; Tanasi, 2017), and *Pompeii 3D Movie. A buried story* (2015), a real stereoscopic docudrama in full HD, on the last day of the Roman city (Gabellone 2020: 130-131), are stereoscopic documentaries in computer graphics created by a team of scholars, from Lecce-Catania CNR and other research centers. In *Pompeii 3D Movie*, the alternation of two external voices, one fictional, more narrative and evocative, one in a more documentary style, describe both the personal story of Abano, owner of the Villa dei Misteri, and the 3D urban archaeological landscape of Pompeii. Finally, the rain of pumice, ash and lapilli, covering everything, seems to pour directly on the user, creating the immersive experience. This human-centered narrative, in which Pompeii is just the background, offers an engaging experience in which the audience relates emotionally to the protagonist.

The narrative choice, featured in the immersive storytelling project *MARta Racconta. Storie Virtuali di tesori nascosti* (2013) created by the Lecce-Catania CNR for the Archaeological National Museum of Taranto (Giannotta, Gabellone, Dell'Aglio, 2014; Gabellone 2020: 193-205) alternates an evocative with a documentarist voice. The computer graphics animation makes use of modern urban landscape images while showcasing the Museum's precious exhibits.

The alternation of different narrative voices obtains the effect of a sort of emotional suspension in the user's direct engagement, which increases the suspense of the story itself.

The *Palazzo San Teodoro Experience* (2015), created by AppTripper, offers the visitor the opportunity to enjoy informative and narrative content, with 3D reconstructions of the 1700s architectural landscape, in the Naples so admired by the Grand Tour travellers and described by Alexander Dumas's voiceover (Errichello et al., 2019).

*L'Ara com'era project* (2016), created for Zetema by ETT Solutions, aimed at making the Mausoleum of Augustus accessible, by restoring in AR the original colours of the reliefs and offering a VR storytelling in Augustan times, carried out in a mix of live footage and 3D computer graphics reconstructions (Trunfio, Campana and Magnelli, 2020).

Since mid-2017, the *Teatro della Scala Virtual Experience* offers visitors a first-person immersive storytelling, in which the prima ballerina Nicoletta Manni lets the user discover the secret places behind the scenes of the Theater.

*Apud Cannas* (2017) is an immersive stereoscopic movie on the Battle of Canne in 216 BC, a real example of a cultural and scientific product becoming pure cinematography, thanks to stereoscopy and massive character computer animation (40,000 characters), in a real historical 3D re-enactment (Gabellone et al., 2017; Gabellone 2020: 181-191).

As a final example of mixed reality there is *Circo Maximo Experience* (2019), created for Zetema by GSNET Italia/Inglobe, which tells the story of the Circus in all its phases, up to the emotions aroused by the VR storytelling experience "A day at the Circus", by AppTripper, thanks to which the user becomes a witness of a chariot competition, perfectly rebuilt in computer graphics. The story is developed through a real script played by professional actors.

### 2.1.2 Best practices from abroad

In 2017, in collaboration with Samsung, the Museo Arqueológico Nacional in Madrid launched *Vive el Pasado*, an immersive digital animated virtual tour through Spanish history and the museum's collections, accompanied by an archaeologist as the digital storyteller (Sánchez Mateos 2018: 342).

For the *Modigliani exhibition* (2017-2018) the Tate Modern in London offered the *Modigliani VR - The Ocher Atelier* experience, a behind-the-scenes project in which the artist's last studio in Paris was recreated, through a meticulous 3D

reconstruction of the real apartment in all its details. Storytelling was an essential component: an external voiceover introduced the visitor, who personally met other protagonists in his life.

*Slav Epic VR* (2019-2020) at the National Palace Museum in Taiwan highlighted how useful immersive technologies can be in making works not currently on display accessible. Indeed, this is precisely the case of the immersive experience inside the epic narrative of *Slovanská epopej*, a cycle of 20 large canvases painted by the Czech Art Nouveau painter Alfons Mucha between 1910 and 1928, which have not been on display since 2016.

Another immersive digital storytelling experience of the highest quality within a painting is *Mona Lisa: Beyond the Glass*, within the *Leonardo da Vinci* exhibition (2019-2020). The immersive storytelling penetrates directly into the painting, transforming the experience into a *tête à tête avec la Joconde*, created to replace the real painting in the Louvre Museum. The story aims to reveal the woman's identity, her social status and additional details otherwise difficult to perceive (Rea 2019).

Finally, immersive storytelling productions, made both in computer graphics, virtual reconstructions and green screen filming, have new horizons to explore in the cultural, theatrical and cinematographic fields, as demonstrated by two projects, carried out by Dublin Trinity College: the stereoscopic VR movie *Faoladh* (2018), produced in collaboration with Google VR and TileFilms, revolving around the mythical repertoire of Irish stories, such as the werewolf Faoladh; *Virtual Play* (2019), a VR theatrical performance reinterpreting *Play* by Samuel Beckett with the virtual reproduction of real actors in action (vologram).

### **3 Noto. The day of fear (1693)**

#### **3.1 The historical contest: the 1693 earthquake**

On January 11th 1693 the *Val di Noto* region, in the South-east of Sicily, was struck by a major earthquake, around 20:30/21:00 local time (corresponding with today's 1.30 pm): according to the National Institute of Vulcanology (INGV) it had a maximum intensity of 11 on the Mercalli scale. The earthquake had been foretold by another strong shock on the 9th and by one on the 11th in the morning (corresponding with today's 9.30 am). Significant damage was reported everywhere but the 1.30 pm shock was devastating: nearly 70 urban centers were

partially or entirely destroyed and about 60,000 people died. Catania, the largest city, was the most seriously hit, losing 16,000 citizens out of an estimated population of 20,000. Among the destroyed cities, Noto Antica was seriously damaged, and after years of discussing where to rebuild the city, they decided to build a new town, abandoning Noto Antica. Following this event, the new city was founded, and new houses, palaces, churches and monasteries were built in a Late Baroque style. All 9 Late Baroque towns of Sicily, built after 1693, were included in the UNESCO WHL in 2005.

Few are the remains of the abandoned site of Noto Antica and little is known of its buildings: it was a late-medieval city, important from the Norman age and under subsequent dominations. In 1693, it was a rich city, embellished with numerous noble palaces, 56 churches, 11 convents and 8 monasteries; it was surrounded by walls and dominated by an imposing Castle, inhabited by over 12,000 inhabitants. Noto suffered 2,000 deaths, but between hunger, famine and pestilence after the earthquake, its population was soon reduced to 6,000 inhabitants. Today portions of the castle are visible, with the church of San Michele, and of the walls not to mention the desolating remains of churches and palaces which is why it has been called the "Sicilian Pompeii".

### ***3.2 The participatory production process and the ethnoanthropological 3D citizens reconstruction***

The project, assigned to AppTripper by the Municipality of Noto, was born from the idea of recreating the last moments of Noto Antica, seen through the eyes of the protagonists and based on historical and scientific references.

An important aspect of the project was that it should involve the participation of both the local scientific heritage community and Noto's living heritage community, in keeping with the Faro Convention.

A committee of experts was, in fact, established, including local historians and architects from the University of Palermo, volcanologists from INGV, archaeologists from the Superintendency of Syracuse and other experts in the field of fashion, costumes and furniture of the time. First the editorial project (a real research and pre-production book) was shared with the committee, then the screenplay, thus ensuring participation in the review and selection process of scenes to be digitally recreated (fig.1). They contributed also in providing data, scientific references, comparisons, each for their field (architecture, furniture, the

fashion of the time, reconstructions of ancient landscapes, music, even the majolica tiles on the floors and the pictures and weapons hanging on the walls) in order to guarantee the philological adherence for both the digital reconstruction of the urban landscape and the one of the citizens, from an historical and ethnoanthropological point of view.

The 3D modelling of some digital characters, through the rendering of the true faces of the citizens of today's Noto, was made through a "digital casting" of 130 volunteers (fig.2). There was a selection and digital reproduction of 30 people's faces, who can recognize themselves in those of the Captain of Justice, the Mayor, the Jesuit, the Prisoner (figg.3-4) or other characters from the crowd.

### **3.3 The VR immersive movie**

From a technical point of view, Unity3D engine with a real-time technology compatible with Oculus platform was used for the VR fruition; the content was created with animations, storytelling and visuals produced in FULL CGI 3D, with a 360° viewing angle.

The high performance visualization can scale up to 4K resolution, providing stronger levels of engagement. For less powerful and more user-friendly devices, converted and optimized versions of the movie are available, which are not immersive but can also work on smartphones, as long as they are equipped with an accelerometer and gyroscope (users can explore the scene even without the viewer).

The use of 3D advanced techniques, such as sculpting, mapping and matte painting, made it possible to obtain realistic and academically comprehensive results, while preserving their integration within the limits of mobile and wearable technology, thanks to an almost constant process of optimization.

In the texturing phase, all the urban and architectural elements have been reconstructed with a precise and evident note of general degradation (the city suffered much damage from the previous shocks), mixed with poor chromatic tones to simulate a veil of decadence, a suspension of the drama that is bearing down on people, buildings and objects.

With this approach, the user can see some structures, already damaged before the moment of the earthquake, in a general scenario documenting a widespread precariousness.



Furthermore, the use of mixed cinematographic techniques (depth fogging, particle dynamics, colour correction, light painting) has therefore made it possible to generate a kind of “virtual fresco” for each environment.

The result is 25 min. of an immersive movie, divided into a few scenes: the introduction starts in the dust (fig.5), capturing an already damaged city; the Captain of Justice in his house, almost impassive, while having lunch (fig.6); a meeting between the city authorities, inside the Church of San Michele, to whom the Mayor reads their agreed decision after the 9.30 shock (fig.7); a prisoner who sings a popular song, recalling when he was travelling by sea; a scene in which citizens try to convince the Carmelite friars to carry the Madonna’s statue out in a procession to obtain her intercession (fig.8); a terrible sermon by an old Jesuit, who announces a catastrophe in the style of Girolamo Savonarola (fig.9). Finally, the terrible 13.30 shock overwhelms everything and everyone, nullifying the history of the city and enveloping everything in dust, while a copy of the Laocon’s sculpture stands out, almost in a last desperate cry and proof of resilience (fig.10).

Special attention needs to be dedicated to the characters. In the movie, as described, after a digital casting selection, 20 people were selected and digitally replicated in 20 3D characters, who all have a real-life counterpart. Thanks to visual references and photos, the 3d models were rebuilt and painted with different techniques. The resulting character is thus far more realistic; the authors wanted to enhance the historical protagonists of the earthquake era with traits of real people (instead of procedurally generated by computer). This process is evocative of the underlying concept of the narrative: the resilience that overcomes the drama and events and emerges from the ruins of the centuries. Thanks to 3D technologies, it was therefore possible to faithfully reconstruct the faces and somatic features of the characters, who were then associated with really existing people, with their social rules, dressed in keeping with XVII century fashion, as agreed by the scientific committee, in order to obtain convincing, charismatic figures, endowed with complexity and personality.

In parallel, in the case of the Mayor, the Prisoner and the Jesuit, voice actors were also involved: the three mentioned characters were also able to express themselves vocally, thanks to facial animation and lipsync techniques (a particular type of animation by which the digital character imitates the movements of the lips and gives the impression of speaking and articulating sentences).

An external storyteller introduces the story in some scenes.

For many characters, motion capture integration (the reproduction of body movements achieved through the capture of real actors) was also used, so as to create the sensation of being in front of extremely more credible acting characters, increasing the emotional involvement and texture of the scenes in terms of storytelling and acting.

Some technical expedients used during the earthquake representation merit description. The use of light and the strong chromatic degradation convey the distressing narrative of the event. In accordance with scientific data, the animation of the earthquake and vibrations were carried out following two main techniques: creating an irregular deviation on the jolting plane and on the undulatory axis which was both continuous and unpredictable and the violence on collapse, which can be conveyed by the range of oscillation in all directions. A feeling of devastation, but at the same time of inexorability and the impossibility of escape, was therefore recreated. The computation of the collision, obtained by simulation, largely mimics seismic events though often an artistic intervention was necessary to enhance the experience, preventing buildings from collapsing in unison); the story of the earthquake becomes the protagonist with its own chromatic vestige, with its own visual unity, with a sequence that puts poor, unarmed humanity in the background, a victim in front of the monster so letting the event take over and overwhelm the viewer

#### **4 Conclusion**

In line with modern learning dynamics, the contemporary historical 3D re-enactment, which represents the final moment of a philological study, is presented to entice the visitor to know, to read, to study the same sources which inspire the reenactment (Gabellone 2020: 182-183).

In *Noto: The Day of Fear (1693)*, the last moments of the city are told, creating a "digital bridge" between generations to regain awareness of their ancient roots and the heritage communities which they all represent. The VR project is in fact remarkable for its participatory production process, involving local experts and citizens in rebuilding the last moment of Noto, and because it is the very first VR immersive movie telling, from an emotional and evocative storytelling, of a recent human tragedy, such as an earthquake.

The authors are sure that this is a new frontier of immersive and evocative storytelling. Thus it is possible to digitally reconnect distant generations with each

other, not only through the storytelling itself, but also by allowing a sort of digital transition of historical memory through digital characters.



*Fig. 1. The committee of experts for the editorial project and the screenplay editing.*



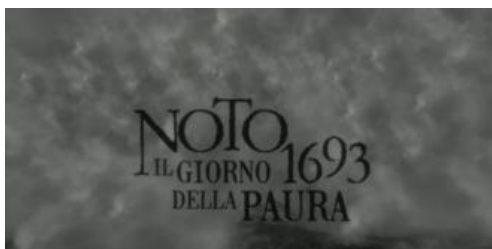
*Fig. 2 3D Casting.*



*Fig. 3 Digital rendering of Noto's inhabitants (Father Antonino Marescalco).*



*Fig. 4 3D character creation of a prisoner in popolar dresses.*



*Fig. 5 Opening title of the movie.*



*Fig. 6 Scene in the House of don Antonino Impellizzeri, Captain of Justice.*



*Fig. 7 Emergency meeting between the Mayor Don Giacomo Borgia with the 5 Magistrates and the Priest Don Francesco di Lorenzo, inside the Church of San Michele.*



*Fig. 8 Discussion about the transfer of the Madonna statue outside the Carmine church.*



*Fig. 9 Preaching by the Jesuit father Antonio Marescalco, near the Mother Church.*



*Fig. 10 Final scene with the Statue of the Laocoon (a copy located in Piazza Maggiore) emerging from the destruction, indicating resilience after tragedy.*

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## Individual-Level Impediments to Digital Transformation: a Bibliometric Literature Review

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### Abstract

Digital transformation creates opportunities through new digital technologies, but it also pressures organizations to change the working environment. Research from the last few decades has empirically documented resistance by individuals when organizations are changed. Surprisingly, far less has been reported about individuals resisting change in the context of digital transformation.

Using the Web of Science database, we conducted a structured literature review and identified that there is indeed a staggering amount of published research addressing digital transformation and resistance to change, separately. However, research that addresses these issues in combination is very limited. Therefore, this study aimed to provide a foundation for both future research and for practice concerning individual-level impediments within digital transformation processes and how these processes can be managed.

Our search method found 365 articles, which were further analysed using bibliographic methods. Subsequently, 20 relevant articles were identified, and a content analysis was performed. The meticulous analysis of extant literature revealed a strong emphasis on managerial issues within the transformation process. Remarkably, very few articles explicitly



focus on employees and rather address the influence of management over the employees when attempting to pursue digital transformation processes.

This study identified six managerial factors that link the individual level to the organizational level in digital transformation processes: beliefs and mindsets, preparedness and strategy framework, culture, competencies, communication, and management. The core articles explain how all these factors affect the resistance to change by individuals. Additionally, we offer a conceptual model providing a foundation for further theory development and guidance for practitioners aiming for a more agile digital transformation.

**Keywords** – Digital Transformation, Resistance to Change, Digitalization, Change Management, Structured Literature Review

**Paper type** – Academic Research Paper

## 1 Introduction

Digital transformation is a hot topic for researchers and practitioners alike (Sainger, 2018). A quick search on Google Scholar with the search text “digital transformation” yields a staggering 3.5 million hits. Since 2020, more than 60,000 articles have been published, thus indicating an overwhelming interest in the topic.

However, despite huge interest and the provision of new strategic opportunities through digital technologies, McKinsey (2016) has found that 70% of organizations going through a digital transformation process fail. Extant research also highlights the complexity of comprehensive digital transformation processes as they involve the transformation of many organizational dimensions, client interactions and business model innovations (Svadberg, Holand, & Breunig, 2019). Moreover, there are several overlapping terms in use (e.g., digitization, digitalization and digital transformation). Digital transformation is the most overarching term used, and digital transformation processes pressure organizations and leaders to change the organizational structure as well as the working environment in organizations to yield benefits from the adaptation of these technologies (Frick, Mirbabaie, Stieglitz, & Salomon, 2021). Furthermore, the transformation has both positive and negative impacts, thus making it more challenging to predict outcomes from the change process (Smith, 2018).

Change processes involve individuals in the organization (Coch & French Jr, 1994). However, little has been empirically documented to demonstrate how

individuals react to a digital transformation process in particular. This is puzzling, since a fundamental theme within the change management literature emphasizes an individual's resistance to change. Theories on resistance to change have developed over many years, and early sources document the resistance of Luddites to the technological adaptations of the early industrial age (Brynjolfsson & McAfee, 2016). The body of literature encompassing resistance to change related to technology adaptation amounts to an overwhelming 131,000 contributions. Nevertheless, to date, the relationship between an individual's resistance explicitly towards digital transformation processes has been less empirically documented.

Therefore, this study aimed to provide a foundation upon which a link between extant research on digital transformation and resistance to change can be established. In particular, we sought to identify extant research related to the individual level, as changes in the working practices of employees are a consequence of digital transformation endeavours. To provide this foundation, a structured literature review aided by bibliometric analysis was conducted to identify core articles upon which a content analysis could be performed in order to explore the following research question: *How can a structured literature review utilizing bibliometric analysis of current published scientific research contribute to identify and reduce individual-level impediments to digital transformation?*

Our structured literature review revealed that individual-level impediments to digital transformation are documented to a limited extent in extant research. Still, our search yielded 365 articles, which were subsequently reduced to a core canon of 20 articles providing a foundation for the improved understanding of an individual's reaction to digital transformation processes. Additionally, a structured overview of the existing literature addressing individual-level impediments to digital transformation processes is presented. Our analysis demonstrates that digital transformation affects individuals in the organization, including both managers and employees. Moreover, this study identified six managerial factors affecting an employee's response to digital transformation processes, and these factors function as a foundation upon which further theorization and guidelines for practitioners can be built. Furthermore, the relationships between the identified factors relating individual-level resistance to change and digital transformation processes are illustrated.

## 2 Theory

Since the literature addressing digital transformation and resistance to change is less integrated than anticipated, we will address these two topics by emphasizing how they have been treated at the individual level.

### 2.1 Digital transformation

Digital transformation concerns people and their adoption of digital technologies brought to an organization's business model, offerings, organizational structure and processes (Bloomberg, 2018). Vial (2019) has defined digital transformation as *"a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies"* (p. 121). This involves transformation of their key business operations, organizational structures, products and processes. The effects of the intended transformation can be observed at both the organizational level (Gregory, Keil, Muntermann, & Mähring, 2015) and the individual level (Lee, Sambamurthy, Lim, & Wei, 2015).

These types of complex transformations need strong management practices in order for them to be implemented in the organizations (Abdelaal, Khater, & Zaki, 2019). Therefore, management has to find ways to innovate with the new and emerging digital technologies, and strategies that embrace the use of digital transformation will have an increased likelihood of better operational performance (Hess, Matt, Benlian, & Wiesböck, 2016). In order for digital transformation to be successful, organizations have to take into consideration all factors that can set back or delay implementation of the process. By doing this, organizations can remain competitive, have operational efficiency and obtain improved organizational performance (Vial, 2019). Thus, it is assumed that a successful digital transformation process is linked to the organization's strategy, which shapes how the process is coordinated and prioritizes when digital technology is implemented through an integrated process (Hess, Matt, Benlian, & Wiesböck, 2016).

McAfee and Brynjolfsson (2016) have emphasized the importance of individuals within these strategic transformation processes. Moreover, they have highlighted that organizations should have employees with special competence in their field, acquired understanding and the ability to solve problems with high complexity (Hernaes, 2020). When routine tasks are automated, there is a greater need for

creativity and problem-solving competence, especially among managers (Schwarzmüller, Brosi, Duman, & Welp, 2018). New skills in analytics, design and technology as well as the identification of new roles that are more diverse and adaptive have been suggested as vital for success with digital transformation (Bughin, Catlin, Hirt, & Willmott, 2018). Kompas (2010) has stated that employees with high commitment will work passionately and provide maximum creativity so that they can ensure good performance of the organization. The importance of teamwork is also increased in such a transformation, since *"knowledge as a resource can only be developed and advanced together"* (p. 126); thus, these two elements are a prerequisite for digital transformation for individuals (Schwarzmüller, Brosi, Duman, & Welp, 2018). Additionally, research has documented how structural changes affect individuals, particularly related to new job descriptions or changed roles, and that the new role might have higher competence requirements (Schwarzmüller, Brosi, Duman, & Welp, 2018).

## **2.2 Resistance to change**

It is well documented that many attempts to implement technology, thereby changing organizations, fail as people naturally prefer to keep to what they know and feel familiar with, rather than to accept the unknown and therefore to accept innovation (Laumer, 2011). Thus, a determining factor often identified when organizations fail in their change efforts is the lack of employee commitment or individual-level resistance to change (Coch & French Jr, 1994). Resistance to change is a negative expression of stress or cynicism by employees caused by conflicting emotions and cognitions about the transformation (McKay, Kuntz, & Näswall, 2013).

### **2.2.1 Change management**

Change management seeks optimal adaptation primarily directed inward, toward the members of the organization implementing the change (Lauer, 2021). A radical shift in the norms of the organization requires active support of the employees by managers, as these norms are embedded in social structures and involve individual needs, ideas, experiences, emotions and characters (Armenakis, Harris, & Mossholder, 1993). Lewin (1995) has stated that organizations persist in a steady state until external forces, such as new disruptive technologies or stronger competition, push them to change. In response to this, the organization

pursues adaptation and change (Quoted in Swanson, Jin, Fawcett, & Fawcett (2017). If managers and their team have enough commitment to change, then they can influence both the change process and the outcomes of it. Furthermore, it is important that they encourage collaborative change (Swanson, Jin, Fawcett, & Fawcett, 2017).

McKay, Kuntz and Näswall (2013) have found that resistance to change comes from an experience of personal loss and that the loss is especially prevalent when it involves familiar routines that make the employees feel safe. Therefore, changes can trigger individual anxiety and subsequently affect further job stability and growth (Erwin, 2009). Resistance is also much more likely to happen when agreements and trust are broken (Ford, Ford, & D'Amelio, 2008; Kreitner, 1992). The lack of information, e.g., when managers are unable to express the need for change or be honest about the consequences of change, can lead to fear and uncertainty for the individuals involved (Bateh, Castaneda, & Farah, 2013). Moreover, Ford (2008) have emphasized the importance of relationships between individuals and communication within the organization as valued mechanisms to handle resistance to change.

Consequently, the extant literature highlights the importance of individual commitment, competence and trust, and it further emphasizes the managerial role of facilitation of information that fosters trust and a feeling of safety among the employees to succeed with the change process.

### **3 Methodology**

To address individual-level impediments to digital transformation, we decided to explore the extant published research through a structured literature review aided by a bibliometric analysis.

Initially, we experimented with different structured search term combinations. In order to identify research addressing both "digital transformation" and "resistance to change", we used the following search string in the Web of Science database on February, 15, 2021: "digital transformation" OR "digitalization" OR "digitization" OR "digi\* transformation" AND "change resistance" OR "resistance to change" OR "cognitive inertia" OR "change readiness" OR "change capacity" OR "change barriers" OR "resistance" OR "readiness" OR "barriers". This search identified 427 potential articles, which were subsequently reduced to 365 papers by only including full-text articles published in English prior to 2021.

Thereafter, all 365 articles were downloaded, and a database was created that could be analysed using VOSviewer bibliometric analysis software, with the aim of identifying articles that explicitly address the individual level. Different co-occurrence analyses were conducted using “all keywords” and “author keywords”. Keywords can create clusters that show how different terms are related and connected to other terms. Our search was then combined with the topic “individual”, and 72 potential articles were identified within the categories business and management. Subsequently, the abstracts of all 72 articles were read to assess the relevance of our sample to our ambition of identifying extant research addressing individual-level impediments to digital transformation.

Through this meticulous process, 20 core articles with the potential to inform our research ambition were identified, and a content analysis of this sample of articles was conducted. The core articles were read and analysed by two researchers independently. The articles were categorized and coded in Excel to ensure that the same variables were recorded in all articles and to enable a consistent format for article comparison. Finally, the results were compared; any discrepancies were discussed between two researchers to attain a higher objectivity in the selection procedure.

## **4 Findings**

### ***4.1 Descriptive analysis***

Extant research relating the two topics “digital transformation” and “change resistance” only account for 365 English full-text articles up until 2021; however, the number is increasing exponentially, indicating an increased interest and awareness of the relevance of the topic (Figure 1).

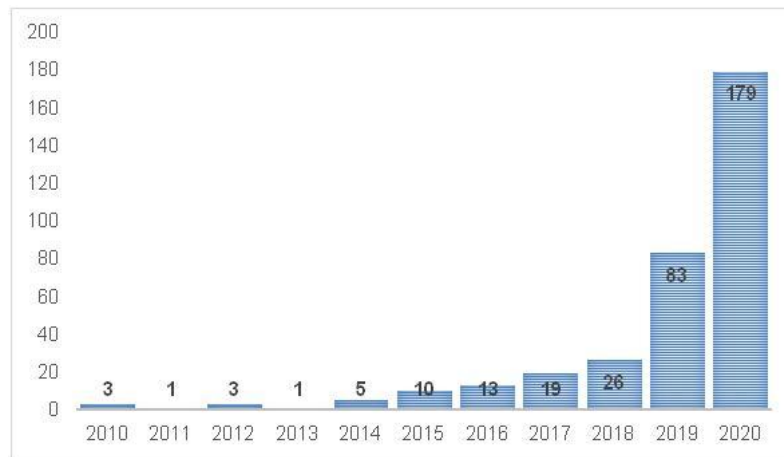


Figure 1: Bar-graph representation of publications per year (sample of 365)

Moreover, the core 20 articles were all published between 2018 and 2020, of which 75% of the articles were published in 2020. This corresponds with the exponential development we observed regarding the articles for our main search as well, and it also shows that there is a growing interest in this field. At the same time, this finding demonstrates that digital transformation in connection with resistance to change at the individual level has not been researched much but is beginning to receive more attention. However, 515,347 articles were identified by using the term "digi\*". This finding indicates that our 20 core articles only account for 0.0039% of all articles published on "digi"-related topics and that there is a huge potential for further research addressing the individual-level impediments to digital transformation. In general, the literature on digital transformation and resistance to change appears complicated and unstructured, and the number of empirical contributions is limited. Even though we first assumed that there was an astonishing amount of publications addressing these two topics, our structured search revealed that this was not the case for their combination.

#### 4.2 Bibliometric analysis

We conducted several different bibliometric analyses, such as co-occurrence analysis (Figure 2) using the VOSviewer software tool, to identify articles within our database of 365 articles addressing the individual level.

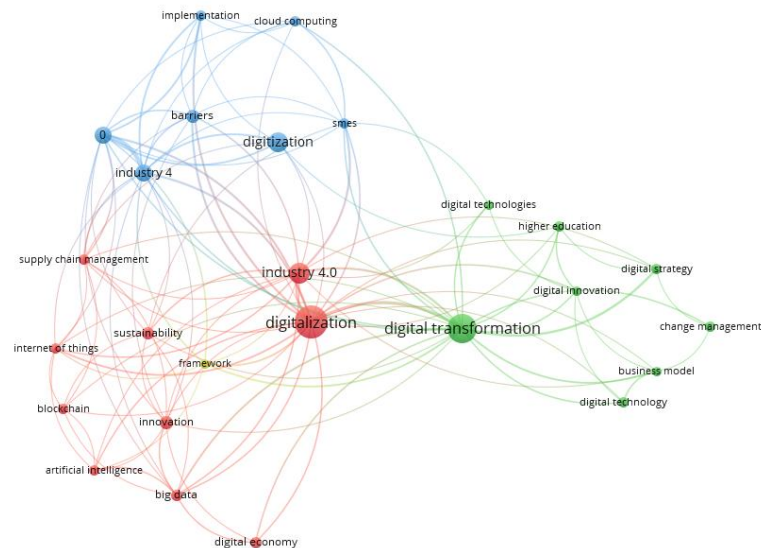


Figure 2: VOSviewer illustration of co-occurrence analysis with author keywords (5)

Our aim was to identify a cluster with connections between digital transformation and resistance to change at the individual level, but there were almost no keywords related to resistance to change in any of the clusters. The only keyword we found was “barriers” in the blue cluster, but nothing indicated whether this was a general barrier towards digital transformation or it was at an individual level. The other two clusters showed a clear technological focus rather than a change management perspective.

Consequently, our bibliometric analysis confirmed that there is only limited research that combines the two topics of digital transformation and resistance to change at an individual level. In total, only 1.44% of the research articles focused on digi\*-related fields (Figure 3). Furthermore, it was unspecified for industry; thus, many articles that were irrelevant for our research aim were included.



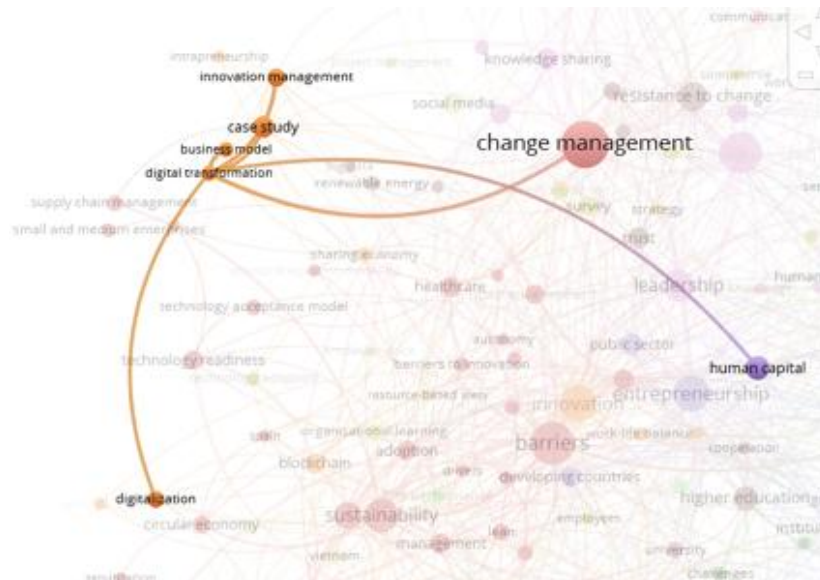


Figure 3: Close up of clusters in connection with *digi\**-related fields using author keywords (15 occurrences) from the VOSviewer illustration of co-occurrence analysis

The analysis identified a very limited intersection between the two topics. Subsequently, the relevance of 72 of our initial 365 articles was assessed. After a classification assessment, 20 articles were identified as relevant for further content analysis.

#### 4.3 Content analysis

Through content analysis, four articles were found to be irrelevant to our research question. Of the remaining 16 relevant articles, 9 of the articles used the term “digital transformation”, 5 of the articles used “digitalization”, 1 article used “digital innovations” and 1 article used “digital strategy”. After analysing the use of these terms, it was clear that “digital transformation” and “digitalization” are used interchangeably.

A pattern of factors emerged from this analysis. These were factors that specifically related individuals to the digital transformation process of the organizations. The topic addressed by all articles was related to management. Beyond that, 11 articles focused on preparedness and strategy framework, 8 articles addressed beliefs and mindsets, and 7, 6 and 5 articles referred to culture,

communication and competencies, respectively. Table 1 shows an overview of which factors are addressed in the various articles. The factors presented were addressed by a minimum of five articles, and all other factors addressed by fewer than five articles were left out, since they do not provide enough basis for comparison. Also excluded were general change process factors discussed in change resistance theory. The table additionally presents how these factors are related to individual-level impediments in connection with change resistance experienced due to digital transformation. Addressing individual-level impediments is important to improve the likelihood of an organization's success with digital transformation.

Table 9: Six factors relating digital transformation and individual-level impediments

Factor	Relationship to digital transformation (DT)	Individual-level impediments	References
<b>Management</b>	<ul style="list-style-type: none"> <li>- Allow employees to take risks</li> <li>- Management needs to adopt DT in order for employees to adopt DT</li> <li>- Identify additional opportunities offered by new technology</li> <li>- Assess their own beliefs about the changes they are leading</li> <li>- Job rotation</li> <li>- No hierarchy</li> </ul>	<ul style="list-style-type: none"> <li>- Affect employee's sense of security and trust</li> <li>- More encouraged</li> <li>- Affect employee's beliefs</li> <li>- Experience more digital readiness</li> </ul>	(Gfrerer, 2020; Trivedi, 2020; Schneider, 2020; El-Haddadeh, 2019; Solberg, 2020; Črešnar, 2020; Blštáková, 2020; Nasution, 2020; Meske, 2020; Peter, Kraft, & Lindeque, 2020; Bagrationi & Thurner, 2020; Christ-Brendemühl & Schaarschmidt, 2019; Tekic & Koroteev, 2019; Horváth & Szabó, 2019; Birkel, Veile, Müller, Hartmann, & Voigt, 2019; Hirte, 2018)
<b>Communication</b>	<ul style="list-style-type: none"> <li>- Communicate how DT will change their role both now and in the future</li> <li>- Let employees participate actively in the transformation</li> <li>- Platforms like online communication blogs, allowing free-flowing information, employees pose direct questions and suggestions to the management</li> </ul>	<ul style="list-style-type: none"> <li>- Feel valued</li> <li>- Being heard and included</li> <li>- Less uncertainty and role ambiguity</li> <li>- Know more about what's expected</li> <li>- Less resistance</li> </ul>	(Gfrerer, 2020; Schneider, 2020; Meske, 2020; Bagrationi & Thurner, 2020; Birkel, Veile, Müller, Hartmann, & Voigt, 2019; Hirte, 2018)
<b>Culture</b>	<ul style="list-style-type: none"> <li>- Develop a culture that constructively analyses, does</li> </ul>	<ul style="list-style-type: none"> <li>- Give more courage</li> <li>- More innovativeness</li> </ul>	(Gfrerer, 2020; El-Haddadeh, 2019; Črešnar,

	<ul style="list-style-type: none"> <li>- not conceal errors and where failure is not viewed negatively</li> <li>- Design thinking workshops or innovation sprints</li> </ul>	<ul style="list-style-type: none"> <li>- Individuals are more likely to adapt and implement new technology</li> <li>- More creativeness</li> <li>- Feel less likely to be replaced</li> </ul>	2020; Nasution, 2020; Bagrationi & Thurner, 2020; Horváth & Szabó, 2019; Birkel, Veile, Müller, Hartmann, & Voigt, 2019)
<b>Competencies</b>	<ul style="list-style-type: none"> <li>- Environment that appreciates the adoption and use of new technology</li> <li>- Bring in new important competencies or create a workforce with digital fluency</li> </ul>	<ul style="list-style-type: none"> <li>- Less overload and strain</li> <li>- Enhance performance and facilitate innovation</li> <li>- Interpersonal skills for collaboration</li> <li>- Strengthen the competence</li> <li>- Digital fluency</li> </ul>	(Gfrerer, 2020; El-Haddadeh, 2019; Nasution, 2020; Peter, Kraft, & Lindeque, 2020; Birkel, Veile, Müller, Hartmann, & Voigt, 2019)
<b>Beliefs and mindsets</b>	<ul style="list-style-type: none"> <li>- Create a digital mindset</li> <li>- Create shared thinking by collaboration and cross-hierarchical communication</li> <li>- Workshops that boost their self-image and confidence</li> </ul>	<ul style="list-style-type: none"> <li>- Believe in their personal abilities and become more confident</li> <li>- Personal growth and resources for personal growth</li> <li>- Lack of it can cause individuals to disengage and withdraw from DT initiatives</li> <li>- Feel less threatened and scared and more enthusiastic and curious</li> <li>- Less role ambiguity</li> <li>- More committed</li> </ul>	(Trivedi, 2020; Schneider, 2020; Solberg, 2020; Blštáková, 2020; Nasution, 2020; Meske, 2020; Bagrationi & Thurner, 2020; Christ-Brendemühl & Schaarschmidt, 2019)
<b>Preparedness &amp; strategy framework</b>	<ul style="list-style-type: none"> <li>- Form a common understanding of DT</li> <li>- Expertise centre equipped with technological knowledge</li> <li>- Provide a strategy for new problems due to DT</li> <li>- Assess employee's current abilities and not limit them to their current or previous jobs</li> </ul>	<ul style="list-style-type: none"> <li>- Feel like they are a part of the change</li> <li>- Sense of ownership</li> <li>- New technologies will be perceived as sustainable and be utilized successfully</li> </ul>	(Gfrerer, 2020; El-Haddadeh, 2019; Solberg, 2020; Črešnar, 2020; Blštáková, 2020; Meske, 2020; Peter, Kraft, & Lindeque, 2020; Bagrationi & Thurner, 2020; Christ-Brendemühl & Schaarschmidt, 2019; Tekic & Koroteev, 2019; Hirte, 2018)

## **5 Discussion**

Below we will discuss the six identified factors and explain how the individual-level impediments are linked to the organizational-level digital transformation process.

### **5.1 Management**

The content analysis identified literature addressing how managers play an essential role in the digital transformation of an organization (Nasution, 2020; Bagrationi & Thurner, 2020) because they act as role models for digital readiness among the employees (Gfrerer, 2020). Managers possess a strong understanding of the organization and have a lot of expertise; therefore, they can influence systems, processes and their employees. Their attitude and initiative impact and encourage change by allowing their employees to take risks (Hirte, 2018). Managers themselves are also individuals; therefore, the change process will also affect them and, like their employees, they can also be resistant towards change (Birkel, Veile, Müller, Hartmann, & Voigt, 2019; Peter, Kraft, & Lindeque, 2020).

Managers often adopt the concept of digital transformation, but they do not always support it wholeheartedly. The reasons for this might vary, but explanations offered include feeling an intense pressure to change (Tekic & Koroteev, 2019), fear of the unknown (Horváth & Szabó, 2019) and having enough knowledge (Hirte, 2018). They then tend to underestimate the sense of urgency of the digital transformation (Hirte, 2018), are more reluctant to change and show more resistance.

Digital transformation encompasses processes that can lead to role ambiguity and stress, causing resistance in the employees if not handled well by the managers (Christ-Brendemühl & Schaarschmidt, 2019). The digital transformation results in changed requirements for employees as well as the need for new competences (Birkel, Veile, Müller, Hartmann, & Voigt, 2019). These changes potentially result in fears in the employees like losing their jobs (Horváth & Szabó, 2019; Birkel, Veile, Müller, Hartmann, & Voigt, 2019). Knowing employees' perceptions and addressing their readiness becomes even more important for managers in a world where new digital technologies are used more frequently (Gfrerer, 2020). Managers need to have the necessary skills, experience and knowledge to control and support implementation of a digital transformation (Horváth & Szabó, 2019; Birkel, Veile, Müller, Hartmann, & Voigt, 2019).

## **5.2 Communication**

Resistance is connected to shortcomings in the interactions between individuals and the firm (Bagrationi & Thurner, 2020), and internal resistance will be the result of unclear or dishonest communication from the management to the employees (Birkel, Veile, Müller, Hartmann, & Voigt, 2019). Resistance is much more likely to occur when agreements and trust are broken; in addition, the lack of good communication leads to more fear and uncertainty (Bagrationi & Thurner, 2020; Christ-Brendemühl & Schaarschmidt, 2019).

The most crucial step for managers is to communicate decisions of symbolic importance that emphasize the organization's roots and preserve employees' identities, thereby addressing employees' emotions and feelings (Schneider, 2020). While actively interacting with their employees, the management will establish a feeling of security, and the changes will not be seen as occurring too rapidly (Hirte, 2018).

## **5.3 Culture**

With new technology, it is also important that the organization has a strong culture that supports change (Birkel, Veile, Müller, Hartmann, & Voigt, 2019). Since the organizational culture is so rooted in the daily practices, it can hinder employees from innovating and using new digital technologies effectively. This is because the culture can prevent the free flow of information across departments; therefore, it can become a significant barrier to form collaborations and creativity among employees in an organization undergoing a transformation.

An inadequate corporate culture contributes to a rise of additional risks in a transformation process (Birkel, Veile, Müller, Hartmann, & Voigt, 2019). A culture that constructively analyses and does not conceal errors should be developed within the organization, where failure is not viewed as wrong, so employees will not be afraid to contribute and adapt to new ideas.

## **5.4 Competencies**

Dynamic capabilities allow organizations to create, extend and modify their resource base to gain competitive advantages; in addition, they are essential for organizations to integrate and take advantage of digital technologies (Peter, Kraft, & Lindeque, 2020).

Nasution (2020) has found that an organization can either bring in new important competencies to the workplace or can create a workforce with digital fluency, where employees would be able to build their interpersonal skills for collaborating in ways that provide significance for organizations. Strong leadership promotes dynamic capabilities and is an important component of digital transformation processes that increase the performance of businesses in the digital age (Peter, Kraft, & Lindeque, 2020). With a focus on creating a strong workforce, the organization will be able to strengthen the competence they already have in many of their employees. With this workforce that has digital fluency, the employees will have a strong combination of skills, knowledge and resources to invest in a strong digital future (Nasution, 2020).

### **5.5 Beliefs and mindsets**

Bagrationi and Thurner (2020) have stated that the beliefs and mindsets the employees hold towards organizational change affect how successful the change process will be. The importance of changing the general mindset to a “digital” mindset, looking at new technologies with optimism and fully supporting the digital transformation are highlighted (Solberg, 2020; Trivedi, 2020; Tekic & Koroteev, 2019).

Solberg (2020) has discussed shared thinking and how it is an important tool for adapting the behaviour of employees with the vision and goals of the organization regarding digital transformation. It is important to have a change-oriented mindset and collaboration skills (Nasution, 2020). Lack of these characteristics can lead to poor and uncoordinated digital transformation, which in turn affects business performance.

A positive attitude is highlighted as a positive reinforcement of the digital mindset, while a negative attitude is related to employees feeling threatened and scared (Schneider, 2020; Blštáková, 2020; Bagrationi & Thurner, 2020; Christ-Brendemühl & Schaarschmidt, 2019). A positive view of the future will make it more likely that employees will embrace change and find a new role for themselves in the new environment (Bagrationi & Thurner, 2020).

### **5.6 Preparedness and strategy framework**

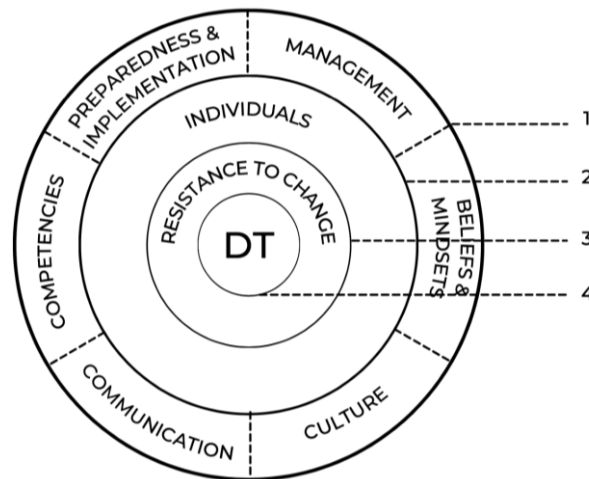
Raising awareness of a common understanding and collaborating to create a framework can be crucial for the potential application of digital transformation that organizations can achieve. The digital transformation is expected to have a significant impact on both the private and professional lives of individuals. Having a strategy that takes this into consideration is therefore crucial (Meske, 2020).

Introducing technologies alone will not be enough, and employees must be introduced to the new technologies and solutions so that they can be perceived as sustainable and utilized successfully (El-Haddadeh, 2019). The lack of a strategic focus in the digital transformation can result in a poorer transformation, implicating that there can be resistance to change, and the employees not understanding the scope of the digital transformation (Črešnar, 2020).

Therefore, it is crucial that managers assess both the current and potential abilities of their employees as they are related to the digital transformation; moreover, they should not limit these assessments to the current or previous jobs of their employees (Blštáková, 2020).

## **6 Conceptualization**

Through our analysis, we identified articles that have made it possible to distinguish between different factors that affect individuals and their resistance to the digital transformation process. These six identified factors include management, communication, culture, competencies, beliefs and mindsets, and preparedness and strategy framework. Figure 4 depicts the relationships between the six identified factors linking individual-level resistance to change and digital transformation processes.



*Figure 4: Relationships between the six identified factors connecting individuals and their resistance to the digital transformation process*

The six factors (1 on Fig. 4) will affect the individual and influence how individuals perceive change (2 on Fig. 4) when going through a digital transformation process. How these factors are handled will affect the perception of the individuals and help to determine how much resistance individuals might have in regard to the changes of the transformation process (3 on Fig. 4). The degree of resistance to change will consequently determine how agile and successful a digital transformation process is (4 on Fig. 4). Ultimately, these six factors will affect the likelihood that the digital transformation is successful. Of note, the focus is not on how resistance to change occurs but rather how to reduce and minimize resistance in individuals with respect to digital transformation. Organizations should create their own independent strategy customized to their employees and organization. It should focus solely on digital transformation and the factors presented. This will help managers navigate through the transformation process and create a common understanding, while reducing and preventing resistance. Therefore, the objective of Figure 4 is to provide an overview of the six factors and how they are related to an individual's resistance to change stemming from participation in digital transformation processes, thereby providing practitioners with an understanding of how these six factors can be handled to improve the likelihood of success with the digital



transformation endeavour by minimizing the potential for evoking resistance of individuals to change.

## 7 Conclusion

This study conducted a structured literature review of extant published research to address the question: How can a structured literature review utilizing bibliometric analysis of current published scientific research contribute to identify and reduce individual-level impediments to digital transformation. The aim of the study was to provide a foundation for future research as well as practical implications that would guide organizations and leaders on individual-level impediments to digital transformation.

This study revealed that surprisingly little empirical research has addressed individual-level impediments to digital transformation. In order to provide a foundation for more research, we identified six factors that link the individual-level resistance to change to the organizational-level digital transformation process. These six factors can improve the understanding of potential causes for individual-level resistance and provide practitioners with knowledge regarding how to strengthen the success of digital transformation processes through increased awareness of individual-level impediments. The results of this study will be of great practical value as a large percentage of digital transformation processes fail and these comprehensive changes affect all individuals within the organization, including both managers and employees.

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## **Are Team Leaders' Skill Gaps Hindering the Diffusion of Data-Driven Decision-Making in Manufacturing?**

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### **Abstract**

With the diffusion of digitalization technologies that allow to analyze high volumes of operational data in real time, data-driven decision-making can now entail benefits on organizational performance not only at the strategic, but also at the operational level. However, little is known about the individual and organizational preconditions that make this approach possible on the shop-floor. Through a quantitative survey issued to 101 Italian auto supplier firms and regression models, this article investigates the antecedents of data-driven decision making at the micro- and meso-level, by analyzing the effect of involving production workers in continuous improvement, and moderating it with the skill gaps of Team Leaders and Supervisors. The results show that production workers' involvement has a positive impact on the adoption of data-driven decision-making at the plant level; notwithstanding, when Team Leaders suffer skill gaps, the effect becomes negative. Therefore, the involvement of production workers for the sense-making of operational data might be ineffective because of skill gaps in those who are in charge of recombining their context-dependent knowledge with data analysis to create knowledge and make operational decisions. The same results were not confirmed for Supervisors, suggesting a possible layering in favour of a central role of Team Leaders, yet to be tested with further qualitative empirical research. This study contributes to work organization and knowledge management literatures using the concept of organizational knowing cycle for operational decision-making, disentangling the roles of different organizational levels (production workers and first-line managers) in sense-making of, and knowledge creation from, the analysis of operational data. As such, this study positions the digital transformation as a "skill-biased technological and organizational change". In this vein, the present study has relevant implications for practitioners, too, as it highlights that specific operational employees' capabilities can limit the benefits of digitalization,

hindering the diffusion of data-driven decision-making. Recommendations are offered to HR managers and education policymakers, who are called to foster the diffusion of high-involvement managerial practices and promote an urgent upskilling of first-line managerial roles through ad-hoc education and training paths.

**Keywords** – Data-Driven Decision Making, Knowledge-Based Theory of the firm, Knowledge Management, Middle-Skills Gap, Skill-Biased Technological and Organizational Change.

**Paper type** – Academic Research Paper

## 1 Introduction

With the advent of Industry 4.0, the increasing availability, volume and quality of operational data are generating high expectations about the impact of data-driven decision-making approaches on organizational performance. According to recent studies, firms that base their strategic or operational decisions on big data and analytics, rather than on intuition and experience, achieve superior performance (e.g., Brynjolfsson et al., 2011; McAfee et al., 2012). Especially if operations are well-structured, a data-driven approach to decision-making, enabled by digital technologies and data analytics software, can lead to operational performance at the shop-floor level (Flores-Garcia et al., 2019; Julmi, 2019).

However, the impact of digitalization is often analyzed under a pure technological perspective, despite wide evidences in literature that innovation needs to be approached considering organizational and managerial innovation too (Damanpour, 2014). Technological, organizational and managerial perspectives need to be analyzed together to capture the complex implications brought by the digitalization of manufacturing, using a socio-technical approach (e.g. Damanpour, 2014; Cagliano et al., 2019). The relationships between the use of digital technologies and change in organizational structures and decision-making management practices are still insufficiently explored in the literature (Cagliano et al. 2019; Mishra et al., 2017), and the micro-foundations concerning the changes induced by digital technologies in individual workers' capabilities and HRM practices are still an unexplored black box in literature (Appio et al., 2021). In this regard, research has focused on production workers and their complementarity with new information technologies (e.g., Helper, 2009), but not on their role in data-driven decision-making. Related to the use of data-driven



approaches, other studies have focused on the emerging high-skilled professions, such as data scientists and data engineers (e.g., Davenport and Patil, 2012; Carillo, 2017), but scant literature focus on what lies in the middle: Team Leaders and Supervisors, i.e. the first-line production managers who monitor and use production KPIs real-time data on a daily basis. With their interpersonal, informational and decisional roles in knowledge creation and decision making, they are in the position to play a key role for creating value in the age of digital transformation. However, they might not have the competencies required to adequately foster data-driven decision-making at the plant level, which would entail the urgent need to address these skill shortages to avoid that digitalization widen the so-called "middle-skills gap" (Kochan et al., 2012; Fuller et al., 2014). This article aims at exploring the adoption of data-driven operational decision-making through a Knowledge Management perspective, for which involved production workers and adequately skilled first-line managers are complementary in the sense-making and knowledge creation driven by big data collected and used in real time. Hence the research questions:

*RQ1: Is the involvement of production workers related to the adoption of data-driven approaches to decision-making?*

*RQ2: Do the skill gaps of first-line managers (Team Leaders and Supervisors) moderate the effect of production workers' involvement on the diffusion of data-driven decision-making?*

## **2 Theoretical framework**

Using a knowledge management perspective applied to literatures on high involvement management practices, this section aims at presenting the antecedents of data-driven decision making at the shop-floor level: the organizational knowing cycle leading to operational data-driven decision-making, the enabling roles of first-line managers, and the involvement of production workers in data-informed continuous improvement.

### **2.1 Operational data-driven decision-making: A Knowledge Management perspective**

Digital transformation is setting the ground for the bottom-up model envisaged by Nonaka (1994), in which 'those who create information are not top managers, but middle and lower managers'. Such decentralized decision-making

opens the way for the use of a Knowledge Management perspective on decision-making (Choo, 1996) not only for strategic, but also for operational, decision-making. The “organizational knowing cycle” (Choo, 1996) consist of sense-making, knowledge creation and decision-making. *Sense-making* is the action through which “things that have already happened” are made meaningful to the observant (Boland et al., 2008). Digital technologies have a huge impact on the sense-making of events happening on the shopfloor (failures, stoppages, slowdowns, etc.), as they enable a massive collection and analysis of data, entailing a more complex (though effective) understanding of which problems should or could be addressed (Verganti et al., 2020). First, operational data are transformed into information through sense-making; then, information is used in process innovation, which leads to creation of new knowledge (Nonaka, 1994). To transform information into process innovation and allow *knowledge creation*, a mix of tacit/implicit knowledge (personal knowledge that is difficult to formalize or communicate: experiential know-how, insights and intuition hard to express and formalize) and codified/explicit knowledge (formal knowledge that is transmitted between individuals and groups: formulas, rules, procedures, specifications and databases) – is required to be recombined (Nonaka, 1994). First-line employees can interpret, analyze, and communicate information (Helper, 2009), to integrate context-dependent and system-level knowledge into the knowledge extracted from big data. Last, following the knowledge creation, effective operational decisions can be taken effectively, with the final aim of operational action. Two different approaches to *decision-making* are identified: normative decision making – data-driven, analytical, conscious and sequential – and intuitive decision making – experiential, unconscious and holistic (Flores-Garcia et al., 2019). When events are well-structured (i.e. unambiguous and analyzable), data-driven decision making can be superior to intuition-driven decision making (Flores-Garcia et al., 2019; Julmi, 2019).

However, employees that benefit of visualization, simulation and interaction with digital technologies for their decision making will need knowledge, skills, and attitudes to embrace data-driven approaches (Dougherty and Dunne, 2012). Despite their importance for organizational performance, either team leaders’ and supervisors’ roles have been neglected in many studies concerning team effectiveness and operational performance (e.g. Inamizu et al., 2014; Ingvaldsen and Benders, 2016).

## **2.2 The roles of first-line managers in high-involvement work environments**

At the shop-floor level, the ability of handling production data and take operational decisions upon them is in charge of first-line managers such as Team Leaders and Supervisors. According to the definitions of Ingvaldsen and Benders (2016), for every five or six production workers there is a *hancho* (who we call Team Leader) leading the *han*, and for every two or three *hans* there is a *kumicho* (who we call Supervisor). Both Supervisors and Team Leaders are “lower-level managers responsible for operational control, maintaining day-to-day interaction with blue collar workers” (Ingvaldsen and Benders, 2016). Having to deal with operational control and monitoring, materials handling, and decision making, many first-line individual roles contain both managerial and supervisory elements (Lowe, 1993). Especially with lean production, many specialist functions have moved to the line, in order for supervisors to keep more managerial and strategic tasks as monitoring, informing, and making decisions. As such, supervisors and team leaders exhibit most of the ten roles of the managers identified by Mintzberg (1989). Supervisors, for example, are in charge of training workers for discipline, multi-skilling and continuous improvement (Ingvaldsen and Benders, 2016), and of performing managerial (“control and schedule” – Olivella, 2008) activities without working on the line: they manage workers’ vacancies, prepare statistical process control charts, revise standard operating procedures, acquire information about failures and give instructions to act accordingly (from the “group leader” job description of Inamizu et al., 2014). Also, they are in charge of creating a climate that encourages participation of production workers and continuous improvement (Forza, 1996).

Team leaders, on the other hand, are in charge of the micro-management of the line by responding to malfunctions, keeping the production flowing and facilitating kaizen activities; moreover, when a vacancy occurs, they substitute the production worker and join the line (Inamizu et al., 2014), a peculiarity for which they need to know the standard operating procedures as they were production workers. Team leaders have ‘primary responsibility of process improvement’, they set the work pace and the training activities (Olivella, 2008, citing Delbridge et al., 2000). Team leaders have also the “transformational leadership” role of facilitating team members’ creativity leveraging on their capabilities and team knowledge (Shibata 2001).

First-line managers are in charge of involving production workers, who collect the so-called "small data" (Lam et al., 2017), and perform a liaison role with data analysts, who are in charge of processing the big data coming from new digital technologies. Especially when knowledge has to be created from big data, volume can have a negative impact, but veracity a positive impact (Cappa et al., 2021), making it fundamental having them input properly by production workers in charge of documenting defects, breakdowns, line slowdowns. Indeed, data-driven decision making approaches are suitable for non-ambiguous and analyzable events (Flores-Garcia et al., 2019), that are enabled by the availability and quality of data (Pigni et al., 2016). In this vein, production management systems that formalize the involvement of production workers, such as lean production (Womack and Jones 1997), could have an advantage data-driven decision-making. In a continuous-improvement approach, big data – collected through sensors, materials tracking, machine vision and other digital technologies – can be the ground for better root-cause analyses carried out by Team Leaders and Supervisors in quality circles, kaizen weeks, or through suggestion systems through the involvement of production workers (Neirotti, 2018). Therefore, this involvement enables joint decision-making among production workers and their supervisors (Langfred, 2004), that has been defined as "participation in decision making" (Parker, 2003). However, despite the theoretical interest for investigating the effects of employee involvement and participation in decision-making on operational outcomes, the literature on this still needs to be expanded with more empirical studies (Boxall and Macky, 2009).

### **2.3 Conceptual framework**

Drawing from literature and field research, a visual representation of first-line managers' and production workers' tasks in the sense-making, knowledge creation and decision-making in a big data context is shown in Figure 1.

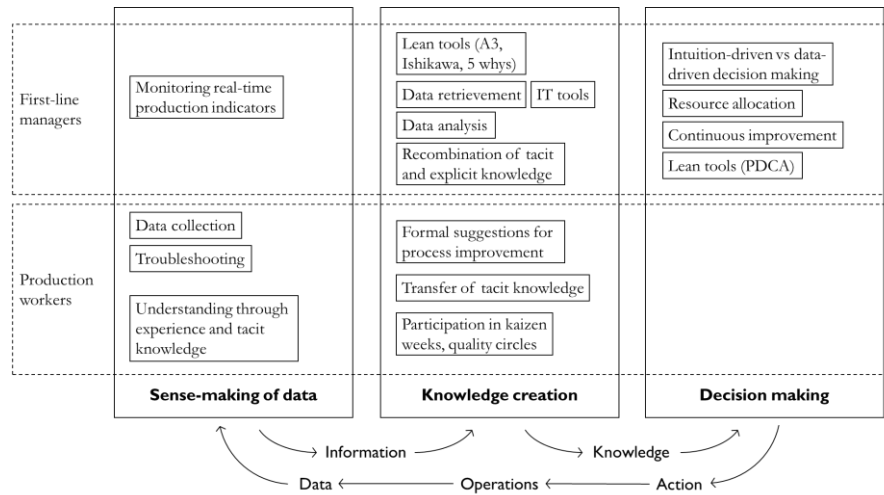


Figure 1. Conceptual framework

With a socio-technical approach (as suggested by Cagliano, 2019), the model considers technical aspects as digital *technologies* (to extract and analyze data) and the *organizational structure* (different hierarchical levels), and their relationship with social aspects as *people* (involved production workers and skilled first-line managers) and their *tasks* (data input, sense-making, knowledge creation and decision-making).

### 3 Research Methods

To address the research questions raised, this article adopts a quantitative method consisting of survey data collected in the Italian automotive suppliers' industry and analyzed by means of logistic regressions. Auto suppliers are exposed to international competition, which generates strong pressure on efficiency in the presence of product variety and innovation; these competitive pressures are transferred in turn to the supply chain, to which OEMs have long been making knowledge transfer of technology for the digitalization of production processes and lean practices characterized by continuous improvement, involvement of production workers, and a team-based work organization. Therefore, the automotive suppliers' industry is a suitable setting to study the joint involvement of first-line managers and workers in data-driven decision making.

### 3.1 Data collection

A multi-respondent survey was issued to HR, plant, and sales managers of Italian automotive supply firms between March 2019 and February 2020. Such sampling has been chosen empirically to guarantee appropriateness for this study. A total of 101 auto suppliers' plants participated in the survey, mainly SMEs operating as tier 1 (40%) and tier 2 (25%), constituting a sample representative of the population in terms of plant size, geographical region, and supply chain position. Response rates were 7% over the population and 20% over the sampling frame of firms, which allows generalizability with a 10% margin error. The questionnaire is comprehensive and contains – other than the queries strictly related to the research objective – questions to depict a complete and socio-technical overview of the digital transformation in these firms.

### 3.2 Data analysis

#### 3.2.1 Method

A logistic regression was used to determine the probability of using data-driven decision-making (DDDM) in a production plant using the involvement of production workers (PWI) and the skill gaps of Team Leaders and Supervisors as continuous predictors. The interactions between PWI and TL (model 3) and between PWI and SV (model 6) allow to test the complementarities hypothesized in the theoretical model (Figure 2).

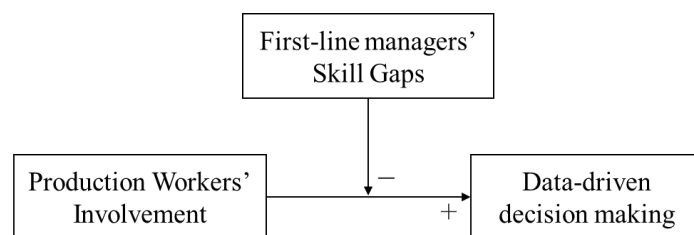


Figure 2. Theoretical model

#### 3.2.2 Measures

Dependent variable:

- *Data-driven decision making* is a dummy variable that indicates whether the use of intuition and experience (0) or data (1) is

predominant in the decision making process, the other being still present but secondary.

Independent variables:

- *Skill gaps of production Team Leaders and Supervisors.* These two measures were computed using likert scales through which HR managers assessed these employees' adequate competencies to perform their specific tasks.
- *Involvement of production workers in continuous improvement* is a summated scale that takes into consideration organizational elements of participation of production workers in decision making related to corrective actions and changes to the process (continuous improvement). It incorporates transparency in data diffusion at the shop-floor level, that we needed to create as no other scale found in literature considers the participation of workers in monitoring data coming from sensorized equipment, yet. The five items, validated through a PCA with  $\alpha=0.8$ , are detailed in Table 1.

Table 10. Operationalization of the production workers' involvement variable

Variable	Operationalization
Formal lean production programs for the involvement of production workers in formal meetings (quality circles and kaizen weeks, see Olivella et al. 2008; Jin and Doolen 2014)	<ul style="list-style-type: none"> <li>• 0 if no</li> <li>• 1 if yes</li> </ul>
% of production workers who took part in the mentioned formal-lean meetings in the past six months	<ul style="list-style-type: none"> <li>• 0 if 0%</li> <li>• 1 if &gt;0%</li> </ul>
"Performance is continuously tracked and communicated, both formally and informally, to all staff (including production workers) using a range of visual management tools" (adapted from Bloom and Van Reenen, 2007, and Olivella et al., 2008: "work teams receive detailed information about quality, performance and accidents").	<ul style="list-style-type: none"> <li>• 0 if 1 or 2 or 3</li> <li>• 1 if 4 or 5</li> </ul>
% of production workers who carried out formal training activities on lean production methodologies and / or continuous improvement (see Olivella et al., 2008)	<ul style="list-style-type: none"> <li>• 0 if 0%</li> <li>• 1 if &gt;0%</li> </ul>
Formal program for collecting lean suggestions from production workers (see Olivella et al., 2008)	<ul style="list-style-type: none"> <li>• 0 if no</li> <li>• 1 if yes</li> </ul>

Control variables:

- *Firm Size* (number of employees in the plant) and *Employees Average Age*, to control for the plant workforce composition (e.g. long-standing workforce could have a bias in being more driven by their experience rather than by data);
- *Digitalization* is a summated scale that considers the main digital technologies used to collect data: (i) "sensors installed on equipment to continuously monitor work conditions and process parameters"; (ii) "tracking technologies for product components, e.g. RFID, bar codes, QR codes etc., to track location and status within the plant for logistic purposes"; (iii) "machine vision that allows the computer to inspect images used in metrology and other activities of process quality control";
- *Education level of Team Leaders* and *Education level of Supervisors* (0 = no title, 0.5 = high school diploma, 1 = degree or more) to ensure that the gap is not due by choices of hiring lower-educated workers driven by cost-saving reasons, but rather a characteristic nested in the institutional background of the labor market, generated by actual gaps between education and work.

## 4 Results

### 4.1 Descriptive statistics

Data-driven approaches to decision-making are adopted in the 54% of production plants. The more frequent educational level is the high school diploma for both Team Leaders (75%) and Supervisors (63%), followed by a university degree (21% Team Leaders, 33% Supervisors); these professions are done without a title in only 4% of the firms. However, the results show diffused skill gaps: 39% of firms report them for Team Leaders, 44% for Supervisors. Table 2 shows these and the rest of descriptive statistics concerning the measures used in the regressions.



Table 11. Descriptive statistics of the variables used in the regressions

Variable	Obs	Mean	Std. Dev.
DDDM (Data-Driven Decision-Making)	98	.541	.501
Firm Size (number of employees)	100	148.43	214.60
Employees Average Age	98	42.61	4.34
Digitalization	95	.589	.381
Sensorized equipment	96	.719	.452
Materials tracking	99	.556	.499
Machine vision	98	.510	.503
Educational level of Team Leaders	75	.587	.238
Educational level of Supervisors	76	.645	.269
Production Workers' Involvement (PWI)	88	.560	.372
Quality circles, kaizen weeks	96	.490	.503
PWs involved in lean meetings	95	.547	.500
Data diffused on shop floor	89	.629	.486
Lean training for PWs	96	.698	.462
Suggestion programs	96	.354	.481
Team Leaders' Skill Gaps (TL)	75	.387	.490
Supervisors' Skill Gaps (SV)	72	.444	.500

#### 4.2 Regression results

Table 3 shows the results of the three logistic regression models concerning Team Leaders: the involvement of production workers, alone, has a statistically significant positive effect on the use of data-driven decision-making (models 2 and 3), but the effect becomes strongly negative when Team Leaders show skill gaps (interaction in model 3). The results of the three models run using Supervisors' skill gaps and education level show the same result for what concerns the involvement of production workers, but the effect of the interaction is much lower and not statistically significant (Table 4).

Table 12. Logistic regressions models – Team Leaders

Dependent Variable: DDDM	(1)	(2)	(3)
Firm Size	1.315 *** (0.411)	1.108 *** (0.428)	1.445 *** (0.497)
Firm Digitalization Level	-0.011 (0.228)	-0.002 (0.231)	-0.095 (0.248)
Employees Average Age	-0.023	-0.012	-0.492

	(0.085)	(0.090)	(0.638)
Education Level of Team Leaders	0.449 (0.652)	0.395 (0.683)	0.329 (0.762)
Production Workers' Involvement (PWI)		0.554 * (0.357)	0.742 * (0.417)
Team Leaders' Skill Gaps (TL)		0.091 (0.350)	0.263 (0.385)
PWI x TL			-1.166 *** (0.454)
Constant	-5.532 (4.113)	-5.073 (4.341)	-4.660 (5.259)
N	72	72	72
Pseudo R <sup>2</sup>	0.263	0.290	0.383

**Note:** Coefficients expressed in log-odds ratios. Standard errors in parentheses.  
\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 13. Logistic regressions models – Supervisors

<b>Dependent Variable: DDDM</b>	<b>(4)</b>	<b>(5)</b>	<b>(6)</b>
Firm Size	0.959 *** (0.351)	0.792 *** (0.396)	0.802 *** (0.394)
Firm Digitalization Level	0.149 (0.209)	0.119 (0.217)	0.107 (0.220)
Employees Average Age	-0.004 (0.083)	-0.033 (0.093)	-0.020 (0.099)
Education Level of Supervisors	0.283 (0.528)	0.524 (0.593)	0.523 (0.606)
Production Workers' Involvement (PWI)		0.557 * (0.343)	0.593 * (0.357)
Supervisors' Skill Gaps (SV)		0.366 (0.339)	0.379 (0.346)
PWI x SV			-0.498 (0.346)
Constant	-4.672 (3.673)	-5.998 (4.135)	-5.497 (4.327)
N	72	72	72
Pseudo R <sup>2</sup>	0.206	0.250	0.206

**Note:** Coefficients expressed in log-odds ratios. Standard errors in parentheses.  
\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## 5 Discussion

By providing empirical evidence on the importance of production workers' involvement and team leaders' capabilities as antecedents of shop-floor data-driven decision-making, the study provides the following relevant contributions

to work organization and knowledge management literatures, and valuable recommendations to practitioners (HR managers, education policymakers).

### ***5.1 Micro- and meso-level antecedents of data-driven decision-making***

From a socio-technical perspective, the results suggest that the propensity toward data-driven decision-making practices depend more on social (organizational and individual capabilities) variables than on technological variables. Indeed, the digitalization level does not show any relevant impact on the adoption of data-driven decision-making. On the other hand, being data-driven in digitalized production plants is possible when production workers are involved in data-informed continuous improvement, and their Team Leaders have no previous formal education skill gaps related to their jobs.

This article provides a contribution to Knowledge Management literature with empirical research on the exploitation of domain knowledge through data-driven approaches enabled by digital technologies. At the micro-level, it contributes to literatures of technological change, work organization and skills, confirming the importance of individual capabilities in exploiting new technologies and reinforcing the idea of digital transformation as a “skill-biased technological and organizational change” (Piva, 2005), for which an effective digitalization depends – in this case – on skilled team leaders. At the meso-level, a contribution to work organization literature is that Team Leaders seem not likely to be delayed, confirming the propositions of Ingvaldsen and Benders, 2016 and disconfirming prior literature on lean (e.g. Womack, 1990). The results, however, suggest that further studies – preferably qualitative, to investigate how and why this is the case – are needed to confirm whether this is also true for Supervisors, as their preparedness does not result fundamental in the data-driven transition. Also concerning organizational structure, when production workers are involved in continuous improvement, data-driven approaches are made possible. This can be explained through organizational and ecological knowledge management perspectives, focused on organizational design and interaction among individuals to facilitate knowledge processes. The empirical results can support the view for which production workers’ tacit knowledge and experience are fundamental in the sense-making of shopfloor data (Helper 2009), and that involving them could increase veracity of data and thus the propensity toward using them for operational decision-making.

Insisting on the importance of formal involvement of production workers in continuous improvement typical of lean production, this work contributes to the literature stream that explores the interplay between digitalization and lean practices (e.g., Buer et al., 2018; Pereira et al., 2019; Wang et al., 2016), suggesting that the introduction of formal lean programs could pave the way to data-driven decision-making. This work also contributes to literatures of High Involvement Management Practices by proposing a scale for measuring employee involvement in continuous improvement in digitalized environments that incorporates elements of production data transparency and availability to those of formal lean programs (quality circles, kaizen weeks, regular meetings, suggestion programs, training). The use of similar approaches could become a standard for studies concerning digitalization. Also, scales assessing perceived participation at the individual level (e.g. Kahnweiler and Thompson 2000; Delery and Gupta 2016) might be biased, as production workers could not be aware of which activities are part of continuous improvement initiatives. Therefore, computing this measure at the meso-level allows a better focus on work organizational practices.

Production workers' role in operational decision making can be empowered by increasing the exchange of information with team leaders and supervisors (Langfred, 2004). First-line managers, in turn, can facilitate continuous process improvement by fostering an "organizational climate where workers feel safe and obliged to contribute their knowledge and suggestions" (Ingvaldesen, citing Edmondson, 1999). Doing so, they can extract value from production workers and create knowledge by combining 'strategic, macro, universal information and hands-on, micro, specific information' (Nonaka, 1994: 32). This exposes first-line managers to new skill gaps, that arise due to changes in their managerial roles identified by Mintzberg (1989). They will need upskilling of interaction skills of teamwork, leadership, communication (interpersonal roles for sense-making); the "monitor" role to search – and the "disseminator" role for the recombination of – knowledge (informational roles for knowledge creation); and skills for – and attitudes towards – troubleshooting, continuous improvement, day-by-day and medium-term allocation of resources (decisional roles for decision-making).

## ***5.2 Implications for HR managers and education policymakers***

The results of this study show that such gaps in operational employees' capabilities can limit the benefits of digitalization. In particular, this confirms

previous studies according to which Team Leaders' skill gaps can lead to worse performance (Shibata 2001), updating them with skill gaps related to data-driven decision-making. In this vein, this article contributes to practice by showing the needs for a formal upskilling of specific job profiles to exploit the benefits of digitalization through data-driven approaches to decision making. Concerning implications for practitioners, this study could contribute to at least three categories: policymakers, universities, and secondary education systems.

Team Leaders' and Supervisors' activities are predominantly carried out with secondary-level education, and 89.8% of the firms in the sample envisage additional training after they take on their roles. This makes these jobs fall in the category of so-called "middle-skill jobs", i.e. those occupations that can be performed with a high-school diploma and additional training, but for which a degree is not usually needed (Holzer and Lerman, 2007). The "middle-skill jobs" category (Fuller, 2014) includes not only skilled technical jobs as IT technicians or quality and maintenance specialists, but also first-line and middle-line skilled blue-collar and managers (Osterman et al., 2011; Carnevale et al., 2013). For them, the digital transformation has been generating a demand for digital and interaction skills in the last decade, that is not being met, generating the so-called "middle-skills gap" (Kochan et al., 2012; Fuller, 2014). In the last decade, many studies showed how middle-skills gap have a huge impact on the productivity of advanced manufacturing countries (e.g. Fuller et al., 2014). Gaps in middle-skill jobs represent an increasingly urgent issue for the competitiveness of manufacturing industries (Kochan et al., 2012); in the US, 69% of HR executives stated that firms' performances are affected by a difficulty in attracting and retaining them (Fuller et al., 2014). Therefore, for HR managers, this work highlights the importance for operational roles to acquire, develop and retain the competencies required to create knowledge from big data and context-dependent knowledge.

From the educational point of view, the implications are two-fold: embrace a shift towards the "academization" (Bøje, 2012) of this category, requiring a university degree to perform it, or adapt secondary and post-secondary schools' curricula to match the new requirements. The first path, as graduates are increasingly available on the job market, is already being undertaken by companies to fill gaps in soft skills such as communication, leadership and reliability (Fuller, 2014). However, it represents an inefficiency in terms of over-education, and as such the second path might be more recommendable. For

example, there are curricula to become IT technician, programmer, electrician, robot operator, but no specific curricula – focused on lean production, basic statistics, team- and problem-based learning, etc. – are in place to become a first-line manager. These curricula could benefit from being designed to prepare the future team leaders for the “organizational knowing cycle” of sense-making, knowledge creation and decision-making. In this vein, (i) sense-making of data will require basics of statistics to interpret the data, team-based learning to develop interaction skills, and more humanities subjects, to develop communication and narrative skills; (ii) knowledge creation needs the interaction among – if not even integration of – technical schools, universities and firms for search of knowledge, and coaching systems like apprenticeships to exploit experiential learning cycle in recombining tacit knowledge and explicit knowledge; and (iii) decision making could find in workplace learning an accelerator of troubleshooting skill development, and in Challenge-Based Learning a method to develop problem solving and analytical decision-making (Colombiari and Neirotti, 2021).

This upskilling becomes crucial in this digital transition phase. However, Vocational Education and Training systems are not being able to keep the pace of technological innovation (Cedefop, 2018), therefore companies must keep insisting on developing the so-called “training academies” or “teaching factories” to fulfil the needs of future middle-skill “knowledge workers” (Mavrikios, 2013). On the other hand, with a progressive automation of operations, where the new “production workers” are machines, this upskilling of team leaders will acquire further importance, along with urgent reskilling plans (WEF, 2019) for production workers.

## **6 Conclusion**

In the last decades, management literature has largely stressed the importance of high involvement management practices and knowledge management for operational performance. More recently, practitioner literature has been stressing on the middle-skills gap issue – that involves also skilled blue collars and first-line production managers – being exasperated by digitalization and threatening the competitiveness of firms. Grounded in the knowledge-based theory of the firm, which interprets the knowledge creation for decision-making as a collaborative process integrating information coming from interpretation of data and context-

dependent knowledge, this article stresses the importance of taking both involvement of production workers and upskilling of team leaders into consideration as organizational enablers of data-driven decision-making. A main limitation of this study is that it is based on a single country and industry, therefore further research could compare and contrast these results in other institutional backgrounds and settings. The present work offers opportunities for further qualitative research aimed at characterizing specific skill gaps in sense-making, knowledge creation, and decision making in big data contexts, and explore ways to address them more punctually. This stream of further research could allow to address upskilling needs for team leaders and reskilling needs for production workers. Further considerations on employees' training practices, which can favor a stronger exploitation of digitalization, will be needed for an increasingly comprehensive theoretical and empirical understanding of the challenges and the benefits entailed by the adoption of new digital technologies.

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## In Search for a Successful Digital Transformation: Three Case Studies in the Valves Industry

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### Abstract

How can firms leverage on digital technologies to improve their survival odds in an increasingly challenging and competitive environment? And what explains the differences observed in adoption timing and usage patterns? This paper resorts on the concept of resilience to justify the existence of different yet effective approaches to the digital transformation by contrasting the success stories of three Italian companies in the valves industry. The hypothesis underlying this study is that digital technologies aligned with the resilience level of the adopting organisation support an appropriate engagement with the external environment. The case studies of digital transformation examined in this paper point out three main findings. First, for all companies the digital transformation represents an evolutionary rather than a revolutionary process. Second, resilience has a continuous nature that increases with the coherent intensification of its underlying components. In each company a unique blend of resources and cognitive tools enable the design and the enactment of consistent routines and meta-routines. Third, digital technologies adoption patterns align with the resilience level of each company and with the organisation engagement with the external environment. When the resilience model focuses on the shift to a new equilibrium the adoption process is centrally governed, and organisational change is limited. In contrast, when the resilience model focuses on coping with continuous and unpredictable change the digital transformation involves more decentralised decision making and significant organisational change.

**Keywords** – Digital transformation, Resilience, Complexity, Organisational change, Case studies

**Paper type** – Academic Research Paper

## 1 Introduction

The digital transformation is probably the most pervasive innovation in the last decades. Despite some concerns on the possible negative consequences for the mid- and low-skilled workforce, there is a widespread agreement on the importance of digital technologies in support of firm competitiveness and innovativeness (Brynjolfsson and McAfee, 2014; European Commission, 2019). However, systematic evidence on which conditions turn the adoption of digital technologies at the firm level into a successful growth path is still lacking. In addition, existing information suggests that adoption timing and mode, usage patterns, and impact on internal organisation widely vary across firms (Kiel *et al.*, 2017; Butollo *et al.*, 2018; Codara and Sgobbi, 2020; Götz and Jankowska, 2020). What justifies those differences? And how could firms leverage on digital technologies to improve their survival odds in an increasingly challenging and competitive environment? The empirical analysis in this paper supports the idea that the construct of resilience may help answering these questions. Defined as the capability to recover from a one-time shock or thrive under frequent, eventually continuous significant and unpredictable change, resilience is an enabling factor of survival and success in a turbulent environment (Manyena *et al.*, 2011). Based on a strong set of shared values, the resilient organisation develops a vision of the competitive environment, devises its role within this framework, and builds up and adapts a suitable set of routines to support the achievement of organisational targets. Resilience is therefore a powerful asset to navigate a complex external environment characterised by dynamic and unpredictable relationships between diverse players and forces (Ashmos *et al.*, 2000).

The hypothesis underlying this study is that successful firms configure digital technologies to reinforce their resilience and improve the probability of choosing a strategy that matches external complexity. The unique blend of resilience factors that characterises each company thus justifies variance in technology adoption and usage patterns.

This paper illustrates how resilience capability can explain the existence of different approaches to the digital transformation by contrasting the success stories of three Italian companies in the valves industry. We operationalise the construct of resilience based on Lengnick-Hall and Beck (2005), who frame resilience as a combination of cognitive, behavioural, and contextual factors.

The rest of the paper is organised as follows. Section 2 sets out the research hypothesis based on key suggestions from the literature on organisational resilience and complexity. Section 3 introduces the empirical methodology that drove the elaboration of the case studies reported in Section 4. Section 5 discusses the research findings and concludes.

## **2 Digital technologies, complexity, and resilience**

The diffusion of digital technologies has revived the debate on the relationship between organisations and their external environment. On the one hand, by increasing interconnectedness the digital transformation raises external complexity (Child and McGrath, 2001; Schroeder *et al.*, 2019). On the other one, digital technologies provide organisations with powerful tools to govern and adapt to external complexity (Tortorella *et al.*, 2021).

Past literature has shown how organisations, and firms in particular, can turn external complexity into an asset by actively selecting and shaping their task environment (Ashmos *et al.*, 2000; Daft, 2015) and even by leveraging on external complexity to exploit their distinctive capabilities (Aitken *et al.*, 2016). Decision makers' perception and interpretation of reality crucially shape engagement with external complexity because strategies and actions are undertaken based on representations and understanding of external complexity rather than objective measures (Boisot and Child, 1999). The richer the perception of the external environment, the more varied the representations held by decision makers, the higher the probability that purposive action taken by key organisational actors will actually match the features of the external environment.

A range of internal and external factors affect decision makers' interpretive processes, including interaction rules and power distribution among internal agents (Ashmos *et al.*, 2002; Accard, 2019), external collaborations (Schneider *et al.*, 2017), and environment segmentation (Child and Rodrigues, 2011). A comprehensive framework to connect all involved drivers and their interactions is provided by the construct of resilience. Lengnick-Hall and Beck (2005) identify resilience as the organisational feature that mediates between external complexity and organisational approaches to this complexity. According to the authors, organisational resilience results from the composition of interpretive capabilities (cognitive factors), routines and structures (behavioural factors), and resources (contextual factors). This model of organisational resilience allows for a

multi-faceted understanding of an organisation approach to external complexity. First, by disentangling the behavioural and the contextual dimensions of participation it stresses that routines and structure need enactment by properly endowed human resources. Second, by including among behavioural factors both current routines and the procedures to change current routines the model accounts for both the knowledge exploiting and the knowledge exploring mechanisms that take place within an organisation (March, 1991; Boisot and Child, 1999). Lengnick-Hall and Beck therefore suggest that resilience is more than the sum of its components. Resilience increases with the coherent growth of its underlying factors, which interact according to non-linear and non-strictly predictable patterns. The degree of organisational resilience can therefore be regarded as a proxy for internal complexity. The higher the resilience level, the wider the scale and the scope of change it can identify, select, and successfully master. Accordingly, more resilient organisations benefit from a higher probability to select an approach to external complexity that matches actual environment conditions (Lengnick-Hall and Beck, 2005; Lengnick-Hall et al., 2011).

The literature has identified in complexity reduction and complexity absorption two archetypal approaches to external complexity (Boisot and Child, 1999). Complexity reduction is appropriate when decision makers perceive a low degree of variety in the external environment and frame change as a shift from a no longer sustainable equilibrium to a new one. In this case, a simplified representation of the environment suffices to anticipate change and devise a strategy to achieve a new equilibrium. In contrast, when the external environment is perceived as highly variable and change is consistent and continuous complexity absorption is the most effective response to what Lengnick-Hall and Beck (2005) define as a robust transformation. A strategy based on complexity absorption requires the organisation to hold multiple (even conflicting) representations of its environment and redundant resources, which support a range of emergent routines and relations that provide strategical and operational flexibility under fluid conditions.

Complexity reduction and complexity absorption are typically presented as distinct, alternative approaches (Boisot and Child, 1999; Ashmos *et al.*, 2000; Walters and Bhuian, 2004). However, given the existence of multiple states for any system that represents the external environment of an organisation, whose complexity grows with the variety and the predictability of components and connections, a binary representation of the strategies available to face external

complexity may sound conceptually useful, yet unrealistic (Child and Rodrigues, 2011). Complexity reduction and complexity absorption may rather represent two extreme cases. The composition of the cognitive, behavioural, and contextual properties of an organisation contributes to defining different levels of resilience and therefore different degrees of complexity in context representation, viable strategies, and actual choices. Accordingly, real organisations position along a continuum that ranges from unique and stable representations of reality, corresponding to simplified strategies, to multiple and variable representations that support highly complex strategies. As the level of resilience increases, an organisation's ability to develop multiple representations of the environment and to foreshadow strategies and actions progressively gets more and more sophisticated. Complexity reduction may therefore represent the only perceived and feasible strategy for less resilient organisations, whereas more resilient ones can choose in a range that spans from complexity reduction to the maximum degree of complexity absorption they are able to deal with.

Our research hypothesis is that successful firms choose to compete in environments where their resilience level matches external complexity. In successful digital transformations we expect technology implementation and technology usage to reinforce cognitive, behavioural, and contextual factors, laying the foundations to raise the level of resilience of the organisation and therefore enabling the absorption of higher levels of complexity.

### **3 Methodology**

The relationship between digital technologies and resilience was explored by means of a case study approach. Based on in-depth analysis, case studies allow investigating a phenomenon within the peculiar environment it rises from. A case study approach is therefore particularly appropriate to appreciate organisational resilience, which cannot be separated from the environment and the people it originates from (Branicki *et al.*, 2019). More specifically, this study adopts a multi-case method (Lijphart, 1975) based on three comparable firms that recently adopted a bundle of digital technologies. The examined firms match on variables not central to the research hypothesis, including membership in the valves industry, a long familiarity with technological innovation, and an excellent capability to leverage on innovation in support of growth and economic performance. However, the sampled firms differ in resilience capability and digital

strategy, allowing for an assessment of the relationship between those dimensions.

Information collected during the case studies, which developed between late 2019 and early 2020, concerned two areas: the components of organisation resilience and the digital transformation projects. Lengnick-Hall and Beck (2005) stress that resilience capability at the organization level results from a unique blend of cognitive, behavioural, and contextual factors, each one can be further detailed in two elements. The cognitive dimension originates from a combination of organisational identity and constructive sensemaking. Organisational identity founds "on a strong sense of purpose, core values, a genuine vision, and a deliberate use of language" (Lengnick-Hall *et al.*, 2011, p.245). Strong organisational identity feeds high levels of motivation and encourage to face situations of crisis and change by mobilising all available resources in support of problem solving and action. Constructive sensemaking "relies on the language of the organization (i.e., its words, images, and stories) to construct meaning, describe situations, and imply both understanding and emotion." (Lengnick-Hall *et al.*, 2011, p.246). Constructive sensemaking, which reveals in situation-specific interpretations rather than plans and programmes, has to do with the guidelines rooted in the company's culture and shapes organisational propensity to innovation and change and the orientation towards external collaborations. Constructive sensemaking also has to do with power distribution, which delimitates what organisational units and which positions will have a voice in decision-making.

The behavioural dimension of organisational resilience, which turns cognitive properties into visible responses to uncertain situations, includes two components: the variety of the inventory of operational routines and the richness of functional habits that support the exploration of further courses of action and, consequently, the creative response to change. Both components are linked to internal variety and to the orientation of organisation design. On the one hand internal variety, which may be proxied by products diversification and by the heterogeneity of internal processes and organisation units, is proportional to the number and the diversity of operational routines and to the need for changing existing routines, due to higher probability of tensions and conflicts motivated by competition for the same (limited) resources (Größler *et al.*, 2006). On the other hand, the impact of organisational design on behavioural factors may arise by contrasting an organisation designed for efficiency to an organisation designed



for learning (Daft, 2015). The first model is characterised by a vertical structure based on strict hierarchy, centralised decision-making, and limited use of teamwork. In contrast, the learning organisation favours a horizontal structure characterised by more relaxed hierarchy, decentralised and participative decision-making, horizontal information flows, inter-functional work teams, and liaison roles. The stronger the orientation to a vertical organisation, the higher the formalisation of tasks and processes, the larger the number of detailed routines to manage day-by-day operations, and the stronger the resistance to change. The stronger the orientation to learning and the richer the internal connections, the more complex and varied the functional habits and, consequently, the creative response to change. Continuous Improvement and Total Quality Management provide examples of generative meta-routines that inform the behaviour of organisation members in horizontal organisations (Zamarian, 2010).

The third property of organizational resilience, contextual resilience, allows for integrating cognitive and behavioural resilience and includes social capital and resources network. "Deep social capital evolves from repeated, personal interactions between people and between organizations and is most effective when based on trust" (Lengnick-Hall and Beck, 2005, p.752). Consequently, the social capital of the observed companies was measured based on the use of practices aimed at enriching and deepening personnel relations, including high-performance work practices, training, personnel retention, and collaborative work. These practices impact not only human capital but also the social context of the organisation, therefore promoting the "ability of participants ... to subordinate individual goals and associated actions to collective goals and actions" and mutual trust which makes collaborative efforts possible. (Leana and Van Buren 1999). In a similar way, resource networks are assessed via the extension and the intensity of interdependent relationships with environmental agents (including suppliers, customers, research centres, and institutions).

The second set of variables examined in the case studies concerned the adoption of digital technologies. The interviews explored the contents of innovation programs, the degree of decentralisation in associated decision-making, employees' involvement, the solutions to monitor the progress of the innovation projects, and possible changes in organisational design. Thanks to significant differences among the examined companies, data in this area allow assessing the coherence between the nature of the involved technological

solutions, the adoption process, and the firm resilience capability as shaped by cognitive, behavioural, and contextual factors.

## **4 Three case studies**

All companies examined are highly internationalised family businesses based in an industrialised province of Northern Italy and operating in the valves industry. With a turnover of 9 billion euros and 30,000 employees in 2019, the taps and valves industry is an important sector of Italian manufacturing (Prometeia, 2019). The strength of Italian companies is witnessed by the high share of exports (65% of turnover in 2019), yet competition is fierce due both to the aggressiveness of low-cost producers from Far East countries, the more and more binding standards imposed by downstream clients such as oil and gas companies, and the raise of new application fields, as in the case of hydrogen valves.

This section reports how the examined companies – henceforth Company Alpha, Company Beta, and Company Gamma – explored unique paths to turn digital technologies into a tool for engaging with a complex external environment.

### **4.1 Firms characteristics**

As a preliminary step, Table 1 characterises the market and the organisation structure of the three companies, whose recent story witnesses the attempt to reposition in top market segments.

Company Alpha was founded in the 1970s as a branch of a taps and fittings parent company to produce make-to-stock steel ball valves and butterfly valves. In recent years, due to increasing price-based competition from Far East companies, Alpha entered the made-to-order market of valves for the oil and gas sector, where suppliers need to comply with the strict requirements imposed by large clients. In 2019 oil and gas valves represented 1% of produced volumes but accounted for 20% of turnover. The business of standard valves is still sustainable thanks to the value added by pre- and post-sales services, which allow for a price premium compared to products from low labour cost countries. The production of both standard and made-to-order valves include two main phases, allocated to separate job shops: highly automated fabrication and labour-intensive assembling and testing. Company Alpha employs about 90 employees and exports account for 45% of turnover.

Company Beta manufactures Liquefied Petroleum Gas (LPG) valves for multinational oil corporations and LPG cylinder producers. Founded in the 1950, Company Beta belongs to a vertically integrated corporate group that is world leader in equipment and components for gas control. Due to the increasing competitive pressure on lower market segments, Company Beta progressively focused on certified LPG valves, which secure higher margins but impose strict quality standards that require more sophisticated design and production processes.

Company Gamma was founded in the early 1980s and has since consolidated a reputation for producing made-to-stock and customised valves for utilities industries. The company subsequently expanded to valves for the automobile industry, to subcontracting and, in the last decade, to hydrogen valves. The latter move reflects the willingness to build on the company traditional strengths to reposition in a higher value-added yet more demanding and uncertain segment of the valves market to lessen the cost-based competition from mature products. Each product line corresponds to a business unit with dedicated sales, purchases, and quality control functions. R&D, support staff, and operations serve all business units. Company Gamma employs about 180 employees, including 40 R&D engineers.

#### **4.2 Sources of organisational resilience**

Table 2 reports the main differences and similarities in the cognitive, behavioural, and contextual properties of resilience at the three companies. Both Company Alpha, Beta, and Gamma display a high degree of coherence among the dimensions of organisation resilience identified by Lengnick-Hall and Beck (2005), with overall resilience growing from Company Alpha to Beta, and to Gamma.

Thanks to informal coordination and direct supervision Company Alpha can provide a flexible answer in case of limited change, whereas poor functional habits question the company resilience in front of more robust and continuous change. However, strong cohesion around the company values may enable a discontinuity, provided that modifications are sponsored by the CEO, supported by the parent company, and compatible with the existing social capital. In contrast, the higher resilience level allows Company Beta to face uncertainty by exploring change opportunities rather than exploiting already beaten roads.

Company Beta's resilience builds on a multidecade-long history of R&D and technical excellence in the LPG valves technology, on the parent company leadership in the field, on the capability to manage a high variety of products, processes, and customers, and on a consolidated focus on effectiveness and learning.

All resilience factors of Company Gamma reflect the founder's vision of the firm as a social community based on participation. If organisational identity builds on the innovativeness and the quality of products deriving from firm members' engagement, constructive sensemaking explicitly connects the company success to a technological performance rooted in participation. Thanks to intense vertical and horizontal communication, decentralised decision-making, and lean approach to manufacturing the company benefits from a wide repertoire of standard routines and meta-routines for continuous improvement and change management. In addition, Company Gamma has been developing appropriate internal and external resources to support engagement with an external environment perceived as complex and challenging. On the one hand the company social capital has been the target of sustained investments, on the other hand Company Gamma benefits from an extended network of R&D partners and consultants and from collaboration with clients that represent the state-of-the-art of technology in their application fields.

Table 1. Main characteristics of the surveyed companies

		<i>Company Alpha</i>	<i>Company Beta</i>	<i>Company Gamma</i>
Size [No. employees]		90	100	140
Foundation		1970s	1950s	1980s
Membership in an industrial group		Yes	Yes	No
Market	Traditional products	Water valves	LPG valves	Water valves, LPG valves
	New products	Oil & gas valves	Certified LPG valves	Hydrogen valves
Organisation	Organisation structure	Simple	Simple	Divisional
	Decision-making	Centralised	Partially decentralised	Selectively decentralised
	Managerial style	Family-style	Formal	Participative

#### **4.3 The investments in digital technologies**

Table 3 synthesises the feature of the investments in digital technologies recently undertaken by the observed companies. Table 3 outlines that, despite the differences in served markets, organisational structure, and resilience levels

recalled above, investment in digital technologies presents important commonalities across the three companies. First, all projects are promoted by top managers, with the agreement of the parent company in the case of subsidiary firms. Second, the common search for higher efficiency signals the competitive pressure in the industry. Third, all projects leverage digital technologies to integrate information from the operations in higher-level decision-making, as witnessed by the common introduction or upgrading of an MES system.

Table 2. Sources of organisational resilience of the surveyed companies

		<i>Company Alpha</i>	<i>Company Beta</i>	<i>Company Gamma</i>
Cognitive properties	Organisation identity	Family business – 3 <sup>rd</sup> generation Membership in an industrial corporation Lifelong employment International span, local roots Product quality and client service	Family business – 3 <sup>rd</sup> generation Membership in an industrial corporation Employees' wellbeing International span, local roots Product quality and client service	Family business – 1 <sup>st</sup> generation Lean production to raise participation Employees' wellbeing International span, local roots Product quality and client service
	Constructive sense-making	Technological excellence Success history "Familiar" management style	Technological excellence and innovation Success history Vertically integrated parent company	Technological excellence and innovation Success history Participation
Behavioural properties	Routine repertoire	Formalisation focused on operations	Formalisation extended to coordination	Focus on knowledge codification (lean production)
	Functional habits	Limited by focus on control	Focus on R&D and integration	Focus on learning and participation
Contextual properties	Social capital	Focus on trust Internal labour market	Focus on skills and training Internal/external labour market	Focus on skills and training Mainly internal labour market
	Resource network	Input commodities from global suppliers Informal support by parent company	Key inputs from internal suppliers Extended network of clients and R&D partners	Demanding clients Extended network of R&D partners and consultants

However, important differences also exist. The adoption of new digital technologies at Company Alpha had limited impact on resilience factors. Tasks and skills did not suffer significant alterations. No new position or organisational unit were created. In addition, the MES supports new decision processes only among managers. Internal change answers a need for increasing the efficiency of the existing processes rather than redefining and integrating the overall organisation design. The lack of radical structural changes and the persistence of

centralised control suggest that Company Alpha is using digital technologies to overcome the difficulties posed by increased competition and bounce back to a new equilibrium rather than to pursue continuous change.

In contrast, the digital transformation had a significant impact on resilience factors at Company Beta. Internal variety grew up with the institution of new positions and new organisational units to govern the technological change. Even if top management ruled adoption, implementation encouraged users' involvement and empowerment, also by means of training. In most cases the automation of manufacturing tasks lowered physical effort for operators and redesign jobs based on job enriching and job rotation. Company Beta uses new technologies to reposition in the higher segment of the market for LPG valves where it already operated. By enriching the cognitive, behavioural, and contextual dimensions of organisational resilience digital technologies create more suitable conditions to engage in continuous change according to a complexity absorption approach.

Table 3. Main feature of the investments in digital technologies

	<i>Company Alpha</i>	<i>Company Beta</i>	<i>Company Gamma</i>
Decision-maker	Company CEO and parent company top management	Company CEO and parent company top management	Company top management
Pursued targets	Efficiency increase; timely availability of shop-floor information	Efficiency increase; employees' wellbeing	Employees' wellbeing; efficiency increase
Adopted technologies	MES; automated warehouse	Integration between MES and ERP; highly automated assembly lines; collaborative robots	Integration between MES and ERP; integrated design and simulation software; 3D printers; machining centres with robotic loading and unloading
Innovation scope	Limited to involved processes	New positions in operations; new organizational units, including a change management unit	Company-wide support to the lean-production approach
Implementation strategy	Working group including managers of involved functions; external consultants; centralised management and limited user involvement; limited training for users	External consultants and technical support from engineering group subsidiary; key users early involvement; training for users	Launch of operative projects preceded by a taskforce to outline the overall vision; external consultants; implementation teams including key users from involved units; steering committee to supervise coherence among projects; training for users

Company Gamma shares with Company Beta the resort to digital technologies to absorb external complexity, which in this case is driven by entry in the highly innovative market segment of hydrogen valves. However, for Company Gamma the use of new technologies in search for greater efficiency and flexibility has been accompanied by an even stronger attention to expanding the workforce autonomy, reducing physical fatigue, and providing new tools and opportunities to involve all company employees in designing and implementing innovative solutions. We may therefore claim that the digital transformation further reinforces the already remarkable resilience level of Company Gamma and allows for the absorption of a high degree of external complexity.

## **5 Discussion and conclusions**

Based on interviews with managers and financial statements, the cases studied in this paper are successful examples of technological change. Our analysis points out three main empirical findings. First, for all companies the digital transformation represents an evolutionary rather than a revolutionary process. A habit of technological excellence rooted in market competition is still a powerful driver to adopt state-of-the-art solutions also in the knowledge economy.

Second, each company presents a unique blend of the factors that characterise an organisation resilience level. However, in the successful examples examined in this paper the combination of cognitive, behavioural, and contextual factors is not random. It rather composes a coherent picture of internal variety, where resources and cognitive tools enable the design and the enactment of consistent routines and meta-routines. Centralised government and reduced functional habits at Company Alpha suggest lower levels of resilience compared to the more structured and better endowed Company Beta, and even lower in comparison with participative Company Gamma. Our analysis consequently supports the intuition that resilience has a continuous rather than binary nature and that resilience increases with the coherent intensification of its underlying components.

Third, digital technologies adoption patterns align with the resilience level of each company and with the organisation engagement with the external environment. When the company resilience level is limited the adoption process is centrally governed and involves narrow organisation adjustments. In this case, exemplified by Company Alpha, technological change basically pursues a shift to

a new equilibrium. In contrast, when the company resilience allows for coping with continuous and unpredictable change the digital transformation involves more decentralised decision processes and significant organisational change. Company Beta and Company Gamma both aim at coping with environmental challenges by means of complexity absorption. However, whereas the former exploits large internal and external resources to reinforce its position in existing application fields, the latter leverages on structure and workforce flexibility to diversify in new markets. The continuous nature of resilience thus reflects into no clear-cut separation between complexity reduction and complexity absorption. Therefore, the proposed analysis supports our research hypothesis that successful firms configure digital technologies to reinforce their resilience and match external complexity.

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## Is Digital Supply Chain Calling for new KPIs?

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### Abstract

In the last decade, the introduction of digital technologies has completely transformed the supply chain. Digital technologies have made the supply chain more efficient, reliable, and responsive. As a result, Digital Supply Chain (DSC) is now a major source of competitive advantage for firms. Significant resources are dedicated to manage, operate and control DSC and its performance. Performance Measurement System (PMS) is an integral part of any operation. Over the years, the role of PMS has evolved from merely measuring and reporting performance gaps to support managers in strategic decision making. PMS rely on a set of KPIs that a firm adopts as per its goals and needs. Different streams of literature have debated for and against the need for newer KPIs for measuring DSC performance. With the help of industry and academic experts, this study investigated the usefulness of existing KPIs in measuring DSC performance by collecting survey responses. A different set of experts were also interviewed to gain meaningful insights to contribute to the debate. The analysis of the responses confirms that the need for newer KPIs is not imminent. Another contribution of the study is to present a definition for DSC based on insights from the experts.

**Keywords** – Digital supply chain, performance metrics, Performance KPIs, performance measurement, Digital transformation

**Paper type** – Academic Research Paper / Practical Paper

## 1 Introduction

With the emergence of global procurement, manufacturing, and distribution, supply chain systems have become strategically important. During the last two decades, the focus has shifted from the factory level management of supply chains to enterprise-level management. These enterprise-level entities are often located in different corners of the globe but are closely connected/dependent on each other. This real-time integration of two or more physically apart entities is achieved by adopting digital technologies into the supply chain system. As a result of this adoption, supply chains become digitalized and are referred to as smart supply chain (Wu et al., 2016), supply chain 4.0 (Frederico et al., 2020) and Digital Supply Chain (DSC) (Büyüközkan & Göçer, 2018), including others. This study combines all these terms and refers to these interconnected supply chain as DSC. Studies have reported several benefits of DSC over the traditional supply chain, including higher customer satisfaction (Jiang & Zhao, 2014; Jonsson & Gunnarsson, 2005; Zhao & Jiang, 2013), operational efficiency (Lu et al., 2012; Sharma & Bhagwat, 2006; Zhao & Jiang, 2013), supplier relations (Ranganathan et al., 2011; Zhao & Jiang, 2013) and superior financial performance (Haoud & Hasnaoui, 2019; Youssef & El-Nakib, 2015).

On the one hand, the introduction of digital technologies makes the supply chain faster, efficient and more reliable. On the other hand, these introduce a higher level of complexity and variables into the system that need to be controlled and monitored. Chae (2009) argued that the Performance Measurement System (PMS) could help firms detect areas of problem and areas of improvement by identifying gaps between planning and execution. Over the years, the PMS has shifted its focus from merely measuring and reporting performance to participate and facilitate strategic decision-making (Nudurupati et al., 2021). These goals are achieved using different Key Performance Indicators (KPIs). These KPIs are used for *"assessing and controlling progress, highlighting achievements, enhancing understanding of key processes, identifying potential problems (e.g., bottlenecks), and providing insight into possible future actions, among others"* (Ahi & Searcy, 2015, p. 361). Researchers have argued that new complex systems will require more sophisticated KPIs to measure their performance (Cho et al., 2012; Mondragon et al., 2006; Ralston et al., 2015). Therefore there is a need to develop new KPIs for measuring DSC performance (Lima-Junior & Carpinetti, 2017; Rasool et al., 2021).

Previous studies have provided frameworks/guidelines to incorporate into DSC for better performance measurement and control (Dweekat et al., 2017; Marimin et al., 2017; Yadav et al., 2020). But surprisingly, the only study available that focused on developing KPIs for DSC was by (Sambasivan et al., 2009)). Since then, a lot has changed, and newer technologies have emerged and have become an integral part of the DSC system. Melnyk (2014) argued that it is vital for a firm to adopt an appropriate performance measuring method to record and report the system's performance, but this is not often the case. Recent literature emphasized the need for newer KPIs for DSC (Cho et al., 2012; Lima-Junior & Carpinetti, 2017; Mondragon et al., 2006; Ralston et al., 2015; Rasool et al., 2021). A different stream of literature used existing KPIs to measure DSC performance and demonstrated their appropriateness (Gilbert et al., 2017; Haoud & Hasnaoui, 2019; Llach & Alonso-Almeida, 2015; Youn et al., 2014; Youssef & El-Nakib, 2015). Given this background, this study investigates the capabilities of existing KPIs to measure DSC performance and if there is a need for newer KPIs. Such empirical testing will contribute to the current debate and identify future directions by improving the theoretical understanding of PMS used for DSC.

## **2 Theoretical background**

Historically, PMSs have received substantial attention from both academia and industry (Schleicher et al., 2018). Cascio (2012) estimated that over 90% of global firms have formal PMSs to control and monitor their performance. PMSs help firms in controlling, reporting, and correcting their performance to meet firm-level goals by highlighting the gap between planning and execution (Chae, 2009; Melnyk et al., 2014). One of the earliest attempt to systematize the performance measurement process was made by Flappe et al. (1996). The authors proposed a three-step method to develop and use a set of interconnected and consistent Performance Indicators (PIs) to cover all aspects of a business. Since then, the PMS has shifted its focus from merely measuring and reporting the performance to strategic decision making and implementation (Nudurupati et al., 2021). Therefore, the importance and reliance of firms on PMS have significantly increased. The researchers have proposed several methods to measure firm performance for financial and operational aspects (Hassan & Deraman, 2018). One important application of PMS is in supply chain management. Due to its importance, a plethora of this research is dedicated towards performance

measurement of supply chain systems that is synthesized in several literature reviews (Ahi & Searcy, 2015; Akyuz & Erkan, 2010; Duarte et al., 2011; Guersola et al., 2018; Rasool et al., 2021; Saleheen et al., 2018a).

Supply chain management refers to the process of managing suppliers, manufacturers, warehouses, and stores to produce and distribute goods in the right quantity, at the right location, at the right time to minimize system-wide costs while satisfying the service-level requirements (Simchi-Levi et al., 2000). In other words, it is the process that operates all activities of converting raw material into a finished product that satisfies the customer (Potoèan & Mulej, 2008). The increased customer expectations of faster delivery, higher quality and cheaper price have made it vital for firms to continuously improve, upgrade, and invest in their supply chain. Many of these efforts focus on making supply efficient, adaptive, and responsive by digitizing it. Studies have reported several financial (Di Vaio & Varriale, 2020; Korpela et al., 2017; Youssef & El-Nakib, 2015) and non-financial benefits (Haoud & Hasnaoui, 2019; Lu et al., 2012; Sharma & Bhagwat, 2006; Zhao & Jiang, 2013) of adopting digital technologies into a supply chain. But this digitalization is not straightforward. Researchers have cautioned that these technologies act as a double-edged sword and can harm firm efficiency and performance if not implemented and managed correctly (Hazen et al., 2014; Zhang et al., 2019).

To avoid the failures and benefit from digital technologies, their performance needs to be measured using the KPIs that can accurately record and report these newer capabilities (Ralston et al., 2015). Melnyk et al. (2014) argued that this is not the case in the majority of firms. The authors argued that even though the managers understand that they are operating under a new environment and need to develop newer KPIs, but often fail to act on it. Similarly, (Saleheen et al., 2018b) also pointed out the drawback of existing KPIs. They recommended developing newer KPIs that can capture the performance of today's supply chain. These arguments were also echoed by Rasool et al. (2021) in their recent literature review of digital supply chain performance KPIs. The authors emphasized the need to define new KPIs and validate the existing ones. The following section details the process adopted in this study to validate existing KPIs and propose new ones.

### 3 Methodology

The KPIs used in this study were obtained from a recent literature review of DSC performance metrics by Rasool et al. (2021). The authors reviewed the available scientific literature on DSC performance measurement and presented a list of 37 KPIs divided into four Balance Score Card perspectives. To the best of our knowledge, Rasool et al. (2021) is the only available study that synthesized the performance measurement literature on DSC and presented an exhaustive list of KPIs in use in academia. The authors noted that the frequency of adoption of these KPIs widely varied in the literature. Therefore, the authors recommended that before using these KPIs, these should be validated and further analyzed. In this study, the 37 KPIs were further analyzed by academic and industry experts to understand appropriateness and use. The following criteria were used to select the experts.

**Academic experts:** The digital supply chain literature is still in its infancy, and theory is evolving rapidly (Büyüközkan & Göçer, 2018). To ensure that the academic experts have the most recent information, only the experts having a PhD with at least two recent scientific publications (in the last three years) related to DSC were contacted. As a result, 86 academic experts meeting the initial set criteria were contacted via email.

**Industry experts:** Similarly, industry experts' minimum criteria included a college degree and work experience in the supply chain division at a managerial position. The profiles for industry experts were searched at LinkedIn using the keywords "digital supply chain" and "e-supply chain". A total of 515 experts meeting the criteria were contacted at LinkedIn.

The respondents were asked to participate in an online interview with the research team where possible or complete an online survey. Two reminders were sent to academic experts after the eighth and fifteen days of the first contact. No reminder was sent to industry experts due to restrictions from the LinkedIn platform. At the end of the period assigned to this phase of the study (2.5 months), eleven and thirty-three academic and industry experts filled the survey, respectively. Additionally, two academic and twelve industry experts joined the online interview with the researchers making an effective response rate of 9.6%. The average working experience for respondents was eight and fifteen years for academic and industry experts, respectively. The demographic location of the respondents varied greatly, with most respondents coming from the US (09),

Germany (06) and India (04). The interviews lasted between 35 to 55 minutes. In the online survey, the respondents were asked to rate the usefulness of each KPI collected from the literature. In addition, they were encouraged to propose additional KPIs that were not available on the list during the survey. An explanation of each KPI was also provided to remove ambiguity and difficulties in understanding the KPIs' purpose (The questionnaire sample is available at <https://tinyurl.com/DSCKPI>). While during the interviews, the experts were actively encouraged to elaborate on each KPIs usefulness and problems.

## **4 Data collection and processing**

### ***4.1 Expert interviews***

In the first phase of the semi-structured interviews, the interviewees were asked to define DSC and list the most important KPIs for DSC. This phase also investigated the opinion of the interviewees on the need for newer KPIs and how different KPIs will perform in the future. In the second phase of the interview, the interviewees were asked to list important KPIs from the provided list and discuss their usability and future. The definition and understanding of the DSC vary among the interviewees. Still, the ability to record and produce accurate (meta) data, transparency, seamless integration among stakeholders, and maximize utilization of human intelligence were common themes. The interviewees believed that in the next few years, the DSC would become the norm, and the use of digital tools such as Artificial Intelligence (AI), Machine Learning (ML) and Big Data (BD) will be as common as the use of email in today's environment. Expert 8 summarised this discussion by stating that the DSC will be a supply chain "with the capability to produce real-time information on demand, whenever it is needed, however, it is needed". Even though all experts were confident that DSC would become the new norm, expert 7 and expert 9 cautioned about overuse/misuse of the concept. Expert 9 pointed out several examples (shipping industry) where real-time information is not needed but are being pushed by industry leaders.

Similarly, expert seven was concerned about practitioners that fail to grasp the DSC concept and its potentials. Expert 7 commented, "it's not simply automating the supply chain, but it's also switching that over. So that where humans are involved, they're actually applying human insight and intelligence, and not just



using a human to insert the number and or go check metre or something like that". This insight highlighted the problem associated with digitalization, where digital technology is merely used to automate the task instead of using it to automate decision making.

This lack of understanding was also reflected in other questions; for example, when asked about the need to develop newer KPIs for the DSC, the academic experts emphasized that we already have sufficient KPIs. The industry experts believed that newer KPIs would be needed, and a hybrid system of old and new KPIs will prevail. However, the discussion revealed that the industry expects to keep on measuring the same KPIs, but the capabilities needed to measure these KPIs will evolve. For example, expert 12 said, "things like inventory, cycle time, and efficiency will always be important, but in future, we will be measuring them using different capabilities". This argument was in line with the academic experts who emphasized developing newer capabilities to measure the same KPIs instead of developing new KPIs. This approach was also visible while listing the most important KPIs for the traditional and DSC. Most of them listed KPIs related to customer satisfaction as the most important ones in both types of the supply chain. For example, expert 1 stated, "the purpose of the supply chain is to deliver ultimate customer experience in whatever shape or form. The supply chain is a business support function. Good supply chains save money, great supply chains make money, So you can only make money if your customers are happy". Surprisingly, the experts also emphasized the need for reducing the number of KPIs instead of developing new ones and encouraged researchers to merge several KPIs and measure them effectively with the help of digital technologies. Expert 2 commented, "It's not the volume. It's the critical data points, and that changes for every industry, every person, every company".

Similarly, expert 1 commented, "it's not how many times you measure it. It is how, where and why you measure it". These insights were in line with the suggestions of Melnyk et al. (2014) and Hazen et al. (2014), where authors recommended focusing on the quality of KPIs instead of quantity. One important thing that emerges is that even though experts believed that fewer KPIs should be used, they were quick to suggest additional KPIs particular to their own and industry. These insights partially disconfirm the need for DSC KPIs discussed in previous studies (Lima-Junior & Carpinetti, 2017; Rasool et al., 2021). The discussion with experts highlighted the problematic and complex nature of digitization. Even though all of them are certain that the supply chain will

become digitized soon, they are uncertain about what the future will look like and how this digitization will be achieved.

#### **4.2 Questionnaire responses**

The respondents were asked to select the important KPIs from the 37 KPIs proposed by (Rasool et al., 2021). During the interviews, the experts recommended reducing the number of KPIs by measuring only the most relevant. The survey respondents also confirmed this opinion by rating a limited number of KPIs as useful from the list. As a result, the 37 KPIs were divided into three categories depending on the frequency of selection. The KPIs selected by 80% or more respondents were categorized as very strongly recommended. Similarly, with selection rate between 60%-79% were categorized as strongly recommended. The KPIs with a selection rate between 40%-59% were categorized as recommended KPIs. There were no KPI with a selection rate of less than 40%. Table 1 presents the summary of these results. In contrast to the scientific literature, where more focus is placed on measuring the internal and financial performance of the digital supply chain (Rasool et al. 2021), the experts emphasized the focus should be on the customer and their satisfaction, not the firm and its performance.

In line with the insights from the interviews, where experts emphasized having fewer KPIs to make PMS efficient and less complex, the survey respondents also tend to agree on this. This can be deduced from Table 1, where 15 out of 37 KPIs tested fall under the recommended category, while only 07 are highly recommended.

### **5 Discussion**

The survey results and analysis of interview transcripts uncovered several insights useful for both industry and academia discussed in the following subsections.

#### **5.1 Academic contribution**

Headd & Saade (2008) and Podsakof et al. (2016) emphasized the importance of having an appropriate definition and argued that its absence could distort the results and impact negatively on theory building. However, the definition of the

DSC is still somewhat opaque, and experts had a different understanding of what is a DSC and what level of digitalization is required to call a supply chain digital. Several studies in the past have attempted to distinguish digital from traditional supply chain and proposed definitions (Büyüközkan & Göçer, 2018; Wei et al., 2019; Wu et al., 2016). These studies derived their inspiration from the academic literature and therefore have not received industry-wide acceptance. Based on the insights from the interviews, this study proposes the following definition. DSC is a seamlessly interconnected transparent supply chain, that independently performs decision support activities to minimize human input needs.

Another academic contribution of the study was answering the questions towards the needs for newer KPIs for DSC. The theory for supply chain performance measurement has been evolving for several decades. Saleheen et al. (2018a) reviewed the most prominent performance measurement systems available and categorized them into financial and non-financial systems. The authors argued that the top management needs financial KPIs to make strategic decisions while middle management requires operational KPIs to perform day to day activities. In contrast to the previous studies that emphasized the urgent need for developing newer KPIs for DSC (Lima-Junior & Carpinetti, 2017; Rasool et al., 2021), this study highlights that the need for newer KPIs is not as eminent as considered earlier. Instead, the focus should be shifted towards developing standardized systems and theories that can be employed across different interconnected entities to make DSC effective. The study also provided the evidence to support the argument proposed by Elrod et al. (2013) to reduce the number of KPIs used in PMS.

## **5.2 Practical contributions**

The fast-paced business environment has left managers busier than ever with fewer resources to spend on tasks, not directly contributing to profit generation. As a result, measuring the right performance indicators has become even more crucial in PMS success. The main contribution of this study for practitioners is the identification of highly recommended KPIs presented in Table 1. The Table presents the seven identified highly recommended KPIs that managers should focus on while deciding on what to measure. Another insight from the analysis was that KPIs related to customer satisfaction are the most important KPIs, not the ones measuring a firm's operational and financial performance, which is a

general practice and recommendation of the scientific literature (Rasool et al., 2021).

This study also concludes that more is not always better. Fewer well placed KPIs to measure critical business activities will produce better results than measuring every aspect of a business. This insight encourages managers to focus on only important aspects of a business. The study also highlights that there is no need to reinvent the wheel for managers when it comes to performance measurement. They already have appropriate KPIs that will be able to serve them well in the future as well. Instead, they should focus on developing a better understanding of the DSC capabilities and weaknesses and do not under or overestimate its value.

## **6 Conclusion and limitation**

In the last decade, the firms' reliance on sophisticated supply chain systems have significantly increased, and supply chain has become the main source of competitive advantage (Bi et al., 2010; Büyüközkan & Göçer, 2018). As a result, significant technological advancements were made to make supply chain systems digitalized in the last two decades. On the one hand, these technologies make the supply chain efficient, reliable, and responsive (Haoud & Hasnaoui, 2019; Zhao & Jiang, 2013). On the other hand, they make the system complex and sensitive (Rasool et al., 2021). This study investigated the usefulness of existing KPIs and the need for new indexes to measure the performance of this new and complex supply chain, commonly referred to as DSC. To this end, semi-structured interviews and survey questionnaires were conducted with both academia and industry experts. The interviews provided several insights, including the need for newer KPIs for DSC, which is overemphasized in literature. The experts believed that the existing KPIs would be sufficient with changes in performance measuring methods that arrive with the new supply chain. It was observed that understanding of DSC and its capabilities varied among the experts. To harmonize these differences, a definition for DSC was derived by synthesizing the interview transcripts. In the second phase, the 37 KPIs used in this study were divided into three categories, namely "very strongly recommended", "strongly recommended", and "recommended", by analyzing responses to the questionnaire. The categorization will help practitioners to identify important KPIs when limited resources can be dedicated to managing PMS. Lastly, contrary to general practice in literature where the emphasis is placed on internal and

financial performance. The analysis of both interview transcripts and questionnaire responses revealed that the KPIs associated with customers and their satisfaction are the most important ones.

This study is not without its limitations. First, although the recent literature review by Rasool et al. (2021) on performance KPIs is comprehensive may still have shortcomings. This might have prevented some KPIs to be included in the study for further analysis. Second, the selection criteria and database used for identifying experts have their limitations. It is acknowledged that the wider search may have included a more diverse selection of experts in the study. A larger number of interviewees would be useful in mitigating the interviewer biases during the semi-structured interviews. Also, more responses to the questionnaire would be useful in better classifying the KPIs into three proposed categories.

Table 14 Classification of KPIs

KPI	Academic		Industry		Combined		
	Responses	% Agreed	Responses	% Agreed	Responses	% Agreed	
Delivery reliability	10	91%	28	88%	38	88%	Very strongly recommended
Operational efficiency	9	82%	27	84%	36	84%	
Logistics cost	9	82%	27	84%	36	84%	
Firm innovativeness	8	73%	28	88%	36	84%	
On time delivery	8	73%	27	84%	35	81%	
Responsiveness to customers	8	73%	27	84%	35	81%	
Employee skills	8	73%	27	84%	35	81%	
Customer satisfaction	9	82%	25	78%	34	79%	Strongly recommended
Operational cost	9	82%	23	72%	32	74%	
Inventory level	5	45%	27	84%	32	74%	
System reliability	8	73%	24	75%	32	74%	
System flexibility	9	82%	22	69%	31	72%	
Information availability	8	73%	23	72%	31	72%	
Inventory cost	7	64%	23	72%	30	70%	
Cash cycle time	4	36%	25	78%	29	67%	
Data security	8	73%	21	66%	29	67%	
Return on investment	6	55%	22	69%	28	65%	
Production cost	6	55%	21	66%	27	63%	
Operational speed	7	64%	20	63%	27	63%	
Supplier relation	5	45%	21	66%	26	60%	
Resource utilization	6	55%	20	63%	26	60%	

Customer ease	5	45%	21	66%	26	60%	Recommended
Profit	5	45%	19	59%	24	56%	
Environmental cost	7	64%	17	53%	24	56%	
Employee satisfaction	3	27%	21	66%	24	56%	
Error cost	5	45%	18	56%	23	53%	
Production cycle time	4	36%	19	59%	23	53%	
Communication with supplier	7	64%	15	47%	22	51%	
Error rate	6	55%	15	47%	21	49%	
Responsiveness to supplier	3	27%	18	56%	21	49%	
Workplace safety	3	27%	18	56%	21	49%	
Sales	4	36%	17	53%	21	49%	
Market share	4	36%	16	50%	20	47%	
Labor cost	6	55%	13	41%	19	44%	
System ease of use	3	27%	15	47%	18	42%	
Data collection points	4	36%	13	41%	17	40%	
Communication with customers	5	45%	15	47%	20	47%	

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## The Impact of Digital Transformation: Managing Skills to Deal with Digitalization

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### Abstract

In the digital age, organizations are built upon and rely on people and their technical skills, which are becoming an important source of competitive advantage. In this context, the role of Human Resources Management changes significantly, and this change has a direct impact on the governance of the company as well, thus configuring it as a Strategic Human Resource Management. It has the task of transmitting an innovative and cooperative corporate culture directly to the employees, helping them to develop a digital mind-set and new digital skills in line with the objectives of the business model.

This research aims to provide a qualitative analysis of the impact of Digital Transformation on Human Resources processes, to address organizational change, and on the development of appropriate transversal skills of individuals to incorporate and capitalize on innovations in the digital environment.

The research work was carried out using the methodology of the illustrative (and explanatory) case study, involving an Italian company that has witnessed a relevant digital transformation process in the last years.

Results show that Human Resources Management can (and must) have a guiding role in driving the organizational change through digitalization, particularly by incubating and accelerating digital innovations, while at the same time fostering the development of Digital Leadership.

**Keywords** – Digital Transformation, Case study, Digital Business Strategy, Digitalization capabilities, Digital leadership

**Paper type** – Academic Research Paper

## **1 Introduction and background**

In recent years we are witnessing a relevant Digital Transformation that will guarantee the future for companies, under the guidance of people (Braga, 2017). It is not a mere technological change, but it also represents the opportunity to rethink works and tasks, and to reinterpret values, through an innovative culture, while maintaining people at the very centre of business (El Sawy et al., 2016).

Digital Transformation is seen mainly as a cultural change that must take place both at an organizational and intra-organizational level and is a "Human and Business Transformation" with consequences on the organization of work and on the management of people (Rogers, 2016). It is important to understand, in a real context, how HR Managers deal with the process of managing and developing adequate transversal skills of human resources in line with a new innovative and cooperative corporate culture, in order to efficiently deal with digitization and guarantee that the internal organization obtains and maintains the qualified and well-motivated workforce in influencing the creation of corporate value.

The phenomenon of digitalization gives birth to a new era of corporate IT, in which technology is increasingly integrated into the company and where corporate IT moves from a legacy perspective to a digital one, suggesting that there is a need to develop a Digital Leadership (El Sawy et al., 2016). Digital Leadership skills must be nurtured to ensure integration between IT technologies and to seize new opportunities and realize them in a competitive advantage, but also to improve the Digital Business Strategy (DBS) on the development of agile and scalable digital operations and digital innovations (Sia et al. 2016).

In the digital age, organizations are built upon and rely on people and their technical skills, which are becoming an important source of competitive advantage (Hansen et al., 2011). In this context, the role of Human Resources (HR) Management changes significantly, leading the HR department to perform different functions that range across an organization, increasing their influence in the decision making process. This change has a direct impact on the governance of the company as well, thus configuring this process as a Strategic Human Resource Management (Oh et al., 2012; Annarelli et al., 2021).

HR Management has the task of transmitting an innovative and cooperative corporate culture directly to the employees, helping them to develop a digital mind-set and new digital skills in line with the objectives of the business model (Battistella et al., 2017; Rachinger et al., 2019).

## 2 Research aim and methodology

This research aims to provide a qualitative analysis of the impact of Digital Transformation on HR processes, to address organizational change, and on the development of appropriate transversal skills of individuals to incorporate and capitalize on innovations in the digital environment.

The following research questions were formulated accordingly to the research purpose detailed above:

*RQ1: How are people structured, in terms of digital mind-set and digitalization capabilities, in a digital context?*

*RQ2: How did internal processes and the HR function transform to meet the challenges posed by the development of a Digital Business Strategy?*

The research work was carried out using the methodology of the illustrative (and explanatory) case study (Yin, 1984; Eisenhardt, 1989) involving an Italian company that has witnessed a relevant digital transformation process since 2017: Telepass S.p.A.

For data collection, we defined an interview protocol in accordance to our framework of analysis (detailed in the next section). We interviewed various professionals who have been working for several years within the company. More in detail, the following figures were involved in the study:

- Chief of People and Organization Officer;
- Director of Product Development (R&D, innovation);
- HR Manager;
- Chief of Staff to the CEO;
- Smart Devices & Tolling Technologies Manager.

## 3 Theoretical framework of analysis

Given the strategic importance for companies to explore the opportunities represented by the intersection between business and technology, it is essential to analyse the impacts deriving from new technologies on the "people" component, that is, on the people who are called to the company, to apply and bring to life new development strategies (Camarinha-Mathos et al., 2017). To take full advantage of the opportunities offered by digital transformation, companies must in fact ask themselves whether the internal organization and its employees are really ready to face this challenge (Zangiacomi et al., 2020). If the company changes by exploiting the potential of digital more and more, HR functions must

also adapt to this change to accompany the transformation of skills and work behaviours. Thanks to new technologies, HR and Talent Management processes are evolving from centralized processes to something increasingly incorporated into daily work (Grover and Kohli, 2013).

This research aims to provide a qualitative analysis of the impact of Digital Transformation both on HR processes, to deal with organizational change, and on the development of adequate transversal skills of human resources to understand and capitalize on innovations in the digital environment. In other words, the study in question is structured on the analysis of two factors that are part of the same business system to ensure the creation of corporate value, or how HR is structured in terms of behaviours and skills in a digital context, and on the other hand, how the human resources management process is transformed to meet the challenges of Digital Business Strategy.

In order to answer the research questions, a framework was defined to highlight and represent the relationship between HR Management and its impact on company performance, in a context of organizational transformation (Jerez-Gómez, et al. 2019). Within this framework, we identified two main dimensions that characterize the digital transformation:

- *Ability to incubate and to accelerate emerging digital innovations:* companies must face the challenges of innovation to remain constantly at the forefront of technology and to keep in touch with customer needs (Sia et al. 2016);
- *Cultivating Leadership for Digital Transformation:* it is essential to articulate the Business Digital Strategy and to align the necessary investments in resources (O'Reilly and Tushman, 2004). Managers must understand the potential and challenges of technological innovation and have a shared vision of digitalization as a central element for business growth.

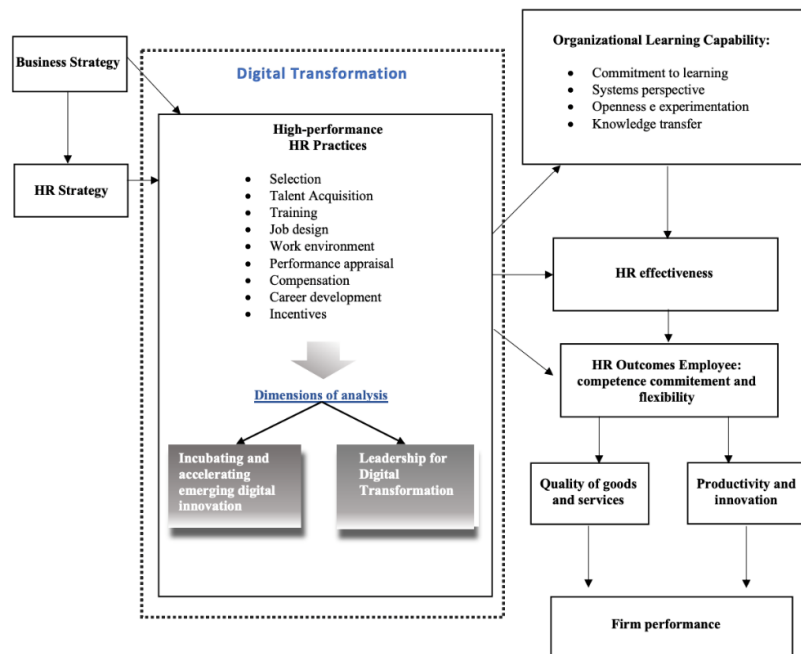


Figure 1. Dimensions identified in the context of Digital Transformation

To carry out an in-depth study, each dimension was detailed into sub-dimensions, which brought to the definition of the interview protocol. The analysis allowed us to evaluate the ability of the company to perceive the path towards digital transformation, and to develop a clear strategy to accompany employees and organizational structures in this new challenge, anticipating future needs in terms of skills, behaviours, tools and leadership as much as possible. Table 1 details the sub-dimensions of the framework.

Table 1. Sub-dimensions and variables of the research

Dimension	Sub-dimension	Variables
<b>Ability to incubate and to accelerate emerging digital innovations</b>	<b>Understanding digital transformation</b>	Research of technological trends and tendencies to interpret digital scenarios (Zangiacomi et al., 2020)
		New technologies to analyse, integrate data and change workflow (Zangiacomi et al., 2020)
		Extend the vision of digital processes to the entire organization (Zangiacomi et al., 2020)
		Use of digital analytical tools to read and interpret data (Zangiacomi et al., 2020)

Dimension	Sub-dimension	Variables
		Level of readiness of human resources to accept digital transformation (Zangiacomi et al., 2020)
		Propensity to collaborate with external sources of knowledge to accelerate innovation (Liao et al., 2017)
		Seeking expert support (Chief Digital Office) to efficiently invest in promising technologies (Sia et al., 2016)
	<b>Digital Maturity</b>	HRs' digital background and level of digital experience of the company (Zangiacomi et al., 2020)
		Adoption of modern information systems (e.g. mobile devices, machine-to-machine communication) to improve performance (Zangiacomi et al., 2020)
		Awareness of the increasing accessibility and usability of innovative technologies by employees (Zangiacomi et al., 2020)
		Level of integration between transversal skills and digitalization capabilities (Chryssolouris, 2013)
		Proactive involvement of human resources in the definition of procedures and qualifications for the adoption of new technologies (Bauer et al., 2018)
	<b>Knowledge Sharing</b>	Importance of sharing and disseminating practices for successful implementation of new technologies (Camarinha-Matos et al., 2017)
		Alignment between strategies and resources to allow the exploitation of potential synergies with suppliers and customers (Zangiacomi et al., 2020)
		Importance of partnerships with digital start-ups and companies (Zangiacomi et al., 2020)
		Exploitation of connections and data sharing practices with external networks (Bessant and Rush, 1995)
		Ability to promote the know-how on the experience of digital transformation (Zangiacomi et al., 2020)
<b>Cultivating Leadership for Digital Transformation</b>	<b>Investment in human capital</b>	Investments in training (Grover and Kohli, 2013)
		Readiness of high-potential resources, in terms of career advancement and taking on new responsibilities (Srai et al., 2016)
		Talent recruiting (Warner, 2019)
		Development of training paths for specialized skills to support digital transformation (Kache and Seuring, 2017)
		Ability to involve employees in the digital transformation and provide them with digital experience (El Sawy et al., 2016)
		Involvement of partners to outsource training for specific digital skills (El Sawy et al., 2016)
		Facilitation of training conditions, coherence between objectives and methodologies adopted (Senge, 1990)



Dimension	Sub-dimension	Variables
		Understanding training as a way to foster people's commitment (McClelland, 1985)
		Development of training initiatives in line with organizational needs (Senge, 1990)
	<b>Promote an innovative and cooperative culture</b>	Smart working attitude towards independent and flexible work (Bauer et al., 2018)
		Development and promotion of group-based activities (McDonough, 2000)
		Ability of the company to understand and emphasize with the personal sphere of employees to maintain and improve productivity (El Sawy et al., 2016)
		Investing in digital platforms for distance work (El Sawy et al., 2016)
		Technological support service (El Sawy et al., 2016)
		Availability of information (El Sawy et al., 2016)
		Encouraging a collaborative culture (McDonough, 2000)
	<b>Human Resources Management</b>	Job rotation frequency and speed in reallocating resources (Becker and Muendler, 2015)
		Awareness of the correct balance between talent acquisition and training of existing resources (Heavin and Power, 2018)
		Fostering motivation and commitment through promotions and career advancements (McClelland, 1985)

The research analysis model shows how the phenomenon of Digital Transformation entails the need to adapt both corporate work systems and digitalization capabilities and dynamic capabilities (Teece et al., 2016; Annarelli et al., 2021) to a new context.

The study is structured on the analysis of factors that are part of the same business system to ensure the creation of business value, because if well-developed these can act as enablers for a full exploitation of digital innovation. This is why we want to understand on the one hand how human resources are structured in terms of behaviours and skills in a digital context, and on the other hand how human resources management processes are transformed to respond to the challenges posed by Digital Business Strategy (Bharadwaj et al. 2013).

#### 4 Results and discussion

The case study company operates in the sector of urban and extra-urban mobility, and for about thirty years played (essentially) a monopolistic role with

only one type of substantially physical business, namely that of raising the bar at motorway toll booths. With the development of technology, the need arises to move the company from a low-tech legacy, made up of a single physical product, to a strong digitalization of services to guarantee more performing, agile and above all scalable solutions.

The Digital Transformation in the company started in 2017, when they began to diversify the business by introducing multiple services aimed at both the consumer market and B2B in digital form using a single mobile application.

To do this, it was necessary to start from the type of initial business and, once new technological assets were created, greater power was guaranteed on the mobility market and to undertake an internal change within the company, also addressing the outside world and creating new partnerships.

To quickly implement its strategy, the company has leveraged opportunities offered by the digital world by completely revisiting the processes of accession and subscription to services in a way that has now become "natively digital" both on the web and via their mobile application.

The key intuition of the Management was to take as a starting point their competitive advantage, namely that of having 6 million customers and knowing their movements by thoroughly investigating their mobility habits on the motorway. In this way, the company successfully establishes itself on a more general market which is that of mobility, which at this time cannot be separated from a digital evolution. The starting point of this strategy is precisely the collection of data, monitoring customers to obtain useful information and then offering services tailored to their needs.

Following, the analysis of the company's Digital Transformation will be structured in two sections, representing the main dimensions of the framework.

#### ***4.1 Incubating and accelerating digital innovations***

The Digital Transformation took place in terms of processes, organization and platform evolution. In particular, through technological evolution, Telepass has made all its services available to customers through a single access platform. This allowed to overcome the real challenge of Digital Transformation, namely that of enhancing the Data Warehouse with customer transactions and, therefore, using the available information assets in such a way as to be able to optimize the commercial approach based on artificial intelligence logic.

Following the change in business model and the possibility of selling new services to customers, it has become essential to exploit the information available in Telepass. Today the Marketing Clustering model is waning and that is why Telepass has transformed it into Event Driven Marketing, in which customer behaviours are analysed on a certain occasion to understand what their needs are in real time and provide, consequently, an immediate solution.

Data analysis requires increasingly powerful models and technologies due to their variety and volume, in order to provide useful information for business management. For this reason, the implementation of Big Data and Analytics is becoming such a relevant development area in Telepass that it can be considered a business critical capability.

For the above reasons, the company has built a Data Management Office structure that deals with the policy regarding data management and a Big Data structure that aggregates all customer data in a simple and rapid way in order to be able to develop (in compliance with privacy laws) further service initiatives.

For what concerns the pace in carrying out activities and processes, the management realized that the traditional way of handling IT projects was showing enormous limits. For this reason, it was necessary to define a new more flexible and agile development paradigm. When the time-to-market of innovations is long enough, when there is little room for flexibility and there is limited knowledge and/or visibility of what is going on until everything is finished, there is a natural aversion to innovation and a very strong break between IT and the rest of the company. Therefore, the company needed to switch to a more dynamic reality, and to a more dynamic approach in managing innovations. This, in turn, not only allowed a better management of innovative IT projects, but also reduced the "conceptual" distance and allowed a better integration of IT and technology throughout the whole company.

Another key aspect that enabled the company's Digital Transformation was to define new technological assets as "small bricks", giving the possibility to assemble new and customizable models of interaction with customers. This, in turn, allowed to implement an effective customer care and to define flexible (almost in real time) billing models.

## ***4.2 Cultivating Leadership for Digital Transformation***

Digital Transformation requires changes not only from the point of view of the development of new IT systems, digitized logistics and Big Data management, but also for the internal perspective.

The company is continuously encouraging managers to entrust their collaborators, to delegate responsibilities, fostering in this way individualism (in a positive perspective), and creativity. This does not mean giving up control obligations, but instead giving people the opportunity to express themselves, sometimes to dare in order to grow and therefore stimulating individual contributions, with the aim of creating a culture based on sharing in which managers act as mediators. Thanks to digital tools people are always more led by networks and not hierarchies, thus opening doors, eliminating barriers, supporting innovation and encouraging collaboration within and outside teams.

The digital and cultural change within Telepass affected also the development process of new skills and organizational capabilities. To this regard, the HR department started a thorough acquisition plan of new talents with digital hard skills so as to allow a rapid growth of IT capabilities. This, of course, has to be intended as complementary with training and internal skills development, in order to ensure a quicker construction of new digital capabilities at a company level.

The HR function of Telepass today believes that learning does not have to be necessarily guided, but must become a proactive effort, in which employees are leading their own skills development. The key role of the HR function is to create a positive and stimulating environment, which allows employees to gain insights into the digital world with greater freedom of learning and to have greater responsibility for their own professional growth. This, in turn, also ensures greater awareness of people's professional background and the development of self-learning skills.

Nonetheless, Telepass guarantees continuous growth paths for employees especially through on-the-job training initiatives, to develop new competences and handle more effectively unforeseen situations and problems. This training methodology is the most used within the company since it minimizes the gap between the training experience and the working reality, while maximizing the learning effectiveness.

As regards training for the development of new digital skills, this is mainly outsourced to external experts specialized in technological innovations. In this

way, it is possible to reduce personnel management costs and also decrease the workload for internal resources, that can be engaged in core business activities. One of the most effective training initiatives, according to HR, is to insert new talents in key projects in order to create heterogeneous teams, and in doing so they can foster both team spirit development and skills acquisition.

To encourage the increase of digital skills, two factors have been defined in Telepass:

- the selection, or the acquisition of skills from highly specialized external markets;
- the contamination, that is the creation of common spaces and the construction of integrated work groups made up of people with different skills and experiences.

The Company is working hard on the development of a common digital language, to be adopted in the organization at all levels, through digital contamination by up-to-date specialists on emerging innovations. This will also guarantee the entire organization a greater awareness of what it means to work in a digital way, which not only includes knowing how digital applications work, but also having the ability of human resources to experiment and manage errors along with feedback.

A challenge for the company, therefore, is to have the ability to manage talents capable of providing the necessary push for innovation. To this regards, the concept of Digital Leadership will have a profound impact on the organization. As a matter of facts, Digital Leadership is essential in fostering a close collaboration between people with different backgrounds (business and IT), belonging to different generations and, therefore, with heterogeneous points of view on possible "digital" evolutions in areas that have traditionally been less technology-driven.

## **5 Conclusions**

In recent years the company has been increasingly considered as a reference point for the many digital services that it delivers in a short time, thanks to the work that has carried out the IT function, especially in terms of speed in responding to customer needs and downsizing of technological assets.

The company also invested a lot on human capital for the development of digital skills and the digital mind-set. This favoured the transition from a much

more "paternalistic" approach, from an organizational point of view, to a setting where each employee, who is up-to-date on technological innovations, contributes with its knowledge to the professional and digital development of senior colleagues.

To cope with a dynamic and constantly changing world, the company did not invest in traditional forms of training, which is seen as an unnecessary and time-consuming activity. On the contrary, "on-the-job training" learning has been encouraged, with the awareness that more innovative ideas can rise spontaneously from this approach.

Following this method, the employee becomes not only a "learning worker", but an "agile self-learner", that is an individual willing to independently research the methods and contents to keep its skills and personal capabilities up to date. The individual is entrusted with the task, not only of organizing his own learning, but also of managing his own self-development through a process of change for which he is the main responsible. We thus go from being able to "learn" continuously to "learning to learn and unlearn" through a continuous evolution of their knowledge and skills.

The company has adopted the policy of collaboration, sharing and maximum responsibility for employees. This has allowed the company to innovate quickly and make all employees more accomplished and prepared for change: think exponentially, act quickly and know how to take risks.

This work contributes to the development of knowledge on the phenomenon of digital transformation, by investigating the guiding role that HR can and should have in driving organizational change through new digital business models.

Nevertheless, we must acknowledge that results are limited to a single case study. Future studies should involve a larger sample of cases, so as to allow for a generalization of results and a theory building effort.

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## **Sustainable Decommissioning of Offshore Platforms: a Proposal of Life-Cycle Cost-Benefit Analysis in Italian Oil and Gas Industry**

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### **Abstract**

The decommissioning of offshore Oil & Gas platforms, at the end of their life cycle, has been a very controversial topic in recent years. Moreover, the decommissioning complexity increases if we consider a shift towards a linear economy to a circular one. The latter pushes to innovate business models and re-configure the value chain activities in a sustainable way. Starting from these considerations, this work aims to identify a cost-benefit model suitable for evaluating sustainable business models of offshore platforms. After a literature review of different models for analysing maintenance and decommissioning Real Options (ROs), the Life-Cycle Cost-Benefit (LCCB) analysis has been selected as the most adequate managerial tool for evaluating and comparing the Net Present Value (NPV) of platforms compared the maintenance and decommissioning costs. The LCCB tool could aid the managers in the oil and gas industry to quantify the decommissioning and maintenance costs including capital expenditure (CapEx) and risk expenditure (RiskEx). In the future steps, to test the LCCB model, an empirical analysis could be carried out on a sample of organizations interested in the sustainable decommissioning of offshore platforms.

**Keywords** - offshore platform decommissioning, life-cycle cost-benefit (LCCB) analysis, Life cycle assessment, sustainable business model, Multi-Use Platforms at Sea (MUPS), circular economy

## 1 Introduction

In the last twenty years, the decommissioning of offshore oil and gas platforms at the end of their life cycle has been a very controversial and debated issue. The offshore industry expanded rapidly to currently number over 12,000 offshore installations globally (Ars and Rios, 2017). Offshore platforms are situated on the continental shelves of 53 countries, making offshore oil and gas production a major global industry (Parente et al., 2006). Several nations require the complete removal of obsolete structures, which presents substantial engineering challenges and requires incredibly expensive and labour-intensive. Therefore, the considerable decommissioning costs have led to a gradual change in international regulations considering a more flexible approach (Henrion et al., 2015). Consequently, economic considerations have influenced the decisions of the oil and gas companies, which are increasingly inclined to postpone the removal process according to economic and technical conjectures. Our main research questions were: *"Is there a cost-benefit model suitable for evaluating sustainable business models for offshore platforms?"* or rather: *"The eventual emerging analytic model is useful for an estimate the asset integrity in the Italian oil and gas industry?"* In particular, the adoption of Sustainable Business Models (SBMs), based on value creation (Nosratabadi et al., 2019) between the several actors involved as well as the environment and society, shed light on the possibility to reconfigure the value chain activities and reuse these structures to generate an opportunity from an economic, ecological and social perspective (Evans et al. 2017; Lozano, 2018). In this scenario, the offshore platforms (also known as Multi-Use Platforms at Sea, or MUPS) can represent an innovative solution to meet the growing pushes towards sustainability and circular economy. Likewise, MUPS represents a great opportunity for re-using or reconverting the end life structure, restricting the impacts on marine ecosystems as well as offering socio-economic benefits. In a MUPS scenario, some oil and gas platforms can be reconverted, a part of their structure can be used for activities related to a particular sector such as touristic-recreational, aquaculture (e.g., fish farming and shellfish farming), renewable energy, and hydrogen storage. However, these SBMs have not yet been assessed in the literature from a cost-benefit perspective and

the economic sustainability of these initiatives is still unclear. Based on these considerations, this work aims to evaluate the initiatives of reusing the offshore platforms in favour of SBMs in terms of cost-benefits analysis. The emerging cost/benefit model links with a broader framework of assets and infrastructures subjected to obsolescence or final removal (e.g., bridges, wind farms, marine turbines, and offshore platforms). To reach this goal, different models for analysing maintenance and decommissioning Real Options (ROs) have been analysed to identify the most adequate managerial tool for evaluating and comparing the Net Present Value (NPV).

## 2 Literature Review

### 2.1 The life cost benefit analysis

The theoretical fundamentals of the Life Cycle Cost-Benefit analysis start from its antecedents that were: the Life Cycle Cost analysis (LCC) and Life Cycle Assessment (LCA). In table 1 are summarized the main literature on this topic. Life Cycle Cost analysis (LCC) and LCA have major methodological differences (Norris, 2001). LCC compares the cost-effectiveness of alternative investments or business decisions from the perspective of an economic decision-maker such as a manufacturing firm or a consumer. LCA evaluates the relative environmental performance of alternative production systems for providing the same function. This environmental performance is assessed as holistically as possible, aiming to consider all important causally connected processes, all-important resources, and consumption flow. Life-Cycle Cost-benefit analysis is a term that is used in several different connections based on engineering knowledge, economic understanding, and mathematical experience. However, it refers in general to a tool, which may help to assess and estimate, a project or business proposal. Thoft-Christensen (2009) proposed a Life-cycle cost-benefit (LCCB) analysis for the bridges' building, but it also applies in designing maintenance strategies for other structures, as well as offshore platforms. The expected total LCCB of an infrastructure consists of the expected benefits for firms  $B_{\text{society}}$ , for the owners (agencies, private companies, etc.) of the infrastructure  $B_{\text{owner}}$ , for the users  $B_{\text{user}}$  and the expected benefits for the environment  $B_{\text{environment}}$  (Thoft-Christensen, 2012). The formula is as follows (1):

$$LCCB = B_{\text{society}} + B_{\text{owner}} + B_{\text{user}} + B_{\text{environment}} \quad (1)$$

Instead, it is more useful also to estimate the expected costs in the lifetime of the infrastructure rather than only the expected benefits. Equation 1 is then integrated with Equation 2. That is:

$$LCC = C_{society} + C_{owner} + C_{user} + C_{environment} \quad (2)$$

According to Thoft-Christensen (2012), the benefit terms as well as the cost terms in Equations (1) and (2) are clearly uncertain and must be modelled by stochastic variables or processes. The Life Cycle Assessment considers the environmental aspects and the Social Life Cycle Assessment the social ones, the LCC integrates the three layers of sustainability by considering its economic aspects (Andrews, 2009). The three types of LCC can be identified as follow: I) Conventional; II) Environmental and III) Social. The recent contributions on sustainable and circular business models (Joyce and Paquin, 2016; García-Muiña et al., 2020; Basile, 2021). offer a wide analysis of the three-layered considered applied to specific case studies. The conventional LCC is the most used type of LCC and is based on an economic evaluation that takes into consideration all the costs in the various phases of the Life Cycle of an asset. The environmental LCC analysis is considered the costs related to the Life Cycle of an asset, incurred by the stakeholders directly involved. Costs defined by external and situational factors with respect to the Life Cycle are also taken into consideration, to internalize them to the analysis. This latter was developed by a Working Group (Hunkeler et al., 2008) of SETAC (Society of Environmental Toxicology and Chemistry), which gave rise to the guidelines on the methodology of environmental LCC, in conjunction with the LCA. The social LCC differs from conventional and environmental LCC because it takes into consideration all the stakeholders not directly connected with the production system of a product or service. Neugebauer et al. (2016) proposed a Life Cycle Sustainability Assessment (LCSA) framework developed for assessing the sustainability performance of assets through Life cycle assessment (LCA), Life cycle costing (LCC), and Social Life Cycle Assessment (SLCA).

Table 1. The main existing literature on asset integrity management and life cycle cost benefit analysis

Authors	Focus	Main empirical evidence
Norris, (2001)	Integrating life cycle cost analysis and LCA	<i>"...standard methods of LCA can and have been tightly, logically, and practically integrated with standard methods for cost accounting, life cycle cost analysis, and scenario-based economic risk modeling. The result is an ability to take both economic and environmental performance- and their trade-off relationships into account in product / process design decision making"</i>
Thoft-Christensen, (2009)	Life-cycle cost-benefit (LCCB) analysis of bridges from a user and social point of view	<i>"The main purpose of this paper is to present and discuss some of these problems from a user and social point of view. A brief presentation of a preliminary study of the importance of including benefits in life-cycle cost-benefit analysis in management systems for bridges is shown. Benefits may be positive as well as negative from the user point of view. In the paper, negative benefits (user costs) are discussed in relation to the maintenance of concrete bridges"</i>
Snyder et al., (2009)	Ecological and economic cost-benefit analysis of offshore wind energy	<i>"...we discuss the costs and benefits of the offshore wind relative to onshore wind power and conventional electricity production. We review cost estimates for offshore wind power and compare these to estimates for onshore wind and conventional power"</i>
Santa-Cruz et al., (2011)	Maintenance and decommissioning real options models for life-cycle cost-benefit analysis of offshore platforms	<i>"Maintenance and decommissioning real options (RO) models are developed for life-cycle cost-benefit (LCCB) analysis of offshore platforms. Uncertainties about hydrocarbon prices, maintenance costs, environmental loading, structural capacity and damage due to deterioration are taken into consideration in the RO modelling. Expressions are derived for expected costs and benefits in terms of the availability function of the platform, which depends on the hazard and restoring functions, and on the annual probability of failure of the structure. Results show that the use of the net present value (NPV) approach can significantly underestimate the LCCB"</i>
Chandima Ratnayake et al., (2012)	Asset integrity management for sustainable industrial operations: measuring the performance	<i>"The main challenge for asset integrity management (AIM) is related to various aspects of its human dimension as apparent on organisational settings and associated cognitive dispensations. (...) The paper provides a review of AIM and a foundation for engineers and managers to analyse the general problem of managing PA' integrity to increase the sustainable value of an asset intensive business in a more holistic way"</i>

Thoft-Christensen, (2012)	Infrastructures and life-cycle cost-benefit analysis	<i>"Repair and/or failure of infrastructures will usually result in user costs greater than the repair or replacement costs of the infrastructure. For the society (and the users) it is therefore of great importance that maintenance or replacement of an infrastructure is performed in such a way that all costs are minimized not only the owners' cost"</i>
Kusumawardhani et al., (2016)	Asset integrity management: offshore installations challenges	<i>"The purpose of this paper is to identify the challenges facing asset integrity management(AIM) practices in the oil and gas industry, to continually develop AIM practices in organizations. (...) The paper identifies, analyses, and validates the challenges and factors that may impact the management of asset integrity on offshore installations. The challenges were discussed to develop an understanding of the root cause and thus aim to resolve underlying issues. (...) The identified challenges can be used by organizations to resolve underlying AIM challenges, improve their AIM strategy and obtain insights into current AIM practices in the petroleum industry"</i>
Neugebauer et al., (2016)	From Life Cycle Costing to Economic Life Cycle Assessment Introducing an Economic Impact Pathway	<i>"...Life cycle sustainability assessment (LCSA) framework has been developed for assessing the sustainability performance of products through Life cycle assessment (LCA), Life cycle costing (LCC), and Social life cycle assessment (SLCA). Yet, the focus of common economic assessments, by means of LCC, is still on financial costs"</i>
Lam et al., (2018)	Life-cycle cost-benefit analysis on sustainable food waste management: The case of Hong Kong International Airport	<i>"The aim of this study is to develop a Life-Cycle Cost-Benefit Analysis (LC-CBA) framework, through the integration of the life-cycle assessment (LCA) and cost-benefit analysis (CBA), to guide decision-making in sustainable food waste management"</i>
Animah et al., (2018)	Selection of the most suitable life extension strategy for ageing offshore assets using a life-cycle cost-benefit analysis approach	<i>"This paper presents a life-cycle cost-benefit analysis approach to identify the most suitable life extension strategy for ageing offshore assets by considering all the capital, installation, operational, maintenance and risk expenditures during the extended phase of operation. The potential of the proposed methodology is demonstrated through a case study involving a three-phase separator vessel which was constructed in the mid-1970s. The results from the application case indicate that the capital expenditure (CapEx) accounts for the largest portion of life cycle cost for the replacement strategy, while risk expenditure (RiskEx) is the major contributor to costs associated with life extension"</i>

Li et al., (2018)	Innovative energy islands: life-cycle cost-benefit analysis for battery energy storage.	<i>"We specifically put forward a life-cycle cost-benefit analysis model to evaluate the economics of battery storage systems used in small communities from a life-cycle perspective. In this research, we put forward a novel cost-benefit analysis model"</i>
Tang et al., (2019)	Risk identification and quantitative evaluation method for asset integrity management of offshore platform equipment and facilities	<i>"By analysing the disadvantages and shortcomings of the existing methods and adapting to the technology requirements of the Asset Integrity Management (AIM), a Streamline Failure Mode Effects and Criticality Analysis (SFMECA) was presented to achieve risk identification and quantitative evaluation based on the traditional FMECA and Borda scoring method"</i>
Nian et al., (2019)	Life cycle cost-benefit analysis of offshore wind energy under the climatic conditions in Southeast Asia—Setting the bottom-line for deployment	<i>"There is thus a need to evaluate the true benefits of offshore wind energy under the region's suboptimal climatic conditions. In response, this study employs the life cycle analysis approach to conduct a cost-benefit analysis of offshore wind energy in the context of Southeast Asia. Findings from study suggest that the cost of offshore wind energy remains high now for Southeast Asia"</i>
Giuffre et al., (2021)	Life-Cycle Costing Decision-Making Methodology and Urban Intersection Design: Modelling and Analysis for a Circular City.	<i>"The chapter presents a case study where the Life-Cycle Cost methodology is used to compare three alternative intersection projects based on their total life-cycle costs"</i>

Source: own elaboration.

## 2.2 Life cycle Management

The studies on life cycle cost (Fuller, 2010; Lam et al., 2018) integrate the Asset Integrity Management (AIM) contribution (Chandima Ratnayake et al., 2012; Kusumawardhani et al., 2016) into a holistic framework of Sustainable Life Cycle Management (SLCM). Generally, the Life Cycle Management (LCM) can be used to define, analyse and manage product-related information and activities towards continuous improvement along the product life cycle (Remmen et al., 2007). Sonnemann et al. (2015) state that Life cycle management is a concept applied in industrial and service sectors to improve products and services, while enhancing the overall sustainability performance of the firms and their value chains.



Fig. 1: Sustainable life cycle management framework  
Source: adapted from Remmen (2007).

The upper side of the SLCM framework has the following three blocks: 1) data, information and, models; 2) tools and techniques and 3) LCCB and AIM analysis. The lower side includes: 1) system and procedures; 2) life cycle thinking, the business case for sustainability and 3) corporate environmental and social responsibility.

### 3 LCCB analysis for evaluating the decommissioning of offshore platforms

The research methodology adopted is based on qualitative analysis and a descriptive approach (Blessing et al., 1998; Ezzy, 2013). Firstly, was carried out an analysis of the relevant academic literature (for the number of citations on Google Scholar, Scopus, and the Web of Science and for the quality of the academic Journals publishing the articles) on the asset integrity management and life cycle



cost-benefit analysis (see table 1 in appendix). The in-depth review (Rowley and Slack, 2004) mentioned above was useful in selecting the managerial tool that is the Life Cycle Cost-Benefit model (LCCB). Among the various conceptual models proposed in the literature on BMs, the LCCB was the one that best fits with the sustainable decommissioning of offshore platforms. The LCCB model, in fact, could be applied to SBM in the following industries: aquaculture (which includes fish farming and shellfish farming) (Troell et al., 2009); tourist-recreational activities (which includes hotel accommodation, water restaurant, a hub for recreation leisure and sports activities, high-experience events and naturalistic tourism, etc.); renewable energy (Elginöz and Bas, 2017); hydrogen storage (Hou, 2017); carbon capture utilization and storage (Yao et al., 2018); non-profit organizations. LCCB is the method used to calculate the economic cost and benefit (revenue streams) of the entire life cycle of a product or service, starting from the phases prior to production up to its final disposal, with the aim of minimizing production and maintenance costs. The LCCB method for offshore platforms makes it possible to relate the quantitative data related to decommissioning costs to acquire an overview of the maintenance cost to estimate the feasibility of the sustainable business. The goal is to achieve better economic sustainability of the business project that you want to implement, and if it is possible. Conducting an LCCB assessment of a platform helps predict the costs that potential companies must incur to start a new business, from securing the former oil and gas platforms to its disposal. The LCCB method enabling much more informed business decisions. For example, the assessment of the LCCB of an offshore platform also considers the maintenance that could be decisive for the purchase of certain raw materials or plans expenditures. The results of the LCCB allow companies to make smart investments: when deciding which resources to opt for, one must not only consider their price but the general cost that the adoption of those certain resources will have on the entire Cost of the Cycle Life of a specific asset. The formulation of lifecycle cost-benefit (LCCB) analysis applied to offshore platforms considers maintenance and decommissioning that is the Real Options<sup>1</sup> (ROs) for management along with the service lifetime. The platform structure is subjected to deterioration, and thus the probability of structural failure due to extreme environmental events evolves with time. Maintenance can be provided, depending on findings from future inspections,

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<sup>1</sup> The RO models are based on the Black and Scholes formulation for financial options.

and management will have the option to provide maintenance or not. Asset integrity management is a great issue for the oil and gas industry. Usually, the management of oil and gas companies prefer to decommissioning the platform, due to the difficulty of estimate the costs for reconversion. The life cycle cost-benefit analysis involves comparing the costs to the benefits of a project and then deciding whether to go ahead with the reconversion options. The costs and benefits of the projects are quantified in monetary terms after adjusting for the time value of money. We can summarize the LCCB analysis in terms of Net Present Value (NPV) and benefit-cost ratio. The formula for Net Present Value (NPV) and benefit-cost ratio is the following:

$$NPV = \sum \text{Present Value of Future Benefits} - \sum \text{Present Value of Future Costs}$$

$$\text{Benefit-Cost Ratio} = \sum \text{Present Value of Future Benefits} / \sum \text{Present Value of Future Costs}$$

NPV expresses the future benefits of offshore reconversion business (artificial reef, renewable energy production, aquaculture, tourism and diving activities, etc). Furthermore, need to consider the present and future costs (decommissioning, maintenance, and reconversion cost).

To calculate the present value of future costs and benefits, we use the present value factor, which is  $1/(1+r)^n$ . Where  $r^1$  is the discount rate, and  $n$  is the number of years. The formula for calculating the present value is:

$$\text{Present Value of Future Benefits} = \text{Future Benefits} * \text{Present Value Factor}$$

$$\text{Present Value of Future Costs} = \text{Future Costs} * \text{Present Value Factor}$$

The Net Present Value can also be evaluated with the following equation:

$$NPV = \sum \text{Present Value of Future Benefits} - \sum \text{Present Value of Future Costs}$$

Therefore, if the Net Present Value (NPV) is positive, the project should be undertaken. If the NPV is negative, the project should not be undertaken. To calculate the Benefit-Cost Ratio, we consider the future benefits. and the present and future costs. After that, we calculate the present value of future costs and benefits. The benefit-cost ratio has the following formula:

$$\text{Benefit-Cost Ratio} = \sum \text{Present Value of Future Benefits} / \sum \text{Present Value of Future Costs}.$$

If the benefit-cost ratio is greater than 1, go ahead with the project. If the benefit-cost ratio is less than 1, you should not go ahead with the project.

<sup>1</sup> In general, the WACC can be calculated with the following formula:  $WACC = (E/V \times Re) + (V/D \times Rd \times (1 - Tc))$  where:  
 $E$ =Market value of the firm's equity;  $D$ =Market value of the firm's debt;  $V=E+D$ ;  $Re$ =Cost of equity;  $Rd$ =Cost of debt and  
 $Tc$ =Corporate tax rate.

#### **4 Implications, research limitations and future lines of research**

This work sheds light on the potentialities of the Life-Cycle Cost-Benefit (LCCB) analysis for evaluating and comparing the Net Present Value (NPV) of platforms compared to the maintenance and decommissioning costs. The LCCB tool could aid the managers in the oil and gas industry to quantify the decommissioning and maintenance costs including capital expenditure (CapEx) and risk expenditure (RiskEx). The results of the analysis highlight the great potential of the adoption of SBM from the oil and gas industry in favour of initiatives aimed at the re-use of offshore platforms. However, the importance of a clear and systems governance framework appears to be crucial to support the actors involved and the viability of these initiatives. In this sense, the study provides several insights for researchers and professionals in the oil and gas industry and in the governance field. In particular, the assessment of the LCCB tool could aid the managers in the oil and gas industry to quantify the decommissioning costs or estimate the maintenance costs for entrepreneurs who want to adopt SBMs for offshore platforms. Evaluating whether to start a particular business is very important for entrepreneurs especially for offshore oil and gas platforms. Using the LCCB method, firms can predict whether the ROI (Return of Investment) of a sustainable business is worth the investment they want to make. For an accurate ROI, one needs to consider the initial cost of decommissioning or reconversion of a platform, plus the future costs associated with it. Therefore, the LCCB model is useful to create a predictive and accurate budget for the total cost of the resources, for maintenance and decommissioning cost compared to prospective revenues. To define an accurate budget, firms must take into consideration: costs, revenues, and profit for the year.

In this sense, the purely investigative nature of the research does not allow us to generalize, although the insights that emerged from this first study on the subject can provide a foundation and useful stimulus for future theoretical and empirical studies, qualitative and quantitative. The main limitations of this contribution are related to the theoretical nature of the study. The literature review implies the complete reliance on previously published research and the availability of these studies using the method outlined in the search methodology (keywords, database) and the appropriateness of these studies with the criteria of the selection/exclusion procedure (coding). Therefore, in the future steps, the analysis of several international contexts could be carried out to broaden and

generalize the emerged findings (Lucas, 2003) and improving the validity and reliability of further inquiring (Golafshani, 2003). Also, in order to test the LCCB model, it could be useful to adopt an empirical analysis on a sample of stakeholders interested in the business feasibility of the three decommissioning ROs, that is, fish farming, hospitality, and hydrogen storage.

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### **Conflicts of Interest**

The authors declare no conflict of interest.

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# Accelerating the Transition towards Sustainability through Green Innovations: an Integrated Framework to Support Business Models Evolution

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## Abstract

This paper proposes an integrated framework that aims to support firms in the transition towards sustainable business models by identify factors favouring the development of green innovations. The aim of this paper is to investigate the several endogenous pushes as well as external solicitations that involving the managerial decisions related to the investments in green innovations. Through a conceptual analysis, the study reviews the literature on business models, sustainability strategies and green innovations. By examining sustainability issues ranging from theory to practical application, the paper provides new insights and critical points by enriching the fragmented literature on green innovations and supporting the managers' commitment to implement successful sustainability strategies. Specifically, the integrated framework suggests implications for both academic and practitioners by shedding light on how firms could improve their ability to select the right strategic moves, at corporate and business level, in order to endorse sustainable investment in green innovation and therefore to improve sustainable paths of growth.

**Keywords** – Strategic management; Sustainability strategies; Sustainable business model; Green innovations; Green management

**Paper Type** - Academic Research Paper

## 1 Introduction

This paper focuses on the challenges that firms have to face for re-orienting their traditional business models towards sustainability (Geissdoerfer *et al.*, 2018; Fiorentino *et al.*, 2020; Bocken *et al.*, 2014). The increasingly relevant socio-environmental issues promote an evolution of business practices to comply – or even to anticipate - the expectations of several stakeholders (Freeman and

Dmytriiev, 2017; Vilanova *et al.*, 2009). In this transition, the broader vision of corporate social responsibility (CSR) approaches has made relevant the interplay among sustainability strategies, strategic management and green innovations for both scholars and practitioners (Taylor *et al.*, 2018; Garzella *et al.*, 2020).

Some studies argue that the formulation and implementation of green innovations is a critical success capability through which firms can pursue their sustainable aims by contributing to corporate communication for external actors (Evans *et al.*, 2017; Repo and Matschoss, 2020; Dangelico *et al.*, 2017). Other scholars claim that green innovations can greatly affect business success by increasing their value creation process (Chesbrough, 2007; Yang *et al.*, 2017). By developing green innovations, firms could gain new competitive advantages and create differentiation benefits with regard to socio-environmentally sensitive customers (Sellitto *et al.*, 2020; Ge *et al.*, 2018; Chen and Liu, 2019); moreover, these green innovative approaches could increase the firm's financial performance, reducing production costs and time to market and improving firms' process security (Qiu *et al.*, 2020; Tang *et al.*, 2018).

The calls for the implementation of new products and processes focusing on sustainability require strategic changes in operational process, governance practices, supply chains, and organizational structures (Du *et al.*, 2018; Fiorentino *et al.*, 2020). The development of green innovations involves the decision-making processes (Bocken *et al.*, 2018); managers should carefully analyse the decisions on green innovations alongside other traditional strategic investments by considering their impact on economic and financial dynamics as well as on medium-long term competitiveness (Saunila *et al.*, 2018; Lin *et al.*, 2019). In this sense, strategic management scholars captured the relevance of green innovations in corporate and business strategies (Soewarno *et al.*, 2019; Garzella *et al.*, 2020).

Despite these research advancements, there is a lack of integration across the several literature streams related to green innovations. Indeed, although scholars identify several endogenous pushes as well as external solicitations involving the managerial decisions related to green innovations (Qiu *et al.*, 2020; Chang, 2014), the academic debate concerning the factors affecting the successful development of green innovations is still fragmented (Albort-Morant *et al.*, 2017; Zhang *et al.*, 2020; de Jesus Pacheco *et al.*, 2017).

In order to bridge this gap, the aim of this paper is to advance an integrated framework on green innovations, useful to identify factors favouring their adoption and the transition towards sustainable business models.

Specifically, the study sets the following research questions: what are the main factors affecting the formulation and implementation of green innovations? how firms can embrace green innovations for accelerating the transition towards sustainable business models?

For developing this conceptual paper, first, we have reviewed the literature on business models, sustainability strategies, and green innovations. By the integration of the compatible elements of previous research, the study highlights the factors that sustain the formulation and implementation of green innovations underlining their integration in the firm's strategic planning process. In this way, we provide a comprehensive framework extending current studies and practices.

In particular, the paper is structured as follows. The next section provides the theoretical background. Section 3 analyses the factors that favour the adoption of green innovations. Section 4 advances a framework concerning the impact of the green innovations at corporate and business level in order to develop successful sustainability strategies. Finally, Section 5 summarizes the main contribution of the paper and provides implications and ideas for future research.

## **2 The literature review**

The broader vision of the CSR concept - seen as "the integration of social, ethical, and environmental concerns into the management criteria for corporate strategy" (Freeman *et al.*, 2010, p. 259) - has led firms to review their goals and objectives (Baumgartner, 2014). According to stakeholder and CSR approaches, an increasing number of firms have decided to integrate socio-environmental concerns into their strategic management and the value creation process (Porter and van der Linde, 1995).

The growing awareness of the crucial role of firms in the pursuit of sustainable paths has led to important development in doctrine and practice (Kiron *et al.*, 2017; Nave and Ferreira, 2019). The literature showed ample interest in whether and how firms could align their strategies to sustainability direction (Roy *et al.*, 2013). The need to pursue a "sustainable attitude" has swept away the traditional views about firms' competitiveness, survival and profitability (Vilanova *et al.*, 2009; Garzella *et al.*, 2020); the profit remains an essential element to pursue, but it

must be consistently balanced with equally important social and environmental purpose. This view opens opportunities for more integrated approaches to CSR. In this sense, some scholars argued that correct implementation of socio-environmental strategies can be considered is a critical variable for firms able to trigger new competitive dynamics (Porter and Van der Linde, 1995; Clarkson *et al.*, 2011; Garzella and Fiorentino, 2014). In particular, recent studies in the field of strategic management claim that the attention to socio-environmental issues can greatly affect business success by strengthening the strategic positioning in the firm-customers and firm-investors relationships (Garzella *et al.*, 2020; Capurro, 2020). In this stream of research, scholars developed the environmental social responsibility (ESR) as an autonomous research topic (Hart, 1995; McWilliams and Siegel, 2001, Devinney, 2009).

The transition to a green economy has opened new opportunities for firms by leading them to improve their business models (Engert and Baumgartner, 2016). This process has led several firms to re-orient their management processes in a perspective of sustainability (Schaltegger *et al.*, 2016; Llerena, and Wagner, 2012); firms progressively conform their strategic, organizational and governance models with the adoption of environmentally sustainable techniques, technologies and production processes to comply – or even anticipate - the expectations of several stakeholders (Freeman and Dmytriiev, 2017; Buysse and Verbeke, 2003). Thus, firms are shifting from a traditional business model to a sustainable one by integrating social, environmental and ethical principles into their value propositions (Fiorentino *et al.*, 2020).

The demand for continuous improvement in environmental, social, and governance (ESG) practices has led scholars to identify actions, decisions and practices that firms could embrace to become more sustainable (Bowen *et al.*, 2018; Burrit *et al.*, 2019). In this process, some studies in the field of strategy and sustainability management argue that the development of green innovations could be considered as key factor for firms to gaining new positions of competitive advantages and creating differentiation benefits (Farla *et al.*, 2012; Jacobsson and Bergek, 2011).

According to Bartlett and Trifilova (2010, p.2) green innovations can be defined as a "new products and processes which provide customer and business value but significantly decrease environmental impacts". Moreover, also the development a new business models can be green innovation (Schiederig *et al.*, 2012). The calls for support the implementation of products/services and/or the firm's business

model focusing on sustainability require new, or significantly improved, production processes, managerial models and institutional procedures (Song *et al.*, 2019; Markard *et al.*, 2012). Overall, the development of green innovations involves the decision-making processes transformations, including strategic changes in operational process, governance practices, supply chains, and organizational models (Lampikoski *et al.*, 2014). Moreover, implementing green innovations requires the availability of adequate tangible and intangible firm's resources; human and financial resources, as well as technological, organizational and management capabilities are assumed to implement green innovations (Kesidou and Demirel, 2012; Song *et al.*, 2019).

In order to support firms' transition toward sustainable business model, it is important to analyze, firstly, the several internal and external factors that favoring the development of green innovations.

### **3 The factors favouring the adoption of green innovations**

In business literature, a flourishing debate concerning the factors that favour the adoption of green innovations is established (Albort-Morant *et al.*, 2017; Weng and Lin, 2011; Cuerva *et al.*, 2014). Scholars identify several external and internal factors affecting the managerial decisions related to the selection and implementation of green innovations (Jun *et al.*, 2019; Engert and Baumgartner, 2016).

With reference to the external factors, the context peculiarities and the business sector characteristics push each firm to develop appropriate management processes and strategic tools to support their sustainable paths of growth (Schiederig *et al.*, 2012). In this scenario, several external pressures towards the adoption of green innovations can be linked to expectations of firm's stakeholders (Cai and Li, 2018; Lampikoski *et al.*, 2014).

Specifically, one of the most influential stakeholders is represented by the public administrations with which firms interface (Hojnik *et al.*, 2018). In addition to the introduction of compulsory regulations, the public bodies endorse the development of green innovations by offering fiscal or monetary benefits in order to obtain positive externalities connected to the socio-environmental sustainability (He *et al.*, 2018; Mazzanti, 2018).

Also, suppliers can press on their client firms to develop green innovations in line with those already adopted by themselves, or to implement their innovative

output (Yalabik and Fairchild, 2011; Guoyou *et al.*, 2013). Similarly, the firms embrace the green innovations to realize products/services in line with needs of customers more and more increasingly attentive to socio-environmental issues (Porter and Van der Linde, 1995). Firms should favour the design and management of green innovation by identifying new integration and coordination opportunities among their value chains and the value chains of external partners, both customers and suppliers (Garzella *et al.*, 2020; Capurro, 2019; Chesbrough, 2003); the greater the degree of integration and cooperation with other companies, the greater the likelihood of adopting eco-innovations (Hojnik *et al.*, 2018).

Moreover, financial intermediaries and investors can stimulate firms to adopt eco-innovations by showing a greater propensity to finance environmentally friendly investments (Aguilera-Caracuel and And Ortiz-de-Mandojana, 2013).

About internal factors, the possession of particular resources and capabilities are determinants to develop successful green innovations. In particular, the availability of tangible human and financial resources, and to the technological, organizational and management capabilities play a key role in the development of green innovations (Llerena, and Wagner, 2012).

Moreover, the diffusion of an organizational culture "sustainability oriented" can have a positive influence on the implementation of green innovations, both internally and externally (Garzella and Fiorentino, 2014). In the first case the top management could stimulate the development of green innovations by encouraging their employees; in this sense, top management efforts could be directed to promote incentive systems based on rewards to employees who develop new environmental ideas or programs to raise employee awareness on environmental issues (Garzella *et al.*, 2020). With reference to the effects on the firm's external, the green culture could favour the adoption of green innovations acting, for example, on image improvement, the firm's legitimacy, on to be a first mover, motivation of employees (Venturelli *et al.*, 2017). These aspects are relevant sources of competitive advantages (Porter and Kramer, 2006).

Overall, the development of green innovations can be motivated by environmental, competitive and economic concerns; like any investments, green innovations impact on consolidated production on actual and expected cost configurations and revenues, with consequences on economic and financial dynamics as well as on medium-long term competitiveness. In this sense, firms should develop a new business model that allows the implementation of

successful green innovations by analysing their impact on the overall firm's strategies, both at corporate and business level.

#### **4 The theoretical framework on green innovations**

The socio-environmental concerns call for new perspectives in the business models of firms. The crossover analysis on green innovations highlights their key role in strengthening the competitive positioning in the firms-stakeholders and in increasing the firm's social value. Based on the insights from literature review, we develop a framework useful to improve firms' sustainable paths of growth, analysing the impact of the green innovations development, with related benefits, into the system of the firm's strategies.

Specifically, strategic management scholars identified two main levels of strategies: the corporate level and the business level (Collis and Montgomery, 1997; Garzella and Fiorentino, 2013). The corporate level concerns the overall objective, scope and processes of firm to accomplish its goals and to fulfil stakeholder's expectations; the business level, instead, involves the achievement of new positions of competitive advantage on based of firm's strategic decisions (Galeotti and Garzella 2013). Moreover, the evolution of studies on the topic lets to recognize also an area related to "boundary zone", occurring activities and processes jointly controlled and influenced by many organizations through "linking" and bearing strategies (Garzella, 2000; Caputo et al., 2019; Capurro 2000; Garzella et al., 2020).

In order to reach the research aim, the framework is modelled on this categorization (Table 1). In this sense, our study provides a theoretical comprehensive framework that allows to capture the variety of strategic green actions and practices that can be connected into each level of the firm's strategies to facilitate the development of green innovations. Furthermore, we suggest the related benefits associated to the development of green innovations for firms supporting their decision-making process; the list of items is not intended to be a comprehensive one but represents a starting point to further and future improvements. Thus, firms can be guided in the transition towards sustainability by supporting an evolution of their business model evolution based on successful green innovations.



Table 1 – Implementing green innovations in the system of the firm's strategies

Level of strategy		Green innovations	
		Green actions	Benefits
<b>Corporate level:</b>			
Portfolio strategy	➤	Restructuring firm's portfolios business	➤ Increase exposure to high-value sustainable market positions
		Green business entry	➤ Reduction of risk exposure
		Pollutant business exit	➤ Efficient resource allocation
		Decisions on centralization/decentralization	➤ Increase corporate image
		Green strategic alliances	➤ Reduction of production
		Green synergies	➤ Increase firm's eco-efficiency
Financial strategy	➤	Implementation of processes in respect of biophysical environment	➤ Possibility of receiving capital at favourable conditions
		Green investments	➤ Less exposed to operational, legal and reputational risks
		Adoption of environmental, social and governance (ESG) practices	➤ More interest by investors and financial stakeholders
Social strategy	➤	Environmental impact reduction	➤ Increase firm's value
		Improve the living conditions of local communities.	➤ Increase social reputation
		Cooperative alliances with environmental organizations	➤ Increase corporate image
		Reduction of air pollution and climate change	➤ Green initiatives found and supports
		Improve waste and water management	➤ Green awards
		Development of greener business transports	➤ Social stakeholders' perception of environmental performance
		Green programs and communication of environmental actions to	

	community		
	➤ Reduction of environmental incidents		
	➤ Use of sustainable energy sources, replaceable resources, components and raw materials		
Organizational strategy	<ul style="list-style-type: none"> <li>➤ Promote incentive systems based on rewards to employees who develop new green ideas</li> <li>➤ Create organizational "green units" projects</li> <li>➤ Promote programs to raise employee awareness on socio-environmental issues</li> <li>➤ Improving the internal communication of sustainable actions to employees</li> </ul>	<ul style="list-style-type: none"> <li>➤ Positive impact on firm's routine</li> <li>➤ Positive impact on corporate culture</li> <li>➤ Positive feedback from employees</li> <li>➤ Shared and clear business objectives</li> <li>➤ Development new competences and capabilities</li> </ul>	
<b>Business level:</b>			
Competitive strategy	<ul style="list-style-type: none"> <li>➤ Environmentally friendly products/services,</li> <li>➤ Product offer for environmental conscious consumers</li> <li>➤ Introduction of recyclable packaging</li> <li>➤ Programs to educate consumers on environmental issues</li> <li>➤ Communication of firm's environmental actions to consumers</li> <li>➤ Environmental standards for suppliers selection</li> <li>➤ Reduction in consumptions of</li> </ul>	<ul style="list-style-type: none"> <li>➤ Competitive advantage by differentiation or by cost leadership options</li> <li>➤ Increase quality perception</li> <li>➤ Increase customer perception of environmental performance</li> <li>➤ Increase corporate image</li> <li>➤ Reduction of production costs</li> </ul>	

natural resources			
Boundary level:			
Linking and Bearing strategies	➤	Collaborative networks	➤ Increase firm's value
	➤	Green strategic alliances	➤ Improve business performance
	➤	Green partnerships	➤ Innovative green ideas
	➤	Green technological clusters	➤ Exploitation of new emerging technologies
	➤	Smart working	➤ Reduction of costs during the design and development of products
	➤	Collaboration with Research centers/Universities to solve general environmental problems	➤ Minimize the environmental impacts related to the overall supply chain.

The framework highlights that the development of green innovation affects the decision makers with regard to, for instance, products differentiation, increasing customer satisfaction, environmental regulations, sustainable incentives and/or technological progress; managers should carefully take decisions regarding, for example, the exit from pollutant business or the increase of eco-R&D investments in order to develop sustainable products, services, processes and initiatives focused on the social needs of people and on the environmental preservation (Peattie and Belz, 2010; Garzella et al., 2020; De Medeiros et al., 2014).

## 5 Conclusion

Our study categorizes internal and external factors that push firms to embrace green innovations in order to guide the decision makers to select the right strategic moves from the available ones. The advanced framework suggests, both at corporate and business level, relevant issues, strategies and actions, with related benefits, in order to improve firms' sustainable paths of growth, by managing at the same time, from a side, the relationship between the firms and the external environment and, from another side, a careful assessment of internal processes. Finally, the crossover analysis on green innovations highlights their key

role in strengthening the competitive positioning in the firms-customers and firms-investors relationships and in increasing the firm's social value.

By examining sustainability issues ranging from theory to practical application, the paper provides new insights and critical points by enriching the fragmented literature on green innovations and supporting the managers' commitment to implement successful sustainability strategies. Moreover, the integrated framework on green innovations provides guidance for both academic and managers offering a concrete response to corporate issues in terms of social and environmental responsibility.

Specifically, the study contributes to several literature streams such as strategic management, sustainability and innovation studies. Specifically, our contribution is relevant for strategic management studies because it proposes a crossover analysis on green innovations highlighting problems and limits related to their integration in the strategic planning process. With reference to sustainability literature stream the study proposes an in-depth analysis of factors, both internal and external, affecting the selection and implementation processes of green innovations. Moreover, with reference to innovation management, the framework provides a conceptual model able to identify sustainable ideas, goals and actions at corporate and business level that firms could embrace to maximize potentiality and reduce risks in implementing green innovations. Finally, the study suggests implications for practitioners to support an evolution of sustainable business models underling how firms could improve their ability to grasp external stimulus and therefore to endorse sustainable investments in green innovations.

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## **Blockchain and Sustainability in the Agri-Food Sector: a Structured Literature Review**

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### **Abstract**

The adoption of blockchain-based technologies for a sustainable agri-food sector is a recently developing area of inquiry. Blockchain technology promises to be a significant enabler of sustainability in the agri-food sector. However, there is still limited understanding on how the blockchain technology can promote agri-food sustainability, because its adoption is still in an early stage and the related literature is relatively limited.

This paper reviews and critically evaluates the available research with the aim to understand 1) how it is developing, 2) what are the main research foci, and 3) what future research directions are needed.

We analyzed a total of 31 studies extracted from the Scopus database using a structured literature review (SRL) methodology. We found evidence that the topic

is attracting a growing research interest and identified two main research areas: studies that focus on the technological components of blockchain with the aim to provide operational frameworks for blockchain-based food traceability, and studies that deepen the potential benefits, the challenges and the boundary conditions for blockchain adoption in the agri-food sector. Additionally, the coding analysis reveals that much of the reviewed studies are from the USA, the UK and India, and tend rely on the case study methodology.

To the best of our knowledge, there are very few review articles that describe the development of this research stream. The main limitations of this study are the sampling method (limited to a Scopus search) and the methodological approach employed to code and analyze the literature, which involves some degree of subjective interpretation.

**Keywords** — Blockchain, sustainability, supply chain, agri-food sector

**Paper type** – Academic Research Paper

## 1 Introduction

In the last few years, the agri-food sector has been facing many challenges concerning scarcity of natural resources, population growth and climate changes, and the need for food safety and quality (FAO, 2019).

The food chain needs to become more sustainable in order to improve consumers' trust and foster their purchase willingness (Feng et al., 2020).

In fact, the solution to address the food safety and quality concerns is to improve traceability transparency, security and integrity (Feng et al., 2020; Tsang et al., 2018; Helo and Hao, 2019; Banerjee et al., 2018; Li et al., 2020).

As ensuring food safety, quality, traceability along with post-harvest management are complex and intricate issues in the agri-food supply chain, food manufacturers have evinced interest to use blockchain with the existing Information and Communication Technologies (ICTs) i.e. Internet of Things (IoT), Radio Frequency Identification (RFID), cloud computing, machine learning, and artificial intelligence (Lehmann et al., 2012).

Blockchain is defined as "a digital, decentralized and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamper-proof records" (Treiblmaier, 2018). As such, blockchain is regarded as a promising technology that can help to build trust

mechanism for solving the transparency and security issues as no single party in the supply chain can alter existing information (Feng et al., 2020).

The literature suggests that the application of blockchain in the agri-food industry can improve process transparency and efficiency (Papa, 2017). In fact, blockchain technology can increase the levels of verification efficiencies and automation (Cole et al., 2019) and facilitates the digital traceability and authentication of food products throughout the entire supply chain suppliers to store shelves and finally to end consumers (Tijan et al., 2019).

In these last few years, studies on the implications of blockchain in agri-food sectors have increased, but there are still some limits to understanding how the blockchain can be used to improve the food traceability performance through the full information transparency and security dimension of food chains (Kim and Laskowski, 2017; Yiannas, 2018). Therefore, there is a need to understand how the blockchain is evolving within the context of agri-food.

Based on a structured literature review (SLR), this paper critically analyses the studies that specifically deal with the application of blockchain in the agri-food sector, provides an overview of the state of literature and outlines a future research agenda.

A SLR is a method for studying a corpus of scholarly literature, to develop insights, critical reflections and future research directions (Massaro et al., 2016).

This paper uses the SRL method to address the following interrelated research questions:

*RQ1. How is the literature on blockchain and sustainability in the agri-food sector developing?*

*RQ2: What are the main research foci?*

*RQ3. What future research directions are needed?*

The remainder of this paper is organized as follows. Section 2 explains the research methodology; Section 3 explores the results and discussion answer the first two research questions. Section 4 which concludes the paper presents our views on the future of blockchain and agri-food research, some closing remarks and the limitations of our research.

## **2 Research Methodology**

SLR methodology is applied to this research (Lombardi and Secundo, 2020; Kraus et al., 2020; Massaro et al., 2016; Petticrew and Roberts, 2006; Tranfield et

al., 2003) for understanding the role of the blockchain in the agri-food sector as an instrument for developing sustainability and traceability.

Following the methodological approach of previous works (Lombardi and Secundo, 2020; Massaro et al., 2016; Dumay and Cai, 2015; Dumay, 2014a; Dumay and Garanina, 2013; Guthrie et al., 2012), we have developed a multi-step review process to collect and analyze the studies on the topic of Blockchain in the agri-food sector.

The following sub-sections detail the steps we took to develop the structured literature review.

### ***2.1 The literature review protocol***

The first step of the review process starts to answer a question: why develop a literature review on blockchain and sustainability in the agri-food sector? In this regard, we have decided to analyze the existing academic literature on the topic of blockchain, because, to date, the review articles that examine the developments, the benefits and challenges connected with the adoption of blockchain in the agri-food field are very few.

The selection of the papers has been restricted to the studies that consider the blockchain as an enabler of sustainability and traceability in the agri-food sector. We selected the studies that featured the terms “blockchain” and “food” and “supply chain” in the title, abstract or keywords. Thus, we excluded from the review those studies that consider the blockchain technology in general terms and do not focus on the agri-food sector. We also narrowed the search to journal articles excluding book chapters, conference articles and editorials and notes. As a result of this search, we found 31 articles over the period 2019–2021. The 31 articles included in the SRL are marked with an asterisk in the References section.

The review process also implied the creation of a citation index and the definition of different categories in order to classify the selected papers. The indexation and categorization of the reviewed papers provides a useful understanding about the pathway followed by researchers.

### ***2.2 The literature review search process***

The second step of the review process involved selecting the database needed to collect the papers subjected to the structured review. Using the Scopus

database, we have selected 31 articles from internationally recognized academic journals that belong to several subject areas (according to Scopus classification) such as Business, management and accounting, Computer Sciences, Engineering, Decision Sciences, and Environmental sciences. The journals that have published the 31 papers included in the sample are the following:

Applied Economic Perspectives and Policy (2)  
British food journal (2)  
Computers in Industry (1)  
Decision Sciences (1)  
International Food and Agribusiness Management Review (1)  
International Journal of Industrial Engineering and Management (1)  
International Journal of Information Management (2)  
International Journal of Logistics Management (1)  
International Journal of Logistics Research and Applications (1)  
International Journal of Production Economics (1)  
International Journal of Production Research (1)  
International Journal of Scientific and Technology Research (1)  
International Journal on Food System Dynamics (1)  
Journal of Cleaner Production (5)  
Management decision (1)  
Production, Planning & Control (2)  
Quality - Access to Success (1)  
Quality Management Journal (1)  
Resource conservation and recycling (1)  
Supply Chain Management (2)  
Sustainability (1)  
Transportation Research Part E: Logistics and Transportation Review (1)

### **2.3 Analytical framework**

The third step consisted in developing the coding framework and categorizing the selected articles accordingly. Our coding framework is based, with some adaptations, on the coding categories developed by Lombardi and Secundo (2020), namely:

- Timing of publication: the evolution over time of the number of papers
- Geographic distribution of papers

- Author and citations analysis: number of citations of articles, citations per year (CPY)
- Research Method: the specification of the research method used in the reviewed studies
- Research Focus: the identification of the research areas emerging in the literature.

The results of this coding procedure will be analyzed in next section.

### 3 Results and discussion

In this section we answer the first two research questions: first, how is the literature on the blockchain and sustainability within the agri-food sector developing? and second, what are the main research foci?

#### 3.1 Timing of Publications

As said previously, we found 31 articles considering the period from 2019 to 2021. This indicates that the literature on blockchain in the agri-food sector is recent but it is growing rapidly, as shown in Figure 1, due to an increasing number of works published over the last two years.

We have decided to include the current year (2021) in the citation analysis, even if it is not yet concluded and we expect other papers to be published.

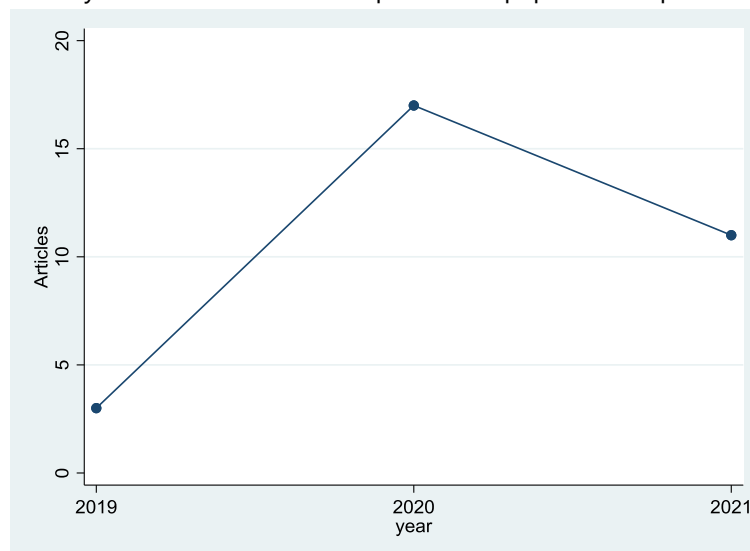


Figure 1 : Articles' evolution over time

### 3.2 Geographic Distribution of articles

In order to analyze the geographic distribution of the reviewed articles, we computed the number of articles and the number of citations per country (Fig. 2). Following Lombardi and Secundo (2020), we considered the involvement of a country (by university / research institution) in the articles' authorship and, when an article was co-authored by authors from different countries, each country received one point. As a result, we found that:

The top four countries in terms of number of articles are USA (7), India (7), Italy (7), UK (7), followed by China (6). 9 out of 16 countries have only one article, and 2 out 16 have two articles.

The top three countries in terms of citations are USA (210), India (182), and UK (171). These are also amongst the first countries in terms of scientific productivity.

Overall, these findings suggest that the existing studies are somewhat 'fragmented' among countries and that, to date, no country is truly specialized on the topic of blockchain adoption for agri-food sustainability, even though some countries are more prolific than others.

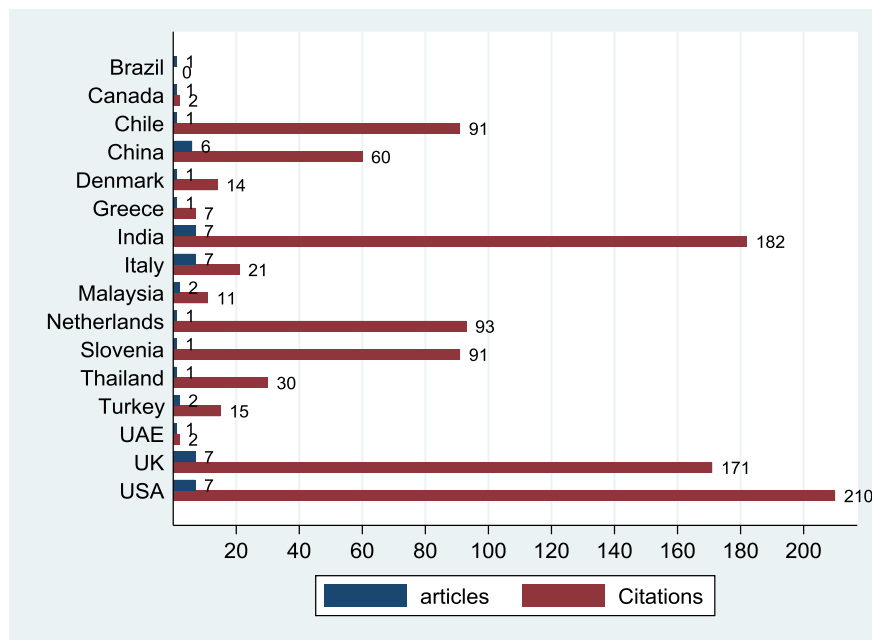


Figure 2: Geography of articles by number of items/citations per country



### 3.3 Articles citation analysis

The third step of the analysis shows the research impact of the sample articles based on the number of Scopus citations. We have chosen two different measures to classify the articles by their citation impact. First, we ranked the articles based on the absolute number of citations extracted from the Scopus database (Table 2).

Table 2. Top ten articles ranked by Scopus citations

Authors	Title	SCOPUS citations
Kamble S.S., Gunasekaran A., Gawankar, S.A. (2020)	Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications	104
Behnke, K., Janssen, M.F.W.H.A (2020)	Boundary conditions for traceability in food supply chains using blockchain technology	93
Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., Boshkoska, B.M. (2019)	Blockchain technology in agri-food value chain management: a synthesis of applications, challenges and future research directions	91
Bumblauskas, D., Mann, A., Dugan, B., Rittmer, J. (2020)	Blockchain use case in food distribution: Do you know where your food has been?	61
Feng H., Wang X., Duan Y., Zhang J., Zhang X. (2020)	Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges	47
George R.V., Harsh H.O., Ray P., Babu A.K. (2019)	Food quality traceability prototype for restaurants using blockchain and food quality data index	40
Kumar A., Liu R., Shan Z. (2020)	Is Blockchain a Silver Bullet for Supply Chain Management? Technical Challenges and Research Opportunities	32
Kittipanya-ngam P., Tan K.H. (2020)	A framework for food supply chain digitalization: lessons from Thailand	30
Rogerson, M. and Parry, G.C. (2020)	Blockchain: case studies in food supply chain visibility	17
Yadav, V.S., Singha, A.R., Rautb, R.D., Govindarajanc, U.H. (2020)	Blockchain technology adoption barriers in the Indian agricultural supply chain: an integrated approach	15

However, as suggested by Dumay and Cai (2015), the problem with determining the research impact by the total number of citations is that older articles can accumulate more citations. For this reason, in order to counterbalance this trend, we also ranked articles using the number of citations per year (CPY).

As shown in Table 3, the results of our analysis remain almost unchanged. This is because, with some exceptions (George et al., 2019; Zhao et al., 2019), the articles with the highest number of citations were published in 2020, and the CPY is calculated as total citations divided by the number of years between the date of analysis and the date of publication (Massaro et al., 2015).

Table 3. Top ten articles ranked by citations per year (CPY)

Authors	Title	CPY
Kamble S.S., Gunasekaran A., Gawankar, S.A. (2020)	Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications	104,00
Behnke and Janssen (2020)	Boundary conditions for traceability in food supply chains using blockchain technology	93,00
Bumblauskas, D., Mann, A., Dugan, B., Rittmer, J. (2020)	Blockchain use case in food distribution: Do you know where your food has been?	61,00
Feng H., Wang X., Duan Y., Zhang J., Zhang X. (2020)	Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges	47,00
Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., Boshkoska, B.M. (2019)	Blockchain technology in agri-food value chain management: a synthesis of applications, challenges and future research directions	46,00
Kumar A., Liu R., Shan Z. (2020)	Is Blockchain a Silver Bullet for Supply Chain Management? Technical Challenges and Research Opportunities	32,00
Kittipanya-ngam P., Tan K.H. (2020)	A framework for food supply chain digitalization: lessons from Thailand	30,00
George R.V., Harsh H.O., Ray P., Babu A.K. (2019)	Food quality traceability prototype for restaurants using blockchain and food quality data index	20,00
Rogerson, M. and Parry, G.C. (2020)	Blockchain: case studies in food supply chain visibility	17,00
Yadav, V.S., Singha, A.R., Rautb, R.D., Govindarajanc, U.H. (2020)	Blockchain technology adoption barriers in the Indian agricultural supply chain: an integrated approach	15,00

### **3.4. Research method**

The articles were further categorized based on the research method into:

- Case study (13 articles)
- Empirical survey (6 articles)
- Literature review (5 articles)
- Conceptual framework (4 articles)
- Mathematical modeling (2 articles)
- Structural equation modelling (1 article)

As expected, we found many articles (13) based on case studies. The topic of blockchain adoption in the agri-food is a recently developing area of inquiry and the case study methodology is particularly suitable to describing, exploring, and understanding an emerging phenomenon in its real-life context. Next, we found six empirical surveys which are aimed at analyzing the benefits and the issues associated with the adoption of blockchain technologies from the perspective of food supply chain actors, consumers or blockchain experts (Aldrighetti et al., 2021; Kayikci et al., 2020; Rainero and Modarelli, 2021, Shew et al., 2021; Yadav et al., 2020).

Furthermore, we found five review articles (Ben-Daya et al. 2021; Feng et al., 2020; Kumar et al., 2020; Rana et al., 2021; Zhao et al., 2019). The relatively low number of literature reviews is not surprising given that the adoption of the blockchain technology in the agri-food sector is still in an early stage and that the related literature has grown only in recent years. Four articles (Casino et al., 2020; Collart and Canales, 2021; Guido et al., 2020; Dinesh Kumar, Manoj Kumar and Anandh, 2020) are based on a conceptual analysis of blockchain-based food traceability systems and one (Hew et al., 2020) uses the structural equation modelling to examine the intention of food supply chain actors to participate in a block-chain based food traceability system.

### **3.5 Research focus**

The last criterion of classification is the research focus of the sample articles. In order to identify the main emerging research areas, the authors performed a deep content analysis of the 31 papers. This process led to identifying two main research areas:

1. Studies that focus on the technical components of a blockchain-based food traceability system;
2. Studies that deeply analyze the potential benefits, the barriers and the boundaries conditions for blockchain adoption in the agri-food sector.

The first category is composed of (14) articles that provide operational frameworks for implementing a blockchain-based food traceability system. Overall, these studies show that the main advantages linked to the use of the blockchain compared to the traceability methods currently used concern: the absence of a third party responsible for controlling the logistics chain; greater transparency of data and information; shorter traceability times in the event of a food crisis; greater ability of the final customer to check the type and characteristics of the purchased product; greater economic security for primary producers thanks to the possibility of planning agricultural and cultural activities according to supply contracts stipulated before the start of activities (Guido et al., 2020). Pappa et al. (2018) conclude that the choice or adoption of integrated blockchain technologies is attributed to an electronic traceability system that has gained salience as a risk management tool to ensure food safety, food quality, and chain integrity.

The second category groups all studies (17) that have deeply analyzed the benefits, the barriers and the boundary conditions to the adoption of blockchain in the agri-food sector.

According to Tiscini et al. (2020), the potential benefits of the blockchain adoption in the agri-food industry can be summarized through four main drivers of sustainability:

1. Traceability
2. Labelling
3. Organic farming
4. Financial efficiency

With respect to point (1), the traceability is regarded as a driver to ensure the quality of food production through transparency and verifiability (Bastian et al., 2013).

With respect to point (2), it is argued that the blockchain allows for the disclosure of a huge amount of data and avoids labeling frauds through QR code (Tripoli and Schmidhuber, 2018).

With respect to point (3), the blockchain adoption is argued to enhance consumer trust regarding the organic farming, because customers and auditors

may be assured of farming processes in a more secure and efficient way (McCarty et al., 2016).

With respect to point (4), the blockchain has the potential to virtually remove the risks of fraud allowing transaction without trusted parties, as the system will certify and enable the payment. In turn, efficient transactions in agri-food supply chains would lead to greater financial inclusion and rural business development (Tripoli and Schmidhuber, 2018).

Further benefits identified in the literature include:

- Informational security

According to Puthal et al. (2018), Ølnes (2016), Conoscenti et al. (2016), the information stored in the blockchain technology is more reliable due to the consensus mechanism. Similarly, Tijan et al. (2019), state that Blockchain facilitates the digital traceability and authentication of food production throughout the entire supply chain from suppliers to store shelves and finally to end consumers. Feng et al. (2020) argue that the blockchain has a strong impact on the research and practice for agri-food product traceability.

- Improvement of trust between supply chain members

Blockchain can enhance trust and collaboration among supply chain partners (Tian, 2016). The blockchain allows the development of participated business model, in which stakeholders can be actively involved in the organization's decision-making process. Such engagement is more trustable, clear and rigorous, thanks to the technological features of the blockchain than other available modern technologies (Dal Mas et al., 2020). The information transparency obtained with the use of the blockchain becomes a strategic element to consolidate relations between company-customer and company-stakeholder and to create durable value over time (Mercuri et al., 2021).

- Sustainability and transparency of traceability management

Kshetri et al. (2018) argue that blockchain technology enables end-to-end traceability. It can meet the requirements for tracing the origin of products from farms to consumers.

As a result, the application of blockchain technology can build trust among stakeholders, which will allow them to gain insight into the entire supply chain (Feng et al., 2020). The application of blockchain can make significant contributions to effective sustainability and transparency of traceability management (Galvez et al., 2018; Hong et al., 2018; Chang et al., 2019). As stated by Mercuri et al. (2021), the lack of transparency and traceability in the agri-food

sector generates inefficiencies and poses future challenges for overcoming fraud attempts, pollution, human rights violations and many other inefficiencies. In an increasingly complex scenario, blockchain has the potential to increase the level of transparency, traceability and sustainability, through the use of a shared and decentralized database, in which information is immutably stored and encrypted, avoiding the problems of tampering and data forgery.

Nevertheless, the existing literature also points to several challenges that need to be addressed if the blockchain is to deliver the promised benefits. Specifically, the reviewed articles (e.g. Feng et al., 2020; Rana et al., 2021; Rogerson and Parry, 2020; Zhao et al., 2019) point to the following challenges for applying the blockchain technology in the agri-food supply chain: 1) technical challenges such as limited storage capacity, scalability and data processing issues (Tian 2016); 2) privacy leakage: the blockchain cannot ensure the transactional privacy because each transaction can be traced and every user identified by all participants to the network; 3) high cost problem: blockchain-based food traceability solutions may be very expensive (Lin and Liao, 2017) and complex blockchains such as blockchain-based agri-food supply chains may require a high computation power, which entails a higher energy consumption as well; 4) the human input element: errors and corruption in data entry are compounded in block-chain based systems because the technology's built-in trust mechanism may lead to accepting data unhesitatingly; 5) regulatory issues: there is a need to introduce a legal and regulatory framework to guide the blockchain application in the agri-food sector considering this issue from a global perspective; 6) lack of skills: there is still limited knowledge and skills about how blockchain can be used on behalf of agri-food value chain participants. Finally, the literature suggests that the blockchain technology will not fulfill its potential until the agri-food supply chains are fully digitized beforehand (Kayikci et al., 2020; Rogerson and Parry, 2020).

#### **4 Conclusions and future directions**

This paper aimed to critically review the available literature on blockchain in the agri-food sector. By employing a multi-step review process, 31 articles were selected, examined in order to determine their impact, and then classified according to their:

- Timing of publication
- Geographic distribution of papers

- Author and citations analysis
- Research Method
- Research Focus

In the first part of the paper we answered the RQ1: “How is the blockchain and sustainability literature within the agri-food sector developing?” and the RQ2: “What is the focus of the blockchain and sustainability within the agri-food sector?”.

In particular, we showed that in these last few years the literature on blockchain adoption in the agri-food sector 1) has rapidly grown with an increased scientific impact as measured by the number of Scopus citations, 2) is somewhat fragmented among countries even though some countries such as USA, the UK and India are more prolific than others; 3) has often employed the case study methodology; and 4) has focused on two main research areas: first, the impact of blockchain-based technologies on the agri-food product traceability mainly from a technical perspective, that is: many studies use the context of agri-food supply chain to discuss the technological components of blockchain and highlight the key design and implementation challenges mainly from a technical perspective; and second, the potential benefits, the barriers and the boundary conditions to blockchain adoption in the agri-food sector.

In response to RQ3: “What is the future of the blockchain and sustainability within the agri-food sector? we point out that the adoption of blockchain for the agri-food sustainability has not yet been fully investigated and that scholars should be committed to develop those areas not yet covered or underexplored by the existing research. Considering the findings of this article, the latter assertion has the following implications.

The first implication concerns the need to further increase the number of case study analyses examining the impact of blockchain on agri-food sustainability in real use cases. In particular, in the literature there are still few studies about the economic and organizational impact of the blockchain application in real agricultural supply chains. Many articles limit themselves to simulate the possible application of this disruptive technology. Therefore, further real case studies could be very useful to estimate actual costs, benefits and socio-organizational impacts.

Second, there is a shortage of studies that explore the actual propensity of the various participants in the agri-food supply chain to adopt the blockchain-based technologies and the key benefits and challenges they perceive with the use of

blockchain. Indeed, we found only a few articles that analyse the benefits and challenges of blockchain adoption from the perspective of agri-food supply chain actors (e.g. Hew et al., 2020; Saurabh and Dey, 2021). This research focus is particularly relevant because the openness of a blockchain based platform may involve the disclosure of confidential data and stakeholders in the supply chain may not be willing to do so.

Third, there is a need to increase studies on the impact of blockchain technology adoption on financial performance in the agri-food sector.

And fourth, we believe it interesting to study the impact of the blockchain technology under the framework of intellectual capital, considering that the blockchain can impact on the structural capital and relational capital. To the best of our knowledge, to date only a few studies have grasped this link (Ruzza et al., 2020).

Our study is not free of limitations. First, the selected articles descended from certain search criteria and thus results may vary according to different search criteria. Second, the chosen coding criteria cannot be considered an exhaustive framework for describing the adoption of blockchain technology research. Finally, as with all interpretative research, the findings are limited by the breadth and depth of the data analysed and by our interpretation of the results. Although the structured literature review method may be deemed more reliable than other traditional authorship literature reviews, researchers using the same method and dataset may come up with different conclusions.

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## The Impact of the Covid-Related Recession on Italian Wineries

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### Abstract

The goal of the paper is to investigate about the impact of the crisis generated by Covid-19 on the Italian wine sector and how technological innovation has contributed to the going concern of Italian wineries.

As is well known, the slowdown in the national economies and, particularly, the dramatic reduction in the tourist flows, has affected the “ho.Re.Ca.” industry, that is strictly connected to the agri-food sector; but nevertheless, the latter managed to maintain good level of profitability both for its characteristic of satisfying unavoidable basic need and for the change in the eating habits of people, who now prepare and consume meals at their own home.

Some researches show that Italian wine sector suffered a drastic reduction in turnover growth rates during the months of lockdown (Paoloni, Cosentino, Dello Strologo, 2020), but they also argue that technological innovation has allowed to some wineries to overcome the crisis. In the wine sector, during the pandemic emergency, the e-commerce infrastructure has become the main success factor.

The questions that then arise are the following: “How does Covid-19 impact on the main financial results of Italian wineries? Have digital sales allowed revenues not to decrease, causing a change in the sales channel, or have not been able to replace the traditional buying experience? Is the present emergency an opportunity, instead of a threat, to make Italian wineries’ economic performance boost through e-commerce?”.

To test our thesis and to answer to the research questions, we set a data sample of Italian wineries and we collected, in addition to the main financial and economic ratios, before and after the pandemic emergency, some e-commerce indicators,. Applying descriptive statistical techniques to the data set, we found interesting results on the resilience of Italian wine sector and on its perspective growth.

**Keywords** – Wine sector – E-commerce in food&wine industry – Covid-19 Era; Italian agri-food sector.

**Paper Type** - Academic Research Paper

## 1 Introduction

Winston Churchill said "some people regard private enterprise as a predatory tiger to be shot. Others look on it as a cow they can milk. Not enough people see it as a healthy horse, pulling a sturdy wagon". Despite the role of the business fabric and its socio-economic implications in the functioning of the world system, the Covid-19 health emergency spared no one and all sectors were affected by the necessary restrictions adopted, generating irreversible consequences.

One of the greatest consequences of Covid-19 for the Italian country and its economy is undoubtedly the impact of the total shutdown of the tourism sector. Due to the close correlation with tourism activities, the agri-food sector has also been affected by the crisis, particularly in a country like Italy, known and appreciated by tourists in terms of culinary values. Tourism is a complex supply chain involving many players. The supply side of the sector is highly fragmented and diverse, covering a wide range of activities and actors (OECD, 2020) such as service and information providers (online/offline), travel and tourism agencies, visitor attractions, accommodation, Food&Beverage suppliers and others (Korže, Škabar, 2020). The outlook for tourism in 2020 was downgraded several times during the pandemic; future uncertainties and lack of situational awareness generated extremely pessimistic scenarios for the future of the sector. During the first weeks of the pandemic the surveys conducted on European stock markets showed that out of a sample of 15 quoted tourism companies, the market cap fell dramatically due to the sharp drop in values. From February to March, the shock caused a contraction of -62.2%; Edreams Odigeo S.A., the Spanish giant tour operator, had seen a 71.1% fall in the time period 17 February to 19 March 2020. By July, the market cap decline had been reduced to 37.8%, still a very high figure explained by the inability to understand when the big chemical companies would get a vaccine that could counter the spread of the virus and give flow to the tourism channels again. The outlook at the end of the first half of 2020 foresaw consequences equivalent to three times those seen the 2008-2009 Global



Economic Crisis (UNWTO, 2020). In May, the international tourist number fell 98% compared to the same month of the previous year. There was a 96% decline in booking to Europe across all sub-regions over the period of January-May 2020 compared to the same period of 2019 (ETC, 2020). On a world scale, the shake-up seen in international tourism translated into a loss of 850 million to 1.1 billion international tourists, 910 billion to 1.2 trillion US\$ in export tourism revenues and a 100 to 120 million direct tourism jobs at risk (UNWTO, 2020a). Moreover, the entrepreneurial fabric of tourism presents characteristics that are not comfortable with negative events of this magnitude. Large multinational corporations operate alongside small companies (EC, 2020). In many tourism destinations, small tourism companies are numerically dominant (OECD, 2008), known as SMTEs in this sector (Small and medium sized tourism enterprises) (Beaver, 2005). SMEs are considered to be a cornerstone of the European economy, accounting for around 99% of all enterprises in the EU and two-thirds of total private sector employment (EC, 2020a). Globally, they provide 70% of jobs (ITC, 2020). The most of agribusiness in the wine sectors are Small and Medium Enterprises (SMEs); the sector is made up of a dense network of small businesses, that, even if they have a crucial role in the socio-economic context, taken individually are extremely vulnerable to economic crisis.

Although tourism has been at a standstill for months, the agri-food sector has shown some resilience due to the fact that what it offers is not only experience but also necessity. Some of these necessities have found expression through e-commerce that seems to be just the tool companies and consumers needed to deal with a situation where governments required minimal travel from home.

The drop in sales through traditional sales channels during Covid-19 has led to a boost in the digital wine business (OIV, 2020). In U.S. a two-month lockdown has sparked triple-digit growth in alcohol sales through e-commerce, alcohol delivery apps like Drizly and Vivino, and virtual tastings. Spirits were up 374 percent, while wine and beer were up 242 percent, respectively, as New York-based Nielsen reported in the June issue of Beverage Industry (Beverage Industry, 2020). The rise of e-commerce in spirits sales during Covid-19 has been confirmed by several industry professionals who have been impressed by the exponential growth curve of orders. Sara Goucher, Director Of Ecommerce at Molson Coors Beverage Company, declared that the company's 2020 online sales had grown 230% by November over the same 11-month period in the previous year, and by Thanksgiving about 50% of U.S. consumers were aware they could

buy beer online. While that figure may seem low, only 20% of consumers were aware of digital brew sales before the pandemic (Tiffany, 2021).

However, it must be acknowledged that Italian wineries have seen a drastic drop in turnover despite the development of the digital business model. In the first two months of 2020, there had been 10% growth in company results compared to the corresponding period of the previous year, while by the end of April, growth had shrunk to +1% compared to the first four months of 2019 (Paoloni, Cosentino, Dello Strologo, 2020). This contraction is mainly explained by two factors: the blockage of the "ho.Re.Ca" channel, which caused domestic and international orders to plummet, and, on the one hand, the propensity to consume and the characteristics of demand. Wine, in fact, is one of the products with the highest symbolic value, a cultural asset with social significance (Paoloni et al., 2020), and the state of emergency due to the pandemic has had a negative impact on consumption choices. A 30% drop sales of sparkling and semi-sparkling wines has been noted, and consumption has shifted towards lower-end wines (Paoloni, Cosentino, Dello Strologo, 2020). The result of the drop in turnover was not primarily dependent on volume but rather on value, demonstrating that wine is not only a commodity but a socio-cultural asset.

## **2 The growing impact of on-line activities in the wine sector**

As a result of this contraction, the business has had to adapt to the necessities of the moment by pursuing new strategies and companies have adopted digital channels as sales tools as much as possible. Other companies, however, have found themselves unprepared for this strategy, partly because digitalisation has not yet taken hold of the sector and partly because the wine sector involves a large number of SMEs that are used to working in the traditional manner, depending mainly on in-store sales and their physical retailers. Large companies use e-business faster than SMEs because for the latter access is often limited by several obstacles (Beynon - Davies et al., 2003), primarily due to the high initial costs and maintenance of web-based e-commerce sites. Nevertheless the gap between large companies and SMEs continues to exist, the recent growth of e-business is having a significant impact on entrepreneurs particularly for SMEs. E-commerce is also an important option for the survival and growth of small farms (EFS) (Brooksbank et al. 2003). The rate of growth and the use of e-business varies depending on the country, industry and firm size (Baourakis et al., 2002).

However, a growing number of studies have highlighted the potential of the Internet to help SMEs to be more competitive in the market. Digital channels offer several opportunities in terms of advertising, strategies and costs. In terms of advertising the lack of difference in the amount of space occupied by small and large companies online and the same freedom to adopt more Internet strategies are certainly an advantage for SMEs (Mason, Gos, 2015).

From a strategic point of view two main factors emerge: the possibility of implementing globalization strategies and networking with partners taking into account that the new risk factor for the competitiveness of SMEs is the reduction of costs for larger companies when entering (via the Internet) niche markets dominated by SMEs (Kleindl, 2000).

Regardless of the target group analysed in the business fabric certainly technological innovation has proved to be a bridge for some companies to cope with unforeseeable difficulties offering connection among market and consumers also during a pandemic emergency. Covid-19 accelerated a trend that has existed for a few years now: the increasing use of digital channels as a means of knowledge and consequent purchase. The tendency is recognised in several industry reports and confirmed by strategists and researchers who believe that consumers are increasingly turning to mobile devices to access the Internet and consequently purchase consumer and collectible products (Agnoli, Begalli, & Capitello, 2011; Dvorak, Ritsma, Lai, Strohmenger, & Pappafotopoulos, 2015). Though apparently limited to transactions, e-commerce owes its main success also (and most likely, above all) to the comfort of the global environment of electronic infrastructure (Colla, Lapoule, 2012); most probably, in fact, the global experience of website purchases is the most important factor for e-commerce (Corbitt, Thanasankit, Yi, 2003).

In the last ten years, the purchase experience had become increasingly melted to the consumption experience and characterized by value co-creation (Jaakkola, Helkkula, Aarikka-Stenroos, 2015); from this point of view, the idea of "serving" when assuming that this serving is mutual, seems to be one of the most important dimensions of experience (Tynan, McKechnie, & Hartley, 2014; Vargo & Lusch, 2017). In the Covid-19, buying online is not only the economic consequence of the shutdown, but it is also a social phenomenon, caused by the exigence of people to feel themselves part of a larger community, even if simply virtual.

This situation seems to be true for many kinds of products and even before the Covid era, it also concerned, in some countries, the wine sector (Fiore, Vrontis, Silvestri, Contò, 2016; Pelet, Lecat et Al., 2017). Previously wineries were already involved with the ICT's mainly in the field of tourism, i.e. trips and experiences focused on the knowledge of wineries and wines. In this type of tourism, market power consists in the use of information using ICT devices to satisfy customers' knowledge needs (Connolly and Olsen, 2000) although the progress of the Internet has brought new marketing opportunities for wineries that need to create and maintain websites in order to, among other objectives, achieve direct sales to customers, carry out direct marketing and promote wine tourism (Sellito, 2005). There are important benefits that digital channels offer to this sector, such as intra-industry interaction, improvement of the business image and brand presence, and the increase of visitors (Nowak, Newton, 2008).

Nevertheless Italy is consistently the most important producer of wine in the world, its supremacy didn't seem to affect, in the recent past, the world of wine e-commerce. Italian wineries have not kept pace with other countries in this matter by not sufficiently developing the correlation between wine and the Internet customers. Even though other countries are certainly more advanced than Italy in using e-commerce for selling and buying wine (Faraoni, Rialti, & Zollo, 2018), it is important to remember that experiences of failure in this business have also arisen in more developed countries (Cho, Bonn, & Kang, 2014; Gebauer & Ginsburg, 2010), giving evidence of the difficulty in designing, organizing, and implementing this kind of business model (Pelet et al., 2018). Several researchers such as Higgins et al. (2015) have shown that there have been efforts by wineries to integrate mobile and social media into their marketing strategies but that wine consumers are slow to accept and adopt the new marketing reality. Furthermore, they have demonstrated that the online wine buyer is an older, married man, with a high income. Thus it seems the online wine buyer is more likely to be a wine connoisseur. Despite access and comfort with technology, millennials, the largest portions of ICT users, are unlikely online buyers. The age factor is certainly not a plus for the wine sector in terms of e-commerce development and consumer attention.

Obviously, in addition to the opportunities offered by innovation, the main negative aspects holding back consumers from using e-commerce were identified: concerns about financial security, slow website navigation and insufficient product information.

However, Italy does not seem to be the only country that does not make much use of technological innovations in the wine sector. In Spain, another leading wine-producing country, after identifying the 101 wineries in Aragón and the 591 in La Rioja, a research was carried out to find out whether or not they had a website on the Internet. The research showed that 37.4% of the wineries analysed had a website. More than 70% of the pages reviewed are purely informative. In other words, they only use their websites to provide basic information about their products or business without trying to establish a relationship with the customer or to develop complementary businesses such as wine tourism. Finally, the presence of a small group of websites, less than 10%, which are clearly oriented towards the online sale of their products but without making any attempt to maintain relations with their customers or to offer them additional services (Mercedes Marzo-Navarro, Marta Pedraja-Iglesias, Lucia Vinzón, 2021).

It is therefore clear that it is not enough to have an e-commerce platform, but it is necessary to know how to use it according to the attitude and type of experience the wine consumer wants to have. Otherwise, it can be obsolete to have a digital channel. In wine and commerce, it is essential to execute a series of effective operations that require interactions between sellers and consumers/buyers that can only result from integrating the sales activity into a continuum of processes, considering information mapping, learning, searching, finding, comparing, choosing, and so on, in a global service flow (Bodini & Zanoli, 2011; Xu, Munson, & Zeng, 2017). It is common to identify cases of lack of strategic approach in digital channels where websites have not visibility and/or attractiveness given an adequate wine quality (Capitello, Agnoli, Begalli, & Codurri, 2014). Clearly, a famous wine (or a famous winery) is a huge attraction for a wine consumer/purchaser, however, a famous wine or winery is not sufficient to transform digital platforms into a successful wine-e-commerce site (Carpio & Lange, 2015; Pelet et al., 2018; Faraoni et al., 2018). Just as in the case of Spain, which we have mentioned above, one of the highest risks and common mistakes of wine e-commerce is the underestimation of experience as a system of activities, which are in turn an holistic sum of services which can be considered as outputs (wine assortment, information quality, purchase convenience, logistics flexibility, etc.) or processes (the integrated services of the global electronic environment). In conclusion, wine e-commerce is obviously a commercial activity (such as wine shops, supermarkets, and so on) but, moreover, its fundamentals go beyond the logic of a tool for selling the product, e-commerce is based on the

concept e-service and, consequently, immateriality, intellectuality, and knowledge (Allee, 2000).

Beyond the fact that ICT for wine producers is not as simple as it seems in terms of image and success strategies, it is also necessary to understand who is best equipped in the field.

In the field of technological innovation, the gap between large and medium-small businesses is still remarkable, as in the food industry SMEs was able to approach the “virtual” markets only after 2000s (Giustiniano, Fraticchi, 2002). Twenty years later, this gap has not been totally filled, because recent studies demonstrated that many important Italian wineries focused on e-commerce with a remarkable delay compared to companies in other sectors (Festa, Cuomo, Metallo, 2019). The limitations of economic, human and time resources mean that SMEs are putting e-commerce on the back burner and prioritising not innovation but their traditional forms of business.

### **3 The empirical evidence**

How much e-commerce has contributed to Italian wineries during the pandemic? Which player has been able to use it the most? We questioned whether the digital sales channel was able to deliver the same financial results as a normalised business scenario, although during our initial research we quickly realised that the answer was negative due to a number of inevitable ICT hurdles. The real question is: during Covid-19 has it been understood how e-commerce can be an added value for wineries? Despite the losses recorded, what has been the contribution of the digital channel on the results? What can e-commerce offer a company outside of sales?

It would seem that the lockdown has awakened the attention of SMEs Italian wineries as they have had to adapt to the needs of the moment and turn to another type of purchaser. In a study conducted by Trebicchieri, a business magazine in the Gamberorosso guide, it appears that in an interview with Roberto Bortolussi, founder of the Wine Marketing Italia community, the strategy for Italian wine companies has changed radically in just a few weeks. With exports and the “ho.Re.Ca” channel totally cancelled, companies have started to turn their attention to private individuals and, in particular, beginning to exploit social channels. In times of lockdown, smartphone use has skyrocketed, it has tripled. Wineries have done everything they can to make themselves known, from virtual

tastings to stories and posts on social media such as Instagram and Facebook. *"You have to tell your story. And especially for the small ones, it is important to put your face out there. Which means dedicating a little time each day to this activity, but with the awareness that, instead of reaching just one person met on the street (in the days when you could go out, ed.), in this way you can reach 10, 100, 1,000, 100,000 recipients all at once, directly from home,"* says Roberto Bortolussi. The director reveals how sales in his community tripled in just a few weeks after the lockdown, stating how incredible advantages are being recognised for many players, opening new doors and possibilities in the future for the Italian wine business. Through the digital sales channels many Italian SMEs were able to sell in one day a volume of bottles worth between 1,000 and 5,000 euros during the pandemic (TreBicchieri, 2020). The results are also cost-effective by offering companies a higher gross margin due to transport costs abroad and through other distribution channels.

The case of the Cinque Quinti winery in Cella del Monte, a very small business that has been active since 2015 and is run by five brothers, is proof of innovation and a reversal of the trend. This little reality represents an annual production of 22 thousand bottles that, before the emergency were mainly destined for the company's point of sale and "ho.Re.Ca" and reaching peaks of in-store sales equivalent to 100 bottles a day. The winery's channels had suddenly gone to zero but the company immediately turned to e-commerce where they had been present since 2017 but without much success. Great results have just been seen by understanding what are the necessary strategies of interaction and online communication with customers, offering a package "Wine-Box" at Easter, a pre-packaged box designed to introduce the different products and guide the customer in a real tasting with the aim of providing a repeatable experience for the consumer and bringing them closer to the company during the pandemic through digital channels. The e-commerce in the next 3 weeks has seen a growth of 5 times compared to the previous months. One of the owner of the winery recognised that future will probably go in this direction: less handshaking, more online communication. Another case is that of Cantine Rossella (220,000 bottles per year), whose debut in the world of online sales was a record: 3,000 bottles of Gutturino 2018 and the house's Ventesimato in just six hours (TreBicchieri, 2020).

Nowadays, an extraordinary situation such as the one we have experienced in recent months has changed the vision of many companies, opening their eyes to other fronts and new opportunities. Italian wine has recognised e-commerce as a

factor that can bring many advantages, not only in terms of new markets and turnover, but also in terms of costs, images and networking. Perhaps some Italian exceptions had already realised the potential; according to some researchers several Italian family-run wineries have already been using social media for a few years now, recognising the advantages there can be in terms of communication strategies and going beyond the concept of sales (Iaia, Scorrano, Fait, Cavallo, 2017). To date, the message has certainly been received by all.

Italy has been for year leader in the winery market in terms of production (volume and value creation), export and consume and the international wine market is, however, highly competitive, with emerging countries, such as Chile, South Africa and Argentina gaining increasing market shares (Morrison, Rabellotti, 2017). The challenge for the future supremacy of actual leaders' market is, therefore, ICT innovation, both for big companies and for SMEs.

To conclude our analysis, we apply a descriptive statistic, that takes into account the main economic and financial ratios of 18 Italian wineries in the periods before and after Covid-19, demonstrating that the pandemic was a hard blow to the wine sector. The results were obviously not as hoped for, but resilience was demonstrated thanks also to the use of new technologies that provided opportunities for reflection: advertising, network marketing, reduction of activity costs, and entry into a new profitable market. Italy's wine industry in lockdown has seen the new future.

In particular, to test the aforementioned hypotheses, we selected a sample of 18 larger Italian wineries.

The tool we used for the sampling was the Bureau Van Dijk database "AIDA". We chose The ATECO codes 110210 "Wine production".

We did not include in the sample the discarded companies because of the unavailability of 2020 balance sheet.

The companies selected have a revenue range from about euro 227 million to about euro 31 million.

For each company we collected the following data, using "AIDA":

- availability of financial statements at a date between December 31st 2018 and 31 December 2020;
- total revenues in the last available year and in previous 2 years;
- net profit in the last available year and in the previous 2 years;
- R.O.I. and R.O.S. in the last available year and in the previous 2 years.



Finally, we examined the web site of each company, and – if available – the Instagram page and the Facebook page and we observed the following information:

- possibility to buy via e-commerce;
- existence of on-line platforms used to sell wines.

We observed that almost all the companies are now experiencing on-line sales, both by e-commerce in their own web site and by Internet platforms, dedicated to wines (Vinicum, Drinks and Co., Callmewine, Diemme Vini, Tannico, Wineexpress, Vineria 43, Costaross, Zoona) or generally employed for on-line shopping (Amazon and Ebay). Only few companies don't use e-commerce.

We also observed that the biggest companies, using e-commerce, have experienced in 2020 an increase in revenues, demonstrating that the negative effects caused by pandemic in the tourism sector, can be balanced by the positive effects of on-line activities.

#### **4 Conclusions and implications for future research**

The current study contributes to emphasize the literature debate on the use of on-line commerce to improve the sales of wineries in pandemic times.

We believe the current study can open the way for new lines of research, concerning the financial and economic consequences of the e-commerce phenomenon.

The current research also presents numerous limitations. The sample is quite small and includes just companies whose 2020 balance sheet was available on AIDA. The sampling number of the companies is too small to give statistically significant results. The eventual multicollinearity between variables has not been detected.

We are confident this study represents a first step to develop studies about sectors in which Italy can confirm its excellence and, over all, to seize the opportunities that new technologies offer without underestimating the risks that they may hide.

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## **The Impact of Responsible Research on Innovation Networks in Additive Manufacturing: an Agent-Based Model**

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### **Abstract**

In recent years, the European Commission (EC) has emphasized inclusive and sustainable governance policies, to offer solutions to the problems that arise in the relationship between science and society. With Horizon 2020's and transversal programs like the Science with and for Society (SwafS) a new approach to research and innovation is born: Responsible Research and Innovation (RRI).

One of the most critical challenges of the SwafS is "modeling and better understanding the dynamics of complex networks of innovation value chains and the openings they provide for RRI." The I AM RRI project responds to this call. In this paper we present an agent-based model in which innovation networks in the context of Additive Manufacturing are

created, evolve, and interact to spread RRI knowledge and practices throughout the system. Agents are characterized by specific knowledge domains, depending on the industry sector in which they operate, and seek to participate in innovation networks to define better or support an innovative idea. Moreover, their decisions are not only economic-based but are constrained by aspects of RRI. In our model three RRI keys identified by the EC are implemented in the model: public engagement, open access, and ethical thinking.

An initial set of experiments and analysis will be presented here to analyze the impact of agents' RRI knowledge and inclinations on their interactions and the economic, strategic, and social performance of the whole innovation system.

**Keywords** – Responsible Research and Innovation, Innovation Value Chains, Complexity, Agent-Based Modelling, Additive Manufacturing

**Paper type** – Academic Research Paper

## 1 Introduction

The impressive progress in scientific research and innovation has led to an intensification of ethical, legal, and social issues concerning science and society's relationship. With the Horizon 2020 (European Commission, 2014a), the European Commission (EC) aims to spread a new approach that anticipates and assesses the potential implications and societal expectations of inclusive and sustainable design of research and innovation — Responsible Research and Innovation (RRI) (European Commission, 2012). RRI is the crucial action of the Horizon 2020 transversal program "Science with and for Society" (SwafS) (European Commission, 2020).

One of the most critical challenges of the SwafS program is "modeling and better understanding the dynamics of complex networks of innovation value chains and the openings they provide for RRI." Currently, the I AM RRI project – Webs of Innovation Value Chains of Additive Manufacturing under Consideration of RRI – responds to this call. Central in the I AM RRI project is developing a dynamic model to simulate and visualize the behavior of complex webs under various conditions. Such models can help researchers and practitioners grasp RRI practices' importance and provide evidence that can favor the adoption and dissemination of good practices, even promoting institutional change in Research Funding (RFO) and Research Performing Organizations (RPO).

In the recent years the concept of Responsible Innovation, which later officially became RRI, has become very popular in Europe (and beyond); this is also due to

the Horizon 2020 project's impetus, for which RRI is an essential theme. The Rome Declaration on RRI provides a precise definition: RRI is an "on-going process of aligning research and innovation with the values, needs and expectations of society" (European Commission, 2014b, p. 1).

Although there are still disagreements between academia and administration on the definition of RRI (Gianni, 2021), it seems clear that among the purposes of RRI practices, societal involvement plays an essential role (Gianni, 2021; Owen et al., 2012; Von Schomberg, 2013). Heterogeneity of stakeholders (understood as the presence of different points of view) is a critical feature in innovative adaptive processes (Stirling, 2007) to make good decisions (Stahl, 2013) and to ensure richer discussion (Flipse et al., 2013). Thus, an innovative project guided by RRI principles must be characterized by more significant heterogeneity of the working group. Kupper et al. (2015) translate this concept by formulating the process requirement of diversity and inclusion, measured in our model through the variable named heterogeneity.

In particular, in this paper we present an agent-based model called I AM RRI that simulates the creation, the evolution, and the interactions of innovation networks in Additive Manufacturing, highlighting diffusion of knowledge and RRI practices. The developed agent-based model starts from the existing agent-based model SKIN - Simulating Knowledge Dynamics in Innovation Networks - (Gilbert et al., 2007; Pyka et al., 2007) and enriches it with new elements and extensions. Our model is "double-industry" meaning that agents can belong to the Automotive Industry, the Biomedical applications industry, or both (this is the case of "broker" agents, able to be involved in Innovation Value Chains in both industries).

Agents' inclination to ethical and societal values is modeled through three endogenous variables representing three fundamental thematic areas in RRI identified by the European Commission (2012): public engagement, open-access, ethical thinking. These RRI characteristics influence agents' decisions, the IVCs' performance in which they participate, and their way of interacting with the environment and other actors. Furthermore, the model considers different types of actors (AM technology company, Supplier, Customer, Research Institution, OEM) assessed by Regulators and Standard Organizations according to RRI values and quality of innovation proposed. Each type of agent is characterized by a peculiar knowledge domain, from which it develops a fuzzy idea of innovation. Through cooperation and learning, an idea can be defined, developed, and

improved. Since the I AM RRI model aims to be a dynamic model we implemented the Innovation Value Chains (IVCs) and its evolution through different phases (Idea Generation and Product Development) each of them with a different duration and "final gate" stage.

The goal of the proposed model is twofold: strengthen the knowledge base for policy orientation in research and innovation and supporting the identification of strategic guidelines for policymakers and funding organizations able to manage innovation network dynamics and the implementation/diffusion of RRI principles. Some virtual experiments and their analysis and implications will be presented to analyze the impact of knowledge and RRI inclinations of agents on their interactions and the economic, strategic, and societal performances of the entire innovation system.

## **2 Methodology**

According to the literature about the development of computational models (Burton, 2004; Gilbert, 2007; Louie & Carley, 2008; Moss, 2008; Richiardi et al., 2006; Sargent, 2005), the methodology used to build up the I AM RRI SKIN ABM can be articulated in five main steps as depicted in Figure 1.

In the first step, the insights coming from the theoretical background analyzed in the preliminary phase of the I AM RRI project (not addressed in this paper) were translated into a conceptual model, reported and described in various deliverables, some of which soon available on the project web page. Furthermore, the SKIN model and its extensions represent another essential source of helpful inspiration to develop the structure of our model.

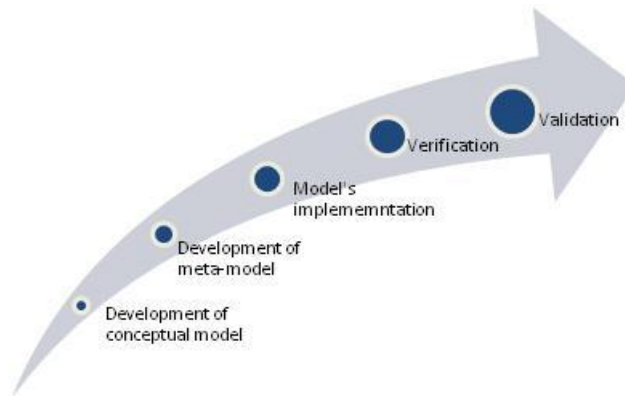
The second step, which regards the construction of the meta-model, helped us to define the building blocks of the ABM and a pseudo-code where micro-specifications of agents' behaviors are reported. In our case, the meta-model specifies the classes of agents, the rules of action and interactions among them, and the variables to be considered in future model simulations. Our meta-model has been developed starting from the conceptualization of the SKIN model. Still, it has been enriched by a new interpretation of the original building blocks and by new features devoted to increasing the representativeness of the model concerning the system under investigation.

The meta-model implementation requires the choice of an adequate software platform and the activity of code writing. The current version of the model,



described here, has been implemented using NetLogo 6.1.1. The implemented model was subjected to an internal analysis to verify consistency with the conceptual model and meta-model (step 4); the methodology, experiments, and results of the validation phase are described in detail in the following Section 4.

Currently, the model is at the beginning of the Validation phase, comparing the model's behavior to evidence in the literature. The project's future developments will deepen this last phase, using empirical data provided by the project's industrial partners.



*Figure 1 The methodology used to develop the AB model.*

### **3 The Agents During Simulation**

The model developed, coded in NetLogo using an ABM approach, originated as an extension of the already existing SKIN model (Ahrweiler, 2017; Gilbert et al., 2001, 2007; Pyka et al., 2007), and it is mainly focused on the study of IVCs, webs of IVCs and especially their openings for RRI. Additive Manufacturing was the basis for developing the model, given the characteristics of its innovation system, prone to the creation of webs of IVCs, and different from other traditional industries. Additive Manufacturing is also an industry that has only recently started to evolve; following innovative approaches to manufacturing, it is already valued at more than \$11 billion and growing (Wohlers Associates, 2020). However, the model is easily adaptable to other types of industries.

The I AM RRI SKIN model incorporates complexity, covering various stages of the IVC life, mainly: Idea Generation and Product Development. The development of the innovation process goes through phases in which the Capabilities (large

domains of knowledge), and the Abilities (applications in these domains) needed for an idea to be further developed, are not well defined. Therefore, cooperation among Agents and the creation of networks of IVCs is essential.

Moreover, unlike SKIN, from which I AM RRI SKIN derives, the innovation process develops through different ticks (simulation time unit), and is not obtained just in one model running cycle. Each IVC phase covers a defined number of running cycles, expressed as a result of the study conducted into the I AM RRI project.

The implemented IVC phases are, as mentioned above, mainly two:

- Idea generation (3 ticks);
- Product development (12 ticks).

This choice derives from the study of use-cases provided by partners of the I AM RRI project (reported in the Acknowledgments below) operating in the AM Automotive or Biomedical industry that ensure realism to the model. The main time-related assumption made by the project is that 1 tick equals 1 month. Additionally, as the main difference, in the I AM RRI SKIN, the agents' decisions and behaviors are not only price-related and cost-related, but time-related and especially RRI-related.

Each agent is equipped with three RRI state variables representing RRI inclinations that are translated into the model in the following three keys:

- Open Access;
- Public Engagement;
- Ethical Thinking.

These keys profoundly influence the decision-making process.

Other relatively minor extensions have been introduced to adapt the I AM RRI SKIN model to Automotive and Biomedical use-cases. A double-industry model has been built, in which six different types of Agents' breeds - particular typologies of Agent Set endowed with particular variables - interact between them also participating in more networks simultaneously. This implies that the agents in the model can belong to the Automotive industry, Biomedical applications industry, or both (this is the case of 'broker' agents, able to be involved in IVCs in both industries). The inter-relationships among the two Industries are assured by 'broker' agents and by the fact that agents in the I AM RRI SKIN model can belong to more than one network simultaneously. Identifying different types of agents, such as the duration of IVCs phases, comes from the

analysis of use-cases provided by partners of the AM RRI that cover two specializations of the AM Industry: Automotive & Biomedical.

The six types of agents' classes (breeds) are:

- AM-techs;
- Suppliers;
- Customers;
- OEMs;
- Research-institutions;
- Networks.

Other agents like the Funding Organisations, Regulators, and the Standard Organisations are modeled in terms of aggregated entities - in the current version of the model, Funding Organisations and Standard Organisations are modeled as environmental-global variables.

### **3.1 Idea Generation**

In the Idea Generation phase, the interaction mechanisms aim to create and improve an innovation idea. The start-project agents are the protagonists of this phase, searching for potential partners looking at prior experience and adequate agents' capabilities. A start-project initiates an IVC or a network since he does not possess all the capabilities needed to develop the Innovation Hypothesis (IH), and some of them are also unknown; therefore, the IH in this first phase has a fuzzy and undefined character.

Agents advertise their Capabilities through an advertisement so that the start-project agent can identify the best potential partners but preferring those of other breeds.

Therefore, the intersection of focal agent advertisement (who starts the project) and potential partner capabilities is assessed.

Other fundamental variables to be considered when searching for partners are their RRI inclinations; the weighted average of RRI values of each agent is a sort of signal considered in the search for suitable partners. The hypothesis at the basis of this computational choice depends on the evidence that a potential partner with high RRI values will be more visible to other agents and the focal.

Once the minimum number of partners has been reached, the start-project agent (also named "focal") can create an IVC/network by incurring a cost for the fine-tuning of the IH and the search for partners, while the participants will have

to pay a share of contributions to constitute the common fund (investment-capital). At this point, the RRI values of each member can be assessed and then averaged. This average is used to model the RRI value of the network agent and will be necessary for subsequent mechanisms of interaction with partners and exogenous agents. Members of a collective organization must have ethical values that conform to the collective values, so a diffusion and updating mechanism of RRI values among network participants is triggered, accounting for inertia to change.

The greater the distance between one's own RRI values and those of the network, the lower the RRI increment and the willingness to conform to the collective values. The agents of the I AM RRI model can be involved in more than one innovative network at the same time; therefore, following the literature (Sarkar et al., 2001), they must take into account all the projects in which they are involved (especially those with ethical values similar to their own) and not only the projects with higher RRI values. This aspect avoids the creation of a "cultural bias."

Finally, network members with sufficient economic resources can learn new knowledge from other partners through a learning and knowledge dissemination mechanism.

The intersection between the two phases represents a filter for networks that do not possess the regulatory bodies' ethical characteristics (ethical thinking). Networks that meet these constraints can access additional financial resources made available by funding bodies. The requirements of these funding bodies relate to the technical quality required by the IH and the RRI inclination.

Networks that do not achieve the level of ethical thinking mandated by regulatory bodies dissolve: network members terminate internal partnerships but keep their memory; the network agent disappears from the simulation environment.

### **3.2 Product Development**

Networks that pass the first next-gate can begin the Product Development phase, which lasts a minimum of 12 ticks.

At the beginning of this phase, networks may lose members who do not have sufficient financial resources to support the promotion cost of the RRI innovation idea. A member could also parasitically exploit the resources provided by the

network. Therefore, the more network resources available to support RRI values, the less effort required of members.

Agents may decide to publish in open access at this stage, taking into account their financial resources and inclination to open access. Each open access publication has a cost that reduces the financial resources of the agent. Once these thresholds are met, an element of randomness also intervenes, representing the various aspects of uncertainty associated with the process. This element of uncertainty is modeled through a Bernoullian variable with parameter  $p$  equal to the open-access value of the agent.

At the end of the Product Development phase, the mechanism of diffusion and updating of RRI values among network members is triggered and downstream of experiential learning, updating of expertise (taken from SKIN).

At the end of the second phase, the networks face the second gate. At this simulation point, the networks and their innovation ideas are evaluated by Regulators and Standardization Organizations. The former still evaluate the ethical thinking orientation of the networks, the latter evaluate the qualitative specifications of the innovation idea.

Networks with positive feedback during the gate-next-phase-3 evaluation can create RRI-focused start-ups that operate in the market or, alternatively, dissolve.

### **3.2 Learning and Outputs**

During the simulation, agents who have not been involved in any network try to increase their attractiveness by acquiring new knowledge through incremental search. As a result of financial availability, a new Capability is added to their Kene, representing the agent's knowledge base.

The Capabilities sought in this phase are part of the set of knowledge that characterizes the agent's typology (called "breed" in NetLogo language). When activated by the agent, the incremental research lasts three ticks, and after a new Capability has been acquired, the agent makes an advert to try to be selected by a focal agent. If not selected again, a new research session could be initiated according to the availability of financial resources.

The outputs are divided into three macro-areas of impact: social, economic, and strategic.

The system's economic performance is analyzed through the continuous evaluation of the average capital of the agents constituting the system and at the end of the simulation.

The strategic performance is evaluated through several indicators:

- The number of start-ups created;
- The average size of the networks;
- The number of agents involved in the networks or the percentage of agents involved;
- The percentage of surviving agents for each phase.

The result in social terms is estimated through a graph that expresses the time trend of the average of RRI values.

Another proxy for the analysis of simulation outputs is the number of open access publications made during the simulation. Obviously, at each time point in the simulation, the number of networks/IVCs relative to each phase and the total number of networks is provided.

#### **4 Experimental Design and Results**

Validation is the process of determining how well the implemented model corresponds to reality. Validation has always played an essential role in modeling issues (Conway et al., 1959), especially concerning computational models (Carley, 1996; Garcia et al., 2007). We could say that the biggest problem related to Validation is that there is no universally accepted approach. In the literature, there are many Validation techniques and the principles on which they are based, so it would be too expensive to use all the possible techniques (Xiang et al., 2005).

There are different validation levels depend on the availability of data, model, and research purpose. As suggested by Carley (1996), illustrative-theoretical models usually require a reduced level of Validation, while case-based models are more demanding in terms of validation because such models are used to give practical advice on some specific aspects.

Different levels of Validation identified by Carley are:

- Face validity;
- Parameter validity;
- Pattern validity;
- Process validity;
- Point validity;

- Distribution validity;
- Value validity.

The first four levels are more related to theoretical or illustrative models while others are more concerned with emulative models of reality. The I AM RRI SKIN model is not a purely theoretical (illustrative) model, but it is not a case-based model. Consequently, we expect to reach, an intermediate level of Validation.

Additionally, some data on Additive Manufacturing in the European market are available, thanks to the presence of industrial partners in the I AM RRI project; however, these data have not been processed sufficiently to be used for a process as complex as Validation. For this reason, we confirm at this stage our choice to only reach a low-intermediate level of Validation. Following the indications of Sargent (2005) and Law et al.(1996), there are different ways of to reach the intermediate levels of rigor approximating the Validation. In this paper, we focus primarily on the correspondence between existing RRI literature and the I AM RRI SKIN model's emerging behaviours.

Below, we report on two experiments whose results may have implications for the understanding and guidance of RRI practices, both at the managerial and governance levels. In addition to the experiments reported, further experiments necessary for Validation and internal Verification were conducted to ensure greater rigor to the model.

Finding a correspondence in the literature on how RRI practices impact innovations is not an easy task since "the impact appears to be elusive and difficult to measure" (Pansera et al., 2020, p. 402). In fact, "the RRI cannot be used as an evaluation tool since it does not have the material metrics to measure how responsible or positive or negative the impacts of innovation are but is a normative framework designed to influence the process of innovation" (Postal et al., 2020, p. 15). Thus, we can say that the RRI intervenes in the innovation process as a whole and indirectly on that process's product.

As Gonzales-Gemio et al. (2020) suggested, the performance of organizations that adopt RRI practices has benefits that can be seen in the long run, such as the acquisition of new knowledge. Another aspect reported in the literature is that RRI practices ensure greater inclusiveness and heterogeneity of working groups (Fitjar et al., 2019; Kupper et al., 2015; Van den Hoven, 2013) to reach better decisions (Stahl, 2013) and to ensure richer discussion (Flipse et al., 2013).

We can conclude that the introduction of RRI practices influences the innovation process and the actors involved in two ways:

1. Increased heterogeneity of actors involved in the innovation projects;
2. Increased knowledge base.

Having identified the impact of adopting RRI practices in innovation processes through the literature review, two experiments were conducted to validate the correspondence between the arguments reported in the literature and the I AM RRI SKIN model's behaviour. We ask then, "*if agents give more importance to RRI practices, select their partners considering RRI principles, will we observe an increase in the heterogeneity of actors involved in networks? Will the knowledge base also increase at the end of the simulation?*" The variable of interest is the threshold of the attractiveness of partners based on RRI values (RRI-attractiveness), while the output inserted are:

- *Average Heterogeneity of Networks*, where Network Heterogeneity is measured as the ratio of the number of different breeds within the Network to the total number of members.

$$Heterogeneity = \frac{\sum_{breed \in Network} breed}{number\ of\ partners} \quad (1)$$

- *Average Knowledge of Agent*. Starting from the Kene, the knowledge ( $k_i$ ) of the agent  $i$ , the average knowledge was modelled considering the length of the Capabilities vector. We could not use the expression for knowledge of the  $i$ -th agent used by Ahrweiler et al. (Ahrweiler et al., 2011, p. 227):

$$k_i = \sqrt{\sum_{j \in \{C\}_i} A_{ij} E_{ij}} \quad (2)$$

To be more explicit, in I AM RRI SKIN, Ability 6 is not "better" than Ability 3: we cannot use Abilities as a factor in a product that quantifies knowledge. Indeed, in the I AM RRI SKIN model the Abilities of the agents do not belong to an ordinal scale but represent the label of the capability in the broader knowledge domain. Thus, the knowledge of the  $i$ -th agent is represented by the number of Capabilities possessed by the agent. Finally, the Average Knowledge of the Agents participating in an innovative project can be represented as:

$$\bar{k} = \frac{1}{nFirms} \sum_{i \in \{partnering\ Firms\}} k_i \quad (3)$$



#### 4.1 Experiment 1

As mentioned, we use RRI-attractiveness as the input variable; all other independent variables were considered control variables and reported in Table 1.

**Table 1.** Control Variables Experiment 1

Numbers of Agents [value]		Firm's Variable [value]		Environmental Variable [value]	
nAM-tech	[200]	Attractiveness-threshold	[0.5]	Standard Organization	[5]
nSupplier	[200]	RRI-start-up-trigger	[0.5]	Funding	[50]
nResearch-inst.	[200]			Funding-RRI	[0.5]
		<i>Publish-open-access</i>		Funding-quality	[5]
nOEM	[200]	Economic-threshold	[50]	RRI-cost	[30]
nCustomer	[200]	RRI-open-access-thres.	[0.5]	Big-firm-percent	[10]
				Regulator	[0.5]

The input variable RRI-attractiveness, which expresses the weight given to RRI values in the partner selection process, has been divided into three ranges: low [0 0.3], medium [0.4 0.6], and high [0.7 1]. The value 1 indicates that the partner selection process is based exclusively on the compatibility of RRI values, while a value of 0 indicates that the selection of partners is based exclusively on the complementarity of the knowledge base.

The combination of variables used to design the experiments is systematized in Table 2.

Table 2. Experiment 1

Control Variables	Run	ticks	Input	output
See Table 1	300	30	RRI-attractiveness [0.2 0.5 0.8]	Average Heterogeneity of Networks

To investigate the issues outlined above, we first used some descriptive statistics concerning the average heterogeneity of the networks when varying the RRI-attractiveness factor. The results reported in Table 3 refer to the 30-th tick of the simulation. For each level of RRI-attractiveness [0.2, 0.5, 0.8], 300 runs were performed.

Table 3. Descriptive Statistics Experiment 1

Descriptive Statistics								
RRI-attractiveness	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
0.2	300	0.6553	0.02982	0.00172	0.6519	0.6587	0.57	0.74
0.5	300	0.6758	0.03027	0.00175	0.6724	0.6793	0.57	0.76
0.8	300	0.6909	0.03017	0.00174	0.6875	0.6944	0.60	0.77
Total	900	0.6740	0.03342	0.00111	0.6718	0.6762	0.57	0.77

The current literature search shows that an increase in the diffusion and importance given to RRI practices corresponds to an increase in heterogeneity within innovation systems. The I AM RRI SKIN model behaves as expected from the literature (Fitjar et al., 2019; Kupper et al., 2015; Van den Hoven, 2013). However, to assess a significant effect of the RRI-attractiveness factor on the dependent variable heterogeneity, a *One-way* ANOVA was used, the results of which are summarised in Table 4.

Table 4. Results of ANOVA for Experiment 1

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
<b>Between Groups</b>	.192	2	.096	106.027	0.000 <sup>*</sup>
<b>Within Groups</b>	.812	897	.001		
<b>Total</b>	1.004	899			

As shown from Table 4, we can reject the null hypothesis  $H_0$  accepting a risk first kind  $\alpha=0.05$ . Thus, we can consider the influence of the RRI-attractiveness factor on network heterogeneity as significant.

In order to further deepen the analysis, Post-hoc tests (Tukey's HSD) were performed following the significance of the ANOVA, whose results are reported in Table 5.

Table 5. HSD Experiment 1

	(I) RRI attractive ness	(J) RRI attractiv eness	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
<b>Tukey HSD</b>	0.2	0.5	-0.02053 <sup>*</sup>	0.0024	0.000	-0.0263	-0.0148
		0.8	-0.03563 <sup>*</sup>	0.0024	0.000	-0.0414	-0.0299
	0.5	0.2	0.02053 <sup>*</sup>	0.0024	0.000	0.0148	0.0263
		0.8	-0.01510 <sup>*</sup>	0.0024	0.000	-0.0209	-0.0093
	0.8	0.2	0.03563 <sup>*</sup>	0.0024	0.000	0.0299	0.0414
		0.5	0.01510 <sup>*</sup>	0.0024	0.000	0.0093	0.0209

\* The mean difference is significant at the 0.05 level.

These tests, performed two by two, offer us experimental evidence that the averages' difference is statistically significant. Therefore, observing that all three levels of RRI-attractiveness produce statistically significant effects, we can consider that this first subdivision into three ranges (low, medium, high) is acceptable.

#### 4.1 Experiment 2

The second experiment investigates the effect of a policy of selection of partners focused on the respect of RRI values, so the input variable remains the RRI-attractiveness. We try to establish whether an increase in this variable leads to an increase in the system's knowledge base. In this case, the variable of output is the Average Knowledge of the Agents described previously. Control variables are the same as in Experiment 1 (Table 1).

Again, the input variable RRI-attractiveness, which expresses the weight given to RRI values in the partner selection process, has been divided into three ranges: low [0 0.3], medium [0.4 0.6], and high [0.7 1]. The combination of variables used to design experiment 2 is systematized in Table 6.

Table 6. Experiment 2

Control Variables	Run	ticks	input	output
See Table 1	300	30	RRI-attractiveness [0.2 0.5 0.8]	Average Knowledge of the Agents

As mentioned, the existing literature indicates that an increase in RRI practices should increase agents' knowledge base. To test this hypothesis, a One-way ANOVA was used, setting the parameters as described above. As can be seen from the following Table 7, there is no experimental evidence to suggest that the effect of RRI-attractiveness input on agents' knowledge is significant.

Table 7. Results of ANOVA Experiment 2

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
<b>Between Groups</b>	0.006	2	0.003	1.448	0.236
<b>Within Groups</b>	1.754	897	0.002		
<b>Total</b>	1.760	899			

At this point, the investigation did not stop. First, the code was modified so that the advertisements were formed only by the IH's Capabilities, as in SKIN (Pyka et al., 2007). This modifies the mechanism of partner selection and learning. However, even in this case, the ANOVA was not significant.

## 5 Conclusions

The proposed model focuses on RRI practices in the decision-making processes of various types of organizations by expanding the understanding of complex research and innovation networks.

I AM RRI SKIN constitutes a first attempt to create an auxiliary tool for institutional bodies and policymakers, assisting them in defining strategic guidelines for disseminating and encouraging RRI best practices. By modifying some model parameters, it is possible to investigate the impact of incentives on RRI practices and innovative performance regulation. Although the conceptual model is inspired by some use-cases provided by partners of the I AM RRI project operating in the AM Automotive or Biomedical industry, it is possible to set endogenous parameters adapting the simulation to different business and industrial contexts.

The validity of the proposed model has been tested through different simulation scenarios, the results of which demonstrate a correspondence between the I AM RRI SKIN artificial world and the existing RRI literature. Furthermore, the

proposed experiments demonstrate the model's use of the types of research questions that can be developed in the future and how to answer them.

The model offers an understanding of IVC networks and the potential of RRI practices and allows to simulate the processes of dissemination and knowledge creation. Based on some use-cases, the I AM RRI SKIN agents are characterized by well-defined knowledge domains found in the AM; however, in this way, the set of knowledge domains has limited numerosity that precludes the performance of exciting experiments. This aspect could be a limitation of the use-cases used, so it will be interesting to base future developments on different narratives and a deepening of those already available.

Finally, the link between RRI variables and the various components of the simulation environment will have to be further investigated using results from the literature and data produced by future workshops in the context of the I AM RRI project.

In this way, the RRI variables would depend more on the context and circumstances in which the organization operates, bringing the model even closer to empirical evidence. From this perspective, it would be interesting to reach the highest levels of the model validation process using empirical data to set the input parameters and compare the simulation results with the empirical evidence.

### **Supplementary Materials:**

The model code can be consulted and downloaded from Github at the following link: I AM RRI SKIN

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Eye-d - <https://www.eye-d.com/>

Lithoz - <https://www.lithoz.com/>

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## Knowledge Visualization and Emergency in the Complex Organizations

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### Abstract

Knowledge Visualisation (KV) is a discipline that focuses on the collaborative use of interactive graphics to create, integrate and apply knowledge, to support the decision-making process, particularly in emergency contexts during the practice of People Management. This study is of an exploratory and confirmatory nature and helps us to understand how the use of KV has been implemented in complex organisations like university through an empirical analysis. Based on literature review and case study, it has been possible to highlight the role of KV in supporting the decision-making process, even during the COVID-19 pandemic.

The decision-maker that is interviewed displayed an awareness of the potential and importance of KV, which has been shown by their use of different tools and bodies with functions related to it.

**Keywords** – Knowledge Visualisation, Emergency, People Management, Complex Organisations, Decision- making

**Paper type** –Practical Paper

## 1 Introduction

In recent years, the importance of exploiting and managing information and knowledge as a strategic resource for organisational growth and competitiveness has been recognised (Schiuma et al., 2012). Knowledge Visualisation is a very young research area that is increasing gaining attention because it examines the use of visual representations to improve knowledge management at all levels, including personal, interpersonal, team, organisational, inter-organisational and social. It focuses on creating images that can convey information about data (Henson and Johnson, 2005); in fact, the process of Knowledge Visualisation contains steps such as collection, interpretation, development of an understanding, organisation and planning. Through graphics, Knowledge Visualisation can transmit or apply knowledge, which includes methods and complex intuitions (Hornbæk, 2011). Many scholars have highlighted the importance of using diagrams, graphs, schemes, mind maps and social graphs captured in real-time (Berinato, 2016; Miah et al., 2017). Such visualisation tools can support management and evaluation knowledge within organisations by providing management means for translation, transfer, sharing, coding, creation and more general knowledge management for decision-making (Eppler, 2013). Visual representations of information and knowledge have been indicated as an essential dimension of modern knowledge management to support decision-making (Miah et al., 2017). Organisations have had to face the pandemic situation that is affecting the whole world, but Knowledge Visualisation could be seen as a support tool that the decision-maker can disseminate to manage the emergency. Hence, in this context, the decision-maker can use Knowledge Visualisation tools (images, maps, diagrams, etc.) to transform raw data and information into accessible forms of representations to extract information. On these premises, this research starts with an analysis of the literature about Knowledge Visualisation and its tools. It then focuses on the empirical analysis of a case study about the University of Catanzaro (Italy) as organisation that have strongly suffered the impact the virus. The aim of the research, with the help of interview university

decision-maker, is first to understand how Knowledge Visualisation is used in the context. Then, specifically, we want to understand, through the Knowledge Visualisation tools used, the impact of these tools on intra-organisational relations as an effect of the emergency.

## **2 Theoretical Framework**

### ***2.1 Knowledge Visualisation Tools***

The area of Knowledge Visualisation studies transferring knowledge through visualisation (Eppler & Burkhard, 2004; Cañas, 2005; Meyer, 2008; Yan, 2011). Eppler and Burkhard (2004) presented a widely accepted definition of knowledge visualisation, stating that it "is defined as a field that examines the use of visual representations to improve the creation and transfer of knowledge between at least two people. Knowledge visualisation thus designates all graphic means that can be used to construct and convey complex insights "(p.551). A corresponding field and predecessor of Knowledge Visualisation (KV) is Information Visualisation (IV), and both these fields are utilising our natural abilities to process visual representations successfully. This definition has allowed numerous scholars to discuss the difference between Knowledge Visualisation and Information Visualisation. The first forms of Information Visualisation were static or based on paper, such as a map or a drawing (Bertin, 1967; Tufte, 1997). However, the term Information Visualisation indicates "the use of interactive visual representations supported by the computer of abstract data to amplify cognition" (Card et al., 1999, p.2). Information Visualisation has the primary purpose of exploring large amounts of abstract data to gain new insights or make stored data more accessible. On the other hand, Knowledge Visualisation tends to improve the transfer and creation of knowledge between people by providing them with the means to express what they know. So, while Information Visualisation helps improve information retrieval, access and the presentation of large data sets, especially in the interaction between humans and computers, Knowledge Visualisation tends to increase knowledge-intensive communication between individuals, for example, by relating new insights to concepts already understood (Eppler et al., 2004). The primary goal of Knowledge Visualisation is to support knowledge creation and sharing processes. Burkhard (2005) compared Knowledge Management (KM) and Knowledge Visualisation and concluded that

both disciplines are intertwined in efforts towards knowledge creation and sharing. Knowledge Visualisation is classified as a component of KM, mainly because knowledge transfer is a key process in knowledge-intensive organisations (Burkhard, 2005). Burkhard proposed a model based on the intuition that knowledge cannot be directly transferred from one person to another. The recipients of the transferred knowledge must integrate it into their knowledge according to their individual background and experiences (Burkhard, 2005). According to Eppler (2013), Knowledge Visualisation refers to all graphic means that can be used to develop or mediate experiences, methods or skills. Starting with the first symbols, the visualisation tools have been designed to improve and enhance knowledge sharing and overcome the limits of time and space. Knowledge Visualisation encourages the creation and transfer of knowledge by providing users with an extended range of tools to express and share what they know. The Knowledge Visualisation framework includes all graphic means that can be used to build and convey complex insights. The transfer of visual knowledge is complex and challenging as the recipient's background can be distinguished. Visual formats need to be specific, but above all, they need to be consistent so that they can go beyond the details of any individual or group. To become knowledge, information must be processed, meaningful and integrated into the user's mental knowledge structure. In literature, Knowledge Visualisation tools are different; the most well-known ones are listed in table n°1.

Table n°1: Tools of Knowledge Visualisation

<b>Tools</b>	<b>Features</b>
Sketches	Simple drawings that help to visualise the key features and the main idea very quickly. They can be used in group reflections and communication processes as they make knowledge debatable. Additionally, they allow room for their own interpretations and thus stimulate creativity and keep the attention of a group fixed on the discussed object.
Diagrams	Schematic representations that are used to display, explore and explain relationships. They reduce complexity, make abstract concepts accessible and amplify cognition. Unlike sketches, they are precise and determined. Examples of the diagrams are bar-

	and pie charts, Gantt-, Fenn- or process diagrams.
Images	They represent reality but can also be artistic. They are able to address emotions and can inspire, motivate or energise the audience and thus are often used for advertisements (images are visual).
Objects	Amplify the effect of visual metaphors.
Knowledge Maps	Consist of two components: The context, which should be easy to understand for all users of the map, and project milestones are mapped within this context.
Concept Maps	Intended to represent meaningful relationships between concepts in the form of propositions
Interactive Visualisation	Computer-based interactive visualisations allow you to access, control, explore, combine and manipulate different types of complex data, information and knowledge. They also fascinate the recipients and enable interactive collaborations and thus help create new insights.

Source: Burkard, 2005; Eppler & Burkhard, 2007; Meyer, 2009

Knowledge Visualisation tools may include a sketch, diagram, map, images, physical model, an interactive visualisation (Meyer, 2008) and digitalisation may be helpful, too (Liao et al., 2012; Ursyn, 2015).

Starting with early symbols, visualisation tools have been designed to improve and enhance knowledge sharing and overcome limitations of time and space (Katuscakova et al., 2019).

To transfer and create knowledge efficiently, Burkhard (2005) proposes four types of perspectives (Figure n°1).

FUNCTION TYPE	KNOWLEDGE TYPE	RECIPIENT TYPE	VISUALIZATION TYPE
Coordination	Know-what	Individual	Sketch
Attention	Know-how	Group	Diagram
Recall	Know-why	Organization	Image
Motivation	Know-where	Network	Map
Elaboration	Know-who		Object
New Insight			Interactive Visualization
			Story

Figure n°1: The Knowledge Visualisation Framework  
Source: Our adaptation Burkhard, 2005 p. 251

The Function Perspective distinguishes six functions of visual representations that can be exploited. The functions of visualisations can be summarised as follows (Eppler & Burkhard, 2004): Coordination; Attention; Recall; Motivation; Elaboration; New Insights. The Knowledge Type Perspective aims to identify the type of knowledge that needs to be transferred. Five types of knowledge have been distinguished: Declarative knowledge (Know-what, e.g., facts); procedural knowledge (Know-how, e.g., processes); experimental knowledge (Know-why, e.g., causes); orientational knowledge (Know-where, e.g., knowledge sources); individual knowledge (Know-who, e.g., experts). The Recipient Type Perspective aims to identify the target group and the recipient's context, which can be an individual, a team, a whole organisation or a network of persons. Knowing the context and the recipient/audience's cognitive background is essential for finding the right visualisation method for the transfer of knowledge. The Visualisation Type Perspective structures the visualisation methods into seven main groups: sketches, diagrams, images, maps, objects, interactive visualisations, and stories (Burkhard, 2004). By using such a framework, organisations can optimise learning and improve the knowledge and skills of its employees.

### 3 Knowledge Visualisation in Emergency

The Knowledge Visualisation (KV) domain focuses on the collaborative use of interactive graphics to create, integrate, and apply knowledge (Hornbaek, 2011, p.6). Eppler (2008) highlighted the functional role of graphic representations for various knowledge management processes and that, in terms of future trends, KV will evolve with respect to new formats and new areas of application. The

emergency context in which we are currently living emphasises the use of different forms and the potential to combine various formats (such as diagrams, maps and metaphors) in a complementary way. That said, within the emergency management context, the use of knowledge visualisation significantly thematic, so that it can be used as a catalyst for creating, sharing, and transferring knowledge. Emergency management refers to the ability to deal with emergency tasks in all their phases and iterations, including mitigation, preparedness, response and recovery (see Figure n°2).

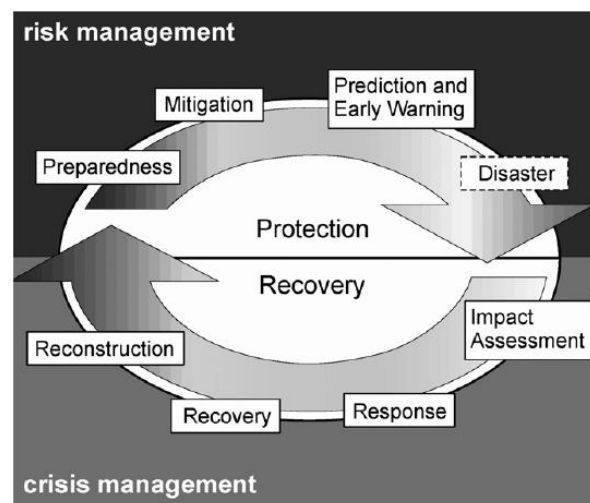


Figure n° 2: Disaster Management Cycle  
Source: National Drought Mitigation Center, University of Nebraska-Lincoln

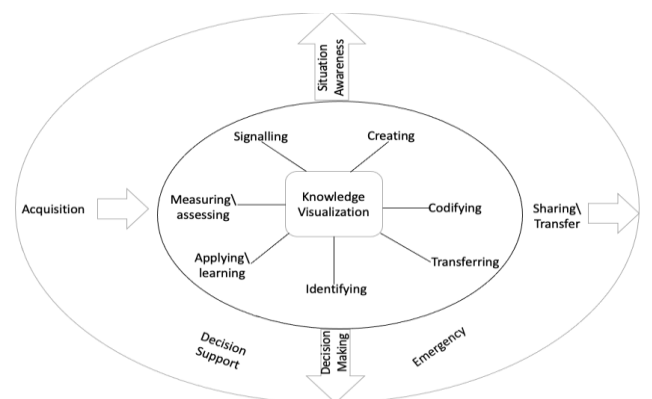
In the emergency era, the traditional ways to exchange and use knowledge among people are probably not sufficient anymore. To do this, each task requires many different types of information coming from several sources related to the emergency. Using mainly text and numbers instead of proper visualisations does not fit our knowledge society's requirements anymore (Burkhard, 2005) because they are complex and dynamic in nature. Such complexity is caused by the extensive, diverse and ever-changing factors involved in the problem, purpose, context and stakeholders. To be useful for the purpose, KV must satisfy different requirements:

1. It has to be able to capture and depict knowledge.
2. It has to relate these ideas to one another.

3. It has to be visual.
4. It has to support the process of knowledge integration among various people.
5. The visualisation has to be flexible, to be able to react to the changing of time.
6. It has to be communicable in the sense that the image can be communicated to others who have not been present during its creation process.

In Covid-19 era, the Organisation (WHO) has requested to take major steps to ensure safety, focusing indirectly on a decision-making process that is fast and appropriate—during and after the emergency.

Specifically, Burkhard (2005) tried to build a framework of KV, which should especially help decision-makers use and create visual representations of business processes. Despite improved awareness concerning the emergency, the emphasis on preparing for such emergencies is inadequate. This aspect is relevant because KV may reduce the cognitive load and enhance the processing abilities by visualising abstract relationships. To do this, they emphasise visual practices through the joint and iterative visualisation of facts, analysis, insights and experiences, and consequently improve the collaboration quality (Nicolini, 2007; White et al., 2007; Zhang, 2012). KV is a decision support system for decision-making in the emergency context. Emergency information is used to obtain situation awareness about a particular event, needs assessment and statistical analysis, while knowledge and experience are used to facilitate decision-making (Figure 3).



*Figure n° 3: The Use of Knowledge Visualisation*  
Source: our adaptation Zhang et al., 2002 and Eppler, 2007



### **3.1 Knowledge Visualisation and People Management**

KV has the potential to support knowledge transfer. The adoption of KV is much more than an effective means for strategists to provide structure to strategic problems because they facilitate knowledge creation and sharing (Kaplan, 2011).

The research reveals that this potential has been underused in the field of emergency management. Parry and Cowley (2015) identified critical aspects of KV how the decision problem. The decision management may involve relevant problem situations, physical surroundings, time, KV tasks and requirements and social and technological contexts.

During the decision-making process, decision-makers need to perceive the problem, gather relevant information, make the right judgment call and conduct a plan of action. In reality, the decision-makers encounter a variety of challenges, for example, how to gather relevant information in a timely and accurate manner, how to store, organise and manage the information efficiently so that the resources can be accessed and shared and how to reuse knowledge or experience to facilitate current decision making (Zhang et al., 2002).

The role of KV in supporting decision making (speed, appropriate, accuracy and completeness) has been considered in our research.

The decision-makers use of KV shows higher performance in terms of accuracy and decision speed (Lurie & Mason, 2007). Based on Eppler and Burkhard's (2007) study, Knowledge Visualisation is defined as the (collaborative) practice of graphically representing insights, experiences, gathered evidence and know-how to share knowledge, create new knowledge or apply knowledge to decision-making, problem-solving or planning. Visualisation shaping and presenting information in a more effective way facilitates better communication and supports sense-making (Al-Kassab, 2014).

The functions of KV in human resource management are: (1) coordination (coordinate the communication of workers); (2) attention (raise awareness and provide a focus for knowledge creation and transfer); (3) recall (improve memorability and thus foster the application of new knowledge); (4) motivation (energise human resources to engage in interpretation and explore the graphic); (5) elaboration (the process of visualising knowledge leads to further understanding and appreciation of concepts and ideas as one interacts with them); (6) new insights (knowledge visualisations can reveal previously hidden

connections and lead to sudden insights, experiences); (7) Furthermore, better the decision making and problem-solving. Diagrams, tables and maps are useful for representing precise and indexical information, both quantitatively and qualitatively, supporting decision-making by constraining the set of alternatives that one must consider during a decision-making activity and specifying paths and commonalities among different problem states within and information space (Parsons & Sedig, 2014). KV enables employees to re-construct, remember and apply insights gained through KV.

In this regard, KV may better aid the decision-making process by uncovering new insights that would otherwise have gone unnoticed from the analysis of datasets. Decision-makers need to be aware that KV can enhance knowledge processes and also bias them by constraining the attention to a limited set of alternatives, focusing the attention on the wrong variables or encouraging inaccurate comparisons (Al-Kassab, 2014).

KV investigates on the use of visualisation techniques to facilitate communication in knowledge-intense processes and to support the creation of new knowledge by using visual techniques in knowledge-intense processes and situations. It also explicates, shares or develops knowledge and supports the creation of visualisations for contents that constantly change, such as a process or complex project (Burkhard, 2006, p.4). The emerging field of KV examines the use of visual representations to improve knowledge management on all levels (personal, interpersonal, team, organisational, inter-organisational and societal). It designates all graphic means that can be used to construct, assess, measure, convey or apply knowledge (i.e., complex insights, experiences, methods, etc.). The decision-makers who employ Knowledge Visualisation aim to create, assess, reference or transfer insights, experiences, attitudes, values, expectations, perspectives, opinions and predictions, and they do this in a way that enables someone else to re-construct, remember, find or apply these insights correctly (Eppler, 2008). In addition, decision-makers often cannot rely on their own expertise alone. They need input from a wide spectrum of specialists and thus at times struggle to integrate knowledge from different sources and use it for idea generation, decision-making or planning. This factor is relevant because the visualisations may reduce the cognitive load and enhance the processing abilities by visualising abstract relationships. They allow us to externalise knowledge, for example, to share it with others or get an overview of the big picture of the field of interest (Tergan, 2006).

## 4 Methodology

The methodological approach implemented in this study is of a dual nature: exploratory and confirmatory. The exploratory nature aims to build the theoretical premises concerning knowledge visualisation, the use of knowledge visualisation in university and the operational and strategic capacity to support decision-making. This phase was not set up as a rigorous review of the literature but rather as a definition of a theoretical framework. Of a confirmatory nature, the second phase aims to understand the characteristics of the knowledge visualisation tools and practices in the case study. The case study identified in this study is public Italian University "Magna-Græcia" of Catanzaro (UMG), located in southern Italy, in the Calabria region, with a campus in Catanzaro. UMG was founded in 1998. The complex nature of the organisation subject to observation requires qualitative methodological approaches suitable for exploring the phenomena under investigation. Indeed, qualitative research allows researchers to generate data and theory that could not satisfactorily derive from existing data (Locke, 2001). Research based on case studies allows us to understand a wide variety of aspects of the investigated phenomenon better (Gerring, 2007; Vennesson, 2008). The case study structure is useful for deeply understanding an organisation in its context (Crowe et al., 2011, p. 1; Hyett et al., 2014). The use of the case brings out the characteristics of the phenomenon in the context.

Data analysis for research consists of three phases: (1) accumulation of data from different sources; (2) Identification of the organisational characteristic of the case study; (3) analysis of the COVID-19 response model.

The data used in this research come from various sources: analysis of university site; analysis of the adopted COVID-19 procedure manuals; interview with university decision-maker. During the interviews with the decision-makers, the experiences, opinions and all elements for the investigation of the phenomenon were collected. The researchers conducted the interviews with two decision-makers of university, who have functions specifically related to knowledge visualisation. The researchers conducted the interviews via video meetings. The interview lasted at least 40 minutes. Specifically, researchers interviewed the rector and the general manager.

The data collected during the interviews were integrated with an analysis of the university documents made available by the interviewees and published on the university websites.

The documents and data collected were analysed to answer the following questions:

*RQ1: Is Knowledge Visualisation (KV) used in the university?*

*RQ2: What is the impact of Knowledge Visualisation (KV) on intra-organisational relationships as an effect of the emergency?*

## 5 Results

This section provides the first results of how KV can be used to facilitate the transfer, creation, identification, and application of knowledge in the university context. Specifically, the following table aims to identify the different uses in this context proposed:

UMG
Knowledge creation Knowledge transfer Application of knowledge

*Source: own elaboration based on interviews*

Objects as visual metaphors are used by UMG for the transfer of knowledge because they are easily understandable and can serve this purpose. In addition, the brain can process them more easily. They facilitate the transfer of inter-functional knowledge between the various stakeholders (technical administrative staff; teaching staff; institutional organisations) with different professional backgrounds (UMG-General Manager). Another area of application of visualization in knowledge management is Knowledge Identification. The university use maps to provide an overview of various forms of knowledge sources to different expert stakeholders, project teams and other organisations (UMG-General Manager). Knowledge visualization can also help in the application of knowledge, through diagrams or interactive graphic frameworks and multidimensional scales. They appear to be maps of knowledge and visual metaphors that are particularly suited to this purpose as they make new material accessible through familiar structures.

The analysis of the area of application of the visualization offers a relationship at different levels (micro-meso-macro) within this university context:

	<b>UMG</b>
<b>Sender</b>	General Manager
<b>Recipient</b>	Institutional Members Professors staff Administrative - technical staff

Source: own elaboration based on interviews; our adaptation by El Sawy et al., 1997; Burkhard, 2005

The diversity of recipients has placed an emphasis on the fact that Knowledge Visualisation must be adapted to the preferences of the target audience (teaching staff, administrative staff, students, etc.) and as such implement the different types of KV.

Through the use of the different visualization applications, the goal is to understand the "Knowledge Type What":

UMG Knowledge Type What?
<b>Know-what</b> <b>Know-how</b> <b>Know-who</b>

Source: adaptation by Eppler, 2008; own elaboration based on interview

Below is the table with the KV applications used in the university before and after the start of the Covid-19 pandemic:

<b>Tools</b>	<b>UMG BEFORE THE PANDEMIC</b>	<b>UMG AFTER THE PANDEMIC</b>	<b>MOST USED</b>
Sketches	NO	NO	NO
Diagrams	YES	YES	YES
Images	YES	YES	YES
Objects	NO	NO	NO
Knowledge Maps	YES	YES	YES

Concept maps	YES	YES	YES
Interactive visualisation	YES	YES	YES

*Source: own elaboration based on interview*

Specifically, the integrated use of multiple tools such as diagrams, charts, schemes, mind maps and interactive visualisations were indicated by the interview as support during the decision-making process. In particular, Knowledge Visualization, in the pandemic era, has given us the possibility to homogenise knowledge and speed up choices (UMG-General Manager).

Particular emphasis has been placed on internal customers, actively involved in the design and construction of the visualization tools. The visualization tools have been evaluated very well in terms of performance and preferences by the internal customers themselves, and the analysis of the visual tools has shown that the different types of KV have a specific degree of usefulness depending on the activity.

Knowledge visualisations served to explain and answer questions about why and what-if. They can also inform multi-level coordinated decision-making to improve knowledge creation, identification and transfer. In this Universities, regarding Knowledge Visualization, various staff management levers have been active, such as: Training and Culture Activities organization in UMG. Furthermore, to date, a Model for Quality Management and a Strategic Plan for Emergency have been implemented in the university.

## 6 Conclusions

This study's results—of an exploratory and confirmatory nature—highlight significant findings in the field of Knowledge Visualisation (KV) studies in complex organisations. In particular, the study has focused its attention on universities understood as complex organisations. From the theoretical point of view, this research—starting with an overview of the main reference theories on KV—highlights that KV has been assuming a central role in the academic debate. The results of this research have allowed us to answer this study's research questions. The first result of the interview and the analysis of the documents show that KV is widely used in university. From the interview with the university decision-maker, we have found that KV supports the decision-making process and above all it

favours a quick transfer of knowledge to administrative staff and professors. The university decision-maker that were interviewed displayed an awareness of the potential and importance of Knowledge Visualisation. Awareness of the importance of KV in universities has also been shown by the use of different tools and organs with functions related to KV. KV tools have been implemented to create, transfer and apply knowledge. Therefore, KV tools allow for more efficient HRM and faster knowledge management. The tools have represented valid support in the COVID-19 emergency phase, especially in the management of Human Resource Management. Indeed, during this COVID-19 pandemic, university have increased their number of KV tools. In fact, UMG have made strategic plans to manage the pandemic available to their stakeholders (administrative staff, professors, students, etc.). The strategic plans made it possible to introduce the new KV tools into HRM organisations and practices.

## **7 Managerial implications**

This study represents one of the first reflections on a special topic that cannot be found in the literature or managerial practices. Therefore, this article aimed to contribute to the debate by considering the real situation that has emerged through this case study—the University of Catanzaro. Nevertheless, some evidence is visible. First of all, university manager showed awareness regarding the importance of KV for safety, especially in emergency time, and it seems that KV tools have largely been used in university. However, some other considerations are necessary. One implication is directly related to the real comprehension of KV regarding people involved in decision-making processes, by avoiding that the topic of KV is linked only to those who buy security services through contracts. In addition, to understand its real impacts, it is necessary to study how people in organisations act regarding KV by building sufficient awareness and also acquiring more knowledge, which we hope can be the next step of the investigation.

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## **The Role of Visualization as a Knowledge Translation Tool in the Automotive Setting**

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## Abstract

This paper is focused on the concept of visualization as a potential tool to foster knowledge translation. We investigate how using ad-hoc visual tools supports knowledge translation and knowledge transfer. The empirical case under analysis concerns the setup of a multi criteria decision-making model to analyse and select alternatives related to the factors that upgrade the lean production process quality, at a FCA Plant. Knowledge visualization can be interpreted as the interactional process where different players translate their know-how, share a framework and develop common ground to support decision-making.

**Keywords** – knowledge translation, knowledge transfer, visualization, automotive

**Paper type** – Academic Research Paper

## 1 Introduction

More and more organizations nowadays collaborate in order to achieve multifaceted outcomes through a joint knowledge effort. An increasing number of industries requires high levels of interconnection among actors of various types rather than being developed in isolation; demand various forms of common effort to manage increasing levels of complexity. Not surprisingly, then, studies on knowledge transfer represent a crucial domain within the broader topic of the management of knowledge in organizations.

Understanding the essence of knowledge transfer is far from simple, due to the lack of a unanimously accepted definition or clearly identified practices for transfer of knowledge. For the purposes of this study, we adhere to a definition able to depict the essence and processual nature of knowledge transfer (Christensen, 2003 in Liyanage et al.; 2009: 122):

*"Knowledge transfer is about identifying (accessible) knowledge that already exists, acquiring it and subsequently applying this knowledge to develop new ideas or enhance the existing ideas to make a process/action faster, better or safer than they would have otherwise been. So, basically knowledge transfer is not only about exploiting accessible resources, i.e. knowledge, but also about how to acquire and absorb it well to make things more efficient and effective".*

In the words of Liyanage et al. (2009: 124), "The process of knowledge transfer is not, per se, a mere transfer of knowledge [...] it requires an additional type of knowledge; the knowledge about how to transfer knowledge".

These reflections represent an important addendum to the literature on knowledge management, being able to provide more accounts on the possibility to effectively transfer knowledge in complex environments.

In recent years, two promising avenues of studies has dealt with the concept of knowledge translation (Simeone et al., 2017; 2018) and knowledge visualization (Gavrilova, 2017). Knowledge translation is required to contextualize the transfer from the source of knowledge to the receiver in a way that can be meaningful for him (Seaton, 2002).

Knowledge visualization is a process of looking at knowledge through the support of a visualizing tool in order to make clearer knowledge and supporting its sharing (Eppler, 2013).

This paper is focused on the concept of visualization as a potential tool to foster knowledge translation. We investigate how using *ad-hoc* visual tools supports knowledge translation and knowledge transfer (Eppler, 2013; Eppler and Burkhard, 2007).

The paper sets out as follows: initially, we review the literature on knowledge transfer and knowledge translation, adding the perspective of the visualization as a knowledge translation mechanism. We then analyse the methodology used for the empirical analysis. Finally, we present and discuss data from the empirical research before summarizing the main findings and conclusions.

## **2. Theoretical Background**

### ***2.1 The concept of knowledge between transfer and translation***

Knowledge transfer is a traditional field of research in the managerial literature, as witnessed by the growing number of articles trying to shed light on how organizations should foster knowledge to be more competitive (Liyanage et al., 2009; Holden and von Kortzfleisch, 2004; Chesbrough, 2003).

Different strategies and proposals to manage knowledge are strictly related to how to define the concept of knowledge itself. One of the main classifications refers to a dichotomy that defines knowledge in two ways. According to the first approach, the “cognitive” one, knowledge is assimilated to any resource management may control; in the second approach, social relationships are the ‘place’ where knowledge is found.

The cognitive model considers knowledge as an objective resource and treats it like information, something that may be codified and passed from one individual to another. It is admitted that knowledge is in the heads of individuals, but also that it may be taken, stored and passed on to others by means of ICT. The level of analysis is the individual; it is inside the individual that knowledge may be retrieved and spread among members of the organization. The concept of knowledge as an "entity" that may be codified, cumulated and stored has its roots in a Newtonian and mechanistic vision of the world (Myers, 1996). If knowledge is in the minds of individuals and may be explicitly represented through digital or mechanical devices, then its transfer takes place through tools and objects where knowledge is managed and memorized.

Alternately, the social-construction approach relies on the social relationship as a "moment" in which knowledge is created, according to a logic of clear sociological matrix. It finds its roots in organizational studies that may date back to the late 1980s and go into the matter of learning (Lave and Wenger, 1991). The value of this trend lies in shifting the debate from a technological viewpoint to a more managerial and organizational one that focuses on a role of human resources (Blackler et al., 1999). Knowing becomes practice: it is not essential to know what, but rather to know how. According to this line of research, knowledge transfer is strictly related to a dynamic process based on practices, interactions and negotiations.

In this sense, the concept of knowledge translation, defined "as a complex process riddled with negotiations" (Simeone et al., 2017), could be useful to support knowledge transfer in a social-construction perspective.

In the managerial literature, knowledge translation is typically associated with the concept of knowledge transfer (Simeone et al., 2017; Liyanage et al., 2009), and translation theory (Holden and von Kortzfleisch, 2004; Jacobson et al., 2004) is a way to explain knowledge transfer (Liyanage et al., 2009). According to Simeone et al. (2017: 3):

"Translating knowledge involves processing new knowledge, interpreting it according to the needs and interests of a specific organization and transforming it into forms that are more suitable for the specific organizational context of application. In this sense, translation is a highly applicable analogy to explore and understand the nature of knowledge transfer".

In this perspective, knowledge translation concerns the need to build up a process to produce new and more comprehensive knowledge. This perspective

tries to answer the need for a more complex environment, where a variety (in terms of technical domains, but also of language, nationality, etc.) of specialists cooperate to attain a specific aim.

According to Liyanage et al. (2009), knowledge translation is a dynamic process that involves different stages of knowledge transformation. As argued by Raven et al. (2011), "Translation is a concept originating from actor-network theory, denoting the transfer of objectives from one actor to other actors, thereby recruiting others into the network surrounding the primary actor". In this sense, it is a process where actors negotiate ideas, perspectives and meanings, and where different mechanisms could support the process in itself.

## ***2.2 Visualization as a tool for knowledge translation***

The knowledge translation perspective is related to the adoption of the boundary object concept, and Eppler (2013, p.9) stated: "They [boundary objects] have different meanings in different social or professional contexts, but their structure is common enough to more than one professional community to make them recognizable means of translation". Some scholars have adopted the concept of knowledge translation (Secundo et al. 2019, p.274) to observe that "when knowledge is transferred across very diverse contexts (e.g., from academia to industry), knowledge needs to be translated to still be interesting and relevant".

Knowledge visualization could be considered as a process where those involved try to facilitate typical knowledge management processes such as knowledge sharing, knowledge translation, and knowledge integration (Gavrilova, 2017; Eppler, 2013).

This paper uses Eppler's definition (2013, p.4):

"KV [Knowledge visualization] designates all (interactive) graphic means that can be used to develop or convey insights, experiences, methods, or skills [6, 7]. This definition implies that the realm of KV is not limited to computer-based images and that the main purpose of KV is to support the (inherently social) processes of creating and sharing knowledge with others."

At a general level, it is possible to argue that knowledge visualization is still in an embryonic stage as a managerial theory, notwithstanding recent contributions discussed by Gavrilova (2017). Eppler and Platts (2009) discussed the role of knowledge visualization in a strategic planning process, including the adoption of

different visualization tools at different steps of the process. The authors offered important reflections and tips about selecting the right visualization tool at each step. Unfortunately, there is no clear reference to Eppler's concept of knowledge visualization as a process.

This paper investigates knowledge visualization as a process supporting knowledge translation and knowledge transfer.

### **3 Methodology**

The empirical case under analysis concerns the set up of a multi criteria decision-making model to analyse and select alternatives related to the factors that upgrade the production process quality at a FCA Plant. As is common in literature, we selected a case study in which the phenomena of interest – in this case, the use of visualizations as knowledge translation mechanism in the automotive setting – were transparently observable. The case study provided a consistent, differentiated and information-rich setting for studying knowledge translation.

The case study origins within an innovative Ph.D. project with industrial characterization, launched in April 2019, which involves the involvement of a research group consisting of a Ph.D. student, two professors from the University of Sannio and two professors from foreign universities and the quality team at the FCA plant in Pratola Serra, project partner. This study used empirical material collected at FCA's Pratola Serra Plant, in Avellino, Italy. The Pratola Serra Plant has achieved in recent years several certifications and awards, but it has also experienced some problems and important organizational development in LPD processes.

Three data collection techniques have been used: internal document analysis, participant observation and semi-structured interviews. The documentary analysis made it possible to understand the nature and origin of the phenomenon of errors made by workers in the engine assembly phase, as well as the logic with which management faces the decision relating to the necessary actions for their resolution. Participant observation was used to explore organizational control report, management control reports for the definition of the most suitable multi-criteria model for the problem being analyzed. During her fieldwork, one of the authors spent two days a week for three months. Having free access to the Plant premises, she was able to make numerous formal and informal contacts and



become relatively familiar with the management. Finally, in-depth interviews with the management of FCA were the main source of data for this study (Canonico et al., 2017). Finally, several semi-structured interviews were conducted in particular with the World Class Manufacturing Plant coordinator, two manufacturing engineering managers (quality team members), the Plant quality manager, and the Pratola Serra plant manager. The interviews were based on an open, wide-ranging protocol provided one week before the first interview. The protocol aimed to stimulate interviewees' interest in this participative research process and to promote a narrative approach, crucial for the success of the interviews. In particular, the questionnaire included questions about:

Each interview was conducted by at least two authors of this paper to reduce interviewer bias (such as first-impression error, non-verbal influences or negative emphasis). The interviews lasted between 90 and 180 min. At the end of each interview, two authors 'in charge' reported, shared and discussed the outcomes of the interviews.

#### **4 Case Study**

The case study analyzes the visualization techniques used to support the construction of a multi-objective optimization mathematical model (Fattoruso et al. 2021) used to improve the selection of critical processes in an FCA plant. The goal of research project was, not to explain the mathematical approach of the portfolio problem used in FCA, but to analyze whether and how knowledge visualization activates different dynamics to support knowledge translation. To fit our framework, the analysis of the activities was articulated into four steps:

1. Definition and analysis of the decision problem;
2. Choice and explanation of portfolio optimization problem using ad hoc visualization tools;
3. Visualization tools to help the decision-maker to choose between alternatives;
4. Sharing the decision moment and common reflection for the final choice.

Visualization tools, in particular, are used to identify the critical process package that best meets the financial needs of the plant. The visualization techniques are used at different moments that characterize the decision-maker's choice process.

The first phase in which visualization techniques were used was following the definition of the objectives declared to be prevalent by the decision maker.

Following the definition of the decision problem, the best mathematical method was identified to support the decision maker in his choice process. The problem identified is the selection of a set of critical processes in which errors occur, taking into account the various financial resources that the company has available. To solve this problem, a multi-objective optimization problem is elaborated by the group of researchers. To make the researchers understand this model without showing the mathematical formulation, the researchers synthesized the mathematical formulation through graphs and images and showed them to the decision maker. This made it possible to involve the decision-maker in the process of building the mathematical model and to generate an initial exchange of knowledge between the parties involved in the decision-making process.

The second phase in which visualization tools were used was precisely in the moment of choosing between the various alternatives available to the decision maker. In particular, the decision-making problem proved to be particularly complex to make understood. For this reason, the alternatives were shown to the decision maker, through horizontal bar histograms (Figure 1). The histograms made it possible for the decision maker to have a clear picture of the composition of the most critical processes in the company and of those that showed a higher number of errors.

The use of visualization tools allowed the decision maker to translate the information obtained with the use of the mathematical model and share it with their team. This allowed the decision maker to choose the best alternative, reducing efforts as much as possible and obtaining a more effective and more shared choice process with the team.

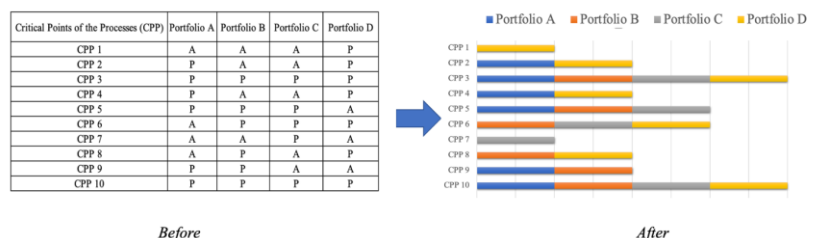


Fig. 1 – Tabular representation vs horizontal bar histogram representation for 50% of financial resources available

The mathematical approaches used were particularly complex Riesz spaces or algebras (Cavallo, 2020), which are difficult for non-experts to understand. Ad hoc visualization tools were created to help the decision-maker to understand the mathematical approach and to simplify the choice between alternatives. For the multi-objective portfolio decision model, the definition of reference levels was envisaged to identify when a process could be considered optimal, tolerable and not tolerable based on the number and severity of errors. The research group therefore created ad hoc visualization tools to help the quality manager understand how the model worked and the reference levels that determined the critical points of the processes.

## **5 Discussion and concluding remarks**

Using the concept of knowledge translation introduced in the theoretical section, here we discuss visualization as a dynamic process able to foster knowledge translation (Liyanage et al., 2009). The context in which the decision-making model was developed was characterized by two very specific domains of knowledge that, in line with Grant's approach (1996), needed a very low degree of integration. The "mathematical" knowledge is fundamental to construct the model, but it does not need to be shared with the company. FCA engineers have highly specific knowledge of processes and portfolios, but this only partially needed to be shared with the mathematical experts. The main purpose of the knowledge visualization was therefore to create a "boundary object" (Eppler and Burkhard, 2007) between these two separate "worlds": a common point of reference to facilitate conversation around different domains (Spee and Jarzabkowski, 2009). This distance should not be bridged or shortened but simply respected. The process of knowledge visualization can therefore be interpreted as the "bridge," a tool that facilitates the communication (conversation) between the two worlds, which use different languages and need "common ground" to interact and understand each other.

In a context where the players are researchers and managers, this bridge could be sustained by translation mechanisms. Simeone et al. (2018) stated that, given the different objectives and languages in academic and industrial contexts, translation mechanisms between these two groups of stakeholders are needed to establish a common platform of communication. Visualization tools fostered knowledge translation among researchers and the quality manager, creating the

conditions for a dialogue between these two worlds (Canonico et al., 2020). These tools also enhanced managerial judgment by translating raw data and information into accessible forms to extract knowledge and selecting the “good” alternatives. The images of the critical points of the processes engaged those from heterogeneous backgrounds and enabled inputs from different actors, allowing a fruitful interaction.

In particular, the process of knowledge translation occurred when the visualization tools were used to share knowledge with other FCA engineers (quality team) and the plant manager. These tools helped to define the alternatives clearly, classifying and then prioritizing them. The team highlighted that the visualization tools were useful for assimilating new practices into the company. Visualization tools and knowledge translation embedded in both the researcher–quality manager relationship and collective reflection about the final choice were the keys to fostering knowledge sharing among the members of the team (academics and practitioners). Templates and ad hoc drawings of complex mathematical formulas helped to direct teamwork (Gavrilova et al., 2017), transfer and share insights and enable quality team members to apply these insights. They acted as facilitators, activating awareness and reactions in-group dynamics and supporting the social processes of sharing knowledge with others to make a decision about the upgrade of the production process.

Knowledge visualization, therefore, goes far beyond the visualization tools themselves (Eppler and Burkhard, 2007). It can be interpreted as the interactional process where different players translate their know-how, share a framework and develop common ground to support decision-making.

The main objective of this paper was to understand if and how, as part of a specific U-I collaboration initiative in the automotive sector, visualization can be interpreted as a mechanism for translating knowledge. Our empirical findings showed why and how knowledge visualization could be used to foster knowledge translation and sharing among individuals and from individuals to groups.

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## **An Overview of the Last 20 years Literature on e-Learning in an Academic Context**

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### **Abstract**

This article aims to implement a systematic review of the literature on e-learning in the academic context that includes the period from 2001 to 2020. We have chosen the 2000s as a starting point to implement this review because they represent the historical moment in which we are witnessing to the diffusion and implementation of e-learning in

universities. Although the flexible learning model via the Internet was introduced in the 1990s and only in the 2000s did these new technologies develop concretely within academic contexts.

The methodological approach adopted was quantitative. The work took place in three different phases. (1) The articles were found by inserting some keywords in the Web of Science (WoS) platform and covered a period from 2001 to 2020. (2) The selection of the articles took place through Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) by Moher et al. (2009). (3) The final data have been reported and represented in special graphs. Furthermore, the 2001-2020 analysis period was divided into four five-year sub-periods (2001-2005, 2006-2010, 2011-2015, 2016-2020), to analyze and explore the evolution of the problems identified during every subperiod.

From the first results found, using the WoS platform and the selection of articles implemented through PRISMA, two important issues emerged.

First, it emerged that the number of publications on e-learning has increased significantly in the last five years (about 50% of the total number of documents analyzed that appeared in 2016-2020), exceeding the number of 100 documents per year.

Secondly, from the in-depth analysis of the four five-year periods, a greater focus appears on the aspects related to technology during the first two sub-periods 2001-2005 and 2006-2021. On the contrary, in the subsequent two phases 2011-2015 and 2016-2020 there is greater attention to topics related to the learning content. All this was examined by comparing Fee's model (2009) with the sankey diagram.

This research could allow us to have a precise overview of the aspects studied and treated by researchers and academics in the field of e-learning in universities over the last twenty years.

**Keywords** – E-Learning; Universities; Blended Learning; Distance Learning; Education.

**Paper type** – Academic Research Paper

## 1 Introduction

E-learning, or Electronic learning, is a system based on digital technologies capable of promoting the acquisition of knowledge and skills by users/students (Bernuy and Garcia, 2006; Hashim, and Tasir, 2014) and which allows to support and improve the learning process (Rodríguez et al, 2019), becoming a fundamental part of the learning experience of students in higher education (Ellis et al., 2009). Thus, most universities have created their own e-learning systems in order to offer Internet-based degree programs and provide online learning materials (Mohamed Sofiadin, 2014). During the last twenty years, many universities have combined traditional forms of classroom activities with those implemented online in blended learning mode (Hwang, and Arbaugh, 2006;



McKenzie, 2020). Recently, the health emergency resulting from the coronavirus pandemic (COVID-19) has forced universities around the world to suspend classroom teaching activities (Ali et al, 2020; García-Peñalvo et al, 2021), leading to a push towards distance and online learning (Ebner et al., 2020).

Yet e-learning in universities has spread in the academic context for some time. Indeed, although the term e-learning was coined between the 1980s (Moore, et al., 2011) and the late 1990s, distance education was developed in universities and organizations around the world, as early as the 1960s (Corbeil and Corbeil in Khan, and Ally, 2015; Harasim, in Weiss et al., 2006).

Six "generations" of Distance Education have spread on the basis of the type of Information and Communication Technology (ICT) used in universities (Kimani, 2019; Taylor, 2001). During the first two generations, before the invention of the Internet, distance learning was offered through two modes of communication channels (Corbeil and Corbeil in Khan, and Ally, 2015). Think of the correspondence courses developed during the late nineteenth century, marking the first generation (Cantoni et al., 2007; Ferri in Nacamulli, 2003; Kimani, 2019; Taylor, 2001). While around the sixties (second generation), the teaching activity is provided through video and audio tapes, radio, television and digital media (Esposito, and Mantese, 2003; Ferri in Nacamulli, 2003). E-learning is part of the history of distance learning, constituting the so-called the third generation (Parricchi, 2004). This type of training is based on two-way communication means, such as the internet or video-conferencing (Bates & Bates, 2005), which involves the creation of virtual environments of communication codes of a synchronous (live) or asynchronous nature (Bates, 1990; Ferri in Nacamulli, 2003; Taylor, 2001).

In the 90s we come to the advent of the fourth generation which was characterized by the adoption of a flexible learning model via the Internet (Taylor, 2001).

But with the launch of the fifth generation (in 2000) of distance education which is essentially a derivation of the fourth generation, we are witnessing the enrichment of the educational offer using the Internet and the Web (Taylor, 2001).

Within universities, the fourth phase began, only "potentially", in the nineties, in the sense that there was the availability of ICT systems to be able to deliver training via the Internet. But most educational and academic contexts implemented the use of these technologies in the following period, namely in 2000 (NCES, 2003; OECD, 2005). Thus, according to Taylor (2001), it has been found that many universities have activated the technologies of the fourth-

generation distance learning initiatives, only when those of the fifth generation had already emerged. This circumstance has had two fundamental consequences. (1) The lack of coincidence between the temporal demarcation of the different generations of distance education outlined and their real and effective application in the university context. (2) The 2000s stand as a real watershed compared to the previous phases, as they represent an important reference period for the evident use and diffusion of new technologies in university learning.

Finally, the sixth generation is the one that includes the delivery and support of educational activity through social media, student management systems, file transfer and storage services such as Dropbox, Google drive and one unit, mobile technologies, Resources Open Educational (OER) and Massive Open Online Courses (MOOCs). (Kimani, 2019).

If this "model of the generations", as defined by Taylor (2001), offers a brief reasoning on technological evolution in teaching, it highlights while we are facing the start of a seventh phase of change. Universities have had to reshape their strategies on their way of teaching following the pandemic situation that has raged since 2020. All this will increasingly require new forms of change in strategies in the academic context in terms of balance between face-to-face teaching and teaching at a distance. To contribute to this debate on the provision of e-learning activity in the academic context, during the period of COVID-19, several articles have been published (Almaiah, et al., 2020; Almanthari, et al., 2020; Kamal, et al, 2000; Kapasia, at al., 2020; Wan Hassan, et al., 2000; Zhu, 2020).

Therefore, it is necessary to better identify and clarify, through the adoption of an information database, how the development of these different phases has been implemented. This approach, in fact, would allow to acquire certain data, but also to grasp and understand the salient elements of this debate.

Based on these considerations, this paper aims to implement a systematic review of the literature on e-learning in the academic context that includes the period from 2001 to 2020. Specifically, the goal is to answer the following research question.

*RQ: Examine the evolution of e-learning issues in universities / higher education.*

As already anticipated, we have chosen the 2000s as a starting moment to implement this revision, within the model of the six generations of distance education (Kimani, 2019; Taylor, 2001), since they represent the historical moment

in which we are witnessing a diffusion and implementation of e-learning in universities.

The article was organized as follows. The methodology adopted will be presented in the next section. The remaining paragraphs will focus on the results achieved and the discussion of the same. The last section will illustrate the conclusions.

## **2 Methodology**

The methodological approach adopted was quantitative (Creswell, 2014). The work was carried out in three different phases.

(1) The articles were found through the inclusion of some keywords in the Web of Science (WoS) platform and covered a period ranging from 2001 to 2020, to collect publications on e-learning experiences in tertiary education.

We queried Web of Science (WoS) – initially developed by the Institute for Scientific Information (ISI) and currently managed by Clarivate Analytics – because it is one of the leading databases that allows you to explore the scientific production of scholars and covers more than 20,000 journals, conference proceedings and books. The quality of WoS information is often considered the highest, we have decided to focus exclusively on this database.

The query was built by observing the keywords: "e-learning" AND "university". First, the synonyms of "e-learning" were examined. Therefore, we included in the research: "distance", "online" and "blended" along with "learning" and "education". Furthermore, we checked the different spelling of the aforementioned terms: including both multi-word terms and those without hyphens. Next, we inserted the terms "university", "college" and the multi-word terms "higher education", "tertiary education" and "post-secondary education". As in the previous case, for both we considered the spelling of different terms with and without hyphens.

(2) The selection of the articles took place through Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) by Moher et al. (2009).

In Figure 1, the salient elements of the selection of articles are shown, based on PRISMA diagram.

The analysis covered a total number of original records of 2,074. Through a series of inclusions and exclusions of contributions, at the end of the process, 1,360 documents were received.

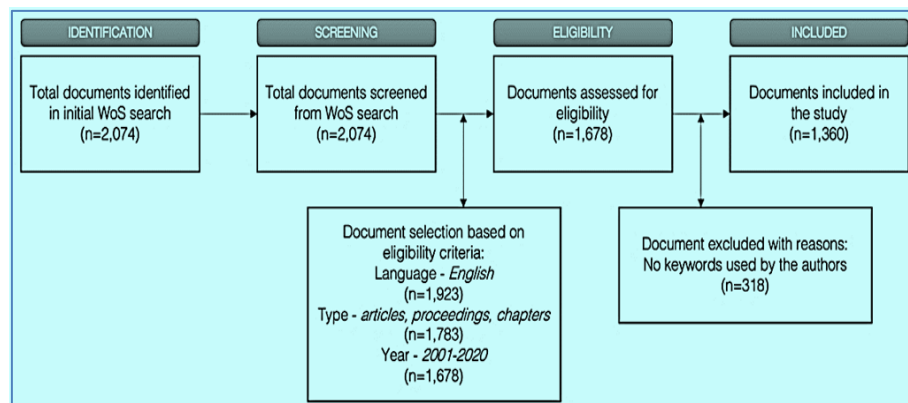


Figure 1. PRISMA flow diagram used in the study

(3) The final data were reported and represented by means of special graphs to crystallize and better identify the evolution on the various e-learning issues addressed over time. In this regard, the 2001-2020 analysis period has been divided into four five-year sub-periods (2001-2005, 2006-2010, 2011-2015, 2016-2020), to analyse in more detail the conceptual structure and explore the evolution of the issues identified over the periods. The topics were automatically tagged considering the most relevant term in each corresponding sector, observing the number of documents in which the terms are present.

### 3 Findings

We have tried to transpose the main results according to a double criterion: general and specific. In the first, we entered the general data found on the subject over the entire period 2001-2020. In the second, we tried to report the different topics on e-learning in universities treated by the authors by dividing the study survey into four sub-periods of five years.

(i) General analysis of the data. Figure 2 shows the year-wise cumulated distribution of documents published during 2001-2020. The number of documents that appeared in the last 20 years was, on average, 68 per year (with a standard deviation of  $\pm 52.40$  documents).

Noteworthy, due to the development of computer technology and the diffusion of the Internet in the field of Education, the number of publications significantly increased in the last five years (about 50% of the total number of

analysed documents appeared in 2016-2020), overcoming the number of 100 documents per year.

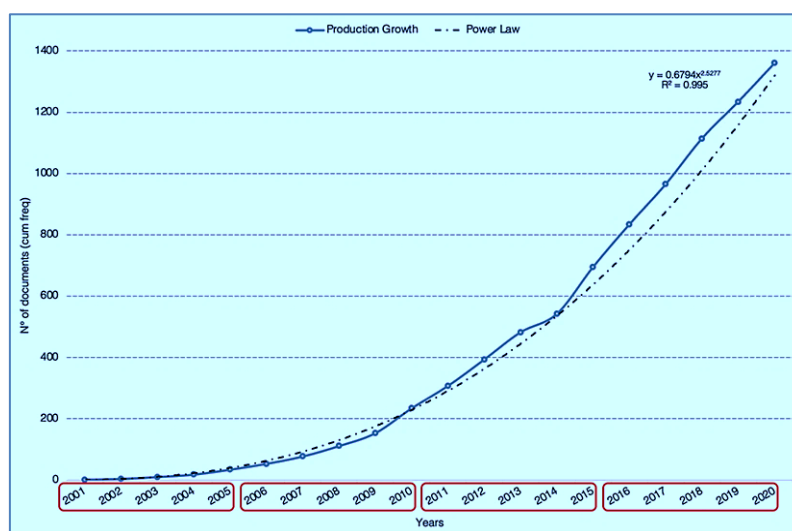


Figure 2. Growth and correlation of publications' production across 2001-2020.

This tendency in scientific production on e-learning in the academic context is likely to continue to increase considerably in the future. We must not forget that the universities, due to the COVID-19 pandemic, have predominantly introduced, as has happened in other areas, the technology to implement teaching activities.

From the dataset examined, throughout the investigation period, in table 1 it emerges that the publications relating to e-learning in the context of the most cited universities are those of Park (2009); López-Pérez et al. (2011); Ozkan and Koseler, (2009). The content of these contributions is linked to the concept of students' acceptance of new technologies and their perceptions. Instead, others analyze the practical implementation of e-learning systems (Graham et al., 2013; Bernard et al., 2014; Porter et al., 2014).

(ii) Specific analysis of the data. *We divided the overall study period (20 years) into four 5-year sub-periods (2001-2005, 2006-2010, 2011-2015, 2016-2020) to verify the topics covered by the authors. The label to each individual theme was automatically assigned.*

*In the first subperiod (2001-2005):* No. 34 publications were found. The number of topics covered is very limited. The leading themes consist of the concepts of

virtual university and computer-based education, while Internet-related issues are niche themes.

*In the second subperiod (2006-2010):* the total number of publications was 199 documents. Among the main topics of study emerge those connected to the organization of the infrastructures used in e-learning (e.g. learning management system, online learning environment). Interestingly, the use of acceptance models to assess the impact of distance learning appeared as a niche topic.

*In the third subperiod (2011-2016):* No. 458 published documents emerged. We are witnessing the shift of the fifth generation of distance learning towards a new phase with the reference to web 2.0 as a driving theme and the strengthening of education on the Internet and ICT.

*In the fourth subperiod (2016-2020):* No. 663 documents emerged. In this phase, the sixth generation of distance learning has been consolidated and a new one seems to appear. The meaning COVID-19 appears among the themes of the subperiod. Thus, it is evident that many institutions, due to the pandemic situation, have had to upgrade their ICT infrastructures and rethink their teaching / learning strategies. The core themes of the period were among others the use of Moodle (one of the most popular learning management systems) and the concept of MOOC.

Table 1. Top ten most cited publications

Author\s, Year, Source	Title	GC	LC	LC/GC Ratio
PARK SY, 2009, EDUC TECHNOL SOC	<i>An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning</i>	501	25	4.99
LOPEZ-PEREZ MV et al., 2011, COMPUT EDUC	<i>Blended learning in higher Education: students'perceptions and their relation to outcomes</i>	259	18	6.95
OZKAN S & KOSELER R, 2009, COMPUT EDUC	<i>Multi-dimensional students'evaluation of e-learning systems in the higher education context: an empirical investigation</i>	254	15	5.91
GRAHAM CR et al., 2013, INTERNET HIGH EDUC	<i>A framework for institutional adoption and implementation of blended learning in higher Education</i>	183	22	12.02
BERNARD RM et al., 2014, J COMPUT HIGH EDUC	<i>A meta-analysis of blended learning and technology use in higher Education: from the general to the applied</i>	152	8	5.26
PORTER WW et al., 2014, COMPUT EDUC	<i>Blended learning in higher Education: institutional adoption and implementation</i>	140	12	8.57
OWSTON R et al., 2013 INTERNET HIGH EDUC	<i>Student perceptions and achievement in a university blended learning strategic initiative</i>	124	10	8.06
MAHDIZADEH H et al., 2008, COMPUT EDUC	<i>Determining factors of the use of e-learning environments by university teachers</i>	99	5	5.05

ISLAM AKMN, 2013, COMPUT EDUC	<i>Investigating e-learning system usage outcomes in the university context</i>	98	5	5.1
MARTINEZ-TORRES MR et al., 2008, BEHAV INFORM TECHNOL	<i>A technological acceptance of e-learning tools used in practical and laboratory teaching, according to the European higher education area</i>	91	3	3.3

**GC** = global citations, **LC** = local citations

## 4 Discussion

Taking up the main results obtained on the thematic evolution of e-learning in the academic field, we can make the following reflections.

(1) In Figure 3, a so-called sankey plot links the four analysed sub-periods (2001-2005, 2006-2010, 2011-2015, 2016-2020) revealing the paths of the different themes discussed in the literature. The extent of each flow connecting two themes graphically represents the magnitude of their conceptual nexus.

Although from the general descriptive analysis of these four phases as shown in figure 3, two main differences emerge that should be emphasized. Firstly, between the first, second and third phases there is a greater interest in the topics of e-learning on the part of researchers. Secondly, from the examination of the fourth phase there is a reduction in the topics covered in the publications on e-learning detected, compared to those exposed in the two previous periods. At the same time, in the last period (2016-2020) the contributions focus on certain e-learning issues, including a considerable number of articles published for each theme and leaving out some lines of study that had developed in previous moments (2006- 2010 and 2011-2015).

(2) According to a specific survey carried out by Fee (2009), e-learning systems are made up of three components which are: (a) technology, (b) learning content and (c) e-learning design (Gentile et al., 2020a; 2020b).

(a) The technological aspect considers the type of infrastructure used to transfer e-learning information (Ghiringhelli and Quacquarelli, in Nacamulli, 2003).

(b) the learning content, on the other hand, examines the type of teaching material and activities that are available in e-learning software (Al-Yahya, et al., 2015).

(c) The concept of learning / e-learning design is a learning process (MacLean and Scott, 2007) that allows to plan e-learning activities through an adequate use of resources and technologies (Brown and Voltz, 2005).

However, different models exist in the managerial literature on e-learning systems, such as the one developed by Ghavifekr et al (2012). Specifically, the authors state that this system is composed of four elements: planning, organization, guidance and monitoring. While according to Urh et al. (2015) the e-learning system is made up of five components: organization, planning, staff recruitment, guidance and control.

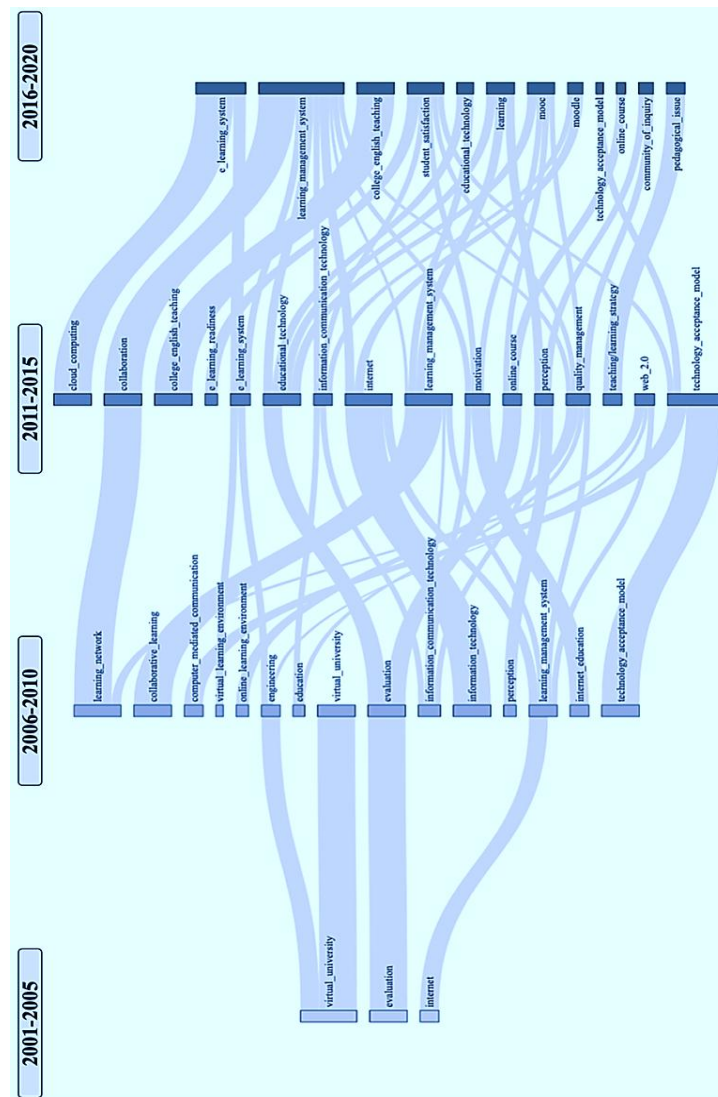


Figure 3. Thematic evolution across 2001-2020.



Instead, Henry (2001) believes that e-learning is made up of content, technology and services, in a holistic context. Within the first component, the author makes a further distinction between: generic content, classroom content and those published. In the field of technology, the second component includes: the technological infrastructures used, Learning Content Management Systems (LCMS), Learning Management Systems (LMS) and learning technologies. Inside the last component you can find the services relating to consultancy, support and design and construction.

More complex systems are those cited by Pahl, (2007) and by Khan (2005). In the first, three reference models are considered: Administration, Pedagogy and Technology.

In the second, an e-learning system is outlined which includes seven dimensions: Institutional; management; Technological; Pedagogical; Ethical; Interface Design, Resource Support and Evaluation. Within these two models of Pahl, (2007) and Khan (2005), there are further divisions that make the analysis more difficult to use for the purposes of our investigation.

We have selected the Fee model (2009) over the others listed for its display simplicity. In fact, it allowed us to have an overall overview of the topic in which the various studies, divided into three areas, can be examined on the basis of the content treated according to a logical criterion.

(3) Taking up the breakdown by thematic areas into four five-year subperiods as reported in the previous paragraph and the Fee model (2009) we selected through the use of the so-called sankey diagram (Figure 3). We verified which were the predominant themes, at internal of each of the subperiods identified, in this diagram, with respect to the three elements identified by Fee (2009): Technology; Learning content; Learning / e-learning design.

*First subperiod: 2001-2005.* The first lines of study that have developed on e-learning in the educational context can be traced back to the technology area of the Fee model (2009) in the context of that which appears in the sankey plot (figure 3) as Virtual University and Internet. Also in this period of time, some research begins to develop that focuses on the content of e-learning (Evaluation), even if the technological aspect is prevalent in this first moment.

According to Arbaugh (2001), the use of collaborative technologies, in the context of university e-learning, makes it possible to reduce social distance, as well as facilitate learning and student satisfaction.

*Second subperiod: 2006-2010.* In this new phase, as can be seen from figure 3, we are witnessing the presence of considerable and different topics treated on e-learning by researchers. Specifically, some of these themes have focused, according to the model of Fee (2009), on the technological aspect. As an example: Computer-Mediated Communication; Virtual Learning Environment; Online Learning Environment; Virtual University; Information Communication Technology; Information Technology; Learning Management System; Technology Acceptance Model.

According to Hwang, and Arbaugh, (2006) these web-based learning environments through blended courses seek to contribute to the nature of actual communicative behaviors and their resulting impact on knowledge acquisition.

Other research is related to the area of Learning content, analyzing, in particular: Learning Network; Collaborative Learning; Education; Evaluation; Perception; Internet Education. For example, Franceschi, et al. (2009) demonstrated that learning content of the virtual world on 3D is more suitable for effective collaboration and engagement of learners for e-learning than the text-based virtual learning environment (e.g., Blackboard, Moodle).

On the contrary, only one argument emerges attributable to the design of e-learning (Engineering). In this second phase, there is a greater interest of researchers in topics related to the technology area according to the Fee model (2009).

*Third subperiod: 2011-2015.* The publications on e-learning in this further period are very widespread, compared to the previous time, based on what emerges from figure 3. In fact, there is a lot of research that examines the technological aspect of e-learning according to the model outlined by Fee (2009) such as: E-learning System; Educational Technology; Information Communication Technology; Internet; Learning Management System; Web 2.0; Technology Acceptance Model. According to Ramayasa (2015), technology represents one of the success factors regarding the acceptance of E-Learning in Universities.

Other studies focus on the content of e-learning by addressing issues related to: Cloud Computing; Collaboration; College English Teaching; E-learning Readiness; Motivation; Online Course; Perception; Quality Management; Teaching Learning Strategy.

Thus, also Koutsabasis, et al. (2011), have shown that the provision of educational material through e-learning, specifically in asynchronous mode, is able to support the management of many types of information and content on

courses and generate student satisfaction. In this third phase there is a greater attention on the part of scholars to the content of e-learning.

*Fourth subperiod: 2016-2020.* In this last period of time, the contributions on e-learning that focused on the technological aspect, as identified in figure 3, were the following: E-learning System; Learning Management System; Educational Technology; Technology Acceptance Model. For example, the research by Alhabeeb and Rowley (2018) considers technological infrastructure as one of the Critical Success Factors (CSFs) associated with the adoption of e-learning.

Instead, the content of e-learning was studied for the following areas: College English Teaching; Student Satisfaction, Learning; MOOC; Moodle; Online Course. According to Nariman (2020), the learning content adopted by e-learning systems has a positive impact and generates high satisfaction for students.

Finally, the publications that have focused on e-learning design including the topics in figure 3 are: Community of Inquiries and Pedagogical Issue. Think of the research carried out by Renda dos Santos, and Okazaki, (2016). The authors tried to explain the factors that led to the adoption of e-learning by creating a specific design model called Decomposed Theory of Planned Behavior (DTPB).

Also, in this last period of time there is a preponderant focus of publications towards problems related to the content of e-learning.

## **5 Conclusions**

This article aimed to implement a systematic review of the literature on e-learning in the academic context during the period from 2001 to 2020. The stimulus to investigate this issue was dictated by the presence of the health emergency resulting from the coronavirus pandemic. (COVID-19) which has forced universities around the world to pervasively introduce and develop forms of distance and online learning (Ali et al, 2020; Ebner et al., 2020; García-Peñalvos et al, 2021). Yet the conduct of e-learning didactic activities is not new in academic contexts (Hwang, and Arbaugh, 2006; McKenzie, 2020; Mohamed Sofiadin, 2014). There were six "generations" of Distance Education that have spread over time based on the type of Information and Communication Technology (ICT) within universities (Kimani, 2019; Taylor, 2001).

But this research has been carried out since the 2000s, although already in the 90s we are witnessing the adoption of a flexible learning model via the Internet (Taylor, 2001). The answer to this depends on the fact that only during the 2000s

did most of the educational and academic contexts concretely introduce the new methods of distance learning (NCES, 2003; OECD, 2005).

At the same time, it would seem to be witnessing the task of a new generation of distance education: the seventh. As a result of the pandemic situation, universities have had to revise their strategies on their way of carrying out teaching activities.

To try to understand how this evolution on e-learning took place, we followed the following methodological approach. First, we entered some keywords in the Web of Science (WoS) platform to search for the articles on e-learning to be selected. Second, we selected items via Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) by Moher et al. (2009).

Finally, we divided the 2001-2020 analysis period into four five-year subperiods (2001-2005, 2006-2010, 2011-2015, 2016-2020), to better explore the evolution of the topic within each subperiod.

From the main results obtained, through the previously explained methodology, some fundamental questions emerge.

First, it should be noted that the number of publications on e-learning has significantly increased in the last five years (approximately 50% of the total number of documents analyzed that appeared in 2016-2020), exceeding the number of 100 documents per year. This trend in science production on e-learning in tertiary education is likely to continue to increase dramatically in the future, due to the SARS-CoV-2 pandemic.

Furthermore, from the in-depth analysis of the four five-year periods, a greater focus appears on the aspects related to technology during the first two subperiods 2001-2005 and 2006-2021.

On the contrary, in the subsequent two phases 2011-2015 and 2016-2020 there is greater attention to topics related to the learning content. All this was examined by comparing Fee's model (2009) with the sankey diagram (Figure 3).

Fee (2009) states that e-learning systems are made up of three components: Technology; Learning content; Learning / e-learning design.

The sankey diagram highlights the different fields of study on e-learning in the context of higher education that developed from 2001 to 2020 divided into the four sub-periods mentioned above. Thus, we tried to group the lines of investigation that emerged in the diagram of Figure 3 within the three aspects identified in the Fee model (2009).

Yet, this work will allow scholars to better understand in a theoretical key what has been the research carried out in the last twenty years on e-learning in the higher education system. Furthermore, it will allow academics to have a clear and comprehensive picture of what e-learning issues will be addressed in the future.

Also, from a practical point of view, this research could have positive implications, especially as regards the period 2016-2020. In fact, the contributions published in this period will be able to support concrete interventions in the use of technologies in teaching and learning, to better respond to the pandemic crisis.

But the main limitation of this study derives from not having reported and included further statistical data in the descriptive study of the results. But our main purpose, in this historical moment, was to implement a general verification of the existing contributions on e-learning in the field of higher education. The further step of our investigation will be to investigate these statistical criteria.

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## Governance of Sustainable Greentech Value Chains

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### Abstract

The paper investigates structural shifts in an exemplary greentech sector, the value chain of semiconductors, between 1980 and 2018 with the aim in mind to uncover risks inherent in the configuration of the value chain. As this sector has seen an unprecedented transition from highly integrated device manufacturers to disintegrated modular value chains and is in the midst of a third wave of reintegration, it serves as a case in point to study potential risk sources based on patent data (WIPO's Patentscope). Tentative conclusions on a governance of these types of value chains are drawn which take into account the conflicting developments of digitization of manufacturing (industry 4.0) and the large-scale sustainability transition underway in most industrialized countries.

**Keywords** – sustainability, governance, Greentech, industry 5.0, patent analysis

**Paper type** – Academic Research Paper

### 1 Background and aim of the paper

The scaling down of production in companies worldwide due to a lack of semiconductor chips lasting well into June 2021 has prompted automotive companies to revert to reduced working hours and once more underscored the risk exposure of an industry with globally dispersed value chains (Tewari 2013). By enlarging their product range to include electric cars, automotive companies have (at least from a strategic perspective) begun to join other greentech industries (like, e. g., wind turbines, smart products) in their dependency on rare earth metals employed in sensors and in high efficiency magnets indispensable for most applications. Relatedly, the cumulative systems technology of semiconductors has contributed to both product innovations on an within-industry level, e. g., miniaturization of electronic circuits printed on silicon wafer chips (Hoeren 2016) built in computers, but also enabled follow-up innovations

for greentech applications in a variety of sectors (e. g., Smart City applications). The European Commission launched its industry 5.0 initiative earlier this year in an effort to reconcile sustainability (epitomized by the Circular Economy) with the promises of digitization of manufacturing inherent in industry 4.0 (European Commission, 2021). The current implementation of industry 4.0 however falls short of meeting the triple bottom line goals (Müller, Kiel, and Voigt, 2018; Nara et al., 2021) and the prospective large-scale digitization wave (Baldwin 2013) may compromise sustainability, e. g. through the digital rebound effect. The move towards digitized manufacturing platforms is a double-edged sword as it may exacerbate the already high energy usage of the manufacturing sector amounting to 38 % of global energy consumption (IEA 2017) and expected to exceed the emission share of the mobility sector in Germany within a few years (BMU 2020), increase product obsolescence and lead to higher resource consumption (Ford und Despeisse 2016). It has been argued that despite both industry 4.0 and environmentally-sustainable manufacturing being all but new technological paradigms, their interface might serve to underpin „a robust new industrial wave“ although their joint dynamics are still ill-understood (Sousa Jabbour, Jabbour, Foropon, and Godinho Filho, 2018, p. 19) contrasting with their relevance for manufacturing at large.

Semiconductors and high performance magnets are two examples where severe repercussions have occurred along the whole value chain in the past decade albeit for different reasons and with different consequences. In the case of magnets the fact that China represents a bottleneck for rare earth supply which is crucial for magnet production enabled it in 2010 to disrupt international rare earth supply by halting exports, a practice sanctioned by the WTO in 2014, once more demonstrating the global dependency on Chinese rare earths and the risk exposure of all related downstream sectors. Both the upstream and downstream end of the magnet value chain are fairly stable. On the contrary, in the case of semiconductors, supply disruptions in the automotive industry have been more recent (since 2020, due to the pandemic) but could be interpreted as a symptom of a more general reconfiguration of the value chain. After a first wave of vertical integration in the 1990s (Anzenbacher und Wagner 2020) power has been shifting from integrated device manufacturers (IDMs) like Intel to foundries and, increasingly, fabless firms specialised in design (Hall and Ziedonis 2001). Furthermore, the downstream end of the value chain formerly dominated by the bargaining power of automotive and electronics companies is in a state of

reconfiguration with chip producers like Dutch STM and TSMC (Taiwan), Samsung and Intel having begun to prioritize the gaming and entertainment sectors over automotive for the first time (Schmidt 2021; Schmidt et al. 2021). In both industries the role of patents is a decisive one as the core product itself as well as production processes are highly complex. Standardization is among the key processes through which complexity is reduced (Gereffi et al. 2005). The two cases are furthermore contrasting as to the degree of modularity (related to codification, particularly standardization in the model of Gereffi et al. 2005) with modularity high in case of semiconductors (with a highly disintegrated semiconductors industry challenging the business model of integrated conglomerates (Park et al. 2018) and low in case of magnets which, apart of mass produced all purpose-magnets, are highly customized.

Although uncertainty reduction arising from power asymmetries in value chains has been addressed before (Inomata 2017; Escaith 2017) and the power residing in either end of the value chain (e. g. power exerted by component manufacturers or large retailers) has been conceptualized as the ability to shape the risk-return profile of the industry (Gereffi 2011; Gereffi et al. 2005), value chain governance has neither been linked to the extant literature on risk exposure (or its counterpart resilience) (for an exception see Quoreshi and Stone 2019) nor to sustainability.

The aim of the paper is as follows: It proposes to establish a link between value chain risk (and how it can be reduced through codification), the different value chain governance types, and sustainability. The technological fields of high efficiency magnets and semiconductors are analyzed on a conceptual level which is followed by a more focused patent analysis of the case of semiconductors. These greentech sectors (categorized as greentech due to their importance for technologies such as wind energy and electromobility) have been chosen as they represent contrasting cases as regards the type of value chain governance with one rather stable but entailing high risk exposure for downstream firms (builder of high efficiency magnets) and one where market forces are in flux with new suppliers and customers from a wide set of industries entering the value chain thereby putting established business models under pressure and with risk originating upstream (suppliers of semiconductors). Also, within semiconductors, differences between the type of firms are taken account of, whether they be integrated device manufacturer (Hung et al. 2004), fabless firms, or foundries (Park et al. 2018) active in different value chain stages as will be explained in more

detail later on. The dynamics in semiconductors also extend to patenting which has gained added importance since the pro-patent shift in US legislation (1979-1995) (Hall/Zidonis 2001). In particular, the cases are used as a backdrop to the question if sustainability potential can be harnessed based on an antagonistic or conducive position of industry 4.0 vis à vis sustainability (Ford and Despeisse, 2016).

Sustainability goals are defined in line with the European Commission's Waste Framework Directive and the UN Sustainable Development Goals (SDGs), especially the goal of „ensuring sustainable consumption and production patterns“ (SDG 12) for which manufacturing is considered crucial not least through the reduction of waste and a better waste management (Kristoffersen, Blomsma, Mikalef, & Li, 2020). Despite its assumed instrumental role in making a sustainability transition, only one third of studies on the industry 4.0 sustainability link have been conducted in the manufacturing sector (Savastano et al. 2019; Min et al. 2019). Exploring the missing link between industry 4.0 and sustainability (epitomised by the Circular Economy) (Kristoffersen et al. 2020; Alcayaga et al. 2019) could contribute to better pinning down how the competitive landscape – in terms of market structure and value chain configuration - in rare earth based industries (e. g., semiconductor and magnet producers and their downstream industries) is likely to evolve.

Based on this, on an applied level, Governance strategies to safeguard against value chain risk are discussed, among them blockchain (which helps to reduce informational risks, Min 2019), standardization and closing the loop of global value chains (e. g., through increased Recycling and Reuse activities and cloud-based business models).

## **2 Conceptual background: value chains and risk exposure**

### ***2.1 Types of value chains in two exemplary rare earth industries***

Gereffi et al. 2005 differentiate between five governance types (and corresponding value chains) depending on concrete realizations of the following three parameters: complexity of transactions, ability to reduce uncertainty through codification and capabilities in the supplier base with the first two being discussed with reference to information related coordination costs.

The paper makes a point in stretching the reference frame of these three parameters to include tangible product and production process related traits, e. g. codification is related to modularized magnets in that their standardized set up would enable to bring down transaction costs of production and (hardly discussed so far) also of Recycling and Reuse. In the original Gereffi model standards (e. g., product and process standards) are mentioned as a means to bring down complexity and thereby facilitating transactions at low cost. For magnets, a too high degree of variation of their set-up have been identified as a hindrance to Recycling and Reuse (Binnemans et al. 2013). In both types of value chains, the interplay between organizational setup (value chain configuration) and traits of the technologies/products on the one hand and consequences for risk governance on the other (chapter 2.2) is particularly addressed.

#### *2.1.1 Value chains in high performance magnets*

Machacek and Fold 2018 characterize the rare earth industry as an opaque industry which is why the “ability to codify” (the second parameter of Gereffi et al. 2005) in their view is considered crucial in engineering the outcomes of global value chain participation. The “ability to codify” pertains to standardization and, more generally, Intellectual Property Rights (IPR) protection which also includes patents. In the early stages of the value chain of high efficiency magnets for instance, where metals are turned into magnet alloy powders (Bast et al. 2012), the efficient allocation of IPR, particularly patents and standards, is of high significance (European Commission 2014). Furthermore, the lack of standardization of the geometry of magnets (which are often glued to each other) as well as the variety of magnet composition prevents their reuse (Binnemans et al. 2013) and thereby hampers the sustainability transition (Markard, Raven, and Truffer, 2012) of the sectors involved. The downstream section of the value chain, pertaining to intermediate and final goods, has been most often analyzed from a value chain risk perspective (Wagner and Neshat 2012), however, magnet producers face exposure to value chain risks particularly upstream, in the materials’ sourcing stage due to a high concentration of suppliers.

Fifarek and Veloso 2010 show that innovation (proxied by patent output) tends to be more clustered in magnet industries than in the comparatively less complex catalysts which are also manufactured from rare earths. Despite the increasing global reach of value chains, innovation activities in magnets became more pronouncedly clustered after China became the market leader in rare earths in

1990 – mirroring the fact that magnet production is dependent on knowledge spillovers along the value chain stages which leads to inventors and producers having to locate as closely as possible (Fifarek and Veloso 2010).

### 2.1.2 Value chains in semiconductors

The value chain of semiconductors consists of a series of production stages which can be technically separated and allow for a disintegration of the value chain: starting with the design, followed by the production of the silicon wafers, the production of the mask (the celluloid filaments carrying the electronic circuits), the assembly of both elements in fabrication (transferral of the circuits in the mask to the wafer by way of etching into its surface), the assembly of transistors, diodes and integrated circuits and the testing of the end product, the finalized semiconductor (Grinberg 2016; Malerba und Nelson 2011).

Besides the classical, highly integrated semiconductor conglomerates like Intel and Texas Instruments (US), Toshiba, Matsushita Electric, Hitachi (Japan) and Samsung (Korea) (integrated device manufacturers) which span large parts of the value chain from design to fabrication, to packaging and testing (Hung et al. 2004) two hybrid types have emerged each covering only a fraction of the value chain: fabless firms (design only) which are highly technology intensive (Park et al. 2018) and foundries (fabrication only) offering high end manufacturing to the former two (Hall and Ziedonis 2001) (Figure 5).

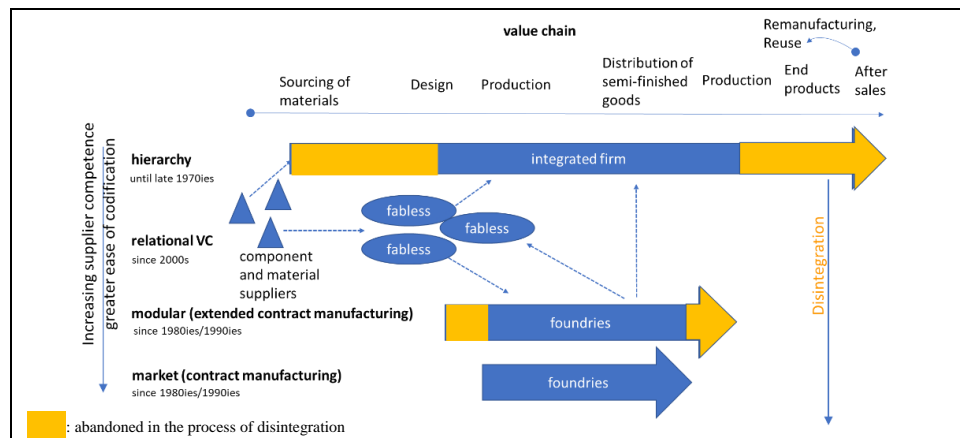


Figure 5: Global value chain evolution in the semiconductors industry  
Source: own representation (systematization of Value Chain (VC) types based on Gereffi et al. 2005)

Semiconductor contract manufacturing offered by foundries, and, to a limited degree, by integrated device manufacturers, has given rise to a high market concentration in the supply stage (Florea 2013). The emergence of a split model of design-only firms (fabless firms) and fabrication-only firms (foundries) now coexisting with classical large-scale manufacturers can be traced back to an upgrading of supplier capabilities (Gereffi et al. 2005) particularly of technological capability related to standardized product platforms in the case of fabless firms (Park et al. 2018) and a shift to modularity in the case of foundries. The needed upgrading of supplier skills was driven by market demand (consumer electronics since 1970s and wireless communication and video gaming since 1980s and 1990s) which, unlike the PC era with the long-lived Intel standard, necessitated customized instead of standardized chips (Adams et al. 2013). The resulting fabless firms as suppliers of on-demand customized chips have experienced a high exposure to hold up by their intermediate users as the low barriers allowed the latter to tap into suppliers' knowledge and finally create their own chips (Adams et al. 2013). The patent analysis of the semiconductors industry for 1980-2018 (section 3) will come back to this by looking whether a higher risk exposure as a result of the structural shifts in the value chain can be verified by using two patent indicators.

The ability to codify (e. g., by means of interface standards) facilitates modularity (e. g. market modularity in arms-length relationships and technical modularity, i. e. pertaining to design, see Ernst 2005) and has enabled a large-scale disintegration of the semiconductor industry. Modularization also contributed to sustained scale economies despite an increasing vertical disintegration of the value chain (Malerba und Nelson 2011). The Taiwanese semiconductor industry (with its own "Silicon Valley", the cluster Hsinchu Science-Based Industrial Park) has seen a steep rise in both foundries and fabless firms since the 1980ies driven by, among other factors, a decrease in development costs and short technology cycles which prompts their categorization as distinct industries by Hung et al. 2004. However, there are signs of the pendulum swinging back, some authors stress the need for tighter coordination when complexity levels become too high to be counteracted by codification which puts a limit to modularization and market coordination (Dibiaggio 2007) and in turn calls for higher degrees of integration in the semiconductor industry (Ernst 2005).

This is equivalent to saying that the governance modes of fabless firms and foundries are in need of being more tightly integrated or coordinated or else that



there may be a renaissance of integrated equipment manufacturers. Prior research has pointed to a relationship between structural shifts (modularization and miniaturization which contributed to a vertical disintegration giving rise to fabless firms) and scientific firm output with foundries more active in patenting and fabless firms publishing more scientific articles (Pellens und Della Malva 2018).

Technology related factors impacting on value chain configuration to be taken into account besides integration are modularization and systems-on-a-chip design with the latter enabling reuse of designs (Dibiaggio 2007) and miniaturization (Hoeren 2016). As both the complexity of transactions and the ability to codify impact on modularity levels, the model of Gereffi et al. 2005 should be a suitable backdrop for analyzing the risk exposure of this exemplary greentech value chain in more detail in what follows.

## ***2.2 Risk exposure in value chains: measures***

Originating in ecological studies (Adger 2006), value chain risk studies in an economic context have addressed resilience and robustness of local value chains (Quoreshi and Stone 2019). Transaction risks proliferate in long and lean value chains (Peck 2005) dominated by few suppliers (Wagner and Bode 2006) in which trading costs (including informational ones) accumulate. The main industries analyzed in prior resilience studies however have been outside greentech, namely chemistry, automotive, pharmaceuticals (Enyinda and Szmerekovsky 2008) and machinery and electronics (Peck 2005; Svensson 2000).

China holds a de factor monopoly on rare earths, estimations range between 67% and 85 % of worldwide heavy rare earth production being concentrated in China which is also the biggest magnet producer (Glöser-Chahoud, Tercero Espinoza 2015, referring to Du, Graedel 2011; Keilhacker & Minner 2017).

For fabless firms specialized in the design stage of the value chain, it is critical to tap in to diverse sources of design related knowledge and, at the same time, to orchestrate the interplay of modules which may become an additional source of uncertainty (Dibiaggio 2007), or, in other words, a driver of value chain risk. Value chain risk also emanates from the structure of the value chain, e. g., from being trapped in contracts with less productive partners (Cantner et al. 2019).

### 3 Patent analysis

#### 3.1 *Measurement of risk exposure based on patent data*

Patent analyses on technologies have been conducted from different angles, e. g. as a means to identify technological sub-trajectories (Kalthaus 2017) and to uncover technological trends as mirrored in patent maps and patent networks (Abbas et al. 2014; Lizin et al. 2013). From the viewpoint of this paper, prior work is of interest which has used patent indicators as a means to identify the developmental stage of a technological innovation system (Berg et al. 2019), particularly as a means to measure sharp intrusion of technologies into established fields (Porter et al. 2019). This can lead to disruptive innovation as radical shifts to new trajectories (Dosi & Nelson 2010) which destroy established governance modes and leads to a repositioning of value chains, e. g. between fabless firms and foundries and, potentially, back to integrated device manufacturers. In what follows, a closer look at the semiconductors value chain is taken, entailing an attempt at measuring shifts in technological fields which are interpreted as entailing risk for established technological fields (uncertainty in the model of Gereffi et al. 2005) by means of a patent indicator.

##### 3.1.1 *Three crucial time spans in semiconductors*

In the semiconductor industry, patent licensing, particularly by integrated device manufacturers, fabless design firms and IP vendors which license designs to the former, is a major source of revenue (Florea 2013). Figure 6 shows the development in granted patents for the top four countries accumulating most of the patents granted in semiconductors in the period 1980-2018.

Almost half of all patents during this period have been granted to Japanese inventors (395.000), followed by the United States (183.986), the Republic of Korea (148.988) and, with a considerable lag, China (54.688). Notable is the recent surge in the number of granted Chinese patents (green line in Figure 6) the quality of which may be lower though compared to its peer economies.

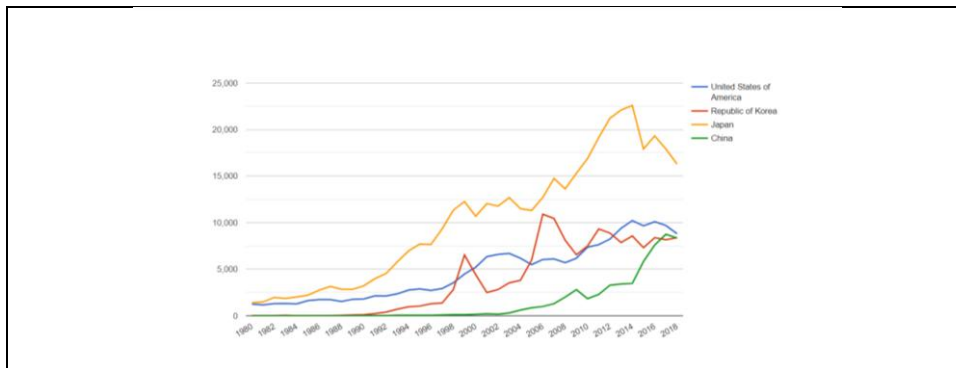


Figure 6: Semiconductor patent grants by country of origin 1990-2018, equivalent count<sup>1</sup>, top 4 patentees only

Source: retrieved from WIPO Statistics Database of World Intellectual Property Organization (WIPO) 2020, 17th June 2021, technology class nr. 8 (World Intellectual Property Organization (WIPO) 2019)

As Boeing und Mueller 2016 have shown (for PCT applications through which countries seek international protection), the steep increase in Chinese patents has been achieved at the expense of patent quality when only foreign and no self-citations of patents are considered. 30 % of the surge in Chinese patenting has been traced back to the policy of grant based patent subsidies initiated between 1999 and 2007 resulting in lower quality patents with narrow claims (Dang und Motohashi 2015).

A more detailed analysis of PCT patents (now looking at applications) is conducted in what follows for three crucial periods in the history of semiconductors:

1. **1980-1994** – Pro-patent shift: This is the era of the pro-patent shift, marked by the 1984 Semiconductor Chip Protection Act (SCPA) which protected the mask work, i. e., the pattern formed by the circuits on the silicon wafer, and the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement (Hoeren 2016; Hall und Ziedonis 2001). TRIPS as a multilateral IP system subject to the WTO dispute settlement mechanism grants extended protection to all types of means to create that pattern (topographies) besides through masks (Hoeren 2016) and grants protection against trade secret theft and

<sup>1</sup> Equivalent count means that „an application filed at a regional IP office is counted multiple times according to the number of its members. This method applies to all regional offices where the filing has an immediate legal effect in all member states“, (WIPO 2021).

compulsory licensing for semiconductors (Semiconductor Industry Association November 2020). The end of the period coincides with the founding of a formal industry association of fabless companies, the Fabless Semiconductor Association in 1994 which suggests a fair amount of stabilization of the fabless governance model (which had existed mainly in the US since the 1950ies whereas Japan invested in IDMs (Hoeren 2016)

2. **1995-2009** – Disintegration: During the 1990ies, the market for semiconductors became substantially more diversified including, after consumer electronics and PCs, gaming and, in the 2000s, communicative platforms in automobiles which necessitated more customized chips and decoupled the manufacturing and design ends of the value chain (Adams et al. 2013) which further fuelled both the entrance of fabless firms and of foundries
3. **2010-2018** – Reintegration (?): Increasingly, modularization contributes to product and technological complexity, bringing the need for coordination back in to semiconductors (Dibiaggio 2007)

During the whole time period 1980-2018, a total 153.710 PCT patents have been applied for at WIPO (the time span is pruned to the year 2018 due to patents pending for a maximum duration of 18 months before being granted).

Three independent searches on WIPO's Patentscope for PCT patent applications have then be conducted (17<sup>th</sup> June 2021) using the search strings included in the Appendix A which cover the three time periods, 1980-1994, 1995-2009 and 2010-2018. The aim is to find out, if these periods, marked by regime shifts in patenting (first period), market structure shifts (second and third period) and shifts in the market power of suppliers and the composition of the demand side (second and third period) are characterized by different levels of exposure to risk induced by the intrusion of other technologies into the core technological category. First, an overview of the prevalent technological categories in the three time periods is provided (Figure 7). Overall, 144.798 PCT patents applications have been registered at WIPO in semiconductors between 1980 and 2018. Summing up patent numbers across technological fields (IPC codes) results in 257.041 PCT patent applications where the difference stems from the fact that patents are filed in multiple IPC codes. Patent applications have increased in all three time spans in all technological categories (IPC codes) from 5748 applications in the first, to 93.550 in the second and 157.743 in the third time span. The biggest increase has

understandably been in the core category of semiconductors, H01L (a separate scale is indicated for this in Figure 7 due to the large difference in application numbers to the other categories), with a particularly steep rise beginning within the first time span (1980-1994) and lasting into the second time span (1995-2009) reflecting at least in part the repercussions of the pro-patent shift happening during these 15 years and culminating in the TRIPS agreement in 1994, and, to a lesser degree, between the second and the third time span (2010-2018).

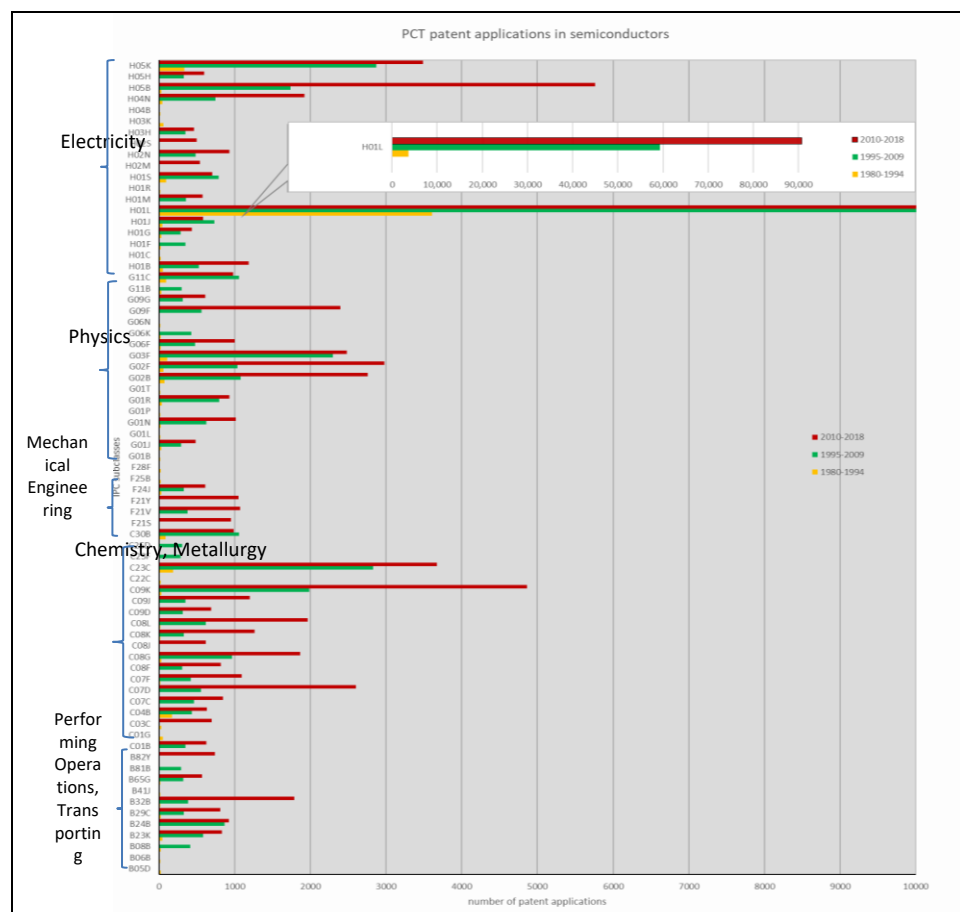


Figure 7: Patent applications 1980-2018 in semiconductors

Source: own representation

PCT patent applications retrieved from WIPO Patentscope, 17<sup>th</sup> June 2021, for the three time spans in comparison (H01L with separate scale due to high numbers of patent applications compared to other IPC codes)

### 3.1.2 Patent indicators as a measure of risk exposure

In what follows, based on two patent indicators developed by Berg et al. 2019 (which build on the technology cycle of Anderson und Tushman 1990), it is investigated for the three time spans if the market structure and market power shifts described at the beginning of this section have affected the composition of technological trajectories.

It is argued that as patent applications (being the nearest indicator of creative inventions) are published ahead of their being granted and can therefore leave a trace in semiconductors as an innovation system in that they spur further inventive activity and therefore can be considered a good representation of early signs of changes in innovation dynamics (and risk exposure). The indicators are defined as follows:

<p>The <b>Patent Trajectory Indicator</b> of year <math>t</math> is defined as</p> $PT_t = \frac{M_t}{\sum_{i=1}^N P_{i,t}}$ $= \frac{\text{number of applied IPC codes in year } t}{\text{sum of total patent applications in year } t}$
<p>The <b>Category Concentration Indicator</b> of technology category 1 and year <math>t</math> is defined as</p> $CC_{c1,t} = \frac{\sum_{i=1}^N P_{i,c1,t}}{\sum_{i=1}^N \sum_{c=1}^M P_{i,c,t}}$ $= \frac{\text{number of patent applications in tech category } c1 \text{ and year } t}{\text{number of patent applications in all tech categories in year } t}$

Figure 8: Two patent indicators for tracking technology development

Source: own representation based on Berg et al. 2019

Legend:

$i = i_1, i_2, \dots, i_N$  : Identification number of patent,  $N$  is the number of patents

$t = t_1, t_2, \dots, t_q$  : application year,  $q$  is the number of years

$c = c_1, c_2, \dots, c_M$  : technology category (proxied by IPC code),  $M$  is the number of applied WIPO technological categories

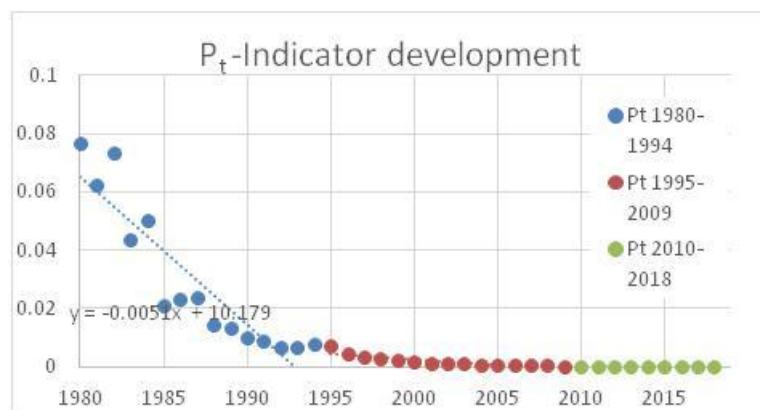
The first indicator, the Patent Trajectory Indicator ( $PT_t$ ) allows to analyze the breadth of the innovation system measured by the number of technological categories divided by the number of patent family applications in a given year with a decline in the indicator pointing at a stabilization of the TIS around a dominant technological category.

The Category Concentration Indicator ( $CC_t$ ) sheds light on how concentrated the TIS is on one technology category which dominates the sample of a given year ( $CC_t > 50\%$  together with a negatively trending  $PT_t$ -Indicator), or, on the contrary, if it is quite dispersed with new trajectories beginning to take shape and to crowd out the dominant technological category. A high degree of dispersion ( $CC_t < 50\%$  for all technology categories and years) together with a varying linear trend of the  $PT_t$ -Indicator can be interpreted as the TIS being in an era of ferment with technology categories not yet fully consolidated possibly marking the beginning of a new technology cycle. This is equivalent of saying that the era of ferment is characterized by externalities. These externalities can be positive: a good example of this is the co-development of mainframe computers and transistors in the 1950ies and minicomputers and integrated circuits in the 1960ies which propelled the further development of their respective industries of origin, the computer and semiconductor industries (Malerba et al. 2006). However, negative externalities arise in the form of market-stealing as a consequence of product market rivalry (Bloom et al. 2013). In the above mentioned case, alleged market-stealing (copying by Japanese chip producers) ended an era of generous cross-licensing between US and Japanese semiconductor and electronics firms and led into what became known as the chip war in the 1960ies (Hoeren 2016).

A positively trending  $PT_t$ -Indicator together with a share of the dominant technology category of more than 50 % ( $CC_t > 50\%$ ) indicate that more remote technological categories begin to invade the core trajectory of the innovation system (era of discontinuity) (Berg et al. 2019). While this may bring in knowledge from outside the system, it can also be a sign of eroding of knowledge boundaries between users and suppliers, endangering established IP positions of suppliers as users incorporate increasing shares of the semiconductor design specific knowledge (Adams et al. 2013) and threaten the competitive edge of suppliers.

The indicators have been calculated for the ten most often occurring IPC patent codes in semiconductors and have been retrieved 25<sup>th</sup> June 2021 from WIPO's

Patentscope (for search string see Appendix A). The results are as follows (Figure 9 and Appendix B): The clear negative trend of the  $P_t$ -Indicator between 1980 and 1994 combined with the dominance (>50 %) of technology category of Electricity which accumulated around 80 % of patent applications indicates that this has been an era of dominance of the central technology, H01L: Semiconductor devices, which is part of Electricity. In the following two time periods, the  $P_t$ -Indicator starts with a slightly negative slope but plateaus off already between 2000 and 2009 (in the second half of the middle period) and ultimately is almost flat between 2010 and 2018. Patents filed in Mechanical engineering are non-existent in the latter two periods and filings in Performing Operations and Transporting wane away since 2004. Thus, the field consolidates around the three remaining technological fields Physics, Electricity and Chemistry since 2010 with Electricity still the dominant category. Neither of the technology cycle phases in semiconductors can therefore be categorized as being in an era of ferment with the competitive edge at stake. However, the fact that the  $P_t$ -Indicator (which is a measure of breadth of the innovation system) is declining substantially, the consolidation around the focal technology appears to be coming to an end which (should the indicator turn out to become positive) would be the beginning of an era of discontinuity with new fields intruding into the core field of semiconductors. This will prospectively be applications from Chemistry and Physics which have both begun to accumulate more patent applications in the course of the last two periods. Chemistry, for instance, has been reaching around 10 % of applications since 2011. This, however, is an open ended development which needs further confirmation as to its long-term stamina.





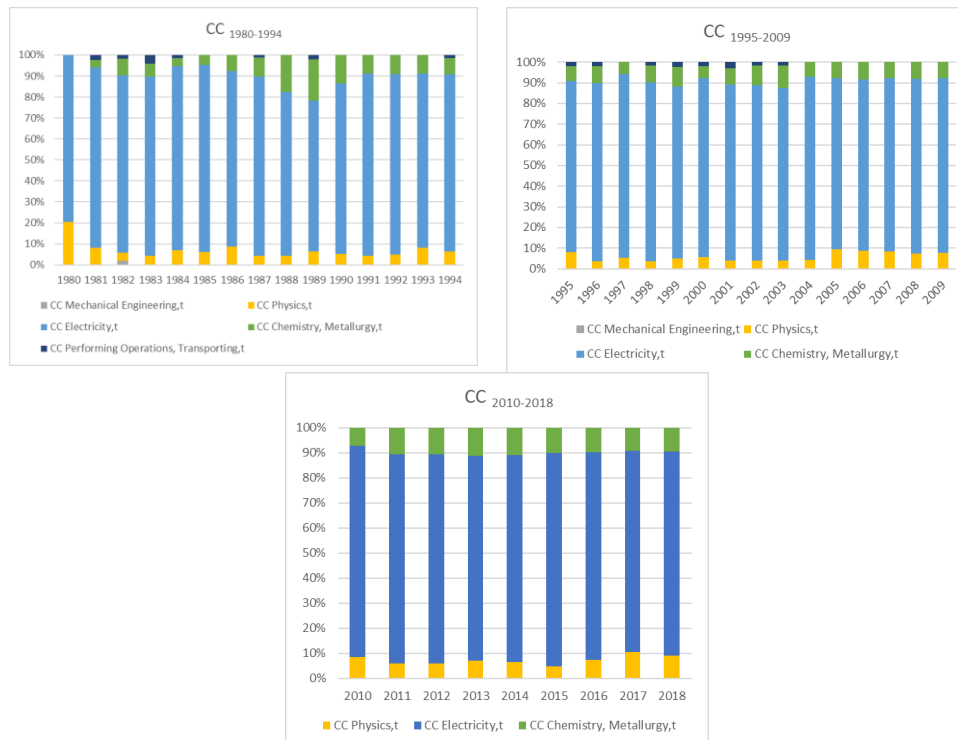


Figure 9: Patent indicators in semiconductors for three time spans in comparison  
Source: own representation based on PCT patent applications, WIPO patentscope, retrieved 25<sup>th</sup> June 2021, indicators based on Berg et al. 2019

#### 4 Governance of the semiconductor value chain

Value chain governance types (in the definition of Gereffi et al. 2005) have been outlined for semiconductors based on patent data. However, governance of value chains may be understood from an applied angle as a set of measures taken to mitigate risk in the value chain. Given space constraints, a range of measures pertaining to sustainability and industry 4.0 shall be outlined.

Although the Re-Use of magnets from car motors is technically feasible with a net positive outcome according to ecological life cycle assessments they are rarely reused due to a lack of standardization of the rotor design (Walachowicz et al., 2014). Electric motors, for instance, are rarely re-used although it is mandatory to explore how a modular set up of these may contribute to prolonging their life-span, provided that the quality and performance requirements are clearly laid down so as to make them eligible for the same or a similar use (Wehrspohn 2017). A combination of standardized components and a modular design of

assembly would help to bring down risks associated with the spare parts business and maintenance contracts and to better align the design of products and service portfolios (Schneider et al. 2016) thereby increasing Re-use and Recycling quota. However, the question remains how materials' origin and composition and the feasibility of recycling methods for RE intensive industries can be ascertained in a timely and efficient manner by both legislators and industry (Schlegel & Rockland 2018). The case of industry 4.0 is an example of a process discontinuity which offers process variants potentially enabling „order-of-magnitude improvements in the cost or quality of the product“ (Anderson und Tushman 1990, p. 607), e. g. in combination with blockchains. Blockchains (which helps to reduce informational risks, Min 2019), standardization of the setup of chips which allows to curb the existing high degrees of complexity as well as closing the loop of global value chains (e. g., through increased Recycling and Reuse activities and cloud-based business models) would help semiconductors to reduce the level of risk in their value chain.

## **5 Results and discussion**

To conclude, a general configuration of the value chain caused by a sharp intrusion of competing technologies could not be ascertained. However, although electronics applications are still the dominant technology category, the rise in the  $P_t$ -Indicator (as a measure of technological breadth) which has started off negative but plateaued off in the course of the last 18 years, could point to the fact that the phase of retention around the focal technology applications in Electronics is coming to an end and that an era of discontinuity in which this dominant technology category could be destroyed (from applications stemming from Physics and Chemistry) may be imminent.

The technology cycle of Anderson und Tushman 1990 has been combined with a model of value chain governance of Gereffi et al. 2005 in this paper. The development of PCT patent applications in the three time spans has been tracked based on WIPO's Patentscope database. In addition, two patent indicators have been calculated based on PCT applications. These indicators have originally been developed as a means to track technology footprints (emerging and declining technologies) in technological innovation systems (Berg et al. 2019) but have been applied in this paper as a measure of the degree of resilience of an exemplary innovation system, semiconductors. Limitations of the indicator

employed translate also to the application in the context of this paper, e. g. the fact that the choice of technology categories (IPC codes) and the selection of the time period are critical for the results obtained (Berg et al. 2019). The patent search only included the most basic IPC code, H01L, but could have been enlarged by a combined keyword and IPC code search enlarged by further codes. The last time span is shorter than the other two (8 years) and the further development cannot be foreseen with any degree of certainty.

Alternative measures could have been used to measure the exposure to risk based on patents, e. g., Lee et al. 2016 have established that a low connectivity of the patent portfolios of Japanese firms particularly in electronics and robotics has insulated the Japanese economy in technologies critical to make a digital transition in the context of industry 4.0. Patent citations mirror knowledge networks and have been used to describe the evolution of knowledge in the design hierarchy of wind energy (Huenteler et al. 2016) which could also be related to uncertainty and risk. The measures applied here however, to the best of the author's knowledge, have not been used as a measure of risk exposure of sectors critical for the sustainability transition, like semiconductors, as they originally stem from a technology emergence background.

It has been contended that the private sector's SDG performance is more objectively investigated by means of patent data than by employing more elusive measures mirrored in reporting (van der Waal et al. 2021). This is in line with the tech mining approach which mandates combining analyses of scientific literature and patent analyses with the aim to trace technological trends in an informative, reproducible and efficient manner (Porter et al., 2019, Lizin et al. 2013). This paper has suggested an approach aimed at measuring the degree to which an innovation system like semiconductors is prone to value chain risk by means of patent indicators.

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## **When Do Ecosystems Facilitate Transformative Social Innovation? A Configurational Analysis of SI Projects in Developing and Emerging Contexts**

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### **Abstract**

Social Innovation (SI) is a configuration of social practices prompted collectively and intentionally by multiple stakeholders in a specific ecosystem to solve problems that would be not effectively solvable through traditional approaches or practices by transforming the social and economic settings. Despite the literature around SI ecosystems has grown considerably in the latest years, what makes an ecosystem facilitator for transformative SI remains unexplored, especially in specific contexts and geographies, such as developing and emerging countries, where structural, cultural, relational, and power conditions differ from those of more powerful stakeholders enacting the SI initiative. Our research aims to fill such a gap by investigating the combination of characteristics - stemming from Stakeholder Theory and Knowledge Management - that enables local stakeholders'

autonomy in developing and emerging coffee-producing countries to increase the impacts of SI initiatives. We adopt a configurational approach through fuzzy set Qualitative Comparative Analysis on 18 projects of SI undertaken by coffee MNEs, NGOs, and institutions to favor an egalitarian value co-creation among local coffee farmers. That entails that farmers overcome being just the projects' target to become the catalysts of local social, economic and environmental initiatives for change ultimately. We demonstrate that stakeholder empowerment, cooperative strategic posture, knowledge transfer, and local knowledge exchange are necessary conditions within the ecosystem for creating local autonomy as antecedent for transformative SI. Our novelty resides in suggesting a combination of characteristics that represents a virtuous process changing the rhetoric of firm-centric view based on stakeholder dependence to move to lower-power stakeholders' interdependence and collaboration through a reconfiguration of relationships, advancing fresh perspectives on stakeholder and knowledge management thinking applied to SI literature. Eventually, we also propose practical ways to deal with the imbalance in stakeholder power, which the literature identifies as a factor that might limit the SI's actual transformation and effectiveness locally.

**Keywords** – Stakeholder Theory; Knowledge Management; Digitalization; Low-power Stakeholders; Social Innovation; Developing and Emerging Contexts

**Paper Type** - Academic Research Paper

## 1 Introduction

Social innovation (SI) is a highly fragmented practice that can be explained through various theoretical angles and involves multiple groups of stakeholders with different levels of power and expectations (Moulaert et al., 2017). SI is intended as a new configuration of social practices prompted collectively and intentionally by a constellation of stakeholders in a certain environment to solve problems that would be not effectively solvable through traditional approaches or practices (Cajaiba- Santana, 2014; Howaldt and Schwarz, 2010). Rethinking and reconfiguring resources, relationships and knowledge are two mainstream actions of SI, aiming to find new methods for accomplishing social goals such as innovation sources and new key strategic partners for developing projects of social interest (Chesbrough, 2006; Herrera, 2015; MacCallum et al., 2009; Mirvis & Googins, 2006; Mulgan, 2006). The context in which SI happens needs to be supportive of the transformative mechanisms behind social innovation. Scholars and practitioners commonly define such a context as an ecosystem (EU Commission, 2015) or enabling ecosystem (Terstriep et al., 2020; Biggeri et al., 2017; OECD-LEED, 2016).

The word ecosystem itself – defined by the Oxford dictionary as “all the plants and living creatures in a particular area considered in relation to their physical environment” – reflects those characteristics of interaction and interconnection, which are common to any SI initiative. In the SI field, an ecosystem is formed by the multiplicity of stakeholders involved in the initiative, their power, their relationships, the elements affecting their interactions as well as any other condition impacting on the processes and the outcomes of SI (Terstriep et al., 2020; Bloom and Dees, 2008). Therefore, the ecosystem framework perspective best fits the study of the transforming nature of social innovation. It gives the idea of continuous interaction among stakeholders and interconnection between stakeholders and the environment, allowing movements and transformation in the structural conditions (Carayannis et al., 2018). An ecosystem needs a combination of enabling and empowering elements to allow SI to grow effectively and transformative (Terstriep et al., 2020).

Even though the literature around SI ecosystems has grown considerably in the latest years in the attempt to formulate adequate responses to social, economic, and environmental issues through a broader conceptualization of innovation (Domanski et al., 2020; Ziegler, 2017), which combination of enabling elements makes an ecosystem a facilitator for transformative SI remains unexplored, especially in certain contexts, such as developing and emerging countries (Sept, 2020; Terstriep et al., 2020; Voorberg et al., 2015; Rüede and Lurtz, 2012; Murray et al., 2010).

Our research aims at filling such a gap by investigating which combination of characteristics—stemming from Stakeholder Theory and Knowledge Management—makes an ecosystem capable of facilitating transformative SI initiatives conducted in coffee developing and emerging countries, where smallholder farmers (coffee owners and producers) struggle with economic, social and environmental issues. In the context of our research, we define transformative SI as initiatives that, despite being prompted by the multinational enterprises (MNEs, in our case coffee roasters) together with other partners such as global and local NGOs and institutions in a logic of support to local coffee farmers’ well-being and coffee sustainability, are undertaken to favor an egalitarian value co-creation among local coffee farmers. The egalitarian logic – opposite to a traditional paternalistic narrative (Civera et al., 2019) – entails that farmers are not merely the objects of the SI initiatives but rather the initiatives aim at turning them into partners and co-designers of further local SI projects (Candelo et al., 2019; Civera et al., 2019;

Candelo et al., 2018). In other words, transformative SI means reconfiguring stakeholder relationships to increase farmers' autonomous decision-making so that they can become the catalysts themselves of local SI with a strong motivation to cooperate and develop participation in their own ecosystem, to foster their local community well-being and independence as well as to reach business sustainability.

Our study aligns with previous research positing that innovative and transformative solutions within SI in complex scenarios need to be investigated through a multidisciplinary and interactive perspective (Scott et al. 2017; Woodside, 2012; Mitleton-Kelly, 2006).

That is why we observe the phenomenon under study through the theoretical lenses of Stakeholder Theory (ST) and Knowledge Management (KM). Those best interpret such kind of transformation in an ecosystem, in terms of relational drivers for redesigning fair, balanced, and trustful relationships (Mirvis et al., 2016; Mirvis et al., 2012; Cajaiba-Santana, 2014; Greenwood and Van Buren III, 2010; Howaldt and Schwarz, 2010) and critical mechanisms of transfer and exchange of knowledge that can help to solve problems, developing new ideas or implementing new practices or policies (Cummings, 2004).

From our theoretical analysis, we outline key constructs within ST and KM – which the literature considers relevant to allow effective social transformations – that we summarize into five enabling characteristics (also named initial variables): stakeholder empowerment; cooperative strategic posture; knowledge transfer; local knowledge exchange; engagement to digital transformation. Those characteristics can be developed to a certain degree and implemented in a specific combination, impacting differently on the local autonomy of farmers for transformative SI, which is the outcome that we aim at testing.

To investigate the degree and combination of those characteristics, we analyzed 18 carefully selected SI initiatives, which involve multiple stakeholders of the coffee supply chain in various developing and emerging countries to enhance local autonomy for transforming the traditional SI nature and outcomes in a twofold way. First, we collected data and information through primary and secondary sources, tested each characteristic's degree of development within the cases through thematic analysis, and evaluated each enabling characteristic per each SI initiative. Second, we adopted a configurational methodological approach by performing fuzzy set Qualitative Comparative Analysis (QCA) (Woodside, 2010; Ragin, 2009; Drass and Ragin, 1992).

The reasons why we focus on such a specific context are threefold. First, since social innovation is 'often highly contingent and context-sensitive' (Nicholls et al., 2015, p. 22), contextualization helps identify key mechanisms for improving the impacts of SI. Second, developing and emerging contexts are full of paradoxes, especially in terms of stakeholder power and culture. Studying a possible enabling ecosystem for SI in those contexts can contribute to overcoming the issue of stakeholder power, limiting SI effectiveness (Sept, 2020; Lannon & Walsh, 2019; Nicholls and Ziegler, 2015; Moulaert et al., 2007). Third, within SI practices, analyzing how to progress the autonomy of lower-power stakeholders who have always been underestimated (Dawkins, 2014; 2015) can be a way to establish a change of mindset and adopt a new perspective of social transformation. Such a change of mindset can be challenging and fruitfully applied in developing and emerging contexts, where we are used to witnessing a traditional firm centric-view through which firms tend to impose social changes through SI initiatives involving powerful stakeholders. This attitude needs a rethinking that might open new challenges for lower-power stakeholders not to be the passive actors of SI projects anymore but to become active co-operators and catalysts for a greater SI impact (Jamali and Mirshak, 2007; Civera et al, 2019; Khavul and Bruton, 2013; Muthuri et al. 2012).

## **2 Social Innovation from a Stakeholder Theory perspective**

The essential argument of Stakeholder Theory (Freeman, 1984) is the conceptualization of organizations and stakeholders as entities entangled in a complex ecosystem of relationships. What makes ST a breakthrough approach in the rhetoric of business is the acceptance of harmonization, cooperation, and joint-ness of interest among various categories of stakeholders (Strand and Freeman, 2015), versus considering conflicts and competition as the main forces governing an ecosystem through a firm-based perspective (Porter, 2008). According to stakeholder scholars, a firm centric view based on transactions might overlook key factors, mechanisms, stakeholder identities, and needs that can enable higher stakeholder participation, proactive actions, and increase the impacts of value co-creation (Bridoux and Stoelhorst, 2016; Den Hond and de Bakker, 2007; Rowley and Moldoveanu, 2003). That is why fresh perspectives on stakeholder thinking posit that looking at stakeholder relationships only from the more powerful stakeholders' perspective (such as the MNE) might overlook the

possibility of valuable collaborations for broader scopes with those groups of stakeholders that have always been considered to be less legitimate and less powerful (Derry, 2012). Therefore, ST scholars posit that power and responsibilities should be spread among stakeholders at multiple levels to encourage joint value creation and higher creative outcomes of SI (Civera and Freeman, 2019; Dawkins, 2014; 2015; Freeman et al., 2010; Jamali and Mirshak, 2007).

Such a perspective fits with the key objectives of SI, which rely upon collaborative engagement and the creative reconfiguration of social relationships within ecosystems for solving social issues (Chesbrough, 2006; MacCallum et al., 2009; Mirvis & Googins, 2006). Therefore, ST can support Social Innovation in a twofold manner.

First, the issue of stakeholder power remains a huge barrier limiting the effectiveness of SI initiatives, because it prevents collaborative engagement (Montiel et al., 2012; Moulaert et al., 2007; Nicholls and Ziegler, 2015). This is particularly true when MNEs establish relationships with stakeholders in contexts that can favor the spread of unfair practices, such as powerless communities in developing and emerging countries where the MNE sources key resources for its business. In this specific case, it is most likely that the relationships between the company and the vulnerable stakeholders are unbalanced and merely based on dependency. To this end, latest ST research has applied the empowerment construct to lower-power and vulnerable stakeholders operating in developing and emerging contexts to increase their independent participation in social and business initiatives (Civera et al., 2019). Stakeholder empowerment (SE) has been conceptualized as a step-by-step process aiming to provide stakeholders with the right tools and knowledge to create awareness and influence over their decisions (Dawkins, 2014; 2015), increase their moral standing, their autonomous voices and their proactive participation to social and economic initiatives (Dawkins, 2015; Freeman et al., 2010; McVea and Freeman 2005). Empowerment goes from the mere economic support to vulnerable communities to the strengthening of lower-power stakeholders' business mindset, the organizational structures of their businesses to operate independently and the establishment of social and sustainable approaches to adopt locally (Civera et al., 2019; Crane and Ruebottom, 2003; Fassin et al., 2017; Kumar and Pansari, 2016).

Second, empowerment is understood as the main antecedent of the cooperative strategic posture needed to effectively reconfigure stakeholder

relationships and responsibilities for enabling stakeholders' participation in SI (Desai, 2018; Shams, 2016). Developing a local cooperative strategic posture (CSP) (Strand and Freeman, 2015; Enright & Bourns, 2010) entails that vulnerable and lower-power stakeholders are empowered enough first to establish fair and trustful relationships (Greenwood and Van Buren III, 2010; Phillips, 1997). That means that stakeholders must perceive that the more powerful actors involved in the SI ecosystem act to meet their needs and rights legitimately without opportunistic behavior and through fair and transparent information-sharing mechanisms, communication, and two-way dialogue (Greenwood and Van Buren III, 2010). Then, empowerment and trust might lead stakeholders to be engaged with both the SI ecosystem actors and their own local communities and resources. Despite being a multi-faceted construct, engagement is, in this context, defined as a process of positive stakeholder involvement (Greenwood, 2007) that is the result of continuous powerful stakeholders' commitment to lower-power and vulnerable stakeholders so that the latter develop consent, commitment, alignment to the organizations' values and are inclined to cooperate through a collaborative mentality (Freeman et al., 2010).

Spreading power and favoring cooperative strategic posture can contribute to redesign relationships in an interdependent way (Freeman et al., 2010). The idea is that once power is redistributed (thanks to the efforts of virtuous organizations within the SI project) and relationships among stakeholders redesigned in a fairer way, responsibility shifts to categories of stakeholders that were previously considered lower-power, vulnerable and dependent, creating a fertile ground for further actions to boost the transformative impacts of SI.

### **3 Social Innovation from a Knowledge Management perspective**

Knowledge Management (KM) scholars agree that establishing knowledge-based relationships through knowledge transfer (KT), local knowledge exchange (LKE) and engagement to digital transformation (EDT) can enhance mutual learning interactions and the chance for co-creating value in the interest of social, economic and environmental outcomes within SI (Wood and Bischoff, 2019; Jali et al., 2017; Avelino et al., 2015; MacCallum et al., 2009; Peloza and Falkenberg, 2009; Usoro et al., 2007).

Knowledge Management is a set of valuable ways to collect the knowledge accumulated in an ecosystem in its path of technological, social, environmental

and business strategies using procedures that allow, at any time, to retrieve it, review it and update it dynamically (Davenport and Prusak, 1998). KM success depends on ensuring that both explicit and implicit knowledge are detected and developed (Frappaolo, 2008). That happens to the extent to which the dimensions of the intangible assets (human, organizational and relational capital) interact in synergy (Janz and Prasarnphanich, 2003). In recent decades, awareness has grown that a large part of an ecosystem's development depends on its intangible factors: the creativity, unpredictability, and emotional intelligence of human capital (Lazovic, 2012). Continuous learning processes based on localization, "cross-fertilization" between different experiences and categories of stakeholders create new skills and make the existing ones evolve, increasing the chances to spread SI in the ecosystem (Dahiyat, 2021).

The management of innovation, starting from the 90s, ceased to be exclusively a rigid and engineeristic process, to coordinate and enhance the knowledge heritage toward complexity and development (du Plessis, 2007). The valorization of knowledge is achieved only when knowledge sharing occurs between people within an ecosystem (Cabrera et al., 2006; Wang and Noe, 2010). If we refer to the local communities of vulnerable and lower-power stakeholders in developing and emerging countries, this can happen because of knowledge transfer, which is defined as the act of moving the knowledge among different entities or organizations (Szulanski et al., 2004). According to Wang and Neo (2010), sharing knowledge can support intra-stakeholder collaboration to solve problems, develop new ideas, or implement new projects (Cummings, 2004). However, it does not deliver results if stakeholders are not keen to absorb the new knowledge (through knowledge transfer from more powerful actors), to look for extra information, inputs and learning, that is knowledge-seeking. Such a process is defined as knowledge exchange and implies both the intention (as a starting point) and the act of sharing knowledge as well as the act of seeking new knowledge for creating innovative solutions.

Clearly, in a context of lower-power and vulnerable stakeholders, the presence of an empowering culture favors, even more than within an organization, a knowledge enhancement culture and motivation, in a virtuous circle (Caniëls et al., 2017). It has already been demonstrated in various contexts that digital innovation within KM practices can boost such a virtuous circle when it is accompanied by a high engagement and cooperative strategic posture of all



stakeholders involved in the digitalization strategy (Candelo et al., 2021; Troise and Camilleri, 2021).

In this sense, KM makes technology, culture, business, and social processes collaborate on an equal basis: new technologies offer the opportunity to increase interactions between people within an ecosystem while at the same time allowing to reach many interlocutors and to accelerate the processes of sharing new ideas and information. Therefore, even though the interactions between the social layer of SI and the role of technology are very complex to detect (Meijer and Bolívar, 2016), digitalization strategies and technological transformations can be considered social actors boosting active participation and multi-stakeholder inclusion in social change (Kar et al., 2019; Bock, 2016; Townsend et al., 2015). Digital transformation can impact the way stakeholders interact in the ecosystem and make decisions by favouring: faster communication through an interactive dialogue; sharing of good practices; transparency and trustful relationships; the possibility to develop new capabilities through faster local knowledge contamination (Jafari-Sadeghi et al, 2021; Tödtling and Trippel, 2018).

Our literature review points out that specific characteristics within ST and KM–stakeholder empowerment (SE); cooperative strategic posture (CSP); knowledge transfer (KT); local knowledge exchange (LKE); engagement to digital transformation (EDT)–might be pivotal to create an enabling ecosystem that favors transformative SI. Here our research question raises: which combination of those characteristics makes an ecosystem facilitator of transformative SI?

#### **4 Research context**

Our research focuses on lower-power and vulnerable stakeholders who are, on the one hand, smallholder farmers, owners of key resources in the complex supply chain of coffee (Hwarng et al., 2005) and, on the other hand, suffer from a given situation of inequality linked to their geographical context (Mongelli and Rullani, 2017) – in this specific case developing and emerging countries.

In those countries, commonly, such a group of stakeholders is characterized by: low income (Ahen, 2017); inequality in business power (Dawkins, 2014; 2015); vulnerability and unfairness in relationships with other stakeholders, even local (Candelo et al., 2018; Dawkins, 2015); lower power in decision making (Dawkins, 2015); incapacity to replicate business rules and models on the local territory and exert influence (Greenwood & Van Buren III, 2010); marginalized and vulnerable

conditions (Derry, 2012); poorer structural condition (Mena et al., 2010); lower access to basic needs (Mena et al., 2010) and sometimes denied human rights (Mena et al., 2010); inability to autonomously develop whatever they think is valuable; impossibility to transform ideas into a successful business, social, and environmental practices (Greenwood & Van Buren III, 2010).

## 5 Method

To explore the simultaneous combination of characteristics that makes an ecosystem facilitator of transformative SI, we used fuzzy set/Qualitative Comparative Analysis (fsQCA) as our main method. Fuzzy-set QCA is a research paradigm (Mellewigt et al., 2018) that suits our investigation in three ways.

First, it strengthens new knowledge generation from a continuous dialogue between theory and case studies and favors learning processes among different theoretical perspectives applied to SI.

Second, it goes beyond the mere cause-effect statistical analyses by focusing on a joint causal system that allows interaction effects among each characteristic within a case and permits to study complex and new phenomena within an ecosystem that is constantly evolving (Woodside, 2012). FsQCA allows to simultaneously explore, based on asymmetric linkages (Ragin, 2009), all the possible interactions between a set of initial variables (in our case 'characteristics') of the phenomena under investigation and the relevant outcome (in our case 'local autonomy for transformative SI'). Essentially, fsQCA focuses on combined effects of causal conditions (initial variables), because it assumes causation to be complex, intertwined, and holistic.

Third, it is ideally applicable to a small-to-medium number of cases (Woodside and Baxter, 2013; Woodside, 2010), requiring familiarity to exploratory investigations (Trueb, 2013).

We used Podsakoff et al. (2012) list of principles for correcting estimated values to minimize common method bias.

We adopted a grounded theory approach (Charmaz, 2014; Corbin and Strauss, 1990). We worked separately, made independent judgments on the case studies, and then agreed to evaluate each characteristic in a final set of discussions.

### **5.1 Sample and Data Collection**

Our sample of case studies consists of 18 SI projects that focus on enhancing local farmers and their families' livelihood conditions, their knowledge on coffee-producing methods and sustainable practices, their capacity to establish local and global relationships of value with the overall outcome of increasing their decision-making power for autonomous business and social choices and for designing SI initiatives locally. These projects are enacted by coffee MNEs and their Foundations; global and local Non-Governmental Organizations (NGOs); global and local research institutes and Foundations; Country Regional Governments; International Coffee Organization (ICO); field project officers operating in the following countries: Brazil; India, Tanzania, Ethiopia; Uganda; Haiti and Dominica Republic; Colombia; Trifinio; Indonesia; Peru; Vietnam.

We have selected the SI projects that, to date, have already concluded at least their initial phase, producing measurable results. Furthermore, we have been guided by the Secretary of the International Coffee Organization during several interviews conducted between January and April 2016 (identification phase), who supported us in the identification of the coffee SI projects that could be global benchmarks in illustrating the characteristics of enabling ecosystems for transformative SI.

To develop the case studies, we collected data respecting triangulation (Yin, 2013) and gathered information from multiple sources of complementary evidence, including the systematic literature review, semi-structured interviews (Bernard, 1988) with 30 main stakeholders involved in the SI projects, and content analysis of reports of each project.

First, the literature review allowed us to detect the five enabling characteristics used as the configurational analysis variables, whose degrees for evaluation will be described in the next section.

Second, the semi-structured interviews were conducted both face-to-face and through virtual meeting platforms with the following stakeholders: MNE 1 chief sustainability manager; MNE 1 chief sustainability manager's collaborator 1; MNE 1 chief sustainability manager's collaborator 2; MNE 2 corporate affairs director; MNE 1 green coffee purchasing manager; Secretary at the MNE 1's Foundation; Secretary of the ICO (International Coffee Organization); project manager at the global NGO 1 in Haiti and Dominican Republic; project manager at the global NGO 2 in Uganda; project manager at the global NGO 3 in Brazil; consultant at

the global NGO 4 in Germany; project manager at the local NGO 5 in Colombia; project manager at the local NGO 6 in India; project manager at the local NGO 7 in Ethiopia; project manager at the local NGO 8 in Indonesia; project manager at the local NGO 9 in Vietnam; project manager at the global foundation 1 in Peru; member of the Regional Government in Peru; representative of the local coffee research institute in Tanzania; eleven (11) field project officers of the MNE 1 in all countries.

Interviews were based on a questionnaire containing open questions addressed to first discuss the content and the main aims of the SI initiative. Second, to investigate each initiative against the five enabling characteristics outlined by the literature. In particular, interviewees were asked to describe in detail: the enacted process of stakeholder empowerment and its stage of development locally (SE); the evaluation of stakeholder engagement and the detection of trustful relationships to favor cooperation locally (CSP); the capacity to move knowledge from the more powerful stakeholders to the local farmers (KT); the ability to exchange knowledge by sharing, seeking and generating new sources of innovation and information locally (LKE); the degree of local digital implementation and contamination, as well as the local autonomous usage and understanding of technology for designing innovative solutions in the economic, social and environmental sphere (EDT).

To follow the procedures of grounded theory, each researcher independently cross-interviewed each participant in a reiterative process (i.e. both researcher 1 and 2 personally interviewed MNE 1 chief sustainability manager on different occasions). Some key stakeholders were interviewed at least twice to monitor the projects' evolution during its different phases. A total of 58 interviews were conducted, recorded and transcribed *verbatim* and kept secure in a folder of the researchers' laptops.

Eventually, we consulted available descriptive documents and reports and impact evaluations of each project.

All data and information were gathered on multiple occasions over a time span of about five years, starting in January 2016.

Table 1 reports the full description of each SI project included in our sample regarding the country where the SI initiative is undertaken and project purpose.

Table 1: Sample description

<b>Projects of social innovation</b>	<b>Country</b>	<b>Description</b>
Coffee resilience	Brazil - Minas Gerais	The project aims at contributing to the increase of incomes of small scale coffee farmers in Southern of Minas Gerais through the quality market access adding value and increasing the resilience of their production systems to climate change.
Sustainable coffee production - Brazil	Brazil - Lambari	The project aims training on good agricultural practices; improving coffee quality; improving techniques to face climate change; improving organizational skills; implementing the "Farmer Field School" Methods; Providing soil analyses services; Quality Contest.
Sustainable coffee production - India	India - Sakleshpur and Mudigere	The project aims at improving the living conditions of the smallholder households through the production of sustainable coffee. Empowering the MAS company which ensures the delivering of services and supporting programmes for its members.
Supporting youth in coffee producing regions	India - Calcutta	The project "EveryOne" aims at combatting child mortality; support to a project in favour of marginalised youth in Calcutta
Sustainable coffee production I phase - Tanzania	Tanzania - Kilimanjaro	The project aims at improving the production systems of 5,000 coffee farmer households in Tanzania within 3 years in order to maximize income, cash flow, asset growth, food security and nutrition in a sustainable way
Sustainable coffee production II phase - Tanzania	Tanzania - Kilimanjaro	The project aims at setting up of 28 Farmer Field Schools; setting up of producers' companies trading coffee; product and quality management; saving programs alternative to loans
Coffee Farmer Alliance in Tanzania	Usa River/ Mbeya, Tanzania	The project aims at giving technical assistance to farmers through the Coffee and Climate Methodology; providing support to existing organisations (Shiviwaka and Tanzania Coffee Farmers Alliance) and to intergenerational and gender challenges; providing support to the development of relationships with other local actors
Ethiopia C.A.F.E.	Ethiopia - Amaro and Amhara	The project aims at improving coffee producing techniques and management skills; improving the product quality through sustainable techniques, aimed also at coping with climate change; improving gender balance within families and empowering women in the household management; in partnership with Slow Food working on food security through crop diversification
Technology transformation for coffee	Colombia	The project aims at establishing the IT infrastructure to guarantee that high speed internet allows constant interaction among local and foreign stakeholders, engagement of young generations for facilitating the emergence of creative solutions, exchange of technical skills needed by different teams and exchange of real time feedbacks on smart agricultural practices as well as access to a central database of technical information

Carcafé - Colombia - Meta	Colombia	The project aims at enhancing product quality and quality consistency through training sessions and investments in infrastructures and in reserach and development to sequence the Arabica coffee genoma in order to enhance the coffee quality to cope with climate change and disease and infection of plants as well as increase the antioxidant effects of coffe.
Sustainable Coffee Program - Uganda	Uganda	The project aims at strengthening the implementation of the national coffee strategy, supporting financially farming households with holistic and innovative strategies that will make a long-term and sustainable impact on the productivity and quality of Uganda's coffee.
Building Coffee Farmers Alliances - Uganda	Uganda - Kasese	The project aims at supporting and consolidating the activities already implemented by the existing Producers organizations; supporting the coffee re-planting initiative; supporting the organizations in the relations with financial institutions
Café Hispanola	Haiti and Dominican Republic	The project aims at improving coffee productivity and empowering smallholder farmers, especially women. It is addressefd to transfer agricultural know-how and promote cooperation as well as improve the coffee purchasing and selling systems.
Verdad y Vida	Guatemala - San Lucas Chiacal, San Cristóbal Verapaz	The project aims at supporting the production of coffee by a group a 20 indigenous women victims of the past civil conflict. It aims at enhancing their technical (e.g. organic fertilizers), organizational and administrative capacities.
Coffee development - Trifinio	Trifinio (Guatemala-Honduras-El Salvador)	The project aims at developing managerial skills; technical assistance to farmers through the Coffee and Climate methodology; supporting thr managing of intergenerational and gender changes; developing relations with other local actors and projects.
Promoting Organized Farmers	Peru	The project aims at increasing the flow of income to improved livelihoods of smallholder farmers in the provinces of Lamas, Moyobamba y Rioja in the department of San Martin, Peru.
Strengthening the smallholder Robusta sector in Sumatra	Indonesia	The project aims at collecting, consolidating and disseminating best practices for adaptation in the project regions. The coffee farmers take part in hands-on training activities, assisting them to find strategies which suit their needs. Coffee farmers have access to an online platform, the c&c toolbox
Coffee environmental sustainability	Dak Lak- Vietnam	The projetc aims at improving production techniques efficiency in order to reduce the carbon foot print amd enhance the environmental practices through training on climate change

## **5.2 Description and evaluation of variables**

Using the systematic literature review, we constructed initial characteristics to operationalize the constructs within ST and KM relating to our research question. As the two initial variables to clarify ST and its constructs applied to SI we will use stakeholder empowerment (SE) and cooperative strategic posture (CSP). As the three initial variables to clarify KM and its constructs applied to SI, we will use knowledge transfer (KT); local knowledge exchange (LKE) and engagement to digital transformation (EDT). Each enabling characteristic was evaluated according to a 1-5 Likert scale ranking the absence (1), low, medium, high or full (5) presence, development or implementation of each characteristic.

For SE, the more advanced the empowerment actions (5 on the Likert scale), the higher the chance for the SI initiative to favor cooperation. Otherwise, when empowerment actions are addressed just to cover local basic needs (1 on the Likert scale), the project is considered to be paternalistic rather than transformative.

For CSP, the higher the local farmers' trust and engagement both to the project and other local and international social and business actors, the greater the cooperative strategic posture they can develop to cooperate locally (5). Otherwise, the lower the engagement and the trust, the lower the chances of developing the cooperative strategic posture needed (1).

The more the training is tailored to local farmers' needs for KT, the more effective the transfer of knowledge (5). Otherwise, the mere knowledge assessment among existing and potential partners of the project reflects just an initial intention of transferring knowledge (1).

For LKE, the more effective sharing of knowledge, the higher the chances of the local proliferation of knowledge sharing behaviors (5). Otherwise, the local knowledge awareness reflects a situation where local farmers might want to seek knowledge but do not implement knowledge-sharing behavior yet (1).

For EDT, the higher the presence of solid partnerships and innovation of local services, the greater the engagement to digital transformation (5). Otherwise, the lower the capacity to partner and contaminate local stakeholders and institutions digitally, the lower the engagement to digital transformation (1).

### **5.3 Fuzzy set calibration**

Before running fsQCA, a calibration process was conducted to transform the original Likert scale into a continuous value range from 0 to 1 (Ragin, 2009; Woodside, 2010). This includes identifying breakpoints that allow the option to assign membership of set cases. All the enabling characteristics were converted into fuzzy set continuous values (Fiss, 2011) by applying the 'direct calibration method' approach to coding (Ragin, 2009). This method relies on identifying specific anchors for each attribute. The anchors were chosen based on a technical (relying on percentiles distribution related to the sample properties) and qualitative (relying on theoretical expertise and qualitative knowledge) assessment (Greckhamer, 2015).

Specifically, in order to simplify the analysis without losing model significance, our original shades through the Likert scale were transformed into a final scale of five categories: 0.95 (corresponds to 5: fully present/developed/implemented), 0.76 (corresponds to 4: highly present/developed/implemented), 0.5 (corresponds to 3: the point of maximum ambiguity where we considered it equally probable to represent a low or high development of that condition), 0.25 (corresponds to 2: low presence/development/implementation); and 0.05 (corresponds to 1: not present/developed/implemented).

For the outcome 'local autonomy for transformative SI' we employed a fuzzy logic, assuming three degrees of the outcome: high, medium, and low. High means that the project has succeeded in generating local autonomy of decision-making, and the farmers have already implemented some local social and business cooperation initiatives. Medium means that the project has partially succeeded in creating local autonomy of decision-making but mostly for autonomous decisions regarding the business (for instance, farmers deciding to start local tourism activities with few social and environmental impacts). Low means that the project has succeeded in supporting the local activities and societies, but the farmers' autonomy of decision making has not been reached; instead, it is being early discussed. Therefore, by adopting the same 'direct calibration method' as before, projects showing high outcome have been evaluated with 0.95; those projects showing a medium outcome achievement are evaluated with 0.5; those projects showing a low outcome achievement are evaluated 0.05. In Tables 2 and 3, the initial values and the fuzzy set scales for each enabling characteristic and the outcome are presented.



Table 2. Initial values and fuzzy set calibration - characteristics

		<b>SE</b>	<b>CSP</b>	<b>KT</b>	<b>LKE</b>	<b>EDT</b>
<b>Original Likert values</b>	<b>Calibration</b>					
1	0,05	Addressing basic needs and upholding human rights	Absence of trust, no engagement	Knowledge assessment among potential partners	Knowledge awakeness	Absence of partnerships, no digital contamination, no product and service innovation
2	0,25	Sustaining income	Low trust, low engagement	Traditional training	Knowledge seeking	Weak partnerships, low digital contamination, poor product and service innovation
3	0,5	Enhancing business and negotiation skills	Initial trust, low engagement	Supporting structures and infrastructures locally	Knowledge sharing intention	Infancy of partnerships, medium digital contamination, low innovation of products and services
4	0,75	Supporting business creation and entrepreneurial innovation	Trustful relationships and initial engagement	Favouring a culture of openness and accessibility of information	Intention to encourage knowledge sharing	Strong partnerships, initial digital contamination, initial innovation of products and services
5	0,95	Strengthening of governance and creation of organizational structures to favour cooperation	Trustful and long term relationships and effective engagement	Training tailored on local needs	Knowledge sharing behaviours	Strong partnerships, high digital contamination, full products and services innovation

Table 3. Initial values and fuzzy set calibration – outcome

<b>Original Likert values</b>	<b>Calibration</b>	<b>Outcome: local autonomy for TSI</b>
low	0,05	Local autonomy is in its discussion and initial phase
medium	0,5	Medium local autonomy with business orientation
high	0,95	High local autonomy for transformative SI for social, environmental and economic impacts

## 6 Data analysis and results

First, we analyzed all collected data through ATLAS.ti, a software for qualitative analysis, data management, and coding. By following the principles of thematic analysis, ATLAS.ti supported our investigation in confirming the enabling characteristics, highlighting the emergence and frequency of keywords that identify the characteristics in all the degrees of implementation per each considered SI initiative, and confirming if the outcome of each project was high, medium, or low. We conducted axial coding (Eisenhardt, 1989; Strauss and Corbin, 1998) and double-checked the keywords that emerged from our theoretical understanding. Keywords emerged from the analysis of the lexicon adopted in primary and secondary sources. According to the grounded theory approach, we personally ranked the degree of implementation or development of each characteristic based on a previously agreed keyword building system for qualitative evaluation, corresponding to the literature background.

One example of keywords building and coding is when respondents described the SI project against stakeholder empowerment as: *"In this initiative we act as a sort of business incubator, supporting the creation of the organizational structure for farmers' cooperative and we design training courses to farmers around the mechanism of governance, in order to support their greater autonomy"* (Project Manager at NGO 3), which we coded as "strengthening of governance and creation of organizational structures to favor cooperation" (fuzzy calibrated 0.95), therefore illustrated as "high SE".

This phase ended with a collaborative discussion among the researchers for agreeing on the evaluation of each enabling characteristic per each SI project as well as on the evaluation of the outcome (high, medium, low) of each project (See appendix 1 for the data set already fuzzy calibrated). It resulted that 6 projects out of 18 reached a high outcome, 9 out of 18 reached a medium outcome, 3 out of 18 reached a low outcome.

Second, we performed the fsQCA through the software fsqca 3.0 based on the theoretical background of Drass and Ragin (1992), by employing a combination of intermediate and complex solutions (in our case they coincided) including all counterfactuals related to core and complementary characteristics (Greckhamer, 2015).

We set a consistency threshold of 0.90 for necessary and sufficient conditions to ensure high model reliability and robustness and, according to Schneider and

Wagemann (2010), we conducted the analysis separately. We found 4 initial variables to be individually necessary and sufficient for reaching the set outcome (local autonomy for transformative SI), as reported in table 4 below: SE; CSP; KT; LKE.

Our analysis suggests that necessary conditions greatly affect the outcome, as the absence of one of these characteristics will prevent SI initiatives from having a high outcome, reaching, in our case, the absence of local autonomy for transformative SI.

Table 4: Analysis of necessary conditions

Analysis of Necessary Conditions		
Outcome variable: Out		
Conditions tested:		
	Consistency	Coverage
SE	0.956522	0.736059
~SE	0.309179	0.703297
CSP	0.963285	0.710114
~CSP	0.252174	0.659091
KT	0.944928	0.638381
~KT	0.197101	0.761194
LKE	0.963285	0.805982
~LKE	0.389372	0.715808
EDT	0.761353	0.975248
~EDT	0.620290	0.647177

As for the remaining characteristic, we obtained a 'Truth Table Algorithm' to highlight configurations of conditions that were subsets of the outcome from those that were not. This evaluation was made using the measure of set-theoretic consistency reported in the consistency row and we selected only the potential configurations falling under the consistency 1.

The final exploration consisted of the Truth Table analysis on the remaining characteristic that was not necessary (EDT), which combined with the other 4 necessary conditions covers 76% of the sample in reaching a high value of the outcome. Using standard analysis to derive intermediate and complex solutions (Ragin, 2009), we observed whether the condition of each initial characteristic contributed to the outcome when the characteristic was either present or absent. As stated, we only selected the configurations with a raw consistency greater than 0.9 to improve our model's robustness (Ragin, 2009).

We, therefore, obtained a final complex solution that included the configuration of the necessary conditions with EDT, as per the following:

$$SE * CSP * KT * LKE * EDT \leq \text{High Out}$$

Table 5: Complex solution

Model: Out = f(EDT) Algorithm: Quine-McCluskey  --- COMPLEX SOLUTION --- frequency cutoff: 4 consistency cutoff: 0.975248			
	raw coverage	unique coverage	consistency
EDT	0.761353	0.761353	0.975248
solution coverage: 0.761353			
solution consistency: 0.975248			

In this solution, we can observe that high stakeholder empowerment combined simultaneously with high cooperative strategic posture, high knowledge transfer and high local knowledge development is a necessary and sufficient configuration for reaching the outcome. If one of the characteristics is missing, there is no outcome. EDT is not a necessary condition, only sufficient, but combined with the other 4 covers 76% of the sample. Having EDT is not necessary for creating a high outcome.

### 7 Discussion

Our results show that four out of five characteristics identified through the literature of ST and KM applied to SI need to be necessarily present and interlinked in the ecosystem in order to make it a facilitator of transformative SI by creating local farmers’ autonomy. Those are: high stakeholder empowerment; high cooperative strategic posture; high knowledge transfer; high local knowledge exchange.

This result suggests that ST and KM constructs are intertwined in a virtuous process that begins with stakeholder empowerment to enhance local knowledge exchange and, in this way, creates the conditions for further empowerment and mutual learning interactions within the groups of local stakeholders and more powerful ones, confirming what KM scholars posit (Wood and Bischoff, 2019; Jali

et al., 2017; Avelino et al., 2015; MacCallum et al., 2009; Peloza and Falkenberg, 2009; Usoro et al., 2007). We confirmed that in a context of lower-power and vulnerable stakeholders, the presence of an empowering culture favours, even more than within an organization, a knowledge enhancement culture and motivation in a virtuous circle (Caniëls et al., 2017). This highlights that for an ecosystem to develop and be a facilitator for social change, it needs to rely upon diverse intangible factors for reconfiguring relationships (Bridoux and Stoelhorst, 2016; Civera et al., 2019; Freeman et al., 2010; Lazovic, 2012). We confirm that "cross-fertilization" between different experiences and categories of stakeholders create new skills and make the existing ones evolve, increasing the chances to spread SI in the ecosystem (Dahiyat, 2021).

Our results strengthened the interrelationship between Stakeholder Theory (ST) and Knowledge Management (KM), in explaining and interpreting the transformations happening in a SI ecosystem, in terms of both relational drivers for redesigning relationships (Mirvis et al., 2016; Mirvis et al., 2012; Cajaiba-Santana, 2014; Greenwood and Van Buren III, 2010; Howaldt and Schwarz, 2010) and outlines that those relationships are key for transferring and exchanging knowledge that can help solving problems, developing new ideas, or implementing new practices or policies (Cummings, 2004).

Our final complex solution points out that, for being a facilitator of transformative SI and creating local autonomy, an ecosystem of stakeholders carrying out initiatives of SI needs to combine the 4 necessary characteristics with engagement to digital transformation (EDT), demonstrating a successful outcome with this combination in 76% of our cases. Such a complex solution suggests that all the characteristics identified in the literature need to be enacted simultaneously and together in an interlinked evolutionary path toward transformative SI.

Most of our projects show an advanced stakeholder empowerment strategy, with initiatives to support business creation and entrepreneurial innovation, strengthen governance, and create organizational structures to favor cooperation. For instance, the "Sustainable coffee production" initiative in India entails supporting local stakeholders for developing and strengthening the MAS company - an organization for technical and commercial services to its producing members. This strategic choice within the SI initiative reflects the will of MNEs, NGOs, and institutions to increase local stakeholders' independent decision

making and influence over their decisions and participation (Civera et al., 2019; Dawkins, 2014; 2015).

In an interdependent and virtuous circle, high stakeholder empowerment becomes the antecedent for collaborative engagement within SI initiatives (Desai, 2018; Montiel et al., 2012; Moulaert et al., 2007; Nicholls and Ziegler, 2015; Shams, 2016). Indeed, the CSP characteristic was evaluated high in 15 projects out of 18, meaning that empowerment was key for facilitating the spread of trustful relationships both in the community and among all powerful and powerless actors of the ecosystem, as reported by the literature (Greenwood and Van Buren III, 2010; Phillips, 1997). Our respondents pointed out that their positive involvement in the projects through on site visits and constant dialogue with local stakeholders was fundamental to create local stakeholder engagement, a sense of affiliation (confirming Freeman et al., 2010; Greenwood, 2007) and the culture to absorb knowledge and replicate it locally (Cabrera et al., 2006; Caniëls et al., 2017; Wang and Noe, 2010).

Therefore, most of our SI initiatives were evaluated with a high knowledge transfer capacity, meaning that the more powerful stakeholder groups were engaged in passing knowledge to local stakeholders by favoring a culture of openness and accessibility of information and tailoring local training needs (Dahiyat, 2021). For instance, our respondents highlighted that within the sustainable coffee production SI initiatives in Tanzania, 30 farmers' field schools were set up with a dual intent. First, to provide ad-hoc technical training on the local environmental and sustainable issues to maintain and increase the coffee quality. Second, to advise on how to set up financial saving programs alternative to loans, given the local financial threat relating to farmers' massive use of loans.

The high effective knowledge transfer appeared to have facilitated a high local knowledge exchange, as emerged by the literature (Wang and Neo (2010), by spreading key tailored knowledge and making local stakeholders more empowered and inclined to collaborate for seeking new knowledge and sharing it. This process increased the chances for developing new ideas and implementing new projects (Cummings, 2004).

Thanks to the "Training the Trainers" program within the SI initiative in Haiti and the Dominican Republic, whose aim was to train farmers on becoming trainers themselves, some groups of farmers started autonomously local training to other farmers to improve the adaptation of their production to climate change.

Our findings show that EDT is the least impacting characteristic on the outcome. One explanation could be that in the analyzed SI initiatives, farmers have just recently developed the virtuous circle proposed by ST and KM, and now they are seeking to increase its impact through digitalization, which is very complex to achieve (Meijer and Bolívar, 2016). Eventually, although EDT is a non-necessary but sufficient condition within our complex solution, its inclusion in the configuration can boost active participation and multi-stakeholder inclusion in social change (Kar et al., 2019; Bock, 2016; Townsend et al., 2015).

Both Colombian SI projects, which fall under the successful pathway of facilitating ecosystems for transformative SI, see coffee-growers proactively taking part in collective local social and economic initiatives to strengthen the area's coffee sector and participate in educational processes and technical advisory. Local farmers have autonomously created working groups intending to strengthen and share educational processes, thanks to a higher level of ICT adoption and the possibility to access training remotely. Furthermore, these groups have formed local citizens' online communities to attract younger generations to the plantations to include them in technical and social processes to improve crop cultivation.

## **8 Conclusion, social and practical implications, limitations**

In this study, we demonstrated that a specific combination of characteristics drawn from ST and KM literature can make an ecosystem capable of facilitating the rise of transformative SI in developing and emerging contexts. In outlining the successful pathway for enabling ecosystems, we discovered that high stakeholder empowerment, high cooperative strategic posture, high knowledge transfer, high local knowledge exchange are necessary conditions within the ecosystem for obtaining a transformative outcome of SI, such as local autonomy of farmers that will allow them to take independent actions locally and increase the impact of SI. We demonstrated that such necessary conditions are interlinked and happen simultaneously in a virtuous circle and that if any one of them is missing in the ecosystem, the SI initiative will not have chances to reach the expected outcome (local autonomy for transformative SI).

From a theoretical standpoint, we proved that a multidisciplinary and interactive perspective best fits the studies on SI in complex ecosystems (Scott et al. 2017; Woodside, 2012; Mitleton-Kelly 2006) and could represent an effective

response to an open issue in Social Innovation research, that is the absence of theoretical and empirical studies investigating what makes an ecosystem enabler of SI in a transformative way (Terstriep et al., 2020).

In filling such a gap, our study also brings some novelty to the SI literature through the adoption of a configurational methodology by suggesting a combination of characteristics that can turn a firm-centric view based on stakeholder dependence into an egalitarian perspective of lower-power stakeholders' interdependence and collaboration, confirming fresh perspectives on stakeholder thinking (Bridoux and Stoelhorst, 2016; Civera and Freeman, 2019; Dawkins, 2014; 2015; Freeman et al., 2010; Greenwood and Van Buren III, 2010; Jamali and Mirshak, 2007; McVea and Freeman 2005; Strand and Freeman, 2015).

In terms of social implications, by examining the combination of characteristics within an enabling ecosystem for SI, we advanced some arguments around the issue of stakeholder power within SI initiatives in developing and emerging countries, which is identified by the literature as a factor limiting the SI effectiveness locally (Sept, 2020; Lannon & Walsh, 2019; Nicholls and Ziegler, 2015; Moulaert et al., 2007). We demonstrated that enhancing the autonomy of lower-power stakeholders can be a way to initiate the process toward that change of mindset to adopt a new perspective of social transformation, which might, eventually, include the engagement to digital transformation as a social factor to boost the outcomes of transformative SI, only when and if the virtuous process (combination of the necessary characteristics) is activated.

Therefore, from a practical standpoint, we suggest to social innovation practitioners (MNEs, NGOs, local and global institutions) to draw a process based on the following:

- Local farmers' empowerment through the creation and strengthening of organizational structures and governance;
- Establishment of constant two-way communication among all actors involved and strengthening of their local presence;
- Co-designing of training activities for farmers that is tailored on local needs and favor replication;
- Supervision of the behaviors enacted by farmers locally to share the knowledge acquired to keep track of the outcomes;
- Establishing partnerships with local service providers to enhance the digital contamination of knowledge and providing online training



activities to foster new habits of knowledge seeking and sharing, where possible.

Eventually, our study suffers from the limitation of analyzing the issue from the perspective of powerful stakeholders who were the catalysts of the examined SI initiatives. Therefore, avenues for further research open as for the investigation of the topic by involving the targets of such SI initiatives through field research in developing and emerging countries directly with local stakeholders.

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## Appendix 1 - Data set

Project	SE	CSP	KT	LKE	EDT	Out
1	0,76	0,95	0,95	0,76	0,5	0,5
2	0,95	0,95	0,95	0,95	0,76	0,95
3	0,95	0,95	0,95	0,5	0,5	0,5
4	0,5	0,5	0,5	0,25	0,05	0,05
5	0,5	0,76	0,76	0,76	0,25	0,5
6	0,95	0,76	0,95	0,76	0,5	0,5
7	0,95	0,95	0,76	0,95	0,5	0,95
8	0,76	0,76	0,95	0,76	0,5	0,5
9	0,95	0,95	0,76	0,95	0,95	0,95
10	0,95	0,95	0,95	0,95	0,76	0,95
11	0,5	0,76	0,76	0,5	0,5	0,5
12	0,95	0,76	0,76	0,76	0,5	0,95
13	0,76	0,76	0,95	0,5	0,25	0,5
14	0,5	0,5	0,95	0,5	0,05	0,05
15	0,76	0,76	0,95	0,76	0,25	0,5
16	0,76	0,76	0,76	0,5	0,25	0,5
17	0,5	0,76	0,95	0,76	0,76	0,95
18	0,5	0,5	0,76	0,5	0,25	0,05

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## **Sustainable Value and Stakeholders: a Conceptual Framework from Multiple Case Studies**

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### **Abstract**

This paper aims to investigate the relationship of stakeholder with the value flow of business model for sustainability. Specifically, it links the topic of stakeholder theory to the value flow perspective of a business model for sustainability, namely: value intention, value proposition, value creation, value delivery, and value capture.

The research methodology is a multiple case study in three Italian B-corporations, where we analyse the stakeholder groups engaged by the company and how they relation with, interact or intervene in the value flow of business models for sustainability.

Main findings are the following. The value intention of the entrepreneur is influenced by society and the environment. The stakeholder that influences value proposition are the employees that suggest innovations and the government by changing regulations. A sustainable value creation is a multi-stakeholder issue, whose aim is to stimulate the balanced exploitation of natural resources at the local level and to limit the social and environmental impacts. Other organizations as the members of the associations or networks to which the company belongs influence the promotional activities of the product or service that increase consumer awareness towards the company's commitment to sustainable development. Companies are committed to having a positive impact on society and the natural environment, so that they as stakeholders could partially capture the value deriving from the business activity.

The research aims at contributing to the knowledge on business models for sustainability by looking for relationships with stakeholders that could be replied by other companies.



The paper contribution is a stakeholder value flow framework of business models for sustainability that categorizes the stakeholders in the specific value flow step. The framework can facilitate a systematic and deeper analysis of stakeholder influences. Moreover, the stakeholder value flow framework can be used to map from the company point of view the most significant relationship and to help companies to inspire and facilitate the stakeholder engagement for business models for sustainability in the future.

**Keywords** – Sustainable value, Business model, Sustainable development, Stakeholders, Conceptual framework

**Paper type** – Academic Research Paper

## 1 Introduction

The growing environmental problems, due to the increase in temperature, population and the consequent consumption of resources, led the United Nations in 2018 to issue a plan that represents a call to action and aims to achieve 17 Sustainable Development Goals (United Nations, 2018). Sustainable development requires the integration of environmental and social issues into the decisions that determine economic and social development, both by the public and private sectors (WCED, 1987). Companies have a great power on the economy and life in general and therefore, sustainable development is not possible without sustainable business development (Schaltegger et al., 2012). However, current economic system is linked to a concept of growth, which is reinforcing the depletion and scarcity of resources.

Since sustainable development requires moving towards a sustainable economy, involving entire systems is necessary to implement a significant change in the scope of the business (Bocken et al., 2014; Boons et al., 2013). Indeed, according to Stubbs (2019), sustainability is increasingly becoming a changing behaviour, and less a technical challenge, because the types of approaches to sustainable innovation are shifting from internally oriented, incremental and focused on efficiency to more radical and systemic (Adams et al., 2016). Generally, business model research is focused on the relationship between the company and its customers and do not take into account that all organizations depend on exchanges with other systems to survive (Scott, 1998). The interactions of companies with their external environment, including stakeholders, represent a fundamental topic for the discussion on business models and especially business models for sustainability (Velter et al., 2020). Companies have to consider not only

the interests of customers, but must adopt a multi-stakeholder perspective at system level (e.g., Evans et al., 2017; Lüdeke-Freund et al., 2016; Schaltegger et al., 2016) to create economic, social and ecological value. In fact, sustainability problems can be solved by reinforcing the participation with competences and resources by different people and organizations and therefore necessitates multi-stakeholder collaboration (Hörisch et al., 2014).

This is even more true if we consider the value flow perspective of a business model. While business model research is focused on the creation of value for customers in exchange for economic value for the business, a sustainable perspective requires a different perspective as the traditional “view of value creation results in a separation of stakeholders into those who receive value and those who contribute to creating it” (Freudenreich et al., 2020; p. 3). Therefore, this paper takes in consideration all the stakeholders that are placed in the value flow with their multi-directional influences.

While current research focuses only on value creation, this paper takes in consideration the perspective of the entire value flow, consisting of: value intention, value proposition, value creation, value delivery, and value capture (Barth et al., 2017; Bocken et al., 2014; Short et al., 2014).

The stakeholder theory sees organizations at the centre of a network of stakeholders that can influence or be influenced by the organization's objectives (Freeman, 2010). For this reason, the stakeholder theory gives a multidirectional connotation to the value flow of a business model for sustainability (i.e., value intention, value proposition, value creation, value delivery and value capture) and its stakeholders (Freudenreich et al., 2020). Thus, this work combines the whole value flow perspective and the stakeholder theory, to address the following research questions: 1) Which stakeholders relate to the business model for sustainability? 2) How do stakeholders relate to the value flow of the business model for sustainability?

This paper provides a stakeholder value flow framework derived from key characteristics of both business model and stakeholder theory. The framework depicts the relationships between the stakeholders and the value flow of business model for sustainability. As a first step towards closing the research gap, this paper examines the whole value flow from a stakeholder theory perspective. Stakeholder theory proposes that value creation is a collaborative effort in relationships, ideally benefitting the focal business and all its stakeholders (Freeman, 2010). This corresponds to the idea of multi-directional relationships

and supports an in-depth analysis of what types of value a stakeholder relationship creates with whom and for whom.

This paper is structured as follows. First, there is an explanation of the main concepts coming from previous literature. Secondly, the methodology is exposed. Then, the results and the contributions follow.

## **2 Theoretical background**

### ***2.1 Stakeholder theory to solve business and sustainability issue***

The term stakeholder first appeared in 1963 in opposition to the notion that shareholders are the only group that management must refer to (Parmar et al., 2010). A stakeholder can be defined as "any group or individual that can influence or be influenced by the achievement of the organization's goals" (Freeman, 1984; p. 46), while for Dunham et al. (2006; p. 25), it represents "a group that the company needs to exist, particularly customers, suppliers, employees, shareholders, and communities."

In a context characterized by high levels of uncertainty and change (as organizations are), stakeholder theory arose to address three business-related and interrelated problems. Specifically, it seeks to understand: 1) how value is created and exchanged, 2) what are the connections between capitalism and ethics, 3) and how managers should think about management to better create value and explicitly link business and ethics.

To effectively address these issues, stakeholder theory proposes to adopt as a unit of analysis the relationships (unilateral, bilateral, or even multiparty) between a firm and its stakeholders (Parmar et al., 2010). From this perspective, it is possible to manage and shape these relationships to create as much value as possible to distribute to stakeholders (Freeman, 1984) and to rethink problems so that the needs of a broad group of stakeholders are addressed (Harrison, et al., 2010).

Additionally, from a moral perspective (Post et al., 2002; Sisodia et al., 2007) effectively managing stakeholder relationships helps businesses survive and prosper in capitalist systems by assessing potential damages and benefits to broad groups and individuals (Phillips, 2003).

Similarities with sustainability emerge from these early concepts related to stakeholder theory, regarding for example: the purpose of business that must go

beyond maximizing short-term shareholder value; the interconnection and conflict between ethical and business issues; and the consideration of a long-term perspective that allows for the creation of stakeholder value now, without compromising the ability to create value in the long term (Hörisch et al., 2014).

Thus, corporate sustainability (understood as a vision) and sustainability management (understood as a general approach to corporate sustainability) challenge companies to engage with stakeholders on a multitude of contemporary social and ecological issues (Hörisch et al., 2014).

The United Nations Sustainable Development Goals (SDGs) include multi-stakeholder partnerships as one of the key goals (United Nation, 2018).

Stakeholder relation has thus been recognized in academia, practice, and policy as a key factor in advancing organizational sustainability (Bäckstrand, 2006; Cazeri et al., 2018; Onkila, 2011). Therefore, several scholars emphasize the need to move from the bare stakeholder management to interacting with a broad range of stakeholders to embed sustainability within organizational practices (Le Roux and Pretorius, 2016; Rhodes et al., 2014; Sloan, 2009).

This because the literature argues that stakeholder relations and interaction with organizations allow for the sharing of resources and knowledge to solve complex environmental and social problems (Fadeeva, 2005; Gray and Purdy, 2018). In addition to a technical exchange that is focused on a specific project and does not affect other units, Vildåsen and Havenvid (2018) identified two other stakeholder interactions for corporate sustainability: cooperation, in which the organization and the stakeholder engage in working together and develop mutual long-term goals; and networking, in which an organization systematically interacts with more than two stakeholders together in joint initiatives (Vildåsen and Havenvid, 2018). The latter stage of interaction has the highest potential for improving sustainability performance (Vildåsen and Havenvid, 2018).

However, stakeholder interaction such as cooperation and collaboration, can go beyond the practice of sustainability to become the foundation of the organization-stakeholder relationship in which organizations integrate intra- or inter-organizational activities (Fobbe and Hilletofth, 2021). Furthermore, the importance of stakeholders to interact with is dynamic and could change depending on the approach to solving sustainability problems (Hall and Wagner, 2012; Mitchell et al., 1997).

The tool that allows organizations to keep track (even if partially) of these stakeholder relationships for sustainability and beyond, is the business model.

Actually, some scholars such as Breuer and Lüdeke-Freund, (2017), Freudenreich et al., (2020), Kujala and Korhonen, (2017) have proposed not only to consider stakeholder interaction as part of sustainability practices, but to implement stakeholder interaction as part of business models.

While stakeholders are recognized as a central element in these sustainability-oriented business models (Bocken et al., 2013; Freudenreich et al., 2020; Stubbs and Cocklin, 2008), the role and function of stakeholders remain vague (Fobbe and Hilletoft, 2020).

## **2.2 Integrating stakeholder theory into sustainable business model**

Traditionally, the business model has been viewed as a tool available to companies useful to describe the logic by which an organization creates, delivers, and captures value (Osterwalder and Pigneur, 2010). The firm - centric view of the business model has since been overcome by Zott and Amit (2011), who view it "as a system of interdependent activities that transcends the focal firm and extends beyond its boundaries. The system of activities allows the firm, in concert with its partners, to create value and also to appropriate a share of that value (Zott and Amit, 2011; p. 216). The same authors call this concept the "networked nature of value creation," claiming that "value creation through business models involves a more complex and interconnected set of relationships and activities among multiple actors" (Zott and Amit, 2011; p.1031). These concepts broaden in the case of business models for sustainability.

One of the definitions of a business model for sustainability sees it as a simplified representation of the elements, the interrelationship between these elements, and the interactions with its stakeholders that an organizational unit uses to create, deliver, capture, and exchange sustainable value for, and in collaboration with, a wide range of stakeholders (Geissdoerfer et al., 2016).

Thus, while for the traditional business model the creation of value occurs together with all stakeholders, in business model for sustainability the concept of completes by adding the exchange of value between the company and its stakeholders. Furthermore, the notion of business model for sustainability "builds on the business model concept and combines it with the important concepts of stakeholder management (Donaldson and Preston, 1995; Freeman, 1984; Post et al., 2002), sustainable value creation (Short et al., 2012), a long-term perspective" (Geissdoerfer et al., 2016; p.2).

Since stakeholder theory is linked to the concept of sustainability (Hörisch et al., 2014), it can be applied to business models for sustainability and can add several points to the discussion, as indicated by Freudenreich et al. (2020). First, it is recognized that company relationships are the basis of value creation. Therefore, it is impossible to make a business model work without solid relationships with stakeholders. Secondly, the creation of value through the business model takes on a multi-directional and multi-actor connotation around a common purpose oriented towards sustainability.

Therefore, value is no longer a one-way flow between the company and its customers, but it is created by joint actions and formal and informal alliances with stakeholders who are both recipients and creators of value (Beattie and Smith, 2013; Freudenreich et al., 2020). Several authors have depicted the value flow in business models by considering value proposition, value creation and delivery, and value capture (Bocken et al., 2014; Short et al., 2014). To these Barth et. al (2017) added value intention.

### **3 Research design**

To address the research question, a systematic review of the literature on business models for sustainability was conducted. The literature was furtherly investigated by considering the two main aspects of this discussion: stakeholders and value flow. Specifically, within the literature on business models for sustainability, it is considered: the stakeholder groups that create or (co-create) the value, the value exchanged, and the stakeholders that receive the value. From this analysis, we derived and classified the stakeholders associated with a business model for sustainability. We derived and adapted a framework from the literature, that we explained below.

In the rows the internal stakeholders (i.e., entrepreneur, leader/manager, employees) and external stakeholders (i.e., customers, shareholders, government, society, other organizations/competitors, influence groups, universities/research institutes, natural environment) are reported.

In the columns the value flow of a business model for sustainability is reported, namely:

1. Value intention. As described by Barth et al. (2017), the value intention is the attitude of the owner-manager to change, innovate towards sustainability, and create sustainable value.

2. Value proposition. As value proposition is meant the sustainable value proposition as defined by Patala et al. (2016; p. 144), namely: "the promise on the economic, environmental and social benefits that a firm's offering delivers to customers and society at large, considering both short-term profits and long-term sustainability".
3. Value creation. Value creation "begins to flesh out the organisation and architecture of the firm. It also specifies and describes the firm's sources of competitive advantage, i.e., its resources and capabilities" (Richardson, 2008; p. 139).
4. Value delivery. It represents how the value is delivered to different stakeholders. It is the "logical next step and is most closely related with the customer. It is focused on customer relationships, customer segments and channels" (Bocken et al., 2018; p. 84).
5. Value capture. It includes different forms of value captured by different key stakeholders (Short et al., 2014).

The cells of the framework, which connect rows (stakeholder groups) and columns (value intention, value proposition, value creation, value delivery, and value capture) represent stakeholder influences on the value flow of the business model for sustainability. In the cell we described how stakeholders are connected with a specific step in the value flow.

To further explore these relationships, the explorative case study is used as research methodology. We chose three case studies to highlight aspects not yet investigated by literature. To guarantee that selected organizations are developing or implementing a business model for sustainability, we chose B Corps as case studies (Yin, 2013). Moreover, we considered other factors in selecting the companies, for instance dimension to guarantee cases will be comparable. The selected cases belong to different sectors: A to the logistics industry, B to the retail industry and C to the natural cosmetics industry. We conducted semi-structured interviews with three B Corps. Moreover, we collected information through secondary data, to guaranteed triangulation (Eisenhardt, 1989).

## 4 Results

In the following section the case studies are described by adopting a value flow perspective as summarised in Table 1.

#### ***4.1 Value flow perspective in Case A***

In Case A, the value intention is dictated by the entrepreneur who wants to pursue common benefit purposes, by proposing as customer value a tailor-made service through a sustainable and inclusive logistics in the territory. Therefore, the value creation is based on new technologies and advanced biofuels (e.g., LNG, bioLNG and H<sub>2</sub>) that reduce vehicle emissions. The value created by the company is then delivered to the customer through partnerships. In addition, Case A distributes value through industry-related trade shows or events related to B-corporations. The value flow proposed, generated and delivered is then captured not only by the company, but also by other stakeholders. For example, employees benefit from a higher insurance policy than the minimum threshold, an extra budget from the welfare project, sustainability-related training, and family engagement initiatives. The drivers that are considered as partners of the company, benefit from less pollution during the transport, greater involvement of their families, and greater safety during work hours, because the company is committed to enforcing work hours and road rules. The society, as a stakeholder, benefits from economic sponsorships in favour of local teams and defibrillators available at each company location. The main benefit for the natural environment derives directly from the creation of value and is the reduction in emissions due to the use of alternative fuels.

##### ***4.1.2 Role and function of stakeholders in Case A business model***

Various stakeholders are involved in the value flow of the business model of Case A. Employees, thanks to the awareness of the benefits obtained, take part in the value proposition by suggesting sustainability innovations through a portal made available by the company. The affiliated drivers, have an active role in the value delivery because they become promoters of the project by participating in various interviews and encouraging colleagues to adopt a more sustainable transport. Other partners are key stakeholders for the value creation: 1) the agro-livestock cooperative, which built a plant that recovers all CO<sub>2</sub> in production: the remaining methane is then purified, cooled, and used to fuel the truck. 2) a company which built the first service station in Lombardy designed for self-service natural gas refueling for heavy vehicles and open to cars as well. However, the government plays the role of a barrier to value proposition and value creation through regulatory changes.



Other stakeholder organizations are the members of the B-corporations network and participate in the value delivery by promoting events to spread the culture of sustainability.

Some groups of influence participate in the value creation. In particular, the Italian biogas consortium enables the value creation by allowing the annual production of 2000 tons of liquefied methane.

#### *4.2.1 Value flow perspective in Case B*

The value intention of Case B is dictated by the entrepreneur who wants to save wildlife and the natural environment by offering a quality product designed with entirely recyclable parts.

The value creation is possible thanks to the use of materials and components from qualified sources, with low environmental impact and respectful of social and ethical aspects. A key element in the value creation is the choice of suppliers, which are evaluated against social criteria, in addition to meeting economic and quality criteria. Value is delivered to customers through company-owned stores, e-commerce, retailers and pop-ups, or through participation in various events organized by the B-corporations' movement. Moreover, customers are reached through the main social networks. The value proposed, created and delivered is not only captured by the company, but also by other stakeholders. In particular, employees benefit from better corporate welfare; suppliers, located mainly in China, benefit from better working conditions imposed by the company policy. The society, especially disadvantaged communities and countries, benefit from donations made in collaboration with NGOs or other organizations, which include companies belonging to the B-corporation network. The natural environment benefits from reduced pollution and animal protection.

#### *4.2.2 Role and function of stakeholders in Case B business model*

Several stakeholders intervene in the value flow of the Case B business model. Suppliers participate in the value creation by selecting, manufacturing, and patenting materials that meet the highest quality and environmental standards. Customers influence the value delivery by asking for more in-depth product information, for instance usage, impacts of microfibers, and innovative features of collections. Further stakeholders of the company are the media. The media influence the value creation by discussing with the company both the sustainability trends of the sector and the measurement of environmental impacts

along the production process. Another stakeholder organization participates in the value delivery through communication activities and strategic brand consulting with a focus on corporate social responsibility strategies and economic, social and environmental sustainability. Other organizations as B corporations are stakeholders of Case C and participate in the value delivery by organizing and promoting events to spread the culture of sustainability.

#### *4.3.1 Value flow perspective in Case C*

In Case C the value intention is dictated by the entrepreneur who wants to enhance the value of his territory by proposing lines of personalized natural cosmetics that respect the environment. The value proposition is then created through the control of the entire supply chain and the use of organic cultivation. Part of the value created comes from the choice of suppliers. Actually, the company turns only to suppliers belonging to the B-corporations network or to companies that have in place a process of change towards sustainability. As regards the value delivery, customers are reached through industry events and demonstrations. In addition to the value captured by the company related to the commissioned product, the company's employees benefit from an extra bonus. The company captures a portion of value related to increased tourism related to the company-owned wellness centre. In addition, the society benefits from sponsorships related to youth entrepreneurship initiatives and donations destined for schools, also with the help of local associations. The natural environment benefits from reduced land use and low-impact cultivation.

#### *4.3.2 Role and function of stakeholders in Case C business model*

Several stakeholders are engaged in the value flow of Case C business model. Specifically, several stakeholders participate in or influence the value creation. For example, the suppliers or partners participate in the value creation by providing sustainable packaging and resources. Secondly, the customers influence the value creation by requesting and defining product characteristics. Finally, the university tests the product efficacy, a key process of the company's activities and the value creation. As regards the other organizations the influence the value flow, there are all companies that join the B corporations network. They participate in the value delivery by promoting events to spread the culture of sustainability. In the case of C, the natural environment does not only play a passive role by deriving

benefits but plays an active role in the value creation by offering quality raw materials.

Table 10 - Synthesis of results

		<b>Value Intention</b>	<b>Value Proposition</b>	<b>Value Creation</b>	<b>Value Delivery</b>	<b>Value Capture</b>
<b>Internal stakeholders</b>	Entrepreneur	Pursue common benefit purpose for society, environment and local territory				
	Employees		Suggest sustainability innovations			Benefit from corporate welfare, family engagement, sustainability-related training
<b>External stakeholders</b>	Suppliers/ partners			Adopt, manufacture, and patent sustainable materials and practices	Promote company sustainability projects	Benefit from family engagement, greater safety during work hours. less pollution
	Customers			Request and define product characteristics	Ask for in-depth information regarding the sustainability	
	Government		Change regulations	Change regulations		

	Society			Discuss both the sustainability trends of the sector and the measurement of environmental impacts along the production process		Benefit from generalized welfare (e.g., donations, sponsorships)
	Other organizations/competitors				Promote and communicate the culture of sustainability (e.g. B-corporations network)	
	Influencing groups			Enabling the production		
	Universities/research institutes			Test products		
	Natural environment			Offer quality raw material		Benefit from reduced pollution, animal protection, low-impact cultivation

## 5 Discussion and conclusions

This section discusses the results in light of the relationship of stakeholders and suggests future research directions in the field of business models for sustainability. Stakeholder engagement is rising attention of companies seeking to increase their competitiveness by moving towards a business models for

sustainability. This implies a rising importance of re-assessing their business models.

This paper looked into both stakeholder and business model theory in order to develop stakeholder value flow framework (Figure 1). The framework is then applied to three case studies belonging to different industries, which consider sustainability having a key role in their strategy. The adoption of the value flow as perspective in analysing the companies' business models led to the following results.

The value intention of the entrepreneur is key in the business model for sustainability; even if it is not a result that emerges explicitly from the case studies, it can be deduced that the value intention of the entrepreneur is influenced by society and the environment. Actually, the entrepreneur does business with the intention of having a positive impact on his main stakeholders which are society and the environment.

The value proposition is the direct consequence of the value intention that takes the form of a promise to offer value not only to the customer but to a wider group of stakeholders. The stakeholders that influence value proposition are the employees that could suggest innovations to make the product or service offered more sustainable. Moreover, the government could influence the value proposition by changing the regulations.

Value is created by a range of activities involving a number of stakeholders. A sustainable value creation is a multi-stakeholder issue, whose aim is to stimulate the balanced exploitation of natural resources at the local level and to limit the social and environmental impacts. The value creation is strongly influenced by suppliers and partners, that provide sustainable packaging and resources and are selected through sustainability criteria. Moreover, the universities or research centres can play a role in creating sustainable value as they test the sustainability characteristics of the product. In the case of production to order, customers can influence the creation of value through requests of sustainable product or service. A final stakeholder that impacts on the value creation are the media through the discussion with the company about the industry sustainability trends and the measurement of environmental impacts along the production process.

The value delivery mostly concerns the communication and dissemination activities of the company's sustainability initiatives. Therefore, other organizations as the members of the associations or networks to which the company belongs influence the promotional activities of the product or service that increase

consumer awareness towards the company's commitment to sustainable development. Moreover, the suppliers or partners have a role in the value delivery, because they promote the sustainability projects of the company. Finally, the customers ask for in-depth information regarding the sustainability of product and service.

The value capture involves other stakeholders, not only the company. The main stakeholders engaged in the value capture are the employees, benefitting from welfare projects, sustainability-related trainings, and family engagement initiatives. The society could capture value especially disadvantaged communities and countries, through donations. Companies are committed to having a positive impact on society and the natural environment, so that they as stakeholders could partially capture the value deriving from the business activity.

The research aims at contributing to the knowledge on business models for sustainability by looking for relationships with stakeholders that could be replied by other companies. The paper contribution is a stakeholder value flow framework of business models for sustainability that categorizes the stakeholders in the specific value flow step. The framework can facilitate a systematic and deeper analysis of stakeholder influences. Moreover, the stakeholder value flow framework can be used to map from the company point of view the most significant relationship and to help companies to inspire and facilitate the stakeholder engagement for business models for sustainability in the future.

Coherently with the objectives of the study, the identification of stakeholder relationships with the business model could support both researchers and enterprises in mapping the value flow. From the academic point of view, the research attempts to reduce the knowledge gap on business models for sustainability and stakeholder theory. From the managerial point of view, the research proposes a framework that could be adopted and implemented in real corporate environments.

As regards limitations of the study, this is mainly due to the explorative aim of the study. Thus, the limited set of cases could show industry-dependent features, which could not be generalized to an overall discussion on companies.

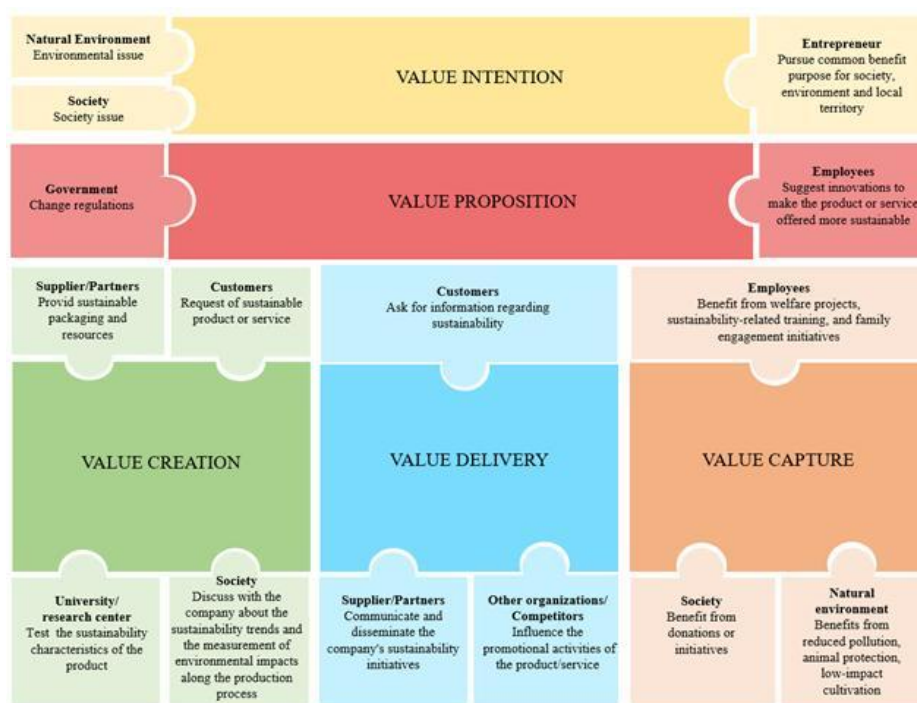


Figure 1 - Stakeholder value flow framework

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## Cultural Mapping 4.0 – Participatory Regional Cultural Planning in Theory and Practice

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### Abstract

Cultural mapping aims to capture and visualize tangible and intangible cultural assets. This extended abstract proposes the consequent extension of analogue forms of cultural mapping using digital technologies, and its contribution is two-fold. First, the necessary theoretical basis is provided by a literature review of the still-young field of cultural mapping and the complementary disciplines of participatory mapping and digital story-mapping. Second, we propose a digitally enhanced Cultural Mapping 4.0 vision based on a case study from an ongoing research project in the Lake Constance region. Digital

participatory mapping approaches are applied to capture data, and to validate and disseminate the results, story-mapping – a spatial form of digital storytelling – is used.

**Keywords** – cultural mapping, GIS, digital regional planning, participatory mapping, story-mapping.

**Paper type** – Academic Research Paper (Extended Abstract)

## 1 Introduction

In recent decades, knowledge has been considered “a key driver of success” in the regional studies discourse (Lönnqvist & Laihonon, 2013). For complex systems such as regions, various stakeholders can act as knowledge carriers and contribute understanding to regional-cultural planning processes. In this respect, cultural mapping can be used as a tool for knowledge management to make different forms of (spatial) knowledge visible and actionable in regional development.

According to Duxbury, Garrett-Petts, and MacLennan (2015), cultural mapping is a method that uses different techniques to capture not only cultural resources but also local histories, memories, and rituals (among other things). It is used in the fields of urban planning, sustainable cultural development, and community development. The digitization boost sparked by the COVID-19 crisis offers new opportunities for capturing, collecting, analysing, and disseminating such data, most of which have a spatial dimension. Geoweb platforms such as Open Street Map make data freely available, and even non-specialists can easily publish local knowledge in the form of geotagged photos, texts, or audio files. Furthermore, mashups, i.e., the combination of data and functions, can be implemented relatively easily through application programming interfaces (APIs) on geoweb platforms.

The core proposal of this extended abstract is the extension of analogue forms of cultural mapping using data capture, visualization workflows, and techniques from geoinformatics, namely, geographical information systems and science (GIS and GISc). Supporting this proposal, the contribution of this extended abstract is two-fold: First, a thorough literature review of the still-young field of cultural mapping and the complementary disciplines of participatory mapping and digital story-mapping provides a theoretical basis. Second, a digitally enhanced “Cultural Mapping 4.0” vision is proposed, based on a case study from an ongoing research

project in the Lake Constance region, which spans the tri-border area of Germany, Switzerland, and Austria. Digitally-enhanced refers both to (a) the use of participatory mapping on the data capture side and (b) the use of digital storytelling and digital story-mapping for disseminating the results (Brown, Sanders, & Reed, 2018; Kerski, 2019).

## 2 Literature Review

The following section presents the results of a comprehensive literature review on digital approaches for participatory regional cultural planning. The literature research focused on the research areas of “cultural mapping”, “participatory mapping”, and “digital storytelling and story-mapping”. It includes research articles and project reports from relevant contributing application areas in cultural management, regional development, and geographic information science.

The table below gives an overview of the search terms used; for brevity, spelling alternatives and keyword combinations are not listed. Literature searches were prioritised for most recent research (from 2017), with selected exceptions referring to pivotal older references.

“Cultural Mapping”	“Participatory Mapping”	“Digital Storytelling and Story-Mapping”
<ul style="list-style-type: none"> <li>• Cultural mapping</li> <li>• Participatory mapping</li> </ul>	<ul style="list-style-type: none"> <li>• Participatory mapping</li> <li>• Participatory GIS (PGIS)</li> <li>• Public participatory GIS (PPGIS)</li> <li>• Volunteered geographic information (VGI)</li> </ul>	<ul style="list-style-type: none"> <li>• Story maps/GIS</li> <li>• Digital/spatial storytelling</li> <li>• Story maps/story-mapping</li> </ul>

### 2.1 Cultural mapping

In recent years, an interdisciplinary field of research has developed around cultural mapping that has attempted to visualize tangible and intangible cultural assets on maps in various contexts. Especially in the cultural sphere, which is relatively complex and ambiguous, mapping has been identified as a valuable tool to understand and compare cultural environments (Duxbury et al., 2015; e.g. Lee & Gilmore, 2012; Sacco, 2017). Early cultural mapping research in the 1960s sought to identify cultural differences, preserve cultural diversity, promote

intercultural dialogue, focusing mainly on indigenous communities (Crawhall, 2007; Poole, 2003). Mainly, analogue mapping processes have been applied in the indigenous context and have proven valuable in making community knowledge, relations, and communication visible through maps (Stewart & Allan, 2013).

Later on, UNESCO also used cultural mapping to visualize cultural differences and boundaries (Poole, 2003), and cultural mapping was soon recognized as a helpful tool for developing public policy measures adjusted to local contexts. As part of its application to become the 2018 European Capital of Culture, Malta's capital – Valetta – hosted a cultural mapping conference in 2015. This revealed different areas of application in research and showed that "mapping projects happen at all kinds of scales, on the initiative of an extremely varied range of actors, and are formalized and transmitted in a variety of different ways" (Sacco, 2017, p. 1). Several case studies in European cities demonstrated the versatility of cultural mapping, for example, as a platform for community engagement to improve understanding of the local culture and creative economy (Murray, 2017), to develop and negotiate a sense of place between city planners and residents (Savić, 2017), as a way for narrative-based ethnography to capture city identities (Huovinen et al., 2017), and by linking geography with art through visually mapping transformational cultural exchanges in migration between Africa and Europe (Khoury, 2017).

In cultural mapping, a distinction is generally made between the mapping of tangible and intangible cultural assets. Cultural mapping has proved successful in various studies (e.g. Lee & Gilmore, 2012) for mapping tangible assets through quantitative approaches, such as cultural organizations, heritage sites, or material resources. However, a qualitative research approach is needed for mapping intangible assets, such as identities, beliefs, or norms, although this is still in its infancy. Therefore, mapping intangibles has evolved in recent years as a critical dimension of current research within cultural mapping (Longley & Duxbury, 2016, p. 2). In recent studies, attempts have been made to solve the problem of portraying the immaterial in maps by using artistic approaches (Carter, 2018; Irwin, 2018; see Radović, 2016) or digital tools (see García-Díez et al., 2020; Martin et al., 2020). The main advantage of cultural mapping in this context is that these maps can be created from the perspectives of indigenous and local people in a participatory process and are, therefore, a powerful way of collecting, visualizing, and interpreting data in different cultural contexts. By making visible how "local cultural assets, stories, practices, relationships, memories, and rituals constitute

places as meaningful locations” (Duxbury et al., 2019, p. 3), cultural maps can – as a methodological tool – promote participation in planning processes, enabling innovative access to cultural perceptions and value attributions that would otherwise be difficult to contextualize and compare. Consequently, digitalization offers new opportunities for creating cultural maps through participatory mapping.

## **2.2 Participatory mapping**

Participatory mapping aims to engage the general public and stakeholders in decision- making for regional planning, typically using online and web-based surveys for data collection (Fagerholm et al., 2021). A wide variety of research fields have shown increasing interest in participatory mapping, typically referring to public participatory geographic information systems (PPGIS), participatory geographic information systems (PGIS), or – increasingly – to volunteered geographic information (VGI) (Brown et al., 2020; Fagerholm et al., 2021). For an in-depth academic discussion about the nuanced differences between these concepts and their theoretical underpinnings, we recommend the review articles by Brown & Kyttä (2014) and Fagerholm et al. (2021).

For a speedy approach to these concepts for applications in cultural-regional planning, each term is presented here with an illustrative example. PPGIS aims to use GIS, the web and communication technologies to enhance public involvement in planning and decision-making in regional development (Fagerholm et al., 2021; Sieber, 2006). For example, Nummi (2018) used map questionnaires for revealing locals’ personal place-based memories and experiences of intangible cultural heritage for regional development in Finland. While PPGIS are often situated in developed countries, PGIS carries a distinct empowerment notion and is usually located in developing countries, where mapping is often educational, and the resulting spatial data are secondary (Brown & Kyttä, 2014). For example, Fagerholm et al. (2019) combined semi-structured interviews with participatory mapping to study spatial patterns of cultural landscape services in rural Tanzania. Finally, in 2017, Michael Goodchild coined the term volunteered geographic information (VGI), reflecting the growing number of applications using the internet to collect and disseminate geographic information using “citizens as sensors” (Goodchild, 2007). Well-known examples of this idea include

OpenStreetMap<sup>1</sup> and FixMyStreet<sup>2</sup>, while Gonzalez-Ramiro et al. (2016) collected substantial variables for their spatial multi criteria evaluation (MCE) to assess the potential of rural tourism in Extremadura, Spain.

To conclude, participatory mapping concepts are strongly related to “sense of place” values and closely associated with the cultural ecosystem services (CES) sub-category within the ecosystem services framework (Brown et al., 2020). The data collection concepts applied in the proposed Lake Constance Cultural Mapping 4.0 framework below are based on PPGIS and VGI.

### ***2.3 Digital storytelling and story-mapping***

Story-mapping is a spatial form of digital storytelling combining textual, visual, and audible communication through interactive web maps (Molden, 2020). Digital storytelling can refer to various forms of developing narratives, ranging from short video sequences applied initially to community development (De Jager et al., 2017) for augmented reality applications in museum exhibitions (Rizvic et al., 2020). While the original notion of “story-mapping” proposed by Nitsche and Thomas (2003) referred to experiencing events within the developing world of 3-D virtual reality, the current notion of story maps refers to combining online content with 2-D web maps – similar to a slide presentation with embedded interactive maps (Walshe, 2016). Story maps have been enthusiastically adopted in classroom applications, offering smooth integration of complex geoinformatics topics in geography teaching (Cope et al., 2018; Walshe, 2016; Wu & Chen, 2020).

Given its elegant and accessible potential to connect the experiences of researchers and participants through digital narratives, story maps have been used in a wide range of contexts in the humanities disciplines (Kallaher & Gamble, 2017). These include the development of user-friendly interactive resources in archaeology (Alemly et al., 2017), setting up a historical geographic information system (Lafreniere et al., 2019), and community development (Lung-Amam & Dawkins, 2020). There are also a few story-mapping applications in the context of regional-cultural planning. While Cabana et al. (2020) presented and integrated an evaluation and communication strategy for cultural ecosystem services, Rizvic et al. (2020) discuss a form of story-mapping to present tangible and intangible cultural heritage. Story-mapping has also offered an excellent way to preserve

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<sup>1</sup> <https://www.openstreetmap.org/>

<sup>2</sup> <https://www.fixmystreet.com/>



experiences and reflections during the COVID-19 pandemic through rich media storytelling and GIS mapping (Bacon & Xu, 2020).

Previous studies have identified limitations of story-mapping worth consideration. For example, by relying on proprietary software solutions such as the Esri Story Map interfaces, communicative interaction between researchers and participants can be restricted by the templates provided (Molden, 2020). The same source also asks for critical reflection about power relations and exclusion when applying story-mapping – another challenge shared with participatory mapping.

All the above examples demonstrate that story-mapping is not only the process of creating web-map-based plots, but it crucially also refers to the process and method of narrative-building relating “to the construction and representation of spatial knowledge between researcher and participant” (Molden, 2020, p. 133), hence underpinning its power to engage with participants. These shared goals with participatory mapping lay the groundwork for Cultural Mapping 4.0, combining the concepts of story-mapping with participatory mapping.

### **3 Study Area and Methodological Approach**

#### ***3.1 The Lake Constance case study***

As one of the oldest European cultural landscapes and located on a tri-national border in the heart of Europe, the Lake Constance region is characterized by its spatial structural diversity. It has both intensely rural areas popular with tourists as well as dynamic, urban centres that belong to the most economically competitive regions of their respective nation-states (Scherer, 2016, p. 3). In addition to their shared history and language, the countries bordering Lake Constance are united by a cultural and economic area that is becoming ever more closely intertwined due to the increasing mobility of their populations. Through this Lake Constance case study, the authors examine the interaction between regional identity, culture, and mobility from a spatial perspective. Residents, tourists, and regional businesses will be asked about their spatial perceptions of the interplay between cultural identity and mobility through participatory mappings. Our focus is on four core topics – cultural resources, civil society and integration, business and labour, and tourism and mobility.

### 3.2 Methodological proposal

In this case study, economic and social science methods are combined with new participatory data capture procedures, geoinformatics, and geo-visualization approaches. Cultural mapping is perceived and used as a method and an outcome simultaneously. Specifically, the methodological proposal presented here extends Duxbury's concept of cultural mapping (2015, 2019) with (a) participatory mapping to capture the local sense of place regarding cultural assets and (b) the use of story-mapping for the dissemination of insights and results (see Figure 1).

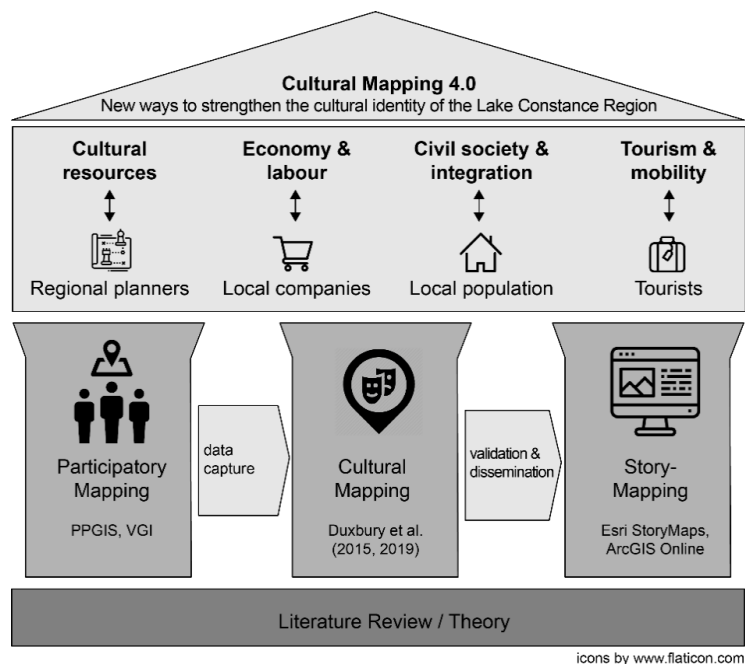


Figure 1. Cultural Mapping 4.0 for the Lake Constance Region

Following a successful pilot study in 2020, summer 2021 will see an extended semi-structured survey combined with web-mapping questionnaires targeting the stakeholder groups and related topics shown in Figure 1 above. While the local population and tourists will be targeted through on-site surveys at popular locations around Lake Constance and by a web survey related to the topics of civil society and integration, tourism and mobility, regional planners and the

commercial sector will be addressed through stakeholder workshops, combining surveys with guided mapping questionnaires. For dissemination and validation purposes, all the results will be summarized into customized story maps.

A cultural mapping study relying largely on field studies conducted by the shores of Lake Constance in the summers of 2020 and 2021 will inevitably be affected by COVID-19 restrictions such as evening curfews, closed restaurants, or travel bans. Our study has reacted to these challenges by further exploiting the potential of digital communication and offering flexible online ways to record stakeholders' cultural sense of place. Where necessary, the survey and participatory mapping questionnaires were swiftly moved from hand-held tablets to web-based questionnaires distributed through social media and targeted dissemination. On reflection, this might be viewed as an excellent example of the added flexibility arising from the digitization of conventional social-science workflows.

#### **4 Concluding Remarks**

This extended abstract focuses on a literature review and a brief overview of the methodological approach regarding participatory regional-cultural planning at the tri-border region around Lake Constance. It explains related concepts such as "cultural mapping", "participatory mapping and participatory GIS", and "digital storytelling" while drawing special attention to their value for stakeholder research. Regarding the case study in question, this stakeholder research comprises cultural resources, civil society and integration, business and labour, and tourism and mobility. The vital inclusion of different stakeholder groups helps generate a differentiated picture of the Lake Constance region depicted in the form of story maps. The data collection necessary to achieve this will be the next stage in this research project and it will deliver information on the identity and image of the Lake Constance region. Our ultimate goal is to provide a viable planning tool for decision-makers.

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## **Sustainability of Urban Regeneration Projects in Resilient Cities: a Multiple Case Study**

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### **Abstract**

In recent years, the integration of sustainability principles in urban planning has become increasingly important. The growing attention to economic, social and environmental aspects is also influencing the practice and policy of urban regeneration. In particular, the search for new ways to regenerate cities in a sustainable way has led to the concept of sustainable urban regeneration. However, despite the relevance of this concept, only a few contributions have quantitatively examined the actual sustainability outcomes of different urban regeneration interventions. This study aims to fill this important gap by examining the level of sustainability of urban regeneration interventions in the Apulian context. The results of the multiple case study analysis show a high level of sustainability of the interventions in all three contexts examined. However, they show some weaknesses related mainly to the absence of strategies aimed at the inclusion of women in the labour market

and to the low efficiency in the use of energy. The results offer important implications and guidelines for municipalities implementing urban regeneration projects.

**Keywords** - Urban regeneration; Urban sustainability; Sustainable urban regeneration; Sustainability indicators; Apulia

## 1 Introduction

The dynamics of urbanisation have changed considerably over time, driven mainly by industrialisation, which has increased the concentration of socio-economic organisations in cities, thereby increasing the urban population (Korkmaz and Balaban, 2020). Today, most of the world's population lives and carries out economic activities inside cities. However, unbridled urbanisation has important consequences mainly related to economic, environmental and social aspects. According to the United Nations (2015), cities occupy only 3% of the earth's surface, but are responsible for 60-80% of energy consumption and 75% of carbon emissions. The disproportionate growth of cities could, therefore, lead to a depletion of the earth's water and food resources, the suffocation of natural ecosystems and could also have major consequences on public health, both because of the high presence of slums (with all the resulting hygiene and public order consequences) and because of the worsening climatic and atmospheric conditions (United Nations, 2015).

In view of this, cities are considered among the key players in achieving the 17 Sustainable Development Goals set out by the United Nations (2015) in the so-called 2030 Agenda. Considered as huge human collectors, economic aggregators and high-impact elements, cities will necessarily have to configure themselves as real spaces for change in economic, social and environmental terms. In this regard, among the 17 Sustainable Development Goals, Goal 11 reads 'Make cities and human settlements inclusive, safe, durable and sustainable'. Therefore, achieving this goal by 2030 should include combating inequalities, improving public transport, strengthening and implementing waste management systems. Moreover, it should include the protection of cultural and artistic heritage, the direct participation of citizens in the management of the city, the enhancement of network economies within the public space and, above all, it should prefer urban regeneration to building speculation.



In this context, the need for sustainability approaches for the definition of urban transformation practices and policies is therefore increasingly emerging (Newman and Jennings, 2008; Evans, 2012; Vojnovic, 2014; La Rosa et al., 2017). The implementation of strategies, programmes and planning strategies for sustainable cities, such as the redevelopment of degraded urban spaces or the reuse of abandoned buildings and previously disused urban land (La Rosa et al., 2017), help to increase the attractiveness of urban centres and the well-being of citizens (Couch and Dennemann, 2000; Turcu, 2012). In this regard, urban regeneration represents one of the most effective tools available to urban planners and designers to address a wide range of urban issues and to find long-term solutions to the economic, social, environmental and physical problems that plague contemporary cities (Roberts, 2000; Alpöpi and Manole, 2013). Urban regeneration represents a multidisciplinary field of research and a broad practice. It is characterised by an integrated and comprehensive vision aimed at solving urban problems and promoting the development of the urban communities concerned (Roberts, 2000; La Rosa et al., 2017). Best practice models and general principles underpinning urban regeneration are fairly well known (La Rosa et al., 2017) and emphasise that urban regeneration interventions should always be adapted to local governments' urban development models and specific geographical contexts (Kleinhans, 2012; La Rosa et al., 2017; Korkmaz and Balaban, 2020). In particular, sustainable urban regeneration interventions (Evans, 2012) should have effects not only at the neighbourhood level but at the city scale (La Rosa et al., 2017) and should address issues such as: the redevelopment of public spaces and the enhancement of public services (Privitera et al., 2013), upgrading urban infrastructure (Huston et al., 2015), improving living conditions in residential neighbourhoods (Alpöpi and Manole, 2013), increasing earthquake response and energy performance (Deakin et al., 2012; Güzey, 2016) and improving the working conditions of inhabitants (Korkmaz and Balaban, 2020).

However, despite the relevance of urban regeneration interventions in the development and design of sustainable cities and in achieving SDG 11, only a few contributions have quantitatively examined the actual sustainability outcomes of different urban regeneration interventions (Villagra et al., 2014; Zheng et al., 2014; Laprise et al., 2015; La Rosa et al., 2017; Korkmaz and Balaban, 2020). This study aims to fill this important gap by examining the level of sustainability of urban regeneration interventions in the Apulian context (an important Italian tourist

territory). In particular, therefore, this study answers the following research question:

RQ1: What is the level of sustainability of urban regeneration interventions in the Apulian context?

In order to answer these questions, this study examines the urban regeneration interventions implemented in the northern Salento area. This area was chosen mainly because of its great relevance from the point of view of tourism.

The reminder of this work is organized as follows: Section 2 introduces the background of this study; Section 3 presents the research methodology. Section 4 offers the results, while Section 5 draws conclusions.

## **2 Background**

### ***2.1 Evolution of sustainable urban regeneration***

Because urban systems are assumed to be affecting physical and social and economic transformations, they are particularly dynamic and complex. It follows that urban regeneration, as a tool used in urban policy following the eighties, cannot merely imply a city's physical development as it refers to all crucial and significant urban development's aspects.

Literature on planning has provided a host of urban regeneration's definitions. Amongst those, there is one that comprehensively explains urban regeneration as an across-cutting vision aimed at finding solutions to urban problems by delivering strategic and long lasting physical, social, environmental and economic opportunities and improvements to area subjected to change and transformations (Lichfield, 1992).

Another definition asserted by Roberts (2000) depicts urban regeneration as an emerging integrated action oriented toward the search of long-term solutions to physical, social, economic and environmental issues through the engagement of stakeholders who co-operate between them.

By the same token, there is the argument put forward by Donnison (1993) that considers regeneration as a method as well as a way that solve simultaneously the environmental, physical, social and economic problems occurring in areas subject to collapse.

It is possible to discern a common denominator to all three definitions: urban regeneration has a multi-dimensional and complex nature.

The concept, however, has evolved over time. According to Güzey (2009), from being a mere physical change it has changed into a more holistic and general approach to regenerating cities through the adoption of via place-specific strategies to solve physical, economic, environmental and social issues.

Currently, urban regeneration is acknowledged to be, as Leary and McCarthy (2003) have assumed, a multidisciplinary model which combines processes of policy-making and implementation in the field of urban development, sustainable solution, economy, urban planning, housing design, urban design, and transportation.

According to Güzey (2009), urban regeneration practices are diverse and there is no single recipe for urban regeneration that stands as a crosscutting field of urban policy.

Nevertheless, urban regeneration's common denominator is fourfold:

- a policy intervention that has an integrated and a wide-ranging nature,
- it refers to a specific area and is durable and strategic,
- as a long-term process, it involves actors across different sectors which are organised according to partnerships,
- it is oriented towards the achievement of a sustainable environment.

The latter provides a solid and inextricable bondage between urban development and environmental issues towards whom cities are deeply responsible. It is for this reason that, according to scholars, sustainability is instrumental to the planning and development of cities that it has been included into systems and processes of planning and management (Wheeler and Beatley, 2008; Evans, 2012). Even though sustainability became popular in the eighties as combined to development, it is, today, is very central to cities' development across the world. Both terms became notorious in 1987 when the World Commission on Environment and Development released the Brundtland Report on common future.

The report gave an inspirational definition of sustainable development where the latter fulfils present needs without compromising next generations' capacity to fulfil their own. In this light, it is assumed that sustainable development implies harmony on human-environment interactions so that relationships among population, resources, environment and development is balanced so establish the foundation of sustainability and health of resources and environment for future generations.

After the failure of the projects of urban regeneration conducted in the eighties, the agenda on urban regeneration has been dependent upon the discussion on sustainable development to the extent that the latter has influenced the former. From 1990s, both concepts have become inextricably connected (Balaban and Puppim de Oliveira, 2014) to the extent that the concept of sustainable urban regeneration emerged. Considered as an urban policy, Güzey (2009) has argued that projects of urban regeneration have been considered as an important instrument and a chance to attain sustainable development through a balanced combination of urban development and natural preservation.

Arguably, urban regeneration carried out through the key of sustainability does not simply emphasises on the physical and economic dimensions of regeneration processes. Above all, in any regeneration, it purposely combines the economic, environmental and social dimensions of sustainable development, at the same time. By this perspective, sustainable urban regeneration has the goal to avoid natural environment be destroyed by urbanization, hence, it prevents that urban resources decrease in the long run (Wheeler and Beatley, 2008; Evans, 2012). Therefore, it could be argued that sustainable urban regeneration represents a policy framework that, from one side, aims at protecting natural environment from eventual urban development's negative impacts, and from the other side, it represents a policy framework that improves the social and economic circumstances inside urban areas. Moreover, this concept offers a host of strategies and policies that while improving the spatial, social and economic organization of urban cities do also preserve the environment by adverse impacts.

Some scholars put forward the argument that sustainable regeneration supports the attainment of other targets such as the delivery of social care through providing social and regional balance, the prevention of local people displacement, support in building participation, engagement of stakeholders and creation of partnership between government and local actors, in other words, the improvement of the quality of urban life (Tallon, 2010; Czischke et al., 2015). Recent evidence from some countries on urban regeneration projects conducted according the perspective of sustainability includes an unequivocal dimension of climate change as they are oriented toward the building of climate-friendly and resource-efficient neighbourhoods. In these urban contexts, as Balaban and Puppim de Oliveira (2014) have demonstrated, the potential of global warming has been reduced by establishing an ecological imprinting to urban development.

## ***2.2 Sustainable urban regeneration and social innovation***

There has been a wide consensus amongst scholars that social innovation, considered as a process of territorial development that takes place within urban regeneration, is creative and contextual. Social innovation has a relationship of path dependency with urban regeneration (Moulaert et al., 2013). Urban regeneration brings to life of urban areas with the cooperative effort of municipalities, citizens and all the stakeholders involved in improving living conditions, enhancing the quality of the environment and the social fabric while strengthening the local economy. Given this backdrop, urban neighbourhoods have become a privileged unit of observation because social innovations aim to develop a specific territory in order to improve the quality of life.

Social innovation is considered as a new structural solution to a social problem and generates a social change. It is a solution because it determines either an improvement in the existing situation either an increase in the quality of life for groups of individuals, communities and the whole society. Social innovation is a solution that is disseminated and adopted whose main purpose is not the profit of a group of people.

According to Cooperrider and Pasmore (1991), the first researcher who used "social innovation" as a term was Taylor (1970). However, literature shows that, at the same time, researchers seem to have adopted a developmental or territorial approach. According to this perspective, social innovation refers to new ways of doing things for the clear purpose of addressing social needs, such as delinquency and poverty. Therefore, the emergence of social innovations is the result of the creation of multidisciplinary teams. By this light, it comes that the object of social innovation, is the solution to the problem and refers exclusively to what is being implemented.

Gabor (1970), for example, views social innovation as a tool for fighting against pollution, crime and corruption, violence, economic inequality, urbanization. Social innovation, therefore, in the development of such a "new social arrangement", stand as a positive response to the social consequences that they entail.

Eradicated within the context of neighbourhoods, social innovation is assumed to generate both spatial and social change in urban quarters by altering social connections between individuals and groups and transforming power relations throughout the process of planning. Social innovation can also promote an

innovative and learning society. In other words, it is a starting point for creating the social dynamics. In fact, given the orientation to community groups and to their surrounding environment, social innovation fits into practices of urban regeneration process ready to be implemented in a marginalized, poor and socially isolated urban area (Walters, 2001).

If at one side, heterogeneous neighbourhoods are expected to show a high degree of capacity to socially innovate, at the other side there is a debate on how social innovation practices develop in such an inclusive and cohesive manner.

Scholars and academics interested in social innovation have emphasised on the potential risk that, within the urban fabric, weak social groups' (Marconi and Ostanel, 2016), needs are marginalised despite a social innovation-based approach. In fact, it could be argued that policy interventions that do not contemplate social exclusion and fragmentation at the local community level have the risk to reproduce and deepen that social gap between the excluded groups versus the integrated ones. The social innovation's debate, more specifically, urges institutions to encourage regulation of durable and enduring practices of social innovation that unfolds within the realm of a democratic state where all citizens' rights are fully recognised.

There is a scholarly recognition on the extent of social innovation initiatives to drive change that particularly occurs in neighbourhoods whose problems are intensified by macro-economic forces. Place-based mechanisms and initiatives that increase the welfare of the individuals drive towards the development of urban regeneration's innovative multilevel governance that sustain institutional learning while solving, at the same time, that "solo" local policies are ineffective. This perspective leads to configure the social and spatial change not in moral communities but in spatialized ones since inequality is considered to be within the spatial and social distribution of disadvantage.

From these premises, it follows that social innovation is a context-specific issue which is studied inside spatial and institutional sites. Rather than being considered as a convenient "tool box" as it offers fast and easy solutions to challenging and demanding issues, social innovation can be better represented as an existing potential, hence as a local resource for change, inside any community.

By this light, this approach views urban regeneration as a process that is bottom-up and incremental to the extent that it leverages on community's cohesive organizations that overcome the top-down regeneration initiatives that, for long, have demonstrated their weaknesses. In this scenario, it is clear that

investments of revitalization as well as regeneration initiatives are supposedly originated from inside the community. This means that the latent potential is expressed and activated by the current community assets.

What is pivotal and crucial in processes of urban regeneration is the public space. The latter is, from one side, a means of empowerment, and at the other side, a host of significant secluded comfort areas that lead up to relevant forms of marginalisation and exclusion as well as enclavization. Also, public space is conceived as an asset used to mobilize a place's genius loci through facilitating social interaction. However, it is opportune to point out that, at times, public space has been used, in a strategic manner, to enhance and boost marginal community groups' exclusion during processes of gentrification (Lees, 2008). Nevertheless, it is worth depicting daily urban space as a set of mutual and dynamic relations enriched with power and symbols (Ostanel, 2014). In this scenario, heterogeneity and differences such as class, ethnicity and gender are portrayed in social constructions and representations that deliver a novel perspective through which the relationship between space and society is interpreted and analysed (Sandercock, 2000).

This study, therefore, considers urban regeneration as a practice of social innovation. However, for an urban regeneration intervention to be in line with social innovation, it must respect the parameters of sustainability.

### **3 Methodology**

This study is based on a multiple case study analysis. This methodology is particularly suitable for analysing the sustainability of urban regeneration as it is particularly effective in investigating complex phenomena that represent a relatively new line of research (Eisenhardt, 1989; Vitolla and Raimo, 2018). In particular, the use of a multiple case study makes the results more robust and favours their generalization (Yin, 1996).

#### **3.1 *Selecting case studies***

This study involves the analysis of three different cases represented by three different areas: San Vito dei Normanni, Brindisi and Mesagne.

The first case study concerns the San Vito dei Normanni area. Among the urban regeneration projects that the municipality of San Vito dei Normanni carried out in 2011, aimed at identifying tools and governance models for the available

public real estate, is a community incubator called Ex Fadda. This project was set up in 2011 thanks to the Apulia Region's 'Bollenti Spiriti' youth policy program, which included, among its measures, a massive urban regeneration action through the transformation of a series of disused, publicly-owned properties into spaces for youth activation. Among these properties was the former 'Dentice di Frasso' wine factory in San Vito dei Normanni. Ex Fadda is now a public space where people can come together, create and innovate in society. It has enabled the urban regeneration of not only the physical but also the human aspects of a community, with the aim of creating relational devices useful for activating the entire population for the revitalization of urban space through the sustainable use of disused green areas. The regeneration project for this container also envisages cultural activities as well as catering based on the principle of employing people with disabilities. An xfarm has also been set up to reuse land confiscated from crime, with the aim of involving young people in agricultural work.

The second case concerns the Brindisi area. Specifically, Punta Del Serrone area is located on the north coast of the city of Brindisi, and was inaugurated in 2014 after the restoration and reclamation of the area known as "cavallino bianco", which reaches as far as the Granchio Rosso beach area. It is a park covering 23 hectares and includes a large expanse of rocks with spontaneous vegetation with various autochthonous essences of the Mediterranean maquis, some of which are also endangered. The area is fenced off with free fronts with gates and pedestrian entrances. Inside, there are flush pedestrian paths with suspended walkways with the addition of signage and information and illustration boards. The park contains elements of naturalistic and landscape interest as well as historical interest.

The third case concerns the Mesagne area. More in detail, the regeneration of Potì Park represents a project inaugurated on 8 May 2016 thanks to funding from PO-FESER Puglia 2014-2020. The inauguration party was accompanied by the marathon of peoples and other various events aimed at sponsoring the different areas of the park. The main themes are those of urban and social regeneration in an area of about 25,000 square meters. In the 1940s and 1950s, the district where the current Potì Park is located hosted the weekly municipal market, a commercial, social and cultural meeting place for the city. Within the area there was a sports facility that was abandoned in the 1990s. The inhabitants of the neighbourhood were mainly elderly people forced to stay at home because of the lack of services and facilities. This project aimed to reverse the situation and create a large public green park in the area of the former sports ground, making



the neighbourhood a new central part of the city. Together with the large park, new services have been created and the entire mobility has been rethought, making it sustainable, slow and safe. Of the 25,000 square meters of the entire park 7590 were allocated to the green area; 13000 have been allocated to a drainage area; 4000 have been allocated to the so-called "zone 30".

### ***3.2 Identification of the framework for the assessment of sustainability***

In the framework of the academic literature related to sustainable urban regeneration, an important question is how to assess the sustainability performance of urban regeneration projects. However, the academic literature has not identified an unambiguous answer. In fact, although there are several studies and researches aimed at identifying tools and frameworks for sustainability assessment, studies assessing the performance and effectiveness of urban regeneration projects against the social, economic and environmental pillars of sustainable development are still insufficient (Zheng et al., 2014). Some of the current evaluation frameworks suggest measures to assess situations where urban regeneration strategies have been implemented and analyse the effects of policy actions (Hemphill et al., 2004). Although good practices for urban regeneration seem to have benefited from some general principles, it is widely accepted that urban regeneration projects should always take into account the circumstances of the territory and be adapted to specific local contexts (Kleinhans, 2012). This principle is also crucial for the design or selection of methods and criteria for assessing the sustainability of urban regeneration projects (Korkmaz and Balaban, 2020). There is a growing recognition that sustainability assessment methods need to be more representative of local conditions and aligned with the values of the target audience (Dahl, 2012). The local context is therefore the most important element in the evaluation of urban regeneration projects (Conte and Monno, 2012). This circumstance makes it necessary to use methods that are more flexible and adaptable to different contexts (Korkmaz and Balaban, 2020). Methods for assessing the sustainability of urban regeneration should also be dynamic in order to allow researchers to understand the long-term effects of interventions (Korkmaz and Balaban, 2020). The academic literature, among the tools for assessing the sustainability of urban regeneration projects, shows a prevalence of indicator-based frameworks (Peng et al., 2015).

However, such frameworks have some limitations. Indeed, they represent a highly technical means of measuring sustainability and, therefore, tend to reduce the idea of sustainability to a set of easily quantifiable aspects of socio-economic development (Weingaertner and Barber, 2010; Elgert, 2018). Thus, the use of indicator-based frameworks carries the risk of ignoring the qualitative outcomes of the urban regeneration project due to a virtually exclusive focus on quantitative results (Korkmaz and Balaban, 2020). This is an important limitation since sustainability cannot be expressed only in quantitative terms (McCool and Stankey, 2004). Therefore, to overcome this limitation, sustainability assessment frameworks from urban regeneration must necessarily include indicators that go beyond quantitative measures (Boyle et al., 2018; Hemphill et al., 2004). So, a third characteristic that urban regeneration evaluation frameworks should have is a proper balance between quantitative and qualitative indicators. The academic literature has identified several indicator-based frameworks for assessing the sustainability of urban regeneration projects (Balaban, 2013).

However, there is no consensus on which framework is the most suitable. The main frameworks are the one developed by Hemphill et al. (2004), Laprise et al. (2015), Larsson (2012), Couch and Dennemann (2000) and Korkmaz and Balaban (2020). In particular, this study is based on the framework used by Korkmaz and Balaban (2020) to measure the sustainability performance of urban regeneration interventions implemented in the Turkish context. This framework is based on the one developed by Couch and Dennemann (2000), but at the same time takes into account the local context. In this regard, the specificities of the Italian context are similar to those of the Turkish context. Both are characterised by the difficulty in collecting quantitative data. These circumstances make the framework developed by Korkmaz and Balaban (2020) particularly suitable for the present study. Table 1 presents in detail the framework used, highlighting the three dimensions of sustainability, the eight aspects analysed and the twenty indicators used. It also provides an overview of the data and information sources in relation to each indicator.

Table 1 - Assessment of the sustainability of urban regeneration, adapted from Korkmaz and Balaban (2020)

Dimensions	Aspects	Indicators	Data
<b>Social</b>	Participation of Stakeholders	Encourage decision-making and action-taking at the local level Community involvement in developing the project	S, I, DO S, I, DO
	Land Use and Buildings	Under-represented groups are taken into account sufficiently	S, I, DO
		Amenities/services are provided locally	DO
		Low capacitated residents are provided with improved access	S, I, DO
		Building are reused or conserved	S, I, DO
<b>Economic</b>	Economy and Jobs	Increased chances for employment Improved environmental awareness of local businesses Support local employment by creating new jobs around the project site	S, I, DO S, I, DO S, I, OD
<b>Environmental</b>	Transportation	Walking & cycling are encouraged Public transport use is encouraged Private car use and traffic is discouraged	S, I, DO S, I, DO S, I, DO
	Environmental Pollution	Reduced levels of air and water pollution	S, I, DO
	Energy Use	Maximization of efficiency in energy use Renewable energy generation and use	S, I, DO S, I, DO
	Waste Management	Reduced waste generation Encourage recycling, reuse and/or repair	S, I, DO S, I, DO
	Open Spaces and Wildlife	Increase the sum of green space per capita Supporting connection with the city's green axis created Support the use of open spaces for public interest	S, I, DO S, I, DO S, I, DO

Note: S: Survey; I: Interviews; DO: Direct observation

### **3.3 Data collection and analysis**

This study is based on primary data. In particular, it is based on data collected through surveys, interviews and direct observation.

The questionnaire consisted of 29 questions under eight titles: community participation; land use and buildings; economy and jobs; transportation; environmental pollution; energy use; waste management; and open space and wildlife. Sixty surveys were completed for each of the three contexts examined. Therefore, a total of 180 surveys were completed. In order to allow for quicker compilation, the web and social networks were used as channels for the transmission of the questionnaire.

In addition to the questionnaires, numerous interviews were conducted with main actors who took part in the conception and implementation of the urban regeneration projects examined. In particular, interviews were conducted with representatives of the municipalities and the companies that carried out the works. In a first phase, the interviews were not structured and were aimed at providing a first approach to the survey topic to the interviewees. Subsequently, in a second phase, the interviews opted for semi-structured interviews in order to enhance the phenomenon with respect to the research objectives of this work.

Finally, in addition to the questionnaires and interviews, direct observation was carried out by the researchers. In particular, the researchers visited several times the places affected by the urban regeneration interventions and the surrounding areas in order to understand and evaluate first-hand the effects of these interventions in relation to sustainability.

The data collected were aggregated and subjected to triangulation. This technique corresponds to the reliability tests of quantitative research (Creswell, 2007; Morrone et al., 2020; Ricciardelli et al., 2020; Vitolla et al. 2020; Raimo et al., 2021a, b) and ensures validity, credibility and accuracy to the results of qualitative studies (Denzin, 1984; Stake, 2000; Creswell, 2007). This study has used three types of triangulation.

Taking into account Katamba, Marvin Nkiko, and Ademson (2016), the first type is defined in terms of data triangulation implying that data, previously collected from the available diverse sources, have been subject to examination (direct observation, survey and interviews) and comparison. This triangulation of sources guarantees a more complete view of the phenomenon that has been investigated.

In addition, triangulation of sources ensures that the collected data are compared by allowing reliability of data themselves.

The second type of triangulation is the methodological one. It contemplates that there are diverse methods for data collection from different sources available. The goal of this technique is to clean data collected from eventual weakness deriving from each single method that has been used.

The theoretical triangulation is the last type of triangulation being used. In this regard, it is necessary to point out that researchers have carried out investigation and, later, implementation of data analysis by leveraging on their different personal theoretical background. To be more precise, one side of researchers has specific knowledge of organisational studies, the other side, instead, owns a background in managerial studies. By this technique it has been possible to emphasise on the common elements of all researchers by leaving aside their diverse theoretical backgrounds. It is important to stress out that all three types of triangulations have enabled not only data reliability and validity but they have, more importantly, increased awareness of the phenomenon on which this subject is based on.

The process of data analysis has unfolded in three different phases: cross-examination of raw data, derivation of descriptive statements and themes from raw data, and interpretation. In the first phase, an assessment and visualisation of the data was carried out, which led to the exclusion of data considered not in line with the objectives of this study. In the second phase, a data coding activity was carried out which involved the identification, naming, extrapolation and classification of the data collected. These activities were fundamental in order to obtain a holistic overview of the sustainability of urban regeneration. Data were classified according to the method used (survey, interview, direct observation). The third phase involved the collection of explanations that clarify themes and observations obtained by data.

## **4 Results**

In this section we examine in detail the sustainability performance of urban regeneration interventions in the Apulian context with particular reference to three different areas: social, economic and environmental.

#### **4.1 Social sustainability**

Some important characteristics of social sustainability are justice, stakeholder participation in the decision-making and implementation processes of urban regeneration interventions and land use. These are the aspects examined in order to assess the social sustainability of urban regeneration interventions in the Apulian context.

With regard to the first elements, the results show an important justice and participation of stakeholders in the decision-making and implementation processes of urban regeneration interventions. In particular, the results of the questionnaire showed particularly high results to the questions related to community participation in all three cases examined, as highlighted in Table 2. In particular, as emerged from direct observation, the three cases examined demonstrate the participation of stakeholders in the decision-making process through the creation of specific information campaigns through the use of social networks. These information campaigns were aimed at learning about stakeholders' needs, presenting projects and gathering feedback from citizens. In addition, as emerged from the interviews, numerous meetings were organised with cultural and environmental associations in order to make citizens participate in urban regeneration processes. These associations were also listened to and involved during the implementation phase of the urban regeneration interventions in order to know the citizens' opinion about the progress of the works. The most vulnerable citizens, such as the elderly and the disabled, were also listened to in order to ensure that their needs and requirements were met. They may have different interests and needs than the rest of the population. The interviews also showed that local governments have tried to involve not only active citizenship, but also those who normally do not care about urban regeneration issues in their area. This fact, according to the interviewees, represented the real challenge, since only urban regeneration projects of a certain value attract the interest of citizens who are not familiar with urban regeneration and the issues of their territory.

In addition, the results of the questionnaires showed a high level of citizen satisfaction with land use and buildings. Accessibility is an increasingly important issue in urban regeneration projects. In this regard, the project areas have easy pedestrian access for people with limited mobility, such as disabled, elderly and pregnant people. Direct observation also showed us a strong relationship

between pedestrian pathways, sociocultural and open spaces. Furthermore, an important need of citizens is connected to the possibility to access all daily services and facilities in and around the urban regeneration project area. In this regard, it is necessary to underline the presence of several essential services for citizens in the urban regeneration areas. Citizens can easily access banks, pharmacies and supermarkets. Finally, the presence of numerous socio-cultural facilities, also demonstrated by the values obtained in the survey, is also noted.

Table 2 - Results of the survey regarding social sustainability

	San Vito dei Normann i	Brindis i	Mesag ne
<b>COMMUNITY PARTECIPATION</b>			
The Municipality organized regular meetings along the planning process to inform all stakeholders and enabled them to participate	3.5	3.1	3.5
Your demands and expectations were taken into consideration and the promises granted during the planning process were sufficiently fulfilled	3.4	2.9	3.3
The promises made during the project planning process have been kept	3.8	3.5	3.8
Strong relationship between the Municipality and the stakeholders continued after the project	3.8	3.4	3.7
You can easily transfer your demands and expectations to the Municipality via nongovernmental organizations	3.8	3.3	3.8
<b>LAND USE AND BUILDINGS</b>			
The pedestrian access is easy and well designed in project area	3.7	3.6	4
You can easily meet your daily needs from project area and its nearby surroundings	4.1	3.8	4.1
There are enough socio-cultural facilities in project area and its surroundings	4.1	3.5	3.8

#### **4.2 Economic sustainability**

Economic aspects are the second pillar of sustainability. In the context of urban regeneration, projects should contribute to the growth and economic development of the project area and its surroundings. In this respect, it is to be expected that a valuable urban regeneration project will create new job

opportunities for the local inhabitants and in particular for special categories such as young people and women in the different phases of planning and implementation as well as in the post-completion phase.

The results of the survey, as shown in Table 3, demonstrated a wide satisfaction of citizens with the impact of urban regeneration projects on employment levels. Through the interviews and direct observation, the involvement of local businesses in the works related to urban regeneration emerged first. This concerned both the definition and implementation phases of the projects. The involvement of local enterprises not only increased the employment level of the municipalities surveyed but also fostered a sense of belonging among the citizens who felt directly involved in the urban regeneration projects of their territory. In addition, people living in the project areas were employed in commercial structures and in the provision of cultural and artistic services within the urban regeneration areas. The increase in employment levels mainly concerned young people. However, it must be stressed that there were no specific strategies and policies to support the participation of women in the entrepreneurial life of the project areas either in the design and implementation phases of the projects or in the post-completion phases.

Table 3 - Results of the survey regarding economic sustainability

	San Vito dei Normanni	Brindisi	Mesagne
<b>ECONOMY AND JOBS</b>			
The project provided job opportunities for you and your acquaintances during preparation and implementation processes	3.5	3	3.3
After the project was completed, new job opportunities emerged, and some of my acquaintances could find work	3.9	3.1	3.3
The project created new job opportunities for women	2.3	1.7	1.9

#### **4.3 Environmental sustainability**

Environmental sustainability is assessed mainly in terms of transport, environmental pollution, energy use, waste management, and open space and wildlife. In this perspective, sustainable urban development is based on the extensive use of efficient and well-organised transport systems, the reduction of



environmental pollution and energy consumption, the use of sustainable energy resources, extensive waste recycling, and the use of large green open spaces. In light of this, urban regeneration interventions should contribute to improving aspects related to transport, pollution, energy, waste and green open spaces. The results of the questionnaire firstly showed a high level of citizen satisfaction with transport. These results are also confirmed by interviews and direct observation. They showed that urban regeneration projects discouraged the use of cars and favoured the use of bicycles and bus-based public transport. They have also encouraged walking by citizens. These interventions have therefore reduced city traffic both in the urban regeneration area and in the surrounding areas. The questionnaires also showed high results in relation to environmental pollution. In this regard, citizens were particularly satisfied with improvements related to air and soil quality, while there was less satisfaction with water quality. This is also evident from the interviews and direct observation that the many green spaces created have significantly increased air and soil quality. In relation to energy use, the results of the questionnaire showed a low level of citizen satisfaction. Interviews and direct observation confirm the lack of use of renewable energies and a not total maximisation of the efficiency of energy use. In this respect, the absence of motion sensors does not support the achievement of full efficiency. In relation to waste management, the results of the questionnaire showed a high level of citizen satisfaction.

This satisfaction derives both from the level of information local governments provide to citizens about waste issues and from waste management. The interviews and direct observation showed that, thanks to urban regeneration interventions, levels of waste production and abandonment have been reduced. Furthermore, thanks to the urban regeneration interventions, the level of waste separation has increased and the level of waste recycling has increased. In addition, these urban regeneration interventions have also changed the culture of a part of the citizens previously not oriented towards separate waste collection. Finally, in relation to open space and wildlife, the results of the questionnaire showed a high level of citizen satisfaction. The urban regeneration interventions have in fact provided citizens with additional green spaces which, as emerged from the interviews and direct observation, are used as meeting places for young people and families. In this perspective, urban regeneration interventions further stimulated the use of open spaces by citizens who increasingly prefer to enjoy

nature instead of staying at home or going indoors. The creation of new green spaces is also an engine for tourism.

Table 4 - Results of the survey regarding environmental sustainability

	San Vito dei Normann i	Brindis i	Mesag ne
<b>TRANSPORTATION</b>			
There is easy pedestrian access to public transportation as well as between public transportation stops, facilities and residences	3.8	3.6	3.9
Pedestrian and cycling routes are well designed and integrated to each other	3.6	3.7	3.7
The frequency of public transportation is not adequate	3.5	3.5	3.8
Having a car is a need that makes life easier in project area	3.6	3.5	4
Low-capacitated residents (i.e. disabled) can reach anywhere on foot in the area	3.9	3.6	4.1
<b>ENVIRONMENTAL POLLUTION</b>			
The project has improved the quality of the air in the area	3.2	3.3	3.5
The project has improved the quality of the water in the area	2.9	3	3.2
The project has improved the quality of the soil in the area	3.2	3.2	3.5
<b>ENERGY USE</b>			
Residential units have no heating problems due to good insulation and solar orientation	2.1	1.9	1.9
Heating expenditures is quite high	1.7	1.6	1.7
<b>WASTE MANAGEMENT</b>			
Municipality collects the wastes regularly	3.9	2.8	4
Residents are informed about waste separation and importance of recycling	4	3.9	4
Recyclable wastes and vegetable oil wastes are collected separately	3.4	3.3	3
<b>OPEN SPACE AND WILDLIFE</b>			
There are enough green spaces, sports areas and playgrounds in project area	4.3	3.9	4.4
You are pleased with the use of open and green spaces around residential areas	4.2	4	4.4
You can use public spaces in the project area at any time of the day	4.2	4	4.1

There are public spaces where different income groups can come together	4.3	4.1	4.4
You prefer to meet with your acquaintances in open spaces in project area	4.4	4.1	4.3

## 5 Conclusions

This study aimed to investigate the sustainability of urban regeneration interventions in the Apulian context. The results showed a high level of sustainability of these interventions in all three contexts examined. However, there are some weaknesses related mainly to the absence of strategies aimed at the inclusion of women in the labour market and to the low efficiency in the use of energy. This study contributes to the academic literature and practice in different ways. Firstly, it contributes to knowledge about the sustainability of urban regeneration interventions. In particular, it represents one of the first attempts to measure the sustainability of urban regeneration in Italy. Secondly, this study provides an important framework for measuring the sustainability of urban regeneration. This framework will be useful for practitioners and professionals to examine this phenomenon in other contexts and for professionals interested in assessing the goodness of urban regeneration interventions implemented by municipalities.

The results of this study have important implications for municipalities implementing urban regeneration projects. In particular, it shows a number of elements that municipalities should pay attention to in order to increase citizen satisfaction and thus gain acceptance. In particular, when implementing urban regeneration projects, municipalities must pay attention to social, economic and environmental aspects. In the field of social aspects, municipalities must first of all involve stakeholders in the planning and implementation of urban regeneration projects. In particular, they must pay attention to and involve the weakest and least represented stakeholders. Furthermore, municipalities must pay attention to land use and the preservation and re-use of buildings. In the field of economic aspects, municipalities must pay attention to revitalising the local economy and increasing the level of employment. In this regard, they must also devise strategies for getting young people and women into work. Finally, in the area of social aspects, municipalities must pay attention to policies related to transport, environmental pollution, energy use, waste management and open and green spaces. With regard to transport, municipalities should discourage car use and

encourage the use of public transport and bicycles. Regarding environmental pollution, they should develop policies to reduce noise and improve air and water quality. Regarding energy, municipalities should maximise the efficiency of energy use and promote the generation and use of renewable energy. Regarding waste management, municipalities should develop policies aimed at reducing the amount of waste produced and increasing separate waste collection. Finally, with regard to open spaces, municipalities should create new green spaces that welcome young people and families.

However, this study is not without limitations. A first limitation is related to the use of only primary data and the absence of secondary data. This may limit the objectivity of the data collected. A second limitation is related to the relatively low number of answers to the questionnaires. However, these limitations do not reduce the overall quality of this work and offer important insights for future research. In relation to the first limitation, they will be able to replicate the study by extending the number of sources used and incorporating secondary data. In relation to the second limitation, they will be able to extend the number of responses to the questionnaires by identifying additional dissemination channels to facilitate circulation. Finally, future studies could examine the sustainability of urban regeneration projects in other contexts and make international comparisons.

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## Civic Wealth Creation: Reinterpreting and Regenerating Historical Cities

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### Abstract

This paper aims to understand factors and processes that leverage from tangible and intangible cultural heritage (i.e., local know-how, tacit and codified knowledge linked to arts masterpieces and cultural heritage assets but also to local crafts and tradition) to sustain citizens' social, cultural and economic wealth. So far not enough attention has been paid about the regeneration of smaller cities which hold major artistic heritage but do not have adequate resources to leverage on it and bring positive societal impacts. The paper adopts a qualitative approach and we followed an abductive approach oriented to the generation of new concepts and the development of new explanatory lens, rather than the confirmation of existing theories. It focuses on the case of Urbino, a UNESCO world heritage site whose population and economic status is declining because citizens and businesses are attracted by the lure of higher revenues and better quality of life of nearby cities. Findings revealed that culture and artistic knowledge and capabilities that belong to the tradition of a city rich in heritage can be the lever of innovation and boost civic wealth. Searching the past for looking to the future is, however, a difficult task and divergences in vision, resistance and even political tensions are among the factors that hinder the city regeneration.

**Keywords** – civic wealth; cultural heritage; historic city centre, social innovation; urban regeneration

**Paper type** – Academic Research Paper



## 1 Introduction

Urban regeneration is a wide research area that mainly focused on how to innovate degraded districts and abandoned modern buildings to contribute to city development. However, urban regeneration also applies to historical cities, rich in cultural heritage, that lack of social and economic opportunities for citizens and risk desertification of their historical centers (Stolarick & Florida, 2006; Cooke & Lazzeretti, 2008; Ertan & Eğercioğlu). The key challenge is to reinvent the way spaces are exploited, build on culture to breathe new life into historic centers and activate local knowledge and capabilities that generate new opportunities to achieve civic wealth creation (Lumpkin & Bacq, 2019; Rock H2020 project). Unfortunately, the mechanisms of how cities can capitalize on cultural legacy, heritage and past knowledge to activate effective and sustainable urban regeneration has not been investigated under a knowledge management perspective with a few rare exceptions (Dameri & Demartini, 2020). Therefore, this paper aims to understand factors and processes that leverage from tangible and intangible cultural heritage (i.e., local know-how, tacit and codified knowledge linked to arts masterpieces and cultural heritage assets but also to local crafts and tradition) to sustain citizens' social, cultural and economic wealth (Magistretti et al., 2020). An important source of stimulus for professionals and researchers is the UNESCO Creative Cities Network (UCCN), which functions as a laboratory of ideas and innovative experiences intended to capitalize on the full potential of culture and creativity for sustainable urban development. However, best practices and existing literature have mainly focused on the regeneration of the historic centers of large cities (Carillo, 2004; Zukin et al., 2015) or great tourist destinations (Martí-Costa & Pradel, 2011; Ginzarly & Teller, 2018), in which the availability of human and financial resources allowed the launch of important culture-driven regeneration projects. On the other hand, not enough attention has been paid about the development of smaller cities or even villages which hold major artistic heritage but do not have adequate resources. Reflecting on these shortcomings, our paper questions: *How can a local administration of a small historical city leverage a World Heritage site to foster the regeneration of the local economy and bring positive societal change?*

Our study has taken advantage of an abductive approach (Dubois & Gadde, 2002). Similar to 'grounded theory', the main concern of the abductive approach

is related to the generation of new concepts and the development of new explanatory lens, rather than the confirmation of existing theories.

The remainder of the paper is structured as follows: section two presents the different research streams we combined to build our framework of analysis; section three elucidates the abductive protocol and provides a brief description of the case study; finding and discussion follow in section 4; conclusions are presented in section 5.

## **2 Combining different streams of research to reinterpret historical cities regeneration**

In order to explore how to foster urban regeneration several interdisciplinary contributions have addressed their attention on cultural heritage (CH), regarded by scholars and policy-makers as a driver of development—especially for historic cities—and a key element of civic wealth and urban sustainability (Cervello´-Royo et al., 2012; Echter 2015; Nyseth & Sognnæs, 2013; Nocca,2017). As a contribution to prior literature on urban regeneration, we combined different streams of research focusing on:

- the context (i.e., regeneration of historic city centres);
- the purpose (i.e., creation of civic wealth);
- the process (i.e., a path for a participatory governance based on context and purpose).

### ***2.1 Regeneration of historic city centres leveraging on CH***

CH includes both tangible culture (material aspects of culture, such as buildings, monuments and objects, e.g., books, works of art and artefacts), natural heritage (e.g., landscape) and intangible culture (non-material aspects, such as folklore, traditions, language and knowledge), which are embodied in social practices and community life (Throsby 1999 and 2003; Blake, 2000).

In recent years, the role of CH role has been extensively recognized, both at the academic and institutional level (UN, 2015; ICOMOS, 2015; Camagni et al., 2020), thus marking a shift towards a holistic, interrelated perspective on CH, which is seen as socially constructed, dynamic and functional. Hence, CH it is conceived both as an element and a tool for socio-economic development (UN-Habitat, 2014; CHCfE Consortium, 2015) and an integral element of territorial capital,

capable to influence local economic dynamics since “it shapes cultural and psychological attitudes of local communities; represents an important component of local social and identitarian capital; enhances creativity of the local intellectual and artistic milieu” (Camagni et al., 2020:35). Indeed, its conservation and valorisation are at the centre of a lively debate on what – how – whom – it contributes in revitalizing cities, local areas and historical districts (UNESCO, 2008; Murzyn-Kupisz, 2012; Azmi et al., 2021).

Moreover, both the New Urban Agenda (UN, 2016; UNESCO, 2016 and 2018) and the 2030 Agenda (UN, 2015) have opened up new avenues to integrate culture into policies for social and economic inclusion and environmental sustainability, resting on the idea that CH and creativity are linked to local places and communities, thus directly and indirectly contribute to a number of targets, particularly SDG 11 (to ‘make cities and human settlements inclusive safe, resilient, and sustainable’).

In this vein, the revitalisation and the social upgrading of historical city centres has become a strong priority and an aspiration of urban policy in all parts of the European continent (Rudokas & Grazuleviciute-Vileniske, 2021).

Historic city centres and historic districts are symbols of the city’s image; above and beyond their own cultural value they fulfil an important mission in modern urban development: they create the identity and the city’s image and are key geographic factors for the local and regional economy (UNESCO, 2008: 9).

The enhancement and regeneration of the historic city centre are considered by many to be an opportunity for sustainable economic development based on the spur of culture and creative industries and sustainable tourism (Sacco, Ferilli, & Blessi, 2014; Sacco, Ghirardi, Tartari & Trimarchi, 2019; Blessi et al., 2016; Ertan & Eğercioğlu, 2016).

A further topic attracting the attention of scholars and politicians is represented by the recovery and resilience of historic small towns (Azmi et al., 2021) included among the World Heritage Sites (WHSs) where the mobilisation of cultural resources for economic revitalisation could be pivotal for the development of a “culture-based economy” (Amin & Thrift, 2007; Power & Scott, 2004; Rakic & Chambers, 2008).

However, there was no lack of criticism because there is also a risk of abusing “the role of culture and creativity in urban processes to legitimise and even encourage organised forms of appropriation of common symbolic and material resources” (Sacco et al., 2019: 200). Culture-driven gentrification is one example

of this type of appropriation (Atkinson & Bridge, 2005; Zukin, Kasinitz, & Chen, 2015).

In this vein the Historic Urban Landscape (HUL) approach proposed by UNESCO (2011 and 2016) and the UN-Habitat New Urban Agenda (2014), suggests that it is possible to integrate CH conservation and socio-economic development of cities (Grefe, 2009) if we consider the urban landscape as an "organism" made of complex characters, and multidimensional inter-relationships (Veldpaus & Pereira Roders, 2014).

## **2.2. Regeneration of historical villages and towns and creation of civic wealth**

Historical villages and towns that populate Europe have many of the attributes and qualitative elements (e.g., pedestrian zone, restaurants, retail shops) that create a dynamic social and cultural place and make the location a great place dear to the community and capable to attract talent companies. However, many of them suffer from unemployment, disengagement and economic stagnation (Thurley et al., 2015). In particular, Italian historic centres have progressively lost their social and economic attractiveness (Micelli & Pellegrini, 2018). Citizens often moved out to search for jobs and opportunities, following the same trend of companies and institutions searching for more rational and better connected locations. In other cases, citizens left historical quarters because life quality was clashing with large flows of overtourism (Jover & Díaz-Parra, 2020). Either the case, cities lose their most valuable resource: the community (Higgings, 2020).

Municipalities and local governments attempted to address these issues using heritage to regenerate towns. However, many initiatives failed because investments focused on restoration only, while social and economic benefits are achieved if wider targets than building conservation, including employment, training and business development are set. Failure of initiatives promoting a sustainable economy that safeguard the tangible and intangible heritage also occurred because they often forgot to put the community at the centre, while the engagement of the broader community is critical in achieving this vision (Feehan & Zingsheim, 2019).

A promising solution is civic wealth creation, i.e., the creation of social, economic, and communal endowments that benefit local communities and allow these communities to be self-sufficient, therefore generating positive societal

change and sustainable impact (Lumpkin & Bacq, 2019; Bacq et al., 2020). This type of wealth goes beyond material resources and physical assets of a community to include intangibles such as health, happiness, culture and social justice. It is a wealth created as outcome of local stakeholders' collaboration and takes the form of new or improved local capacity, capabilities, culture, material and immaterial resources that help to find solutions to community problems and bring about change (Alvord, Brown, & Letts, 2004; Haugh, 2005). According to this perspective communities (people who share place, identity and interests) are actors for societal change and not merely passive beneficiaries (Glynn, 2019). Therefore, communities directly contribute to create real societal impacts (Branzei et al., 2018).

According to this stream of literature, three stakeholders category shall jointly collaborate: local communities, enterprises and supporters/facilitators (i.e. providers of financial, technical, and political assistance) to create civic wealth. Collaboration is successful only when the different stakeholders intentionally pursue joint interests to achieve positive societal change. If one stakeholder category is not committed because its interests diverge from others' interests or because they are only partially involved, civic wealth is not created, although other positive impacts can still be achieved. The mechanisms or strategies to achieve fruitful collaboration that generate civic wealth are mainly three: engaged participation, collaborative innovation and resource mobilization (Lumpkin & Bacq, 2019). The key actor (or orchestrator) that may initiate the process of civic wealth creation can be any key stakeholder, who is committed to bring about positive societal change or maintain the civic vibrancy of a community. Although, in practice, this stakeholder is usually a public subject.

### *2.3 1 Participatory Governance and a shared vision for culture-led civic wealth*

According to the literature (Sacco, Ghirardi, Tartari, & Trimarchi, 2019) a participatory governance, which involves citizens and stakeholders in the culture-led processes of urban regeneration, is a condition to generate positive and lasting impacts over time.

The cultural regeneration of a territory is achieved, indeed, through a plurality of cultural participative initiatives (PCIs) that involve different stakeholders and unfold over time (Biondi et al., 2020). A single project relating to the investment of contributions for the preservation of cultural heritage will not be sufficient to trigger a virtuous spiral of cultural, social and economic growth and impact on

civic wealth. The idea behind this positive spiral is transforming people into "cultural citizen" who, in turn, would nurture culture as an endogenous growth process (Sacco & Segre, 2009).

It is therefore a virtuous growth path that must be activated and nurtured over time and that requires orchestrator (s), usually a public actor. But it can also be a grassroots initiative, in which citizens, members of an association, of a community initiate a cultural project for the regeneration of a public space, a district, an historic city center (Aureli, Del Baldo & Demartini, 2020; Demartini et al., 2020). The role of the orchestrator(s) is fundamental in shaping the vision and enabling participation of all relevant stakeholders (Biondi et al., 2020). The starting phase of a culture-led regeneration project is characterised by the orchestrator's vision, which is long-sighted and requires others to be convinced of its aims and merits. Hence, a key issue is to transform the individual visions of single actors and, specifically, their means and ends into a joint understanding. As Della Lucia & Trunfio (2018: 36) argue, "In the creation of a shared vision of urban development, the greatest challenge is to overcome the significant barriers that inevitably arise when a wide variety of stakeholders are involved, all with different backgrounds, power agendas, aims, roles and competencies."

For this reason, understanding the sharing of the broader strategic vision behind projects for the preservation and reuse of individual heritage assets is fundamental to understand whether or not there is a widespread perception of the value of cultural commons and a cultural project shared by local actors on the enhancement of cultural heritage (Del Baldo & Demartini, 2021).

These last considerations are particularly interesting because they facilitate reflecting on the theme of the renewal of an historical small town thanks to the transfer of tacit and codified knowledge over time among those who, as residents or city users, base their identity on the tangible and intangible cultural heritage left by previous generations. The latter is a phenomenon deeply investigated for business and known as "innovation through tradition strategies" (DeMassis et al., 2016; Magistretti et al., 2020) that can be translated to our context as follows. As scholars reveal that firms leverage knowledge from the past mainly to preserve firm identity, in the same way a cultural project of regeneration of an historical town should innovate while preserving their link with the past, thanks to processes of combination and reinterpretation of past knowledge.

### **3 Methodology**

#### **3.1 *The abductive approach***

The paper adopts a qualitative approach. It focuses on the case of Urbino, a UNESCO world heritage site whose population and economic status is declining because citizens and businesses are attracted by the lure of higher revenues and better quality of life of nearby cities. Maintaining the vibrancy and the well-being of the community represents a challenge for the local government, which launched a series of initiative under the umbrella project named "Urbino per Bene" (Municipality of Urbino, 2016). The paper relies on abductive approach, which is a form of logical inference that begins with an observation or a series of observations and then tries to find out explanation. The basic assumption is that theory cannot be understood without empirical observation and vice versa (Dubois & Gadde, 2002).

Based on the observation of actions and outcomes obtained through one civic initiative known as "the Relaunch of the Data space" (the ancient stables of the Duke Federico da Montefeltro), the paper reconstructs the premises that activated the community process devoted to create civic wealth putting together different visions and perspectives on urban regeneration.

Information on the case study were obtained from six semi-structured interviews with key representatives of the main institutions involved in the Data project, namely the following: the prior Councilor of the Municipality of Urbino appointed for the city planning and, currently, for Tourism; a consultant for public communication of the city Council; three local representatives of art schools (i.e., the Higher Education in graphic design and visual communication; the Academy of fine arts; the Artistic high school of Urbino); the local representative of the Trade association of crafts and small businesses

Further four unstructured interviews regarded the Rector of Urbino University and the University delegate to the third mission; an architect from the city planning office of the Municipality, responsible for urban regeneration, who also dealt with the drafting of the UNESCO site management plan; the CEO of the Incubator appointed by the Municipality to support the most promising business ideas, which take shape within the Labs organized at "the Data space". In our interviews, the Data project opened a discussion on the role of CH in the city of Urbino. Hence, the focus moved from the Data space new functions to the vision

/ strategic plan of the city of Urbino. Insightful information was also obtained from a previous survey launched by the Municipality under the broader project "Urbino per Bene", based on semi-structured questionnaires and interviews addressed to Urbino citizens, tourists and university students. Additional information was extracted from the analysis of public documents such as the municipality website, public speeches and the city strategic plan.

All the conversations were recorded, and notes taken during the meeting formed the basis to write more extensive reports at a later time. In our analysis, we found the use of excerpts highly worthwhile, as they draw attention to the interviewees' perceptions.

On a regular basis, the team members shared the outcomes of the interviews during face-to-face meetings and teleconferences to discuss questions arising from the empirical investigation and identify the main features of the observed phenomenon.

The Data project has launched a discussion on the role of CH in the city of Urbino path of development. Hence, the focus of the interviews moves from the Data project to the vision / strategic plan of the city of Urbino. Following the abductive approach, this dialectic led to a refinement of selected concepts to interpret the phenomenon.

### ***3.2 The case study in brief***

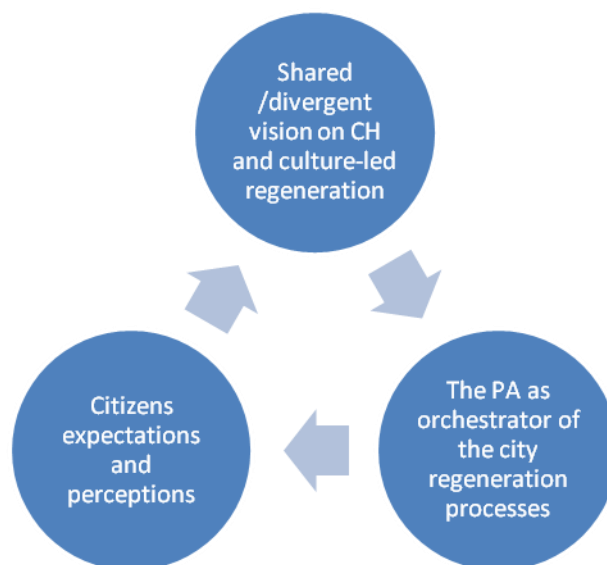
The city of Urbino, included in the UNESCO List of World heritage since 1998 for its outstanding universal value (see the site [whc.unesco.org](http://whc.unesco.org)), offers a paradigmatic case study and an interesting laboratory that allows us to scrutinize and discuss this issue both from a theoretical and practical point of view. Therefore, in selecting the specific Data project, embedded in the UNESCO site management plan, we applied a purposeful sampling technique (Etikan et al., 2016; Patton, 1990). Namely, we aimed to select a project among the different initiatives launched under the umbrella project named "Urbino per Bene", and supported by the Italian Minister for Culture, that: a) was identified as an urban regeneration project for the development of a UNESCO cultural heritage site; b) had received attention and media coverage at the regional level; c) included a considerable number of different initiatives and expected impacts; c) implied the involvement of different stakeholders. The "Data space" is located in the ancient stables of the Duke Federico da Montefeltro, built by the famous architect



Francesco Di Giorgio Martini in the fifteenth century as a part of the nascent Ducal Palace. The Data provides an example of a historical and military place converted into a cultural, social and economic engine. Thanks to the intervention of a prestigious architect Giancarlo De Carlo, it was renovated and transformed into a city observatory, with the intention of making it a multifunctional center equipped with a library, exhibition spaces and a multimedia study center.

#### 4 Findings and discussion

Findings from interviews reveal divergences of vision, resistance and even political tensions. In attempting to understand these dynamics, the interrelated aspects depicted in Figure 1 are discussed in the reminder.



*Figure 1-Refinement of selected concepts*

##### **4.1. The strategic vision on CH and culture-led regeneration projects**

Starting from the analysis of the purposes of the Data project, different visions of city regeneration emerged from the interviews. All of them leverage on the city heritage combined with form of past codified and tacit knowledge. Although

different, all of those visions can be interpreted with the above-mentioned approach "innovation by tradition".

From the point of view of the former Councilor for the city planning who acted as the orchestrator of the Data project, this latter initiative in itself represents a way to activate a catalytic process of the energies present in the territory. *"Experimenting with the Data possibilities of use - letting an old space to live and living the space to make it alive and trigger ideas, energies, relationships and contaminations among different actors: youths, schools and university students, entrepreneurs, artists, etc.- made it possible to verify the concrete feasibility of the cultural, economic, tourist revitalization project, leveraging local excellence"*. From his words, as well as from the interviews conducted with other economic actors, a predefined conception of the city's vocation does not emerge, but rather the awareness of the existence of cultural heritage and knowledge that can be recombined and revitalized through experimentation. *"The co-working activity has already generated a start-up that aims to market local traditional foods with the "Sapori del Duca-Flavours of the Duke" brand. The start-up was born and survived in the context of Data in collaboration with BP Cube which acts as an incubator"*.

On the other hand, representatives of local art schools, express a vision of regeneration of the territory more anchored to the enhancement of the exceptional nature of its cultural heritage. Although the cultural heritage of Urbino, recognized all over the world, dates back to the Renaissance period, they believe that an important example of revitalization took place in the 900s, thanks to great men of culture (including Italian writers such as Volponi, Luzi, Parronchi and even the Noble Prize Ungaretti; scholars such as Carlo Bo and internationally renowned architects such as De Carlo) who have been able to appreciate and enhance the city, seen as an example of beauty and culture. In this perspective, the words of the Director of the School of Fine Arts are exemplary: *"the historic center of Urbino must rediscover its own identity and express a new renaissance, based on the principles of Humanism"*. Consistently, the Data project should be "a space **Devoted to Ars** (Latin word that stands for talent/genius) and **Techne** (ancient Greek word for know-how)". The conception underlying the new functions to be attributed to heritage assets is, therefore, that of offering spaces to develop new technologies and skills for arts. *"A fluid space, a laboratory that recalls the humanistic conception of the knowledge of the enlightened Cortegiano, artist, scientist and scholar at the Duke's court "*. The renewal of the city must therefore focus on the enhancement of art, beauty and quality of life.

In summary, the historical legacy is an important lever for the renewal of Urbino by all our interviewees, but its enhancement is conceived differently. However, without a common and concerted vision on the overall regeneration project of the city, the risk is to remain at the level of individual initiatives that disperse potential of innovation.

#### **4.2. The stakeholders/citizens expectations and perceptions of the PA action**

Findings from the interviews revealed different visions of the city of Urbino and how the local government guides the city development. Visions are linked to the different interests and needs of each stakeholder category. For example, on one hand, entrepreneurs complain that *"the culture and practices of Urbino have remained unchanged over the years"* while there are grand societal challenges to face; *"Urbino is a place of dreams, it does not innovate, politics does not think about the future"*. On the other hand, representatives of local art schools indicate that Urbino is famous because of its artistic heritage, dating back to the Renaissance time but also to the recent artistic graphic design movement of early 900s. Therefore, Urbino's future shall be based on its physical cultural artefacts and artistic spirit: *"public investments should be devoted to the creation of libraries, museums and activities that can employ young people and artists, so that they will not leave the city after the degree.....investments should also focus on aesthetic education of small traders, entrepreneurs and inhabitants that offer or ask for services that are in sharp contrast with the artistic beauty of the city"*.

Despite such differences, common bonds, attachment to the legacy of the place, and proud of belonging to an ancient and important city of the Italian history were considered strong enough to raise active collaboration from different stakeholders around a specific goal: making a public space named Data a lively place where the regeneration of the city could start. The local municipality identified the desire for city regeneration as a shared interest capable to activate collaboration and generate change. The Data project was born *"to serve as a common place to bring the energies of the territory and convey them to sustain the economic, cultural and touristic revitalization of the city"* as reported by the Councillor for Tourism. The local municipality was actually the orchestrator that initiated the public debate and organized meetings on the usage of Data and it was the entity that allocated funds to this project. Discussions and great participation in meetings seemed promising. One year of experimentation in

using the three floors of Data to organize events, exhibitions, public meetings and open a co-working space for start-uppers, a library, a showroom of local products and a bistro also seemed successful in its attempt to attract artists, inhabitants, entrepreneurs and tourists. However, as reported by one interviewed *"the Data project is still a work in progress...After one year of experimentation the project stops and it is not clear the vision of the place"*. Most importantly, the project did not develop capabilities in the community useful to continue creating civic wealth. The civic vibrancy given by the encounter of inhabitants, artists, students and entrepreneurs in the Data space stopped very soon. One key strategy was partially missing: the engagement of all stakeholder categories. While the participation of supporters (i.e., the local municipality) was clear and demonstrated by the commitment in supplying financial and human resources and legal authority to the project, community members and enterprises moderately contributed. Limited participation of students and inhabitants did not favour community empowerment and poor involvement of businesses did not favour the development of effective and long-lasting entrepreneurial solutions that can nurture the regeneration of a city after the stop of public funding (Young, 2006).

Strong communication and public meetings with citizens promising a participatory decision-making process in designing the uses of the Data space generated an initial phase of enthusiasm and resource mobilization. Besides the restored building of the Data, volunteers, professional networks and personal relationships were devoted to the project and contributed as material and immaterial resources to civic wealth creation by building cohesiveness and strengthening mutual interactions among stakeholders. But except a few cases, the sharing of ideas, knowledge and expertise in such meetings did not fully translated into practice with concrete collaborative innovations outcomes.

#### **4.3. The PA as orchestrator of the city regeneration processes**

The strategic plan of the city (Municipality of Urbino, 2016) represented a first attempt to directly involve multiple actors and implement a HUL (UNESCO, 2011) approach to the urban regeneration project of the city centre, thus changing the top-down approach that was prevailing in the previous years when the PA acted more as a "patron of the heritage". In this vein, the project "Urbino per bene" was conceived as a tool useful to trigger and improve dialogue with citizens and city

users and collect new and fresh insights (i.e., by addressing attention to the perceptions and perspectives of youth, tourists, city users and inhabitants of the centre). Hence, the results obtained from the questionnaire administered in early 2018 to students, tourists and permanent inhabitants (Del Baldo & Demartini, 2021) allowed the municipality to understand the coexistence of different and sometime conflicting viewpoints, needs and perceptions among city users, and collect suggestions to trigger innovative ideas to make the historical centre more attracting, and to engage citizens (included youth) in the renewal and regeneration of the cultural and socio-economic fabric. (Sacco & Segre, 2009).

The local PA played a key role in initiating collaborative actions, aimed to fostering dialogue and facilitate the composition of single "voices" and views, eliciting several projects, and among them, launched the Data project.

From the municipality perspective *"the Data project represents an experimentation to learn how to better involve citizens in the protection and revitalization of the site"*. As the city planning councillor states *"Data was -born as a common place to bring the energies of the territory and represented a space for hosting and sharing, and a useful laboratory to trigger ideas, relationships and contaminations among different actors: youths, schools and university students, entrepreneurs, artists, and other city users. The experience made it possible to verify the concrete feasibility of the cultural, economic, tourist revitalization project, leveraging local excellence"*. Hence, drawing from the PA point of view, it could be considered as a first initiative of a regeneration path embedded in the strategic plan of the city and in the UNESCO management plan.

The local PA played a key role acting as a stimulator in starting collaborative actions and supporting the process of involvement and awareness of the various communities and city users and initiated a participatory governance approach (Biondi et al., 2019). Its role was similar to that of "an orchestrator" - that entails gathering together diverse actors, ranging from public to private, industrial associations, local communities, as well as citizens (Abraham & Platteau, 2004; Della Lucia & Trunfio, 2018; Farinosi et al., 2018). *"The current urban regeneration project requires a great amount of financial resources; to complete it, new funding is needed. Private actors (i.e., entrepreneurs, associations, and citizens) begin to move. All this in line with the UNESCO management plan approved in 2013 which contemplates public-private synergies"*.

However, the PA is still at an initial step, that requires to progress and we deem that the role of PA was rather that of a stimulator and a participatory governance

approach is still in its infancy stage (Abraham & Platteau, 2004; Sacco et al., 2014; Della Lucia & Trunfio, 2018; Farinosi et al., 2018). Other interviewees, point out that different visions exist about the value they attributed to CH in driving the socio-cultural and economic regeneration of the place. Such visions mirror and underpin different interests and expectations among stakeholders on the quality of life in a historic center like Urbino and the perspective of urban revitalization expressed by different communities with "different souls".

## **5 Conclusions**

The case study analyzed revealed that culture and artistic knowledge and capabilities that belong to the tradition of a city rich in heritage can be the lever of innovation and boost civic wealth. Searching the past for looking to the future is however a difficult task.

Empirical data allowed to identify the main challenges that a city manager has to face: attract talent, create jobs and trigger the spur of new ventures; establish spaces for artists and cultural activities; preserve and promote local know-how; develop a strategy to attract SMEs belonging to the cultural and creative sector. Moreover, it shows the relevance of involvement of multiple stakeholders in societal change initiatives and the importance of managing assets through public-private cooperation. However, it also identifies the missing elements that hindered the city to continue exploiting its potential related to cultural heritage (e.g., absence of a financing ecosystem available for the creative and cultural sector, scarcity of resources). Lastly, the paper highlights the power of participatory cultural initiatives (Biondi et al., 2020) be used for the preservation, restoration and revitalization of physical heritage assets (Dameri & Moggi, 2019).

The practical implications of our research are as it follows.

Preserving the city's identity while enhancing and revitalizing traditional knowledge is a challenge for policy makers, called to experience innovative, collaborative and circular systemic approach for adaptive reuse of historic city centres by implementing a repertoire of successful heritage-led regeneration initiatives. Additional issues may affect historical World Heritage sites (WHS) where local communities and local people's attitudes towards conservation of the cultural environment and a WHS status can diverge (Jimura, 2011). In such contexts administrations and inhabitants have a dual challenge: "on the one hand the urban fabric has to be preserved; on the other, support must be given to the

vitality of the city's cultural heritage" (UNESCO, 2008:10). The sole preservation of buildings and monuments cannot save historic cities and could generate a "museum" phenomenon (elitist revitalization), thus freezing any development opportunities and hindering social revitalization.

Our findings reveal that the PA is still tackling with an initial step that requires to progress the efforts in stimulating sharing and participation in the current review of the strategic plan of the city and the UNESCO management plan. Therefore, we deem that the role that the PA can play with reference to initiatives aimed to leverage cultural heritage as an engine of development of Urbino historical center should be conceived as flexible and dynamic in nature, being that the role of orchestrator should be merged (or transformed into) that of a mediator of interest.

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## **Is Working from Home Really Smart? Perspectives of Knowledge Workers during the COVID Situation**

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### **Abstract**

Smart Working (SW) refers to new ways of working integrated in a way that enables spatial and temporal autonomy, favor cultural exchanges and trust, enable technological advances, and allow wider intellectual connections. SW is seen to be a way to “modernize” working practices by using ICT applications and new organizational settings, so that flexibility, creativity, engagement and, also, satisfaction of workers can be improved, for the benefit of employees, companies, and societies. However, the literature shows that SW requires the adoption of specific measures and levers, to fully exploit its potential benefits and reduce the risk of refusal by workers.

During the COVID pandemic, many companies, schools, and public organizations all around the world asked their employees to start working from home (WFH). After the pandemic, some observers think that WFH can remain a common way of working especially for knowledge workers. So, it is necessary to understand to what extent this experience can really lead to SW - in other words, to investigate if WHF can be automatically a “smart” working modality for knowledge workers.

The goal of this paper is, therefore, to explore if keeping workers at home can be a first important step towards SW, or if there can be some barriers or possible sources of inefficiency. The “forced” condition caused by the pandemic provides a unique opportunity to investigate what can happen when entire offices move to WFH. The paper reports the

results of an online survey of WFH knowledge workers conducted in Italy during the first weeks of the lockdown (April and May 2020). The research provided some descriptive statistics and classifications, especially regarding the viewpoint of employees. Their real involvement and perception of usefulness of WFH was investigated. The data made it possible to analyse the potential points of strength and weakness of WFH, how a massive introduction of WFH can be seen as a really “smart” working modality for this elective category of employees, and what lessons can be drawn for work management.

**Keywords** – Working from home, Smart Working, Knowledge Workers, COVID-19, Survey

**Paper type** – Academic Research Paper

## 1 Introduction

The term Smart Working (SW) is used to refer to new ways of working opportunities integrated in a way that enables spatial and temporal autonomy of workers, favor cultural exchanges and trust, enable technological advances, and allow wider intellectual connections across social, ethical, and environmental sensitivities “all harmonized to suit the individual working style” (Blackwell, 2008). SW is seen as a way to “modernize” working practices by using not only recent ICT applications but also new organizational settings, so that flexibility, creativity, engagement and also satisfaction of workers can be improved, for the benefit of employees, companies, and societies in a sort of “win-win” strategy (Clapperton and Vanhoutte, 2014). According to the literature, to be really “smart” and produce the positive results that are expected, SW requires numerous technological and organizational solutions be planned and implemented properly (Lake, 2008; Thompson, 2008).

In the last 2 years, during the COVID-19 pandemic, these issues gained momentum. Many companies, schools, and public organizations all around the world asked their employees to start working from home (WFH) (Brynjolfsson et al., 2020; Gottlieb et al., 2020). Conversely, before COVID-19, SW, WFH and the other forms of “working at a distance” from the office were generally restricted to a limited number of employees (Messenger et al., 2017; Sostero et al., 2020). Now, it is likely that after the pandemic this will remain an important way of working especially for clerical workers. Indeed, governments see the potential advantages of reduced pollution (due to less commuting and car traffic), and companies can cut office costs and travel expenses.

The “forced” condition caused by the pandemic provides a unique opportunity to investigate what can happen when entire offices move to WFH. In particular, WFH may impact primarily on knowledge workers, i.e., employees whose task is mainly intellectual, involves complex cognitive processes, learning activities, interactions, and exchanges of knowledge with colleagues and other business partners. The main goal of this paper is to examine if WHF can be automatically a “smart” working modality for knowledge workers. In other words, its purpose is to explore if keeping workers at home can be a first important step towards SW, or if there can be some barriers or possible sources of inefficiency.

At this aim, the paper reports the results of an online survey conducted in Italy during the COVID-19 lockdown. Almost 1,000 responses of a convenience sample of employees of various companies and organizations were collected during the first weeks of the lockdown (April and May 2020), when a large part of clerical work suddenly moved to WFH. The research provided some descriptive statistics and classifications, especially regarding the viewpoint of knowledge workers, about their cognitive interpersonal interactions, their real involvement and perception of usefulness of WFH, and the use of technologies for knowledge sharing.

The data made it possible to analyse the potential points of strength and weakness of WFH from the viewpoint of knowledge workers. Also, it was possible to understand whether and how a massive introduction of WFH can be really seen as a “smart” working modality for this elective category of workers.

## **2 Comparing WFH and SW**

### ***2.1 Definition of WFH and SW***

Working from home can be defined as “a working arrangement in which a worker fulfils the essential responsibilities of his/her job while remaining at home, using information and communications technology (ICT)” (ILO, 2020; p. 5). It can be seen as a special case of “telework” which is generally described as a way to work from any other places outside their “usual” office by means of electronic connections (Malik et al., 2016).

Compared to the previous terms, in the case of “Smart working” there is an emphasis on the adjective “smart” and on the potentially radical (and positive) impacts that are expected on both companies and workers. For Kim et al. (2017),

SW is “telework that individuals perform in a smart and innovative manner”, so that they can “positively accommodate the latest information technology environment without being constrained by time and place” (Kang and Kwon, 2016), “achieve maximum value” and “be more productive” (Fragouli and Ilia, 2019). With SM, they are expected to have more “spatial and temporal flexibility” (Fogarty et al., 2011), better working conditions (Kim and Oh, 2015), improved creativity, and opportunities for change (Kang and Kwong, 2016).

In short, compared to SW, WFH is a situation where employees are asked to or are offered the opportunity to work just from home instead of their offices. In principle, like SW, WFH is still expected to provide benefits for individuals, companies, and societies (Nakrošienė et al., 2019) - e.g., reduction in costs of travel and office space, reduction in pollution and time wasted in commuting, more freedom to combine time of work with personal life, increased flexibility of time work, and more comfort of employees. However, many scholars observe that, to be considered “smart” – i.e., to get the full benefits that this transformation can really bring about – the new working modality requires special conditions of implementation, as will be examined in the next subsection.

## **2.2 SW success factors**

The factors affecting SW success (for employees and firms) have been considered in the literature. Hassan (2016) detected a number of significant factors, namely: nature of the job, clear goals and policies, fitting to immediate needs of workers, and also capability to respect the personal life of the people. Similarly, Kang and Kwon (2016) analysed the determinants of a positive adoption of SW at firm level (such as, the organizational environment - e.g., innovation climate, or style of personnel evaluation - or the characteristics of the information system adopted to support SM), and for the single individual (for example, capability of self-control). The possible differences in acceptance and perception between workers have also been widely considered.

SW efficacy can depend on the specific work organization. For instance, van der Lippe and Lippényi (2020) signal the problems for teams when there are too many members working remotely. Furthermore, job position (Park, 2018) and leadership style (Park and Kim, 2013) can play a role. Finally, SW can have an impact on socialization processes and personal work styles (Mallia and Ferris, 2000; Troup and Rose, 2012). SW may change the forms of interaction between

colleagues, which in turn can modify the processes of knowledge sharing and knowledge management. Effectiveness and quality of work - especially for knowledge workers (Bélanger and Allport, 2008) – can be affected. Dalkir (2008) used the distinction between tacit and explicit knowledge and Nonaka's (1994) model of knowledge conversions to explain that different ICT applications can be more or less effective for interpersonal knowledge sharing, in relation to their capability to transfer tacit and/or explicit contents efficaciously. From another perspective (Bratianu and Bejinaru, 2020) it may be argued that the use of SW can require that workers find a new dynamic balance between the different forms of knowledge (i.e., rational, emotional, and spiritual) which characterize actions and decisions of people.

A final mention deserves gender equality. In principle, it may be expected that women are likely to carry out more domestic responsibilities whilst working flexibly (Chung and van der Lippe, 2018). Therefore, differences may be expected regarding the perception of SW usefulness for different genders.

### ***2.3 Principles and levers of SW***

In consideration to the success factors analysed in the literature, for companies that are willing to adopt SW in their organization, it is important to understand the main points to consider for a fruitful implementation. These can be summarised in the form of 5 principles and 4 levers.

The principles of SW are the characteristics that work (and its management) tends to assume in this modality, and namely:

- Flexibility: this refers to the capability of workers to decide where, how and when to work (Hill et al., 2008). For companies to be able to exploit this flexibility, it is necessary to avoid framing SW into a rigid scheme (Flexibility, 2010).
- Trust: in an organizational context where workers can be dispersed everywhere, building a trustworthy climate facilitates knowledge exchange (Nahapiet and Ghoshal, 1998).
- Collaboration and communication: collaboration is essential in modern organizations that are used to working in teams and networks (Callahan et al., 2008). In a SW environment, collaboration requires very effective communication channels between workers, and between management and workers.

- Autonomy: workers need to become more responsible for their own tasks, and a new balance between organizational control and worker autonomy becomes important (Tafti et al., 2007).
- Empowerment and individual advancement: autonomy leads to a re-distribution of power in the workforce, and it becomes necessary to adopt new technology-based measures that facilitate the exploitation and development of personal talents (Schweyer, 2010).

The levers are organizational and technological settings that a company must adopt to support and facilitate the exploitation of SW principles, namely:

- Job management policies: companies need to adopt appropriate guidelines to facilitate SW implementation, positive perception, and appreciation by workers. This includes policies to facilitate temporal and spatial flexibility of work (Kossek and Friede, 2006). For SW, this doesn't necessarily imply moving all jobs away from the offices to workers' homes, but rather a careful selection of what working style and location can be the most fruitful for each specific job and worker, depending on their peculiar characteristics (Lake, 2016).
- Physical layout: for SW, providing the best physical conditions is the main goal. According to Myerson and Bichard (2010), this implies designing a worker's office space in a way that facilitates the "4 Cs", i.e.: collaboration, concentration, communication, and contemplation. When workers work at home, it becomes essential that the characteristics of their home-office be consistent with these goals (Lake, 2016).
- Leadership: in a new environment where workers must interact at a distance and have a high degree of autonomy, new management styles are required (Cascio, 2000) for leading companies, company departments, or even project teams.
- Digital communications: as mentioned, SW is not simply working from remote, but indeed digital communication technologies are at its core (Vescoukis et al., 2012, Jacobs, 2004). They allow workers to be dispersed but still be able to accomplish work effectively and efficiently (Fisher and Fisher, 2001) across time, geography and culture (Bailey and Kurland, 2002; Kurland and Bailey, 1999). The "new generations" of ICT applications have further raised the expectations for a "revolution in the office" (Messenger et al., 2017). Companies which are more

prepared to digitalization may find it easier to implement SW (Fletcher and Griffith, 2020), although the great variety of systems, platforms, and applications, implies appropriate selections and implementations in relation to the characteristics of each job, worker, and remote office place. In addition, remote communication can impact on the ways of interacting and “socializing” among colleagues and can also affect working performance.

#### **2.4 Perception of the users**

Recent studies show that the perception of users counts in the implementation of SW. For example, drawing inspiration from the popular Technology Acceptance Model, Ollo-Lopez et al. (2020) argue that the success of SW ultimately depends on the acceptance by users, and this, in turn, is associated to their perceptions of usefulness and ease-of-use of this working modality in their specific case.

These perceptions can depend on how the single individuals see their working experience in combination with their personal expectations and private lifestyle, and also on local conditions (including e.g., working organization, legislations, and also cultural or social features – Peters et al., 2016) that can contribute to shape these individual perspectives.

### **3 Research questions and methodology**

The main goal of our study is to address the following research question:

*RQ: to what extent is WFH closed to the “ideal” model of SW as indicated in the previous section?*

A survey was conducted to analyse the people’s experience when they were working from home during the COVID-19 outbreak. The fundamental idea is that this “forced” condition, in which workers had suddenly to change their working habits and adopt WFH with no particular organizational measures or implementation plans by employers, better allows to examine if WFH can become a SW modality “automatically”, i.e. it directly reflects the principles and implementation levers that are considered essential for a successful implementation of SW. In other words, the purpose is to assess “how smart” is WFH.

An online questionnaire was administered during the lockdown of 2020 (March-May 2020) in Italy and other countries. Here, data of Italian workers are



presented. 932 responses were collected. The questionnaire included 23 questions (mostly closed) concerning opinions about their experience of WFH, use of digital technology, modality of working, perceptions of usefulness and problems, and also some essential demographic data. Anonymity was guaranteed. Further information about the questionnaire, its aim, theoretical background, and validation of the single questions, can be found in Ipsen et al. (2020) and Bolisani et al. (2020). The largest part of the questions required a response based on a 5-point Likert scale. The survey was promoted through the personal network of the authors and by using a “snowball technique” (i.e. respondents were also asked to invite their friends to respond to the survey – Baltar and Brunet, 2012).

For this reason, this is a convenience sample with some bias. The adopted method made it possible to collect a relevant number of responses which provided an interesting picture of the investigated matter. Also, responses mainly came from knowledge workers whose job has intellectual or clerical contents, which are generally the main target of SW implementations.

## 4 Findings

### 4.1 Essential demographics

In terms of age, the sample has a balanced representation of working-age population (table 1). As for the educational background (table 2) and the kind of job (table 3), it is confirmed that the sample mainly covers knowledge workers.

Table 1: Age classes and gender of respondents

	Age classes				
Gender	21-30 years	31-40 years	41-50 years	51-60 years	> 60 years
Females	44 (4.7%)	84 (9.1%)	138 (15.0%)	96 (10.4%)	15 (1.7%)
Males	74 (8.0%)	155 (16.8%)	175 (19.0%)	106 (11.5%)	35 (3.8%)

Table 2: Sample composition by educational background

Diploma	Respondents	Percentage
Middle school	8	0.9%
High school	252	27.3%
Professional diploma	33	3.6%
Bachelor's degree	123	13.3%
Master's degree	461	49.9%
PhD	37	4.0%
Other	10	1.0%

Table 3: Sample composition by kind of job (note: more than one response was admitted)

Kind of job	Respondents	Percentage
Clerical work	208	22.3%
Research and development	65	6.9%
System planning and modelling	88	9.4%
Management	157	16.8%
Communications	20	2.1%
Teaching and training	50	5.3%
Sales	103	11.1%
System control and management	77	8.2%
Operations	131	14.1%
Creative works	3	0.3%
Other	25	2.6%

#### 4.2 Changes in work modality

The entire sample regards people that were asked to work from home: 80% of respondents declared they worked only at home during the lockdown, and the rest (20%) declared they worked at least sometimes at home. Almost 90% of the sample affirmed that they worked for home because they were simply ordered to do so or because of a quarantine condition. Table 4 shows that, for the large majority of respondents, WFH was substantially a novelty. Table 5 displays the differences between jobs, confirming that even for this sample some activities require presence in a laboratory, operations site, plant, etc. This not only includes operational activities or system control, but also highly knowledge-intensive work (e.g., R&D activities) that is, however, connected to the use of special equipment and cannot be conducted from remote. Similarly, it is notable that other

intellectual activities like management (e.g., executives, plant managers, project managers) still required some presence in the office.

Table 4: WFH before COVID

	<b>Respondents</b>	<b>Percentage</b>
Never worked at home	639	68.5%
Max 2 days per week	168	18.0%
More than 2 days per week	125	13.4%

Table 5: Intensity of WFH in connection to job

<b>Kind of job</b>	<b>Always WFH</b>	<b>Sometimes WFH</b>
Clerical work	84.6%	15.4%
Research and development	76.9%	23.1%
System planning and modelling	87.5%	12.5%
Management	73.3%	26.7%
Communications	95.0%	5.0%
Teaching and training	90.0%	10.0%
Sales	90.3%	9.7%
System control and management	77.9%	22.1%
Operations	71.7%	28.3%
Creative works	100.0%	0.0%
Other	92.0%	8.0%

The effects on working routine are summarized in table 6. Results represent the average score in a 1-5 Likert scale, where 5 indicates that respondent strongly agreed with the statement. It results that, for the majority of cases, work was considered the same demanding as before (average score 3), and with a comparable productivity, though with more working hours. No problems were signalled regarding the preparation to WFH and the lack of physical contacts with colleagues.

Table 6: Effects of WFH on working routines

	<b>Average</b>
I am working longer than usual	3.42
I am achieving less results than usual	1.98
WFH is more demanding	3.00
My past working experience/education knowledge make me feel prepared to WFH	4.10
I can still keep good relations with colleagues	3.90

As regards how demanding is WFH, there were some differences between those that had experienced WFH before COVID and those that never had, but these differences were not marked. For example, those that declared that there was no significant change in their work routine were 41.6% of those that had some previous WFH experience and 36.6% of those that had none. Actually, it seems that there is some learning effect, given that the perceived problems in working from home tended to reduce the longer the workers had used this modality during the lockdown (table 7). Table 7 is interesting because it shows that, while workers can learn how to work from home, this also implies that they tend to work more - or more intensely - once they learn how to exploit this modality.

Table 7 Effects of learning (average score)

<b>Days of WFH during the lockdown</b>	<b>WFH is more demanding</b>	<b>I fear my results will be insufficient</b>	<b>I need data that I don't have access to at my home</b>	<b>I am achieving less results than usual</b>	<b>WFH is more intense or complex</b>
1-15 days	2.70	2.57	2.86	2.07	2.28
16-30 days	2.90	2.44	2.47	2.41	3.17
31-50 days	2.92	2.04	2.11	1.96	3.00
>50 days	3.16	1.83	1.92	1.81	3.20

In any case, the condition of WFH results to be substantially neutral, given that, in a Likert scale from 1 to 5, the responses of all the various groups to the question "how demanding is WFH" tend to centre around the average value (3), with very slight differences between gender or age (table 8).

Table 8: Differences by gender (average score)

	<b>Age classes</b>			
<b>Gender</b>	<b>21-30 years</b>	<b>31-40 years</b>	<b>41-50 years</b>	<b>&gt;50 years</b>
Females	2.86	2.92	3.15	3.12
Males	2.90	3.00	2.96	3.10

#### **4.3 Technology and communications**

The sample intensely used a range of different technologies, not only simple communication systems, like e.g., email or SMS, but also more complex systems,

like social media platforms and groupware systems, in a mixed combination. Videoconferencing resulted one of the most employed communication technologies. Table 9 shows the average intensity of use by respondents measured in a 1-5 Likert scale.

Table 9: Use of communication systems

<b>System</b>	<b>Average</b>
E-mail	4.42
Shared online folders	4.00
Videoconferencing	4.00
Facebook	1.20
Other groupware systems	2.80
Phone calls	3.80
Chat apps	3.40
SMS	1.56

Table 10 shows the number of contacts that respondents were able to keep daily. Clearly, these numbers can depend on the kind of job, but on average it is likely that, probably thanks to the multiple systems adopted, WFH did not limit interactions with colleagues and other business partners, as confirmed by the fact that respondents indicated, as previously seen in table 6, that they had no particular problems in keeping good relations with colleagues.

Table 10. Number of contacts per day

<b>N° of contacts per day</b>	<b>Respondents</b>	<b>Percentage</b>
1-4	220	23.4%
5-9	319	34.0%
10-19	269	28.6%
> 19	130	8.0%

#### **4.4. Perceived benefits and drawbacks**

Table 11 shows the perceived benefits of WFH workers. It reports the average 1-5 Likert scale of respondents. The main benefits regard more personal life than working modality.

Table 11: Perceived benefits

<b>Benefit</b>	<b>Average</b>
Time saved to reach office	4.52
Preparing and eating own meals	3.92
No distractions	3.78
Staying with family and friends	3.60
Changing routines	3.56
Having a break whenever one likes	3.36
Doing work for which there is no time normally	3.32
Enjoying home atmosphere	3.14
No need for long meetings	2.92
Easier contact with others	2.60
No control	2.20

Table 12: Perceived drawbacks

<b>Drawback</b>	<b>Average</b>
Discomfort to be stuck at home	3.56
Feeling stuck to a computer	2.97
Limited interactions with colleagues	2.81
Less physical exercise	2.58
Discomfort to be without an office routine	2.47
Necessity of special equipment	2.44
Inappropriateness of home as office space	2.29
Lack of documents or data	2.15
Feeling disturbed by people at home	2.15
Less interesting work when at home	2.06
Feeling that work at home is unproductive	2.05
Feeling that some tasks can't be fruitfully performed at home	2.30
Difficult concentration when alone at home	1.67
Missing benefits of office work	1.58
Lack of directives	1.41
Financial problems	1.36

As regards the drawbacks (table 12), it is interesting to note that the average scores are lower than those of the perceived benefits, which confirms the substantial appreciation for WFH. It is worth noting that respondents affirmed that at home they were able to be really productive, especially because they were

able to stay focused without the risk to be disturbed. Is also worth underlining the fact that the lack of directives is not perceived as a problem, which seems to confirm that our sample includes individuals who are able to work autonomously, as knowledge workers are.

## **5 Discussion**

A key point is the large majority of the sample thought they were working more at home (or, at least, not less than at the office), both those who declared they considered WFH more challenging and those who did not. Apparently, for those who felt WFH less challenging, having longer working times (with no waste of time in commuting or in distractions) was an opportunity to accomplish more goals. Those who felt WFH more challenging, may have needed to work more to keep the pace with the requirements of their job. In both cases, all this may confirm that WFH tends to lead to a certain degree of self-control and exercise of autonomy, where the people feel engaged with what they are doing – which is a key principle of SW.

Another point is that the majority of respondents felt that they already had enough knowledge and competence for WFH. This may signal that, for most tasks of knowledge workers, work is already well organized in a way that is compatible with WFH. Clearly, experience and learning can help, as the data confirm.

The relationships with colleagues apparently did not suffer. This may confirm that it is still possible to work at a distance, without continuous contacts with colleagues. This may be explained by the fact that offices are not necessarily a place for personal relationships, and that the people can work together remotely once a sufficient trustworthy climate has been created – which is also in line with the principles of SW.

In any case, although the sample mostly included knowledge workers, i.e., people who have intellectual tasks, this category comprises completely different kinds of jobs. Some may still require the use of special equipment (like, e.g., highly specialized R&D activities, or the management of complex systems or plants), and working remotely may be hard. Executives and management positions may also require some work in the office, to better exercise a control over the activities for which they are responsible.

The variety of communication tools that are now available facilitates the exchange of the knowledge that is necessary for the people to work. In the case

under scrutiny, however, these technologies were more a mix of general applications, already available to people, who can choose what is best for each specific communication.

Finally, as regards work-life balance, beyond the appreciation for some small comfort, apparently WFH did not lead to radical changes. A point to note is that the adoption is neutral regarding age or gender.

## **6 Conclusion**

Coming back to our research question ("to what extent is WFH closed to the ideal model of SW?") the results provide contrasting indications. Firstly, it can be affirmed that WFH has partially some points in common with the characteristics of the SW model depicted in the literature. The principles of personal responsibility and mutual trust between colleagues are apparently the same as those that WFH requires. Similarly, the data show that WFH workers perceived similar benefits (for example, autonomy of organization and home comfort) and drawbacks (e.g., sense of isolation and fear to be stuck at home with a computer) that may be expected in the case of SW. Instead, no clear indication regards the main characteristic of SW, which is spatial and temporal flexibility. In particular, as regards spatial flexibility, WFH simply replaced office with home and no other places.

As regards SW levers, WFH workers showed a high use of communication technologies of many kinds. What is notable is that workers used a mix of generic applications rather than platforms specifically designed for SW. This may also explain why no particular adoption problem was signalled and is also an important message for companies willing to implement SW modalities. As for physical layout, as mentioned WFH just employs homes as office spaces. In SW, instead, the idea is that workers can work wherever they like, so that they can exploit their potential and talent: office space thus becomes an ingredient itself of work. Therefore, it is not a matter of moving work to personal homes: measures to make this process easy and comfortable can be necessary. In this regard, the survey shows contrasting results. On the one hand, for many workers being at home was comfortable, but no particular emphasis was generally put on this. For some, instead, being stuck at home was a problem. In conclusion, simply adopting WFH (like in the "forced" way we experienced during the lockdown)



without appropriate measures and interventions in the home space is not a guarantee of full benefits and appreciation of SW.

Finally, the data show that, contrarily to what can be expected, not all knowledge work (and/or not for every time) is suitable for WFH and SW. Therefore, companies willing to adopt this modality must be flexible, which implies that different approaches must be adopted for the different workers and no standard solution should be adopted. This can raise the prospects of success but, also, makes the management of work more complex.

As a final remark, it can be said that, on the one hand, companies willing to adopt SW cannot simply move workers to their homes. On the other hand, the pandemic has shown that many workers have easily learnt the appropriate way to manage part of their work from home, and therefore some possible barriers to SW can be more easily overcome in the future.

The study is not without limitations. The most relevant ones are that a non-probabilistic sample of respondents was used - which could limit the generalizability of results - and that answers of respondents were affected by the particular conditions due to the lockdown.

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## **Forms of Crafting during COVID-19 Induced Remote Work: Experiences from Finnish Knowledge Workers**

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### **Abstract**

The COVID-19 pandemic forced knowledge workers to switch from company offices to working from home. This switch was abrupt and needed to be conducted without preparation making it potentially challenging particularly to those with little previous experience working from home. Against this backdrop, our study examines what kind of job crafting, i.e. proactive modification of one's work practices without formal approval, can help in dealing with enforced working from home among knowledge workers. The

results of the study illuminate different ways physical, relational, and cognitive crafting can be leveraged when adapting to such a situation. Findings also raise questions whether current rigid theoretical distinctions between job and leisure crafting are sensible in the remote work context as work-life boundaries blur both spatially and temporally.

**Keywords** – job crafting, remote work, work-life balance, COVID-19, public sector

**Paper type** – Academic Research Paper

## 1 Introduction

The COVID-19 pandemic resulted in social distancing measures that forced companies to find new ways to continue operations despite the extraordinary situation (O'Connor et al., 2021; Tuzovic & Kabadayi, 2021). This increased the prevalence of remote work at an unprecedented scale: many who previously did little remote work were suddenly working fully remotely (Eurofound, 2020; Parker et al., 2020). The transition was abrupt and undertaken with little preparation (O'Connor et al., 2021).

It is questionable whether lessons from previous research on remote work can be leveraged as guidance due to the highly distinctive features of COVID-19 induced remote work: remote work was not a voluntary choice, it touched all parts of an organization rather than a predefined group, and mobility overall was restricted (Waizenegger et al., 2020). Waizenegger et al. (2020) even suggest that one should not even talk about remote work but use a different term — enforced work from home (EWH) — to highlight the distinctiveness of the current situation.

The rapidly growing body of research on the implications of COVID-19 to organizations and knowledge workers offers insights into organizing, and especially how management and leadership behaviour needs to be adjusted (Bartsch et al., 2020; Kirchner et al., 2021). Such management-oriented focus is logical as organizing and the ways of working are often determined by those in a leadership position (Parker et al., 2017). However, following the established notions by Alvesson (2001) and Davenport (2015) regarding knowledge work, freedom to promote individual habits is central for enhanced task performance. Thus, management should focus on promoting knowledge workers' independence through nurturing their creativity, well-being and self-efficacy (Drucker, 1999) also in the context of EWH.

This independence can be exercised through employees' proactive modification and adaptation of different aspects of their work without formal approval. This is referred to as *job crafting*, that is, proactive behaviour of individuals to modify different aspects of their work for better fit with one's personal characteristics and preferences (Wrzesniewski & Dutton, 2001; Tims et al., 2013; Lazazzara et al., 2020). Autonomy and the possibility to modify one's job has been observed to support in dealing with the pandemic, but compared to the managerial perspective the phenomenon has been studied less (Kuntz, 2020). In addition, job crafting has not been studied specifically in the context of knowledge work and, more importantly, it has seldom been explored in the context of remote work. A few recent studies have, for example, explored the relationship between job crafting and stress reducing behaviour (Ingusci et al., 2021) and the relationship between job crafting and job engagement (Constantini & Rubini, 2021), but the forms of job crafting have been left outside the scope in these studies. The present study aims to contribute to this emerging research area by examining the role and practices of job crafting among public sector knowledge workers at the early stages of EWH during the COVID-19 pandemic. The specific research question of the study is: "What kind of job crafting knowledge workers suggest for dealing with enforced work from home during the COVID-19 pandemic?"

## **2 Theoretical Background**

Job crafting refers to self-initiated activity that employees engage in to modify the characteristics of their jobs to better fit their personal knowledge, skills, abilities and motivations (Wrzesniewski & Dutton, 2001). Research on job crafting has identified various positive benefits related to this activity, including work engagement (e.g., Bakker et al., 2016; Demerouti et al., 2015), organizational commitment (Ghitulescu, 2007) as well as job performance and satisfaction (Leana et al., 2009).

Job crafting can be directed towards the task (task crafting) or the relational aspects of the job (relational crafting), or it can involve changes in the cognitive orientation towards the job (cognitive crafting) (Wrzesniewski & Dutton, 2001). When engaging in task crafting, individuals make changes to the scope and nature of the tasks, for example, through taking on new responsibilities or requesting more autonomy (Tims et al., 2015). Relational crafting on the other

hand concerns the social domain of work and refers to alterations regarding with whom one interacts and the quality of interaction with others at work, for example, through avoiding contact with emotionally demanding colleagues (Wrzesniewski & Dutton, 2001) or creating new collaborative relationships (Berg et al., 2013). Cognitive crafting involves the changes in how an individual employee perceives and makes sense of his or her job (Wrzesniewski & Dutton, 2001). For example, an individual may engage in cognitive job crafting by reframing the purpose of their job to achieve meaningfulness at work (Geldenhuis et al., 2020) or cognitively emphasizing the positive aspects of their job (Vuori et al., 2012).

Job crafting approaches have been further divided into approach crafting and avoidance crafting (Brunner & Campion, 2018). Approach crafting refers to active efforts toward improvement-focused goals to enrich and expand boundaries of the job (Brunner & Campion, 2018; Zhang & Parker, 2019). Avoidance crafting, on the other hand, focuses on reducing and limiting dimensions of work that are stressful such as avoiding straining interactions or making demanding work tasks easier to perform (Bipp & Demerouti, 2015).

The concept of *leisure crafting* has been used outside the job domain to how craft their free time (Berg et al., 2010; Petrou and Bakker, 2016). Leisure crafting is defined as the proactive pursuit of leisure activities targeted at goal setting, human connection, learning, and personal development, which foster a sense of meaning (Berg et al., 2010). Demerouti et al. (2020) have further suggested *home crafting* to signify the balancing of home demands and resources with personal abilities and needs to experience meaning. In the extant literature, job crafting and leisure/home crafting have been discussed as taking place in completely different life domains, however, relations between these activities have been identified. According to earlier work, leisure crafting is, for example, used to compensate for limited crafting opportunities in the work domain (Petrou and Bakker, 2016) and that it supports the pursuit of occupational callings in the free time that are difficult or impossible to incorporate into one's job (Berg et al., 2010). A recent study by Abdel Hadi et al. (2021) demonstrates the effectiveness of leisure crafting in counteracting emotional exhaustion in remote work during the Covid-19 pandemic. Demerouti et al. (2020) found that individuals engaging in job crafting employ similar approaches in crafting the home domain.

What has so far been left outside these discussions is the blurring of the work and leisure/home domains in the context of remote work from home and the



opportunities this creates in terms of job crafting. Sturges' (2012) indeed acknowledges work-life balance as a domain of crafting. Building on the job crafting dimensions identified by Wrzesniewski and Dutton (2001), Sturges (2012) categorizes work-life balance crafting into physical crafting, cognitive crafting and relational crafting. Cognitive crafting refers in this context to the definition and framing of what work-life balance is and relational crafting to the management of social relationships in a way that enables the achievement of the desired work-home balance (Sturges, 2012). Physical crafting, on the other hand, refers to the crafting of the physical dimensions of work, including the time spent on working, the location of working, choosing the employer and time spent on traveling to work. Remote working (locational crafting) thus represents in Sturges' (2012) study a form of work-life balance crafting, not the object of crafting itself.

Against this background, utilizing the theoretical lens of job crafting our study explores what kinds of suggestions knowledge workers in the field of public administration provide for dealing with enforced work from home caused by COVID-19 pandemic. We presume that explicitly communicated advice and hints are based on personal experiences of practices and ways of working that individuals have found to well fit the new conditions—i.e., results of job crafting. We pay attention especially to how the blurring of the work and leisure/home domains is reflected in the suggestions since further research on this topic seems particularly warranted.

### **3 Research Material & Methods**

The study is based on a larger online survey that was distributed to Finnish knowledge workers from early April to late May 2020, three weeks after the Finnish government made working from home mandatory to all public administration employees whose job role afforded it. The goal of the survey was to understand the changes pandemic brought to respondents' work through nine open-ended questions that probed issues like emotional responses and organizational support.

This paper concentrates on data from responses to a single open question "What kinds of tips for remote work would you give to others in your organization?" since it specifically aimed to understand what kinds of volitional changes switch to remote work entailed. Respondents with strong former experience of remote work (used to working remotely more than one day a week

before the pandemic) were omitted from the dataset. This choice was driven by the assumption that respondents without earlier experiences did not yet have well-established remote work practices and thus were particularly likely to have engaged in crafting due to the pandemic and EWH. Further, we focused our examination on those respondents who reported to work in the field of public administration, as we were particularly interested in the knowledge worker perspective, which public administration workers represent (Fischer, 2020). Also, for public sector workers EWH was mandatory at the time, which was not the case for those working in the private sector. Because of this, they were particularly fitting group to study.

After empty and unintelligible answers were removed from the data, 389 responses remained. The analysis process as a whole followed was explorative and followed an abductive logic (Dubois and Gadde, 2002). Content analysis proceeding from open to axial coding was conducted (Bryant & Charmaz, 2019) to gain an understanding of what kind of job or leisure crafting-related suggestions respondents voiced. Early on in the coding process, it was observed that job crafting models seemed to fit the data well, especially when supplemented with the leisure crafting perspective. While some responses dealt with other issues like top-down job design (Parker et al., 2017), only 15% of the content in responses related to issues outside job or leisure crafting. This suggested that the open question succeeded well in capturing how knowledge workers could proactively modify and adapt different aspects of their work. It also suggested that job crafting was a suitable theoretical lens for analysis.

As the analysis work progressed, different crafting frameworks were explored for structuring the data including Zhang and Parker (2019), Wrzesniewski and Dutton (2002), and Sturges (2012). After an iterative process, the general categorization of Sturges (2012) which divides crafting into physical, cognitive, and relational crafting was found to be the best fit for our data. While her framework was originally developed for examining work-life balance crafting, it seemed to explain our data better than traditional job crafting categorizations, such as those proposed by Wrzesniewski and Dutton (2001) or Zhang and Parker (2001). Considering also the fact that the context of work in the present case was enforced work from home, this observation makes intuitive sense as well. Due to the breadth of our data, we decided to further divide physical crafting behaviour into three subcategories: temporal crafting, which takes inspiration again from Sturges (2012) model; task crafting, which is a part of the original job crafting

categorization of Wrzesniewski and Dutton (2002) and environmental crafting, which is a new category that emerged in our data. For the other two main crafting categories of cognitive and relational crafting sub-categorization was not perceived necessary.

## **4 Results**

The results are organized based on the crafting categorization of Sturges (2012). First, we discuss physical crafting, then proceed to cognitive crafting and finally, relational crafting.

### **4.1 Physical crafting**

In general, suggestions related to physical crafting were more prevalent and detailed in the data compared to other forms of crafting. Because of this, our examination of this crafting type is slightly richer than the other forms.

#### *4.1.1 Task crafting*

Task crafting (Wrzesniewski & Dutton, 2001) was represented in the responses particularly from the perspective of work planning and utilizing new technology. Respondents suggested paying attention to putting effort into making plans, schedules, TODOs and achievement lists rather than doing ad hoc decisions on what to work on.

*I've started making myself a list, where I mark daily all the work I've gotten done, so that the feeling of accomplishment and progress remains when I'm off work. (Informant #59)*

Many also had suggestions regarding the use of digital technologies at work. These tips tended to fall under two categories. The first was leveraging new tools in general. The focus on the suggestions was especially in video and teleconferencing solutions as well as break exercise apps. The second category of tips addressed strategies for dealing with information systems under high load. In particular, respondents suggested trying to time use of such systems during hours when the number of users would be lower, downloading files to one's computer beforehand and just to take into account the fact systems might be working slower when one needed to access the data.

*Make sure beforehand that you have access to necessary databases, documents etc. or stored to your computer / usb-stick if network connections get overloaded or disconnected. (Informant #33)*

#### 4.1.2 Environmental crafting

Physical crafting behaviour present in the data was also addressing the physical environment where one was working. Suggestions discussing this topic could be divided into two broad categories: ergonomics and physically enforcing work-life separation

In terms of ergonomics, respondents underlined the importance of paying attention to workstation ergonomics and posture while working. More concretely, suggestions included acquiring proper digital equipment like displays, noise-canceling headphones, mouse, keyboard etc., rather than simply working with one's laptop. Infrastructure like having a good internet connection was also mentioned as was making sure that one had proper office furniture, including a good table and working chair.

*It's good to have a workstation that you use. Heights (chair & table) to right levels, lightning also. I cleared the work desk I had integrated to my bookshelf so now I have a proper surface where laptop, one big screen, keyboard, mouse with mousepad, headphones and a notepad fit. My wheeled work chair is also in its proper use and not under a pile of clothes. (Informant #21)*

Many respondents also emphasized that it was critical to try to physically enforce work-life separation to prevent the boundaries of the two blurring in a problematic way. Concrete suggestions included completely closing laptops and phones when one finished the workday or even hiding them all together out-of-sight so that their presence would not remind one about work or challenges related to it.

*When work hours end, it's good to put your work equipment away and not to touch them during leisure time. It can be difficult and work things remain in your mind, when they are present in the same space during leisure time. (Informant #53, regular employee)*

Other tips were given too, including trying to dedicate certain spaces to work or leisure specifically, to create a clear divide between the two.

*You should not work in a place where you're used to doing something else (bedroom, living room, hobby room etc. (Informant #32)*

People also proposed creating rituals for starting or ending work. One could, for example, end the workday by going outside to exercise to create a strong symbol for the workday ending. For some respondents, such rituals seemed to represent the building of work-life boundaries. However, this was not always the case. Others saw rituals as positive habits that helped to start orienting to working.

*I change into "work jeans" every morning and put on a nice shirt, so that I feel like I'm going to work. (Informant #49, regular employee)*

#### 4.1.3 Temporal crafting

Suggestions related to temporal crafting were particularly strongly represented in the data. Many respondents emphasized the importance of creating a meaningful rhythm to working. For some, this meant instilling one's personal needs and desires into the work routine and taking advantage of the fact that work and leisure environments were not spatially separated as they normally were. Informants were suggesting utilizing lunch break to go exercising, spending time with family or even cooking or cleaning during meetings.

*Blend work and leisure time by having breaks, where you cook in your own kitchen or clean your terrace. Things you cannot do on office breaks. (Informant #67, supervisory position)*

Others proposed adapting oneself to external factors, by for example working outside regular hours to avoid having to access databases etc. when they were under the biggest usage load and worked slowly. There were also those who recommended keeping the same temporal routine that one had when working at the office to create continuity between the "normal" and "new normal".

*I've noticed that trying to preserve the same rhythm as at the office works for me. I start and end work around the same time as I normally would. I have coffee, lunch etc. breaks and try to remember to do some break exercising sometimes too. (Informant #94, supervisory position)*

While some recommended taking advantage of the possibilities that working from home enabled in terms of creating work-life synergies, others suggested paying particular attention to enforcing temporal work-life separation. EWH was seen as a situation, where the job easily took over and work-life boundaries become hazy. To combat this, one should set time limits to working and avoid working overtime.

*Having a schedule is important both for work and for breaks. You gotta make sure that work and leisure time don't get mixed (Informant #207, regular employee)*

*Hold on to working hours always when possible. And when you stop [working], close skype and email. Otherwise work just goes on and on... (Informant #153, supervisory position)*

#### **4.2 Cognitive crafting**

Suggestions for cognitive crafting were present in the data both from avoidance and approach crafting perspectives (Brunning & Campion, 2018). Many respondents argued that the pandemic situation was by nature such that it created problems and challenges that one couldn't influence, and thus it made sense to simply avoid stressing. Suggestions included being merciful to oneself, accepting slower performance from oneself and others. Some also underlined that work is not the most important thing in the world, especially in the present situation.

*There's never such a hurry with a task that it should be prioritized over own health and well-being. While remote working one is allowed to and should work slowed if technical problems or bad ergonomics require more time / breaks (Informant #27, regular employee)*

Trying to relax mentally and not worrying about things out of one's control were also considered important by the informants. Some also specifically underlined how it is important to make a distinction between issues that are one's own task to solve and those that are the responsibility of the organization.

*Enjoy long mornings without commutes and have breaks. Things you cannot influence you shouldn't worry about. If for example network connections don't work, it's employer's problem, not yours (Informant #117, supervisory position).*

As exemplified in the previous quote, some informants also emphasized how important it is to try to look at the situation positively. It was mentioned that one should appreciate the fact that the requirement to work remotely meant increased freedom and autonomy.

*Now you can also enjoy your own ways of working, for example play music in the background, have breaks based on your own rhythm or even eat garlic without bothering anyone. While working remotely, we all have individual*

*surroundings to work and now it is possible to enjoy those positives.  
(Informant #42, regular employee)*

Further, some mentioned that in EWH, the normal distractions that are present at the office are not necessarily present at home, meaning an increased possibility to do concentrated work. It also provided opportunities for learning that would be difficult to seize under normal conditions.

*Look for information and training related to work that you would not have time to search and learn amidst normal routines! (Informant #210, supervisory position)*

### **4.3 Relational crafting**

Informants' recommendations related to relational crafting were particularly addressing social needs that one might have through leveraging and fostering work relationships. People were suggested to take time for having informal discussions and share things that went outside one's work.

*Give your colleagues more about yourself than just the "work you" and share to your whatsapp group pictures of the house plants you talked about during winter, tell about good recipes that you've tried and share or ask tips about good books. Your workmates are at the moment the only people you can connect with almost daily so respect and acknowledge them. (Informant #12, regular employee)*

In terms of concrete practices, organizing or attending virtual coffee breaks and reaching out to colleagues even without reason was particularly prevalent in the data. This seemed to be tied with looking after one's colleagues and maintaining a sense of togetherness both personally and within the organization in general.

*You should from time to time just contact your colleagues just to contact them, this way you preserve a feeling of belonging to some community.  
(Informant #23, regular employee)*

Further, there were also those who emphasized the importance of leveraging out-of-work relationships and putting particular effort into interacting with one's close ones.

## 5 Discussion

### 5.1. Theoretical implications

The present study does several contributions to the discussion on job crafting and knowledge workers' coping methods to enforced working from home (Lazazzara et al., 2020). Coping refers to resilience and adaptivity as an individual attribute, but it builds organizational capability too (Okkonen 2021). In general, the study contributes to the discussion on knowledge worker performance and how it is constituted by individual freedom to define the framework for working, i.e. environment, conditions, temporality, and approaches. The autonomy in knowledge work is also about how job and leisure are designed and connected, and the autonomous management of this interface is a dimension of knowledge work this study has also explored.

More specifically, the present study contributes to the discussion on job crafting (Lazazzara et al., 2020) by questioning the traditional defining characteristics of job crafting that modification efforts focus on the job especially (Zhang & Parker, 2019). Crafting behaviour outside work has been analytically separated into its own construct, leisure crafting (Petrou and Bakker, 2016), work-home balance crafting (Sturges, 2012) or home crafting (Demerouti et al., 2020). However, the results of the present study illuminate how knowledge workers recommend creating synergies between work and leisure time as a way to make EWH more sensible. Is using break time to clean one's terrace job or leisure crafting or something else? Technically, one could argue that it is not job crafting, because the act does not directly modify the characteristics of one's job, particularly its task-related or relational boundaries, which is the basis of the definition of job crafting by Wrzesniewski and Dutton (2001). On the other hand, such behaviour does modify the temporal experience of one's working day to better-fit one's preferences, making the interpretation that the act is indeed job crafting sensible. These kinds of overlaps and "grey areas" between work raise questions about whether a rigid analytical distinction between leisure and job crafting is advisable, at least in the EWH context. While earlier research has explored the relationship between job crafting and leisure/home crafting and found that individuals engage in similar crafting approaches in the work and home contexts (Demerouti et al, 2020), blurring of the crafting practices within these different domains has not been previously addressed.



The findings of the present study also lend support to recognizing environmental crafting as a category of crafting. In previous literature, modifying one's work environment has not been widely accepted as a form of job crafting, since it too fails to fulfill the traditional definitions of job crafting (see Wrzesniewski & Dutton, 2001). However, some scholars have suggested that such limited perceptions are not necessarily warranted and suggested that time and spatial dimensions of work should be incorporated into the concept of job crafting particularly in the context of knowledge work where flexibility in terms of when and where to work is prevalent (Wessels et al, 2019). In these studies, spatial crafting typically refers to the choosing of the location of work (Sturges, 2012; Wessels et al, 2019). The results of the present study point in the same direction, but deepen the concept of spatial crafting with the concept of environmental crafting, which refers to more micro-level modifications to the work setting. In our data, environmental crafting emerged as a significant type of crafting, suggesting its importance especially when crafting is used to cope with transitioning to enforced working from home. It could be expected that environmental crafting is particularly relevant when working from home, as in such a situation, employees have greater power to influence their surroundings compared to the regular office context. Further, they also have less automatic support from the organization as workstations, tables and chairs are seldom automatically provided and maintained.

Finally, the findings of the present study contributes to previous literature by providing further information on what kind of crafting behavior is used to foster work-life balance. Previous literature on the topic noted how employees preserve work-life balance by selecting a suitable employer, job or project, customize their definition of work-life balance to fit their situation and manage work relationships to preserve good work-life balance or perception of it (Sturges, 2012). The present study extends this discussion by illuminating previously unrecognized ways to enforce work-life separation and synergies. In terms of temporal crafting, respondents created separation by setting time limits to work as well as avoiding working overtime and generated synergies by fostering a fitting rhythm between work and break time, by doing chores, spending time with family or other leisure activities, etc. In terms of physical crafting, respondents were creating rituals to start/end the workday and closing and hiding their work equipment to help ensure one didn't think about work outside working hours. These results provide more depth to our current understanding of the practical ways employees

engage in fostering work-life balance, thus answering calls in previous research (Sturges, 2012).

## **5.2. Limitations and future research directions**

The present study includes certain key limitations, which are critical to recognize. The first one relates to our somewhat unorthodox method of studying job crafting. Traditionally the topic is examined with cross-sectional quantitative surveys (Zhang and Parker, 2019) or in-depth qualitative studies based on interviews, ethnographies or similar (Lazazzara et al., 2020). In our study, neither of these traditions were closely followed, as our dataset consisted of qualitative answers to an open question in a longer survey, analysed with an abductive process (Dubois and Gadde, 2002). Due to this choice, our approach did not enable us to clearly measure the effects of crafting behaviour on well-being or performance, nor gain a deep understanding of the intricacies related to specific crafting approaches and particularly the motives behind them. However, this choice enabled us to collect and use a much broader dataset in terms of informants and organizations compared to traditional qualitative research approaches, while still preserving the ability to get a more detailed understanding of the phenomenon in focus in practice, compared to traditional quantitative approaches. However, with this in mind, it would be interesting from future studies' perspective to try to measure quantitatively how the different job crafting suggestions relate to performance or well-being. Further, it would also be interesting to explore more deeply with qualitative research methods how the observed job crafting suggestions are enacted in practice. Examination of environmental crafting would be especially interesting since this area is currently particularly understudied.

The second key limitation of the study relates to the generalizability of the findings. In the present case, the informant sample consisted of knowledge workers working in the area of public administration. From this perspective, it could be argued that the results are not necessarily directly transferrable to other contexts, such as private companies. Thus, further studies in other contexts are warranted.

More studies of job crafting in the remote work context, in general, are needed too. So far research in this area has been sparse as remote work has merely been seen as one specific job crafting outcome. However, the results of the present

study suggest that in remote context job crafting, leisure crafting, and work-life balance crafting might be intertwined to the extent that separating them can be challenging. Future work is needed to theorize these interrelations further. It would also be interesting to examine what kind of job crafting approaches could be particularly beneficial in dealing with challenges of remote working, both from the perspective of performance and employee well-being.

### **5.3. Practical implications**

Our results lend support to two practical implications. First, it is notable how many suggestions provided by informants were contradictory: For example, some outlined EWH as an opportunity to experiment with new routines allowed by working from home. Others recommended transporting the established routines to home context to the point of dressing up as one would do for the office. This suggests that remote work-related job crafting might result in the proliferation of work practices. Management needs to be attentive to this process to ensure that heterogeneity in ways of working does not lead to unclarity in company values or issues in key work processes.

The second implication relates to the need for knowledge workers to engage in environmental crafting when working from home. When working in the regular office, companies tend to provide employees with workstations that are well-thought-out in terms of ergonomics, which helps to foster the physical well-being of organizational members. If remote working remains popular after the pandemic – as expected – it raises questions whether it might be smart for companies to transfer similar support to home context and go beyond just providing digital equipment like displays etc. Proper desks, chairs, access to ergonomics experts who can help fine-tune home workstations so physical strain from working is minimized might be a good idea particularly in the long run to ensure that the company workforce remains healthy and happy.

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## Italian Smart Working Survey during the Pandemic: Advantages, Limits, Impacts and Organizational Readiness

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### Abstract

Although different studies investigated the SW phenomenon during last years and its evolution during the pandemic, reporting several benefits and advantages, there seems to be a lack of studies investigating whether and to what extent the SW can really impact on company's performance. It is not clear to what extent smart working, especially in the emergence phase, has impacted the organizations, at macrostructure level and at the micro structure level, and whether the SW may be considered as a leverage to achieve new, incremental productivity, both at "people" and "process" level. This paper develops a conceptual framework, built on a series of testable propositions about the impact of SW on the organizations and the characteristics of SW as leverage to improve productivity. Then, a questionnaire to empirically test our theoretical framework is presented. Each construct of the model corresponds a set of questions.

**Keywords** – smart working, remote working, survey, pandemic era.

**Paper type** – Academic Research Paper

## 1 Introduction

The development and diffusion of digital technologies (especially those supporting communication, collaboration and social networking), along with the pervasive dissemination of powerful and easy-to-use mobile devices, can support organisations in developing a Smart Working (SW) system (Ahuja et al., 2007). The organizational literature proposes different definitions of SW, each focusing on different key aspects related to this new working culture. According to the definition provided in 2008 by the Chartered Institute of Personnel and Development (CIPD) *"Smart Working is an approach to organizing work that aims to drive greater efficiency and effectiveness in achieving job outcomes through a combination of flexibility, autonomy and collaboration, in parallel with optimizing tools and working environments for employees"*. This definition reveals both the objectives of SW and the ways of organizing work in order to achieve them. Referring to the definition of the CIPD, McEwan (2013) proposes, years later, the following: *"Smart Working practices are agile, dynamic and emergent. They are the outcomes of designing organizational systems that facilitate customer-focused, value-creating relationships that are good for business and good for people"*. Finally, a sufficiently complete definition of SW is provided by the Smart Working Observatory of the Politecnico of Milan (2018): *"Smart Working means thinking about work from a different, clever angle. It questions the traditional links with working times and locations and gives people a greater say in defining their working conditions, while at the same time making them more responsible for the outcome. Autonomy and flexibility and giving people responsibility and trust are the bywords for this new approach to work"*.

This definition describes SW as a flexible approach in managing workplace, timetable, and technological tools, allowing employees to reach both greater professional efficiency and better work-life balance, through the increase of trust and autonomy, from the company towards the employees, in return for a greater responsibility and accountability on results.

Although the different contributions on the theme of SW present in the organizational literature have focused on specific key aspects characterizing SW, it is possible to identify three essential levers for the implementation of a complete and effective SW model (Birkinshaw et al., 2008; Elsbach and Pratt, 2007; Mann, 2012; Reyt and Wiesenfeld, 2015): organizational culture and managerial practices; ICT-based solutions; workplace.



A growing body of research that recently points to what post-pandemic working patterns may look like reported SM as a common practice due to the Covid-19 emergency. A recent article from Economist reported that "Before the pandemic Americans spent 5% of their working time at home. By spring 2020 the figure was 60%." (The Economist, 2021). In one paper José Maria Barrero, Nick Bloom and Steven Davis, three economists, survey thousands of Americans and conclude that, after the pandemic, the average employee would like to work from home nearly half the time (Barrero et al., 2021).

In Italy, before the crisis SW was adopted in formal and informal ways and involved 58% of large-sized enterprises, 12% of small and medium-sized enterprises, and 16% of the public administration (PA) sector, for a total of 570.000 workers (Smartworking Observatory, 2019). The situation has radically changed since March 2020 when, following the Covid-19 emergency and the need to implement social distancing rules, the Government issued the decree of March 1, 2020, de facto establishing, then extended with subsequent decrees, the possibility to apply SW to any subordinate employment relationship, even in the absence of individual agreements, until the end of July 2020.

In April 2020, according to the Ministry of Labour's data, a total of 1.827.792 workers resulted in SW mode, 1.606.617 of which were started following the epidemiological emergency (Ministry of Labour and Social Policies, 2020). For some companies it was an implementation on a larger scale of a working model already tested and used, for others it was a first experiment.

Although different studies investigated the SW phenomenon during last years and its evolution during the pandemic, reporting several benefits and advantages, there seems to be a lack of studies investigating whether and to what extent the SW can really impact on company's performance.

It is not clear to what extent smart working, especially in the emergence phase, has impacted the organizations, at macrostructure level and at the micro structure level, and whether the SW may be considered as a leverage to achieve new, incremental productivity, both at "people" and "process" level.

This understanding is important because SW requires investments by the companies, in technologies, workspaces, HR management systems, training etc. (Antogiovanni, 2020), that needs to be offset with appropriate benefits.

In light of this main objective, we develop a conceptual framework, built on a series of testable propositions, about the characteristics of SW as leverage to achieve new, incremental productivity, both at "people" and "process" level.

Then, we develop a questionnaire to empirically test our theoretical framework. Each construct of the model corresponds a set of questions. Gathering the answers to each question it will be possible to test the constructs of the model.

This paper presents first findings of this research study, namely the research framework and the validation of the questionnaire developed to empirically test out the theoretical framework.

## **2 The impact of smart working on performance: A theoretical framework**

With the concepts that the organizational studies offer us, we develop a theoretical framework, built on a series of testable propositions, about the characteristics of SW as leverage to achieve new, incremental productivity, both at "people" and "process" level. The overall theoretical model depicted in Figure 1.

Conceptualizing on the effect of SW on the organization, at the level of macro structure and micro structure, the framework hypothesizes whether SW affects the productivity, both at "people" and "process" level, and therefore if SW may improve the organizational performance.

As for the impact of the SW on some structural dimensions of the organization, the adoption of SW brings about changes in processes, knowledge flows, and activity sequencing to the point of radically transforming the coordination mechanisms. In particular, giving greater autonomy to employees reduces the need to adopt coordination mechanism based on direct supervision as well as mutual adjustment mechanisms based on face to face interactions are replaced with virtual interaction, via "broad band" communication technologies (Arnaud and Schminke, 2007; Barney and Hansen, 1994; Serrien, 2008).

Based on this, we formulate the following assumption of the model:

*H1: SW puts in place alternative coordination mechanisms, which are equally effective and far less costly, thus positively affecting the performance.*

As for the impact of the SW on some job characteristics, the micro organizational structure, it is widely accepted that the adoption of SW requires a profound change in the organizational culture and behaviour and the adoption of new managerial practices and leadership styles. In the new SW result-based culture, where the goals are defined collectively, and the individual is accountable for the results he accomplishes, employees have a greater level of autonomy and responsibility for taking decisions about how to schedule their work and how to

do it. The job autonomy is closely linked to the concept of empowerment of employees. Empowerment is the freedom of employees to make decisions on how to schedule the job and on how to reach the goals (Hackman, 1980). According to Blanchard et al. (2007), empowerment can raise their level of involvement and can result in improvements in performances and in the level of efficiency, quality, and profitability.

Based on this, we formulate the second assumption of the model:

*H2: SW enlarges job autonomy and empowerment.*

A further key feature of Smart Working is that it reduces or even completely eliminates the time and space constraints. Through appropriate ICT tools, SW allows employees to define where and when to carry out their work and, consequently, to be efficient wherever they are. Flexibility therefore refers to both dimensions, time and spatial flexibility. In the academic literature, there is clear evidence that flexibility in choosing both when and where to work is generating a positive influence on work-life balance (Byron, 2005; Mesmer-Magnus and Viswesvaran, 2006; Shockley and Allen, 2007).

*H3: SW increases time and spatial flexibility, by positively affecting work-life balance.*

Academic literature provides many examples of how higher levels autonomy on the job, a trustworthy environment, in which employees are given the possibility to acquire higher responsibility, and a higher work-life balance increase job satisfaction, and in some cases, motivation to perform the job (Boxall and Macky, 2014; Ezra and Deckman, 1996; Staines and O'Connor, 1980).

*H4: A higher work-life balance and greater autonomy/empowerment increases job satisfaction and motivation.*

No one questions the central role motivation plays in shaping behavior and, specifically, in influencing work performance in organizations (Ambrose and Kulek, 1999). Nonetheless, as important as motivation is, it is not the only factor that determines performance. A variety of other variables thought to play an important role in performance have been suggested. These include ability, instinct and aspiration level as well as personal factors. Blumberg and Pringle (1982) classify these variables in three categories and relate job performance to the capacity to perform, which is related to the degree to which an individual possess task-relevant skills, abilities, knowledge, and experiences; the opportunity to perform, and the willingness to perform or motivation. The presence of motivation per se, coupled with a capacity to perform, does not ensure high

performance, it is important to create an opportunity to perform, which depends on the availability of equipment, technologies, and organizational and managerial best-practices.

Based on this we formulate the following hypothesis:

*H5: The higher is the opportunity to perform, namely the adoption of targeted interventions to raise awareness and knowledge on the subject, the implementation of SW programs and the provision of correct ICT tools to support SW, the higher will be the job performance.*

SW does not involve simply staggering start times or rethinking support technologies for working from home, or stepping up training throughout the organization on basic digital competencies that serve to effectively use the collaborative platforms that so many have had to grapple with. SW adoption radically transforms work methods and tools. It involves a profound change at each level of the organization and in each of its components.

Change is what presses out of the comfort zone and for most of the people it is uncomfortable to change from one state to the other. Workers in organization may not welcome change with result in a worsened of their work performance.

In a change management process, choices and decisions that managers make are fundamental to mitigate the risk of failure of the organizational change program and avoid a drop performance. Managers as leaders play a crucial role in helping workers let go of past behaviour and move forward to new and different ways of working, increasing workers' propensity and motivation to change, building employee commitment, so increasing employees to perform in a changing organizational environment.

Based on this we formulate the following hypothesis:

*H6: SW may have a negative impact on job performance. The higher is the opportunity to perform, the lower is such a negative effect.*

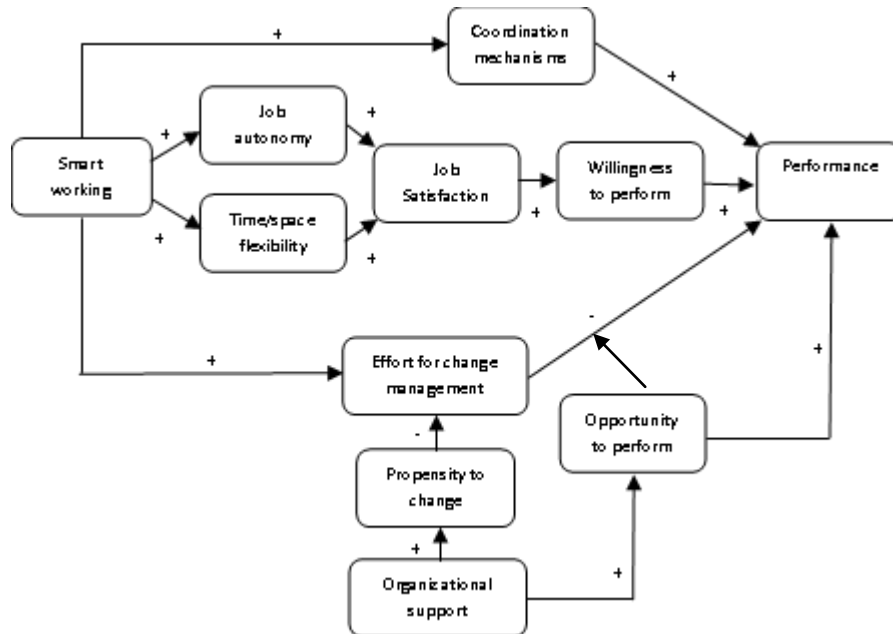


Figure 1. The model.

### 3 The empirical research design

Once having defined the model to be tested, the following step was that of designing the empirical research.

Firstly, we have built a questionnaire, the next step consisted of test the quality and robustness of the questionnaire, finally the data analysis and the test of the model.

#### 3.1 The questionnaire

The questionnaire is composed of 28 questions. The first 8 questions aims at collecting the socio-demographic information of the respondents; the rest of the questions (20) gather information about the workers' perceptions regarding the application of smart working in their own company and are useful to assess the constructs of the theoretical model.

In particular, the sections of the questionnaire are:

1. General data: the focus of this first set of questions is on demographic variables as well as generalities of the respondents (gender, age, type of role they

cover, etc.). This area has also helped to disclose the presence of some control variables to take in consideration. This section consists of 8 of the 28 questions.

2. Impact of SW on the organization: the second section investigates the impact of SW on the coordination mechanisms. It also aims at gathering information on each respondent's perceptions on the degree of time flexibility and spatial flexibility, on his job satisfaction and empowerment, as well as on how much the working practices have changed due to smart working. This section presents 12 of the 28 questions.

3. Organizational support: the third section investigates the working environment of the company in which each respondent, namely the adoption of targeted interventions to raise awareness and knowledge on the subject, the implementation of SW programs and the provision of correct ICT tools to support SW, with the aim of assessing the opportunity to perform. This section presents 4 of the 28 questions.

4. Impact of SW on the performance: the last section aims at gathering information on the performance. This section counts the last 4 questions.

The questions within the first macro area are either multiple choices or blank spaces that the respondent had to fill in. Instead, the other sections are in the form of statements, to which the respondent has to indicate to what extent he/she agrees on a qualitative five-point scale.

### ***3.2 Distribution of the questionnaire***

The questionnaire was administrated in Italian language from June 2020 up to October 2020, was fielded online, respondents were reached both via social media networks and through mailing lists. Data was anonymously collected through Google and Office365 platforms and analysed in aggregate form.

## **4 Results**

In the present study a descriptive analysis of the examined sample and an internal consistency analysis was performed, after coding the variables. In particular, we transform the qualitative variables into quantitative ones, by using a scale ranging from 1 to 5. Then we convert the 5-point scale into 3-point scale: where 1= disagree, 2 = neutral, and 3 = agree.

#### 4.1 The sample

This section provides a complete overview of the respondents' characteristics. The questionnaire reached 1.804 responses, of which 1.648 were fully completed and reported in the database.

Table 1. Characteristics of the respondents

Variable	N (%)
Gender	
Females	890 (54%)
Males	758 (46%)
Age groups	
< 30 years	297 (18%)
30-50 years	824(50%)
> 50 years	527 (32%)
Level of education	
High school licensed	280 (17%)
Post-Secondary Education	890 (54%)
Post-graduate degree	478 (29%)
Responsibilities of respondents	
Children at home	445 (27%)
Elderly people	198 (12%)
Caregiver for disabled	66 (4%)
No responsibilities	939 (57%)
Type of company	
Public Administration	643 (39%)
Small and medium-sized private company	461(28%)
Large private company	544 (33%)
Type of role	
Executive	66 (4%)
Manager	264 (16%)
Office workers	808 (49%)
Schoolteacher	247 (15%)
Academic	82 (5%)
Professionals	132 (8%)
Others	49 (3%)
Distance between home and work	
0-5 km	1.034 (38%)
6-30 km	1.170 (43%)
> 30 km	517 (19%)
Previous experience in SW	
Yes	610 (37%)
No	1.038 (63%)
<b>Total</b>	<b>1.648 (100%)</b>

The characteristics of the respondents are shown in Table 1. The majority of the respondents were women (54%). Three age classes were identified, with 50% of the personnel aged between 30 and 50 years, 18% younger than 30, and 32% older than 50. The level of education is quite high, 54% of respondents declared to be graduated, 29% have a post-university degree and only 17% a high school degree.

Regarding the professional classification, 6 out of 10 work in private companies (61%) and the remaining 39% in the Public Administration. As for the former, 28% works in small and medium-sized companies, and 33% work in large companies.

The workers doing Smart Working that answered the survey have different roles: Almost half of the respondents (49%) is an office workers, 16% works as manager, 4% as executive, 15% are schoolteachers.

Most of the respondents (81%) live and work in the same city or at least in a 30-kilometer range, while the other 19% lived more than 30 kilometers away from the workplace, they have children at home in the 27% of cases, are responsible for elderly people in the 12% of cases, and have no responsibilities in the 57%.

Only 37% of respondents have experienced smart working before the Covid-19 crisis, for 6 out of 10 workers, smart work is a completely new experience.

#### **4.2 Reliability analysis**

Before using the results of the survey to test our theoretical framework, we test the quality and robustness of the questionnaire by performing an internal consistency analysis. Cronbach's alpha was selected to measure the internal consistency of the questionnaire (Cronbach, 1951). This statistical indicator measures reproducibility over time and the homogeneity among the questions. Cronbach's alpha refers to the degree of correlation between the analyzed variables. It is computed among the items of the questionnaire and provides information about the correlation level. The closer to 1 the value of Cronbach's Alpha, the higher the level of correlation among items, thus each item provides a valuable contribution. Conversely, when the Cronbach's Alpha is close to 0, the level of correlation among the items is low, hence some of them are not appropriate. In this case, it is needed to eliminate the items that reduce the value of Cronbach's Alpha (Cho and Kim, 2015).



Cronbach's alpha value should be more than 0.70 in order to give good support for internal consistency reliability (Morgan et al., 2007). Hence, we consider as acceptance threshold of this parameter 0,7.

We perform the analysis of internal consistency of the 20 questions regarding the impact of SW on the organization (second section of the questionnaire), the organizational support (third section) and the impact of SW on the performance (last section).

The analysis showed an overall standardized Cronbach's Alpha of 0,8, corresponding to a very good reliability.

In the analysis by item the value of the alpha decreased to a minimum of 0,77 when the items 19 and 20, related to the impact of SW on the performance, were deleted, while the deletion of items 2, 6, 9, and 11, related to the impact of SW on the organization, led to an increase in the value of alpha. A maximum of 0,86 is reached with the deletion of item 2. The analysis is reported in Table 2.

Table 2. Analysis of internal consistency of the questionnaire

<b>Sections</b>	<b>Items</b>	<b><i>Cronbach's Alpha when the item was deleted</i></b>
Section 2 Impact of SW on the organization	Item1_coord1	0,80
	Item2_coord2	0,86
	Item3_coord3	0,78
	Item4_coord4	0,82
	Item5_coord5	0,82
	Item6_flex1	0,84
	Item7_flex2	0,81
	Item8_emp1	0,83
	Item9_emp1	0,84
	Item10_motiv1	0,82
	Item11_change1	0,85
	Item12_change2	0,83
Section 3 Organizational support	Item13_support1	0,81
	Item14_support2	0,82
	Item15_support3	0,83
	Item16_support4	0,83
Section 4 Impact of SW on performance	Item17_perfm1	0,83
	Item18_perfm2	0,78
	Item19_perfm3	0,77
	Item20_perfm4	0,77

## 5 Conclusion

Recently there has been a proliferation of studies reporting SW as a common practice due to the Covid-19 emergency. Looking at the post-pandemic world, several studies are questioning about the future of SW and whether it will be adopted by companies as an established successful practice. Actually, providing an answer to this issue requires the investigation on whether and to what extent the SW can really impact on company's performance.

Pursued by this objective, this research study aims at investigating to what extent SW may contribute to improve company's performance and, in this vein, it can be considered a successful practice to be adopted in the post pandemic scenario.

This paper presents first findings of this research study, namely a conceptual framework, built on a series of testable propositions, about the characteristics of SW as leverage to achieve new, incremental productivity, both at "people" and "process" level and the validation of the questionnaire developed to empirically test out the theoretical framework.

As a next step of this research study, we will use the results of the survey to test our theoretical framework. This will enhance understating about effect of SW on the organization, at the level of macro structure and micro structure, thus providing an answer on whether the characteristics of SW enable the achievement of new, incremental productivity and therefore if SW may improve the organizational performance.

This understanding is important because it will support companies in investment decisions about technologies, workspaces, HR management systems, training etc., to be adopted in order to make SW an established practice also in the post-pandemic scenario.

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## **Enhancing Resilience in Healthcare Organisations during COVID-19 Pandemic: the Key Role of Information Systems**

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### **Abstract**

In the last year, due to the COVID-19 pandemic outbreak research in resilience has flourished. During the first pandemic wave, health systems had to cope with a high number of severely ill patients and a high degree of unpreparedness at the organizational level. In that period, having a clear understanding of the pandemic situation within the organizations and the systems was essential. Resilient healthcare organizations need to develop information systems concerning positive patients. In light of this evidence, the purpose of this study is to investigate how the use of information systems influence resilience in healthcare organisations during the COVID-19 pandemic.

According to the aim, this research adopts a qualitative approach based on multiple case study to strengthen the findings by triangulation of evidence. Empirical data were gathered from multiple sources, i.e. observations, reports and interviews adopting a multiple case study methodology. In the healthcare organisations involved, the interviews were carried out to the head of the COVID units and the medical directions.

Moving from the literature on resilience and knowledge management and information systems, firstly, the research identifies the elements required for building resilience. Secondly, the knowledge management processes fostered by the use of data. Then, using multiple case studies, it provides a number of propositions concerning the relationships between knowledge management activities, based on the use of information systems, the selected organisations developed and the resilience-building elements they nurtured.

The study shows the importance of integrated COVID-related information systems between healthcare organisations to effectively face the crisis. By the analysis, the development and use of information systems boost resilience elements such as collaboration, flexibility, visibility, etc.

The paper highlights the importance of data integration during the COVID-19 first wave and how the development and use of information systems can enhance resilience

elements. Moreover, it contributes to shedding light on the relationship between the use of knowledge and resilience in healthcare organisations during pandemic events.

**Keywords** – Resilience, healthcare sector, COVID-19, information systems, knowledge management

**Paper type** – Academic Research Paper

## 1 Introduction

Over the last year, the COVID-19 pandemic has put pressure on health systems as never before (Auener et al., 2020; The Lancet Infectious Disease, 2020). Policy-makers and healthcare scholars are putting all their efforts into finding strategies and sharing the best ways to face the current pandemic (European Group on Ethics in Science and New Technologies, 2020; EXPH, 2020; HSRM, 2020).

Framed in this pandemic context, research in resilience has flourished. Related to healthcare, resilience is defined as the ability and capacity of the healthcare systems to absorb, effectively respond and adapt to shocks and structural changes while sustaining day-to-day operations (EXPH, 2020). Even it is not a new concept, it is increasingly crucial today because of the widespread unpreparedness of health systems for a pandemic of this magnitude.

During the COVID-19 first wave, Italian hospitals and local health authorities had to manage huge flows of patients affected by COVID-19. To handle these flows of patients, healthcare organisations needed to have a clear and complete understanding of the patient flows concerning the number of COVID and non-COVID inpatients, the bed occupancy rate, etc. Information systems are already widely adopted to gather data through electronic health record (EHC), to support clinical decision making through clinical decision systems (CDS), to collect information about bed management, etc. During pandemics, they became even more important (Devadoss et al., 2005). They were tasked with collecting epidemiological information and tracking people affected by COVID-19, and they would provide information about bed occupancy rates, bed turnover, etc. to draw up plans for reorganising activities. Whereas a huge literature investigates the relationship between information systems and knowledge management (KM) processes (Alavi and Leidner, 2001; Devadoss *et al.*, 2005), blossoming studies start to investigate KM as a resilience element referred to a specific field of resilience, i.e. supply chain resilience (Ponis and Koronis, 2012; Ponomarov and

Holcomb, 2009; Scholten et al., 2014; Umar et al., 2020). In their recent work, Umar *et al.* (2020) investigated the effects of KM on supply chain resilience (SCRES) and they conclude by highlighting SCRES is enhanced by KM processes through a robust KM infrastructure, among which information systems and technology. However, differently from Umar et al. (2020), we aim at deepening only how the KM activities developed by the use of COVID-related information systems influence resilience in healthcare organisations.

To provide a deep comprehension concerning how KM activities, performed thanks to the development and use of information systems, support patient flow management in order to enhance resilience, we studied the supply chain perspective of resilience. Indeed supply chains in healthcare concern not only material flows but also patient flows (de Vries and Huijsman, 2011) and service provision (Meijboom et al., 2011).

Based on these premises, the purpose of this study is to investigate how the use of information systems favour resilience in healthcare organisations during the COVID-19 pandemic. To gain the purpose of our research, we adopt an inductive based case study research built on multiple case studies in order to strengthen the validity of the study.

The paper is structured as follows. Firstly, we deepen the theoretical background in Section 2. Secondly, Section 3 describes the methodology that we adopted. Section 4 highlight the main findings and discuss them. And finally, Section 5 emphasizes the conclusions and the future research.

## **2 Theoretical background**

Resilience has become a growing concern over the past years. One of the most studied literature reviews carried out by Bhamra et al. (2011) identified five perspectives of resilience: ecological, individual, community, organisational and supply chain.

Supply chain resilience received a blossoming interest starting from 2001 (Bhamra et al., 2011), and after few years Sheffi and Rice (2005, p. 41) emphasized resilience as the ability of a company to recover from a disruption developed by creating flexibility and redundancy into its supply chain. They gave attention both to the development of resilience by improving the supply chain and to the elements that characterized the supply chain. Resilience elements secure supply chain resilience before, during and, after a disruptive event (Jüttner and Maklan,

2011). Just because of their role, in the past years, interest in resilience elements raised among researchers (Christopher and Peck, 2004; Hohenstein et al., 2015; Ponomarov and Holcomb, 2009; Sheffi and Rice, 2005).

Collaboration, flexibility, redundancy, agility and visibility are the most studied resilience elements in the literature. Whereas collaboration enables the human resources to work effectively together at intra- or inter-organisational level (Ali et al., 2017; Christopher and Peck, 2004; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Kamalahmadi and Parast, 2016; Lima et al., 2018; Pettit et al., 2010, 2013; Ponomarov and Holcomb, 2009; Scholten et al., 2014; Scholten and Schilder, 2015), flexibility enables the organization to adjust and change processes and structures according to the contingent situation (Blackhurst et al., 2011; Christopher and Peck, 2004; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Kamalahmadi and Parast, 2016; Pettit et al., 2010, 2013; Ponomarov and Holcomb, 2009). Unlike flexibility, redundancy has been identified as the process of creating a surplus of capacity and/or resources needed during a disturbance (Christopher and Peck, 2004; Dolgui et al., 2018; Hearnshaw and Wilson, 2013; Hohenstein et al., 2015; Ivanov et al., 2019; Kamalahmadi and Parast, 2016; Pettit et al., 2010, 2013; Ponis and Koronis, 2012).

Finally, agility that represents the ability to respond rapidly to changes (Ali et al., 2017; Christopher and Peck, 2004; Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Wieland and Wallenburg, 2013), is constituted by flexibility (Jüttner and Maklan, 2011), velocity and visibility (Christopher and Peck, 2004). Visibility is the ability to see throughout the supply chain (Ali et al., 2017; Blackhurst et al., 2011; Brandon-Jones et al., 2014; Jüttner and Maklan, 2011; Pettit et al., 2010; Ponomarov and Holcomb, 2009; Scholten and Schilder, 2015). Its notion is strictly related to communication, information sharing and knowledge (Barratt and Oke, 2007; Brandon-Jones et al., 2014; Jain et al., 2017).

Knowledge is seen as part of visibility for some authors (Barratt and Oke, 2007; Brandon-Jones et al., 2014; Jain et al., 2017), and properly as a resilience element for others (Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Scholten et al., 2014; Umar et al., 2020). Knowledge and more rightly knowledge management has been studied as the element that enables companies to share information across the supply chain (Ali et al., 2017) or as the element that favours the learning capability of the organization (Ponomarov and Holcomb, 2009). Umar et al. (2020) identify more widely knowledge management as a driver of resilience through the development of knowledge generation, sharing and utilization.



Knowledge management has been defined as a set of activities to manage knowledge within the organisations, whereas KM referred to information systems perspectives has been described as an effective tool to enable KM processes (Dorasamy et al., 2013). KM processes facilitate the acquisition, sharing and utilisation of knowledge (Alavi and Leidner, 2001). However, even if some authors emphasized the importance of a cultural change to be combined with the development of technology to enable KM processes (Davenport and Prusak, 1998; Nonaka and Takeuchi, 1995), during emergency context knowledge management tools favour the development of KM processes (Dorasamy et al., 2013). In their review, Dorasamy et al. (2013) listed 17 tools as enablers of KM processes among which there are the data and information systems, emails, intranet, videoconferencing, etc. As also Ammirato et al. (2020) analyzed in their recent work on pandemics, knowledge management is one of the topics related to managing pandemics and integrated information systems bring benefit to emergency management.

The empirical evidence shows that information systems facilitate KM processes (Ammirato et al., 2020; Dorasamy et al., 2013; Umar et al., 2020) which include knowledge acquisition, sharing and use. These are the most common categories of KM processes (Nonaka and Takeuchi, 2008). Knowledge acquisition refers to acquiring new knowledge inside or outside the organization (Magnier-Watanabe and Senoo, 2008). Knowledge acquisition is a social process between individuals (Nonaka and Takeuchi, 1995). Knowledge sharing is the process of mutually exchange knowledge, experiences and skills among individuals (Rusly et al., 2014) and it involves social interaction (Cockrell and Stone, 2010; Nonaka and Takeuchi, 1995). This interaction to share knowledge can be facilitated through formal training or informal interaction (Umar et al., 2020).

Knowledge use is the way by which knowledge is used by organisations. This third KM process is the one the supply chain scholars referred to (Ponomarov and Holcomb, 2009; Scholten et al., 2014).

### **3 Methodology**

To provide a useful insight into the contemporary events in the healthcare sector during COVID-19, an inductive case study research was carried out (Benbasat et al., 1987; Meredith, 1998).

Moving from the literature on supply chain resilience and KM, firstly, we identified the most studied elements of resilience and, secondly, the KM processes fostered by the use of information systems. Then, using multiple case studies, we empirically investigated the relationships between KM activities, based on the use of information systems, the selected organisations adopted and the resilience-building elements they nurtured.

Through case study research, we were able to collect data using several methods and tools, such as direct observations, interviews, documents and reports in the setting under investigation (Yin, 2018). Moreover, for increasing the understanding of such a new and rapidly evolving phenomenon and strengthening the grounding of theory (Eisenhardt, 1989), this research investigates three public healthcare organisations. The study of multiple case studies follows three stages, i.e. the research design, the data collection and analysis. Semi-structured interviews involved members of the strategic unit and its support staff unit from each organisation to investigate the use of the data systems at the strategic level.

### **3.1 Research design**

This research focuses on the hospitalized COVID patient flows. In order to deepen how the hospital directors and the clinicians carried out KM activities to build resilience, we involved the medical directions and the units that deliver care to COVID patients (e.g., Intensive Care Unit, Pneumology, Infectious Disease, etc.).

The research protocol was designed to answer the following research question (Yin, 2018):

*How the knowledge management processes enabled by the use of information systems favour resilience in healthcare organisations during the COVID-19 pandemic?*

To investigate the relationship between the KM activities supported by the use of information systems and supply chain resilience, we selected multiple cases considering the following criteria:

1. Continuity of care criterium: the emergency room has to be always kept open during COVID-19 first wave;
2. Geographical criterium: healthcare organisations placed in the most COVID-19-affected Italian regions;
3. Service typology criterium: only public organisations;

4. Quality of care criterium: at least acceptable levels of care (i.e. score  $\geq 160$ ) defined by the Health Italian Ministry (Griglia LEA 2018, "Ministero della Salute").

The selected public healthcare organizations could be defined resilient as they kept emergency services open at all times, although heavily affected by the pandemic. They indeed belong to two Italian regions severely impacted by COVID-19, i.e. Emilia Romagna and Veneto. The spread of COVID-19 began on the 21<sup>st</sup> February 2020 in Lombardy. After few days also Veneto and Emilia Romagna reached consistent percentages of confirmed cases ("COVID-19 ITALIA", 2020).

Finally, concerning the quality of delivered care criterium, Veneto obtained the highest score for delivered levels of care in 2018 (222) and Emilia Romagna reached the second (221) highest value ("Ministero della Salute", 2021).

In order to gather useful information about the use of information systems at the strategic and unit level, we involved one or more members of the strategic unit and the support units (e.g. medical direction unit, health profession unit, etc.) and the directors of the units involved with the COVID-19 inpatient pathway. Table 1 synthesizes the profile of the healthcare organisations involved.

Table 11. The profile of the selected organisations.

	<b>Case A</b>	<b>Case B</b>	<b>Case C</b>
Region	Emilia Romagna	Emilia Romagna	Veneto
Typology	University hospital	Local Health Authority	Local Health Authority
No. of hospitals	1	6	6
Beginning of the crisis	01/03/2020	27/02/2020	24/02/2020

### **3.2 Data collection**

Once identified the cases, we designed the interview protocol to drive the semi-structured interviews, observations and document analysis (Eisenhardt, 1989; Yin, 2018). As Table 2 shows, the interviews involved mainly the medical directions in order to collect data about how they use information systems at the strategic level and to the head of the COVID unit in order to deepen how they manage information across the units.

Whereas the investigated period is from the beginning of the COVID-19 outbreak in Italy, i.e., the 21<sup>st</sup> February 2020, to September 2020, the data has been collected mainly during summer 2020.

The duration of the interviews was about 45 minutes and they were audio-recorded and transcribed ad verbatim.

Table 12. Summary of data collection.

		Case A	Case B	Case C
Investigated units	Health Director	✓	✓	✓
	Infectious Disease	✓	✓	✓
	Emergency Unit	✓	✓	✓
	Internal Medicine			✓
	Pneumology		✓	✓
	Intensive Care	✓	✓	✓
	Hospital Director		✓	✓
	Medical Direction	✓		
	Health Profession Unit			✓
	SUEM 118			
	Microbiology	✓		✓
	Maternal and Child Health Area	✓		
	Surgery	✓		
No. of interviews		10	6	11
Duration of each interview		45 minutes	45 minutes	45 minutes
Data collection period		08-09 2020	08-09 2020	07-08 2020

### 3.3 Data analysis

To strengthen the data analysis, we adopted RQDA, an open-source Computer-Assisted Qualitative Data Analysis (CAQDAS). "A CAQDAS increases the transparency, validity, rigour and trustworthiness of qualitative research", as Chandra and Shang highlighted (Chandra and Shang, 2017) (p. 95). A research group coded separately the transcription of the recorded data to enhance the

validity and reliability of analysis (Voss et al., 2002; Yin, 2018). Then, meetings were held to discuss the coding. In cases of disagreement, the decision on codes was discussed and mutually agreed upon, following an iterative approach to coding and analysis (Miles and Huberman, 1994).

The coding process permits the identification of the activities related to the KM acquisition, sharing and use developed by means of information systems (first-order coding). Then, the second-order coding enables us to link these activities to the resilience elements identified in the literature review (i.e. collaboration, flexibility, agility, redundancy, visibility). Finally, in order to increase consistency, the interview data were integrated with the internal documents, the websites of the organisations (Voss et al., 2002; Yin, 2018). Thanks to data triangulation, we were able to verify the reliability of the multiple sources gathered and to increase the understanding of the collected data (Yin, 2018).

Section 4 highlights the empirical evidence derived from the analysis in order to answer the research question.

#### **4 Findings and discussion**

During the COVID-19 first wave, the selected cases experienced the development of information systems at a different level.

Case A created a COVID patient information system integrated with the local health authority of the city to which they both belong and with the private healthcare organisations close to the city. Similarly, case B developed a COVID patient information system integrated with all the hospitals of the local health authority and the private healthcare structures belonging to the province of case B.

The creation of such integrated systems generated a clear understanding of the pressure on hospitals. They enable indeed both the public and private healthcare organisations to coordinate and manage the patient flows by continuing to deliver care.

*"A success element was the dashboard that enables the organization to have a clear understanding about bed occupancy rate, [...] in all the hospitals of the city. This was essential to manage patient flows across the units. [...] Several services could access on the dashboard because there was no confidential data, this was a strength." (Health Director, Case A)*

Besides its ordinary information systems, case C had the access to the regional platform created ad hoc for the COVID pandemic crisis. The organization nurtured the platform with COVID patient information and then it can access and use the system to gather the data to manage the patient flows.

*"At the beginning, we were not aware of COVID epidemiological trend. Then, the Region created and made a platform available to provide a clear reference framework of the hospital pressure, [...] several services have the access to the platform (hospital top management, public hygiene service)."*  
(Health Director, Case C)

In addition to patient information systems, the cases were provided by regional intensive care information systems to manage the available intensive care beds, personal protective equipment (PPE) monitoring systems, emergency unit dashboard (only for case A).

The high degree of autonomy of these cases in creating and managing information systems was a strength of these organisations as they create ad hoc systems based on their needs.

On the contrary, case C used the regional platform as the organization have considered it a helpful tool. The ways by which the information systems have been created have been always seen as a strength. The emphasis indeed has been put on the information gathered. However, top management of case A and B showed greater ease in reaching and providing data from the COVID platform.

Moving from the information systems developed to how they have been used, we listed in Table 3 the activities related to KM acquisition, sharing and utilisation.

Table 13. Activities classified by KM processes developed by the selected cases.

	Activities	Peculiarities of the cases
Knowledge acquisition	Gaining information by:	– Case C gained information by a regional platform
	– COVID patient information system	– Case A and B developed a platform integrated with the hospitals placed in the city/province
	– Regional intensive care information system	– Case A developed a dashboard for the emergency unit
	– Emergency unit dashboard	– The PPE monitoring system is regional for case C.
	– PPE monitoring system	

<b>Knowledge sharing</b>	<ul style="list-style-type: none"> <li>- Access to information systems depending on the interest area</li> <li>- Regional meeting to share information between the top management of the organisations</li> <li>- Crisis unit meeting to share information concerning COVID flows</li> <li>- Cascading communication between the organizational levels by email, intranet and shift change meetings, chat</li> <li>- PPE use training activities</li> </ul>	<ul style="list-style-type: none"> <li>- Top management of case C received a daily report via WhatsApp</li> <li>- Case A shared information about PPE procurement activities</li> </ul>
	<ul style="list-style-type: none"> <li>- Service integration to admit patients from other regional hospitals</li> <li>- Integration and coordination of services with the other healthcare organisation of the city</li> <li>- Integration between the emergency services of the region to manage intensive care beds</li> <li>- Creation of separated paths for COVID and non-COVID patients</li> <li>- Care delivering to urgent activities</li> <li>- Outsourcing of the surgery</li> </ul>	<ul style="list-style-type: none"> <li>- Case B developed service integration also for the coordination with the primary care</li> <li>- Case A coordinated the outsourcing of surgery services with the other hospitals of the city thanks to the information about bed occupancy rate</li> </ul>

The activities divided by KM processes are almost the same even if the information systems are managed in different ways. Thus, even if the selected healthcare organisations acquire knowledge in different ways, they share and use the information to develop similar activities.

Moving from first-order to second-order coding, activities were categorized by elements of resilience they are building.

Firstly, knowledge acquisition activities are related to the activities of gathering information from the information systems. Whatever the information system adopted, the collection is carried out in the same manner if the required information is available in the system. This activity increases the visibility inside and outside the organisations involved in the integrated data management of the information systems. As previously described, visibility represents the element that enables an organisation to see throughout the supply chain (Jüttner and Maklan, 2011; Pettit et al., 2010; Ponomarov and Holcomb, 2009; Scholten and Schilder, 2015). Integrated information systems allow the organisations to see

through all the healthcare organizations involved by showing all the data related to COVID patient flows.

*P1. Knowledge acquisition from data gathered by real-time integrated information systems enhances the visibility of the healthcare organisations involved.*

Secondly, knowledge sharing activities refer to the activities of sharing information from the individual level to the organizational level (Rusly et al., 2014). The healthcare organisations firstly facilitate the sharing of acquired knowledge by using different communication strategies: they provide the access to information systems to the top management and the COVID unit directors, they scheduled daily meeting among crisis unit members to share information gathered at different levels (regional level for the regional information systems and in-house level for enterprise information systems), and they train the workers on PPE use for not wasting them. These differentiated activities to share information promote the development of redundant ways to share information at the organizational level. Redundancy defined as the process of creating a surplus of capacity and/or resources needed during a disturbance (Christopher and Peck, 2004; Dolgui et al., 2018; Hearnshaw and Wilson, 2013; Hohenstein et al., 2015; Ivanov et al., 2019; Kamalahmadi and Parast, 2016; Pettit et al., 2010, 2013; Ponis and Koronis, 2012), is here favoured by creating a surplus of an intangible resource, the differentiated communication strategies, to secure that the information reaches all organizational levels.

*P2a. Knowledge sharing through differentiated communication strategies enhances redundancy within healthcare organisations.*

Knowledge sharing concerns also the vertical integration between the different levels inside and outside the organisations. The cascading communication from the Region and/or the crisis unit at the strategic level to the clinicians and nurses in the units was required. The members of the crisis units communicated news in the units mainly through email, chat and change shift meetings. Securing an effective cascading communication to share knowledge, required working effectively together at intra- or inter-organisational level, i.e. collaboration (Ali et al., 2017; Christopher and Peck, 2004; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Kamalahmadi and Parast, 2016; Lima et al., 2018; Pettit et al., 2010, 2013; Ponomarov and Holcomb, 2009; Scholten et al., 2014; Scholten and Schilder, 2015). In that period, informal communication was the fastest and the most effective way to share knowledge. This new need increased the collaboration



between workers at different levels, as each level was responsible for communicating the new insights to its colleagues to ensure effective cascading communication.

*P2b. Knowledge sharing from the top management to the units enhances collaboration between the healthcare workers.*

As previously described, visibility is the ability to see throughout the supply chain. Concerning knowledge acquisition, visibility has been enhanced because information systems enable few individuals of the organizations involved to “see” the patient flow data. Whereas, concerning knowledge sharing visibility is enhanced by the share of useful information, filtered by the role and task, among all the workers. This enables the workers to have a clear understanding of what is happening inside and outside the organizations.

*P2c. Knowledge sharing to all organizational levels enhances visibility throughout all healthcare organizations.*

Knowledge utilisation is the way by which knowledge has been used. Firstly, thanks to the gathered information, the crisis unit was able to forecast the availability of beds depending on the emergency access, the bed turnover rate, etc., to manage the patient flows inside the organisations, between the units, and outside the organisation, thanks to the integration with the other hospitals. The real-time available information improves agile decision-making processes. The agility element, defined as agility the ability to respond rapidly to changes (Ali et al., 2017; Christopher and Peck, 2004; Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Wieland and Wallenburg, 2013), in KM perspective is enhanced by an updated and available information flow.

*P3a. Knowledge utilisation provided by real-time information systems enhances the agility of decision-making processes.*

Knowledge use concerns also the activities of creating new pathways inside and outside the organisations to manage COVID patient flows. The selected cases developed two different pathways inside the organisation to divide the COVID and non-COVID areas. Then, thanks to the integration of the systems with the other hospitals, they can manage the patient flows efficiently. The regional intensive care information systems, for example, manage the patient transfers towards the hospitals with more available beds. Flexibility, thus, as the adjustment and changing processes and structures according to the contingent situation, has been improved.

*P3b. The knowledge used for integrating care services inside and outside the hospitals enhances the flexibility of patient pathways.*

As previously described redundancy is the process of creating a surplus of capacity and/or resources needed during a disturbance (Christopher and Peck, 2004; Dolgui et al., 2018; Hearnshaw and Wilson, 2013; Hohenstein et al., 2015; Ivanov et al., 2019; Kamalahmadi and Parast, 2016; Pettit et al., 2010, 2013; Ponis and Koronis, 2012). By the use of knowledge, the organizations created not only flexible pathways but also redundant services, diagnostic rooms, etc. Due to the differentiation of paths indeed organisations needed to organize multiple diagnostic rooms, elevators, etc. to ensure the safety of patients and workers. Moreover, thanks to the information gathered from the PPE monitoring systems, the hospitals estimated the need for PPEs and developed procurement activities to ensure a surplus of PPE capacity needed during the crisis.

*P3c. The use of the knowledge provided by the monitoring systems enhances redundancy either in the creation of COVID pathways and in ensuring PPE procurement.*

Figure 1 shows the analysed relationships between resilience elements and KM processes making explicit by the previously described propositions.

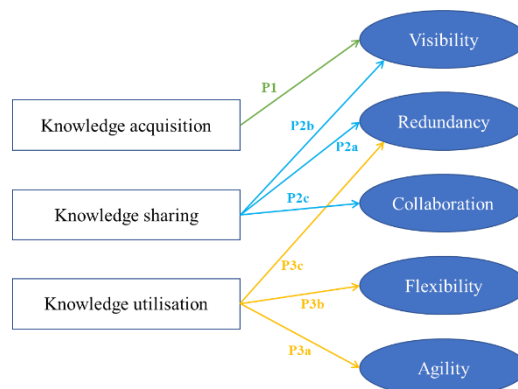


Figure 10. The research findings.

The analysis of the findings sheds light on how the knowledge derived by information systems is acquired, share and use to enhance the most studied resilience elements. In line with Dorasamy et al. (2013), information systems during pandemic events enable healthcare organisations to develop KM processes effectively. However, differently from Ammirato et al. (2020)'s review, KM processes are the drivers for the development of the elements of resilience.

The research highlights the role of KM in developing resilience. Even if some authors (Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Scholten et al., 2014; Umar et al., 2020) consider knowledge management as one of the resilience elements, this research shows that it is an antecedent needed for the development of resilience elements.

The next section shows the contributions and the main limitations of this research.

## 5 Conclusions

This study contributes to making clear the relationships between KM and resilience elements. We explicated the KM processes developed by the COVID related information systems that favour the building of resilience elements. However, only the main resilient elements have been analysed. Future research could investigate if there are additional resilience elements enhanced by KM processes.

Moreover, the study provides empirical evidence for healthcare practitioners. Thanks to the first order coding the main activities concerning KM processes, has been identified. The resilient healthcare organisations provided by COVID information systems carried out specific KM activities that enhance resilience throughout the entire regional system.

However, the research focuses only on COVID first waves. It could be interesting to investigate how the same healthcare organisations modify their actions thanks to the new knowledge acquired, during the other two waves of the COVID-19 pandemic.

Finally, future research could investigate the benefit of enhancing resilience through KM processes also in ordinary time to achieve greater public value.

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## How to Improve the Triage: an Analysis of Factors Affecting its Accuracy

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### Abstract

The Triage process is a crucial process of Emergency Departments, and scholars have proposed several solutions to streamline the processing of patients and reduce the waiting time of more urgent ones. However, a not thoroughly investigated issue concerns the factors influencing the decision-making performed by the nurses in the assignment of Triage's priority code. The Triage decision-making is a dynamic and complex process: the decision emerges after an interpretation process of patient clinical conditions influenced by the interaction of organizational rules and environment conditions with nurse's experience and beliefs. We investigate the Triage process through the fuzzy Qualitative Comparative Analysis (QCA). QCA is a method used to test theory-based conditions considering multiple interrelated variables that lead to the same outcome. More specifically, we show how the QCA allows researchers to figure out how the interaction between individual, organizational, environmental factors affect the Triage decision-making. This analysis will enable us to suggest some possible interventions to improve the Triage process. This research has been performed through direct observation of the Triage carried out in an Emergency Department of a Hospital located in the South of Italy.

**Keywords** – Triage Accuracy, Qualitative comparative analysis, Individual and organizational factors, decision-making

## 1 Introduction

Even before Covid-19, scholars have given great attention to make Triage more efficient to streamline the processing of patients and reduce the waiting time of more urgent ones. Triage is the front-office process of Emergency Departments. It aims to prioritize access to health treatment, "determining who will not be disadvantaged by longer waiting times and who requires immediate attention to achieve optimal outcomes" (Fitzgerald et al., 2010, p. 86). Nurses perform the Triage process, and a potential incorrect decision increases the waiting time of patients with life-threatening conditions (Considine et al., 2007; Fernandes et al., 2005; Fitzgerald et al., 2010; Traub et al., 2015; Wuerz et al., 1998). Nurses can over-assess the priority code and, consequently, more urgent patients could wait longer than necessary. On the contrary, nurses can under-assess the priority code of a patient extending his waiting time.

Scholars have proposed several solutions to improve Triage, but they focused on new organizational pathways for mitigating the patient's flow as well as more accurate algorithms for helping nurses in the assignment. For example, some scholars focused on the layout, such as standardized pathways for managing patients with specific disease conditions (Terris et al., 2004) or fast track areas for low-acute patients (Rodi et al., 2006). Other scholars designed more accurate algorithms for prioritizing patients (Ashour and Okudan Kremer, 2016; Elalouf and Wachtel, 2015).

Few studies investigate nurses' decision-making quality. Moon et al. (2019) evaluated the accuracy of nurses' in Triage assessment with the help of an expert to determine the causes of mistakes. Tam et al. (2018) analyzed the accuracy of Triage, and they prompted emergency department managers to activate training actions. These two works assess the accuracy by analyzing some cases retrospectively. Instead,

Göransson et al. (2006) assessed the accuracy and the concordance among nurses in codifying the patient's urgency using patient scenarios. Instead, a key challenge of Triage is to understand on which information nurses make the decision prioritizing non-urgent patients (Göransson et al., 2005).



How nurses make decisions is an issue not fully investigated, although understanding what factors influence decisions is a relevant aspect to improve Triage effectiveness (Wouters et al., 2020).

Nurse's decision-making is based on cognitive heuristics (Noon, 2014) as he/she attributes patient's priority level based on few cues and small laps of time through an interpretation process of patient's clinical conditions affected by his/her experience and the uncertain conditions of his/her everyday work (Benner and Tanner, 1987; Carnevali et al., 1985). Cognitive heuristics are shortcut strategies used by individuals to make decisions when the information, time, and processing capacity are limited (Simon and Newell, 1971). Ambiguous information, turbulent environments, and time pressure prompt a decision-maker to leverage on few cues to decide a short amount of time (Drechsler et al., 2014; Martignon and Hoffrage, 2002). The decision-making based on cognitive heuristic is a dynamic and complex process: the social-organizational context interacts with an individual's experience and beliefs, guiding the individual in selecting the subset of the available information against which the decision is made (Hogarth, 1981). The inability to distinguish relevant information can lead the decision-maker to misinterpret the subset of the available information, making a wrong decision (Pleggenkuhle-Miles et al., 2013). Individuals can choose the information recalling similar situations from memory (Bazerman, 2003) or through simple organizational rules easy to remember (Eisenhardt and Sull, 2001). From an organizational and management perspective, cognitive heuristics can be applied to coordinate nurses and doctors in treating patients (Rico et al., 2008). The social-organizational context, formed by formal and informal rules, support systems, institutional commitments, becomes a means of providing directions for the decision even if the individual can leverage on his/her discretionary judgment in the final decision to be made (Vuori and Vuori, 2014). In the Triage process, the interplay between social-organizational context and individual discretionary affects the complex interaction between nurses and patients within a turbulent environment (Andersson et al., 2006), causing the variation of nurses' decision-making in assessing the urgency of any individual patient (Andersson et al., 2006; Cone and Murray, 2002; Göransson et al., 2008). This complex interaction nurse-patient concern the interpretation of verbal information (the patient's history), visual cues (non-verbal communication), and possibly vital signs to determine the outcome of the decision-making process.

The Triage decision-making process is a phenomenon for which it is not the single factor but the relationships between them that determine a result: "factors interact and co-evolve, determining specific answers to specific situations, these latter being filtered and interpreted in the light of the constraints and resources of the context in which the decision is made. It is therefore necessary to not isolate individual factors from each other and from the organizational and contextual ones in the analysis" (Ponsiglione et al., 2018, p. 2166).

Against this backdrop, this work aims to understand how individual, organizational and environmental factors or their combinations affect Triage's accuracy in the priority level assigned to patients. Unlike other works, the study collects data for the analysis directly through observing the Triage process while the nurse welcomes the patient and then assigns the priority code. Moreover, we embrace causal complexity (Misangyi et al., 2017) rather than net-effects approaches to theory (Delbridge and Fiss, 2013). Hence, our study aims to investigate asymmetrical relationships and alternative causal paths (equifinality) of combinations of factors (conjunction) that can produce the investigated outcome (Ragin, 2008).

Finally, this study can also offer interesting insights on how to identify possible interventions to improve the accuracy of the Triage in a specific context.

The paper is structured as follows. In section 2, we report the literature on factors affecting nurses' decision-making. Section 3 introduces the Qualitative Comparative Analysis (QCA) methodology to understand the complexity of a phenomenon, focusing on a set of theory-based conditions rather than considering separately the effects of individual factors. In section 4, we present the application of QCA to the Emergency Department of a hospital located in the South of Italy. Discussion, practical implications, and conclusion close the paper.

## **2 Factors influencing the Triage decision-making**

Triage decision-making is a complex decisional process (Arbon et al., 2008) in which the nurse making Triage assessment interacts with the patient and other nurses or physicians. Different factors are outlined in the literature as affecting this process (Ponsiglione et al., 2018). Furthermore, multiple information is in place when the nurse takes the decision, such as visual cues, verbal reports, the clinical history of the patient, and vital signs. Each kind of information could contribute to an effective Triage, with each of them playing a role changing

according to the specific case (Cooper et al., 2002). Additionally, the outcomes of the Triage process are several and are related to effectiveness and efficiency measures. For example, a decision that underestimates the level of severity and urgency of a patient can prevent critical intervention at the right time, while prolonged Triage processes can contribute negatively to safety (Cioffi, 1998; Gerdtz and Bucknall, 2001; Travers, 1999). The accuracy and the duration of the Triage process are the most common aspects used to measure Triage's performances.

A study conducted in an Emergency Department (ED) in Sweden (Andersson et al., 2006) has outlined two categories of factors affecting the decisional process of Triage's nurses: internal factors and external ones. Internal factors include individual knowledge, competencies, and expertise of nurses and their personality traits, such as the individual approach to uncertainty, the risk aversion, and the capacity to support the patient. External factors refer to those elements concerning the organization of work and the environmental aspects in which the Triage assessment occurs. According to the literature (Ponsiglione et al., 2018; Wolf, 2013), this last category could be articulated into two groups: one referring to organizational aspects (i.e., the specific protocols adopted by the organization, the typology of Triage, the organization of work-shifts, the rules of interaction between colleagues) and the other referring to the work environment (i.e., interruptions by colleagues or other patients, the overcrowding of the ED, the layout of the work environment with the position of the Triage desk). Despite this articulation, some factors could be referred to one of the two groups considering the specific analyzed case.

Personal traits, knowledge and competencies, and previous experience are individual factors mainly analyzed in the literature on Triage decision-making (Chung, 2005; Cone and Murray, 2002). According to Handysides (1996), a practical Triage nurse must have three basic skills: the ability to estimate conditions based on the patient's reported clinical history, clinical measurements, and physical examination; comprehensive knowledge of severe injuries as well as extensive knowledge of pathologies; intuition developed through long-standing experience, which helps to decide the patient's condition.

The acquisition of skills or knowledge and the exposure to events are criteria to measure experience jointly to the time spent in a situation or a job position (Watson, 1991). Indeed, some believe that there is a relationship between knowledge, skills, and experience (defined by how nurses transform or change).

Others, instead, think that the exposure to events that define the value of familiarity is the critical factor in making critical decisions (Considine et al., 2007).

The experience is intended both as a time of exposure to the same or similar clinical situations and valuable skills expected to be used in the assessment (Cioffi, 1998). The time spent in an activity or a job position is commonly used to define the nursing experience, where years of experience are used to classify nurses. Experience is also related to the number of years spent in emergency departments (Andersson et al., 2006).

Another relevant internal factor that is analyzed as affecting the decisional process and the outcome of the assessment in Triage is the use of vital signs by nurses to define the Triage priority code. Detection of vital signs is usually considered an internal factor because it depends on a specific choice of individual nurses and is often related to their level of experience. Some studies have investigated the interaction between the nurses' years of experience and the use of vital parameters. In particular, more experienced nurses tend to under-use objective parameters, while for the novice nurse, they represent a handy tool to assess the patient's symptoms (Chung, 2005). Other research evaluated the impact of vital signs' use both in terms of the accuracy of triage decisions and in terms of the duration of the triage-patient interaction (Chung, 2005; Cooper et al., 2002; Gerdts and Bucknall, 2001; Ponsiglione et al., 2018), in order to identify whether an objective reference guarantees a more accurate and timely choice. Gerdts and Bucknall (2001) have established that experienced nurses are more prone to neglect the measurement of vital signs; furthermore, the measurement of vital parameters, as expected, impacts negatively on the time needed to assess the priority of cases. Finally, in the same study, it was verified that a greater recourse to vital signs is needed when the severity and the urgency of the case are higher.

Cooper et al. (2002) researched to understand if and to what extent the use of vital signs can change the judgment of nurses by asking them to formulate the priority code before and after detecting the vital parameters. The study involved 625 nurses who collected data on more than 14,000 patients. Knowledge of vital signs led to an 8% revision of Triage decisions based only on clinical history, visual signs, and limited physical examination. In particular, for the entire sample, 5.5% of the changes concerned an increase in urgency, while 2.4% a reduction in severity.

Contextual factors also affect triage performance (Andersson et al., 2006; Göransson et al., 2005) due to the strict relationship in the context in which this occurs (Smith et al., 2008). These factors include organizational factors and environmental ones. Organizational factors concern staff availability, workload, and work-shifts organization, the type of Triage adopted (Soremekun et al., 2011), the protocols/guidelines used (Cone and Murray, 2002). Therefore, these factors are related to the managerial decisions that determine the organization of the triage process and the objectives and rules shared in a given context, which, internalized through experience in the specific work environment, can influence the perceptions and motivations of nurses. Environmental factors capture the dynamic nature of the EDs, where the unexpected is always a possibility, makes Triage's decisions highly contextual and influenced by several environmental factors such as the occurrence of continuous interruptions during the patient interview, time constraints, and overcrowding (Andersson et al., 2006; Chung, 2005; van der Linden et al., 2016). A potential barrier to providing high-quality patient care could be the occurrence of disruptions intrinsic to the emergency room environment. An interruption can be defined as any activity that requires the nurse to switch his attention away from the patient or any activity that causes the nurse to leave the Triage zone (Johnson et al., 2014). The interruptions cause errors and delays in the treatment of patients and represent a real threat in the Triage decision-making process. The categories of interruptions identified include the provision of services to visitors, interruptions related to colleagues, interruptions related to patient care, localization of family members in ED, and requests from other patients or the arrival of new patients (Johnson et al., 2014). When the Triage process is interrupted, there is a significant increase in the duration of the nurse-patient interaction (Gerdtz and Bucknall, 2001; Johnson et al., 2018), delay in patient treatment and an increase in errors in nursing assessment (Johnson et al., 2018). The occurrence of frequent interruptions and the different sources of these interruptions seem to refer both to specific organizational arrangements (i.e., the number of nurses in each work-shift or the protocols and guidelines established by the health structure) and to environmental aspects (i.e., socio-cultural characteristics of the served population, the level of overcrowding).

Only the actual situation can capture these factors. Gerdtz and Bucknall (1999) state that a limitation of the studies carried out on the decisions of Triage's nurses relies on simulated scenarios that do not adequately replicate situational

elements of the environment in which such decisions are made. Furthermore, literature does not deeply investigate these relationships formally; most real case analyses are conducted on simulated scenarios (Gerdtz and Bucknall, 1999; Ponsiglione et al., 2018), and surveys are, for their nature, retrospective collections of data. This implies the difficulty in identifying the interrelations of individual and contextual factors in determining a decision as well as the lack of data on specific organizational or environmental aspects (for example, the number of interruptions). Additionally, from a methodological perspective, the models applied to analyze collected data on factors and their influence are pure descriptive models or traditional regression analyses that assume an additive linear perspective.

Starting from the premise above and the recognition of the complex nature of the Triage decision-making process, we aim at answering the following research question: How individual, organizational, and environmental factors influence, through their combination, the effectiveness of the Triage decision-making? In particular, we aim at identifying the combination of factors of different categories (individual and organizational/environmental) affecting the accuracy of the Triage process, adopting a configurational methodology such as *fuzzy set Qualitative Comparative Analysis*.

### **3 Qualitative Comparative Analysis (QCA) model**

Qualitative comparative analysis (QCA) aims to understand the complexity of a phenomenon, focusing on a set of theory-based conditions rather than considering separately the effects of individual variables. The conditions are the variables that can affect the outcome. QCA is used in different research fields, and also business and management scholars are showing an increasing interest in this method. Kraus et al. (2018) offer an overview of the existing research on QCA in different management research areas, highlighting its relevance for a deeper understanding of a complex phenomenon. More in-depth, QCA is a comparative case-oriented technique that allows performing an analysis on a small or intermediate number of empirical cases to identify the configurations of causally relevant conditions linked to the outcome under investigation (Marx et al., 2013). This method analyzes the relationships between the conditions and identifies the configurations of conditions that can produce a given outcome. It is an inductive research method inspired by complexity theory based on the principles of

conjunction, equifinality, and causal asymmetry (Misangyi et al., 2017). Conjunction concerns the evidence that we can obtain an outcome with different configurations of conditions. Equifinality means that we can find more effective configurations related to a given outcome. Causal asymmetry implies that some conditions can be absent in a configuration or inversely related and present in another one. This situation is since "the directionality between X and Y depends on what additional simple conditions occur in given contexts" (Woodside et al., 2018), where X is the condition, and Y is the outcome.

QCA conceptualizes the conditions as sets with a different membership degree according to the considered real case: if the condition is not present, the case has a membership degree equal to 0 for such condition; otherwise, the membership is equal to 1 if the condition is fully present. We apply the fuzzy sets (fsQCA and therefore, the membership is a value between 0 and 1, as the condition can be present but not fully present. Finally, QCA assesses the necessity and the sufficiency of the relationships between conditions and the outcome. We have a relationship of necessity if the condition has to be present for the outcome to occur. While, for the sufficiency, the condition can produce the outcome and is a subset of the outcome itself.

QCA methodology is proposed to be the answer for understanding phenomena for which it is not the single variable but the relationships between them that determine a result. This feature of QCA is also well suited in the field of decision-making based on cognitive heuristics such as the Triage process.

In this paper, we adopt a fsQCA approach to analyze row data obtained from the analyzed and observed real cases, according to the following steps:

#### *1) Data Calibration*

The cases are represented as configurations of causal conditions through a matrix whose rows are cases and whose columns are the conditions and the outcome. The cases are the patients arriving at the Emergency Department, whereas the conditions emerge from the literature influencing the decision-making. The calibration process concerns setting membership scores to cases using theoretical and empirical evidence (Wagemann and Schneider, 2010). While the csQCA considers set memberships restricted to binary values of 0 (full non-membership) and 1 (full membership); the fuzzy version that we used allows us to calibrate partial memberships in sets using values in the interval between 0 and 1, without abandoning core set-theoretical principles and operations. In particular, fuzzy membership of the variables derived by the theoretical guidance and the

essential experience on the empirical cases developed by researchers. The calibration was made through the use of the fsQCA R package.

### *2) Truth table Construction*

Unlike the necessity analysis, which derives its Boolean solution directly from the calibrated data, the sufficiency analysis proceeds by first converting the calibrated data into a truth table and then reducing that into a set of Boolean expressions. Thus, constructing the truth table is the second step in fsQCA. Assumed that a calibrated data set represents a multidimensional vector space with one dimension per causal condition, the Truth tables summarize the distribution of observations across the vector space emerged by the calibration. Therefore, it shows as many rows as there are combinations of causal conditions, obtaining a matrix of  $2^k$  rows, where  $k$  is the number of causal conditions.

Then, the FsQCA consists of applying Boolean algorithms using counterfactual analysis (Wagemann and Schneider, 2010) that simplify the configurations in the truth table into three solutions evaluated by two metrics called consistency and coverage. Consistency refers to the degree to which a condition or combination of conditions relates to an outcome within the data (similar to significance for statistical model). Coverage, instead, provides a measure of relevance (similar to  $R^2$  in regression models).

### *3) Necessity and Sufficient Analyses*

The goal of FSQCA is to identify causal condition or groups of them ('configurations') which are either necessary or sufficient for the outcome to occur. A necessary condition is one where the outcome cannot be achieved without it, yet its presence is not enough to produce the outcome. A sufficient condition is one where the outcome always occurs if it is present, but other conditions may also produce the same outcome. As Legewie (2013) notes, a few cases will deviate from the general necessity or sufficiency relations in real data. Thus, the two fit measures described above are used to assess the degree to which groups of causal conditions are associated with the outcome variable. For this step, we adopted the software fsQCA 3.0.

## **4 The application of fsQCA to the Triage process**

Field research has been conducted in the Emergency Department of a private-public Hospital in Naples, South of Italy. The Emergency Department serves the population which does not require specialistic care. Firstly, the research team



shared with the Hospital's management the research plan, obtaining the ethical consensus to perform the analysis. Secondly, the research team observed and mapped the Emergency Department processes with particular attention to Triage and the waiting room, which regulates access to care treatments. Finally, in April–June 2019, before the Covid-19 pandemic, the research team collected data on Triage, observing directly the Triage assignment decision-making made by different nurses, in different daily hours and on different days of the week. Researchers collected priority codes assigned to 100 patients. The 100 patients represent our real cases in the application of fsQCA.

In order to apply the fsQCA, we have, first of all, identified the conditions that are the factors affecting the Triage process.

According to the analysis of literature and after an observation of the Triage, we selected the following factors:

- vital signs (the measurement of vital signs made by nurses to take a decision);
- nurse experience measured as working years;
- number of nurses in each work shift;
- number of interruptions during the Triage process by colleagues;
- the arrival of patients with an ambulance;
- the number of interruptions during the Triage process by patients.

These variables are related to individual, organizational, and environmental factors modeled as causal conditions of the fsQCA model.

The subsequent step concerned the definition of the outcome of the model. The outcome is related to the accuracy of the Triage process, affecting ED's quality. An under or over the assessment of patients can increase the waiting time of urgent patients (Considine et al., 2007; Fernandes et al., 2005; Fitzgerald et al., 2010; Traub et al., 2015; Wuerz et al., 1998). Over-assessment triage occurs if the patient receives a higher priority level than expected, and this could affect the waiting time of more urgent patients. Under-assessment Triage implies that the patient has to wait more time to access care than required. As an outcome, we considered the under Triage as it impacts directly on the waiting time of a specific patient while over Triage can indirectly impact patients.

After defining conditions and the outcome, and after collecting data, researchers performed the calibration phase using both fuzzy variables and crisp ones (Table 1). For crisp variables, we have just the value "yes" or "not". Instead

for fuzzy variables we have a membership function built on the characteristics of the Triage.

Table 1: The variables used in QCA model

Variable	Acronym	Typology	Measurement	QCA Variable
Vital Signs	PV	Individual	Yes (1): if the decision is made measuring the vital signs No (0): otherwise	Crisp
Nurse' Experience	AE	Individual	Number of working years (Exp) in the health sector	Fuzzy
Number of nurses in each work shift	NT	Organizational	Yes: if three nurses are present in the work shift No: otherwise	Crisp
Number of interruptions during the Triage process by colleagues	NI	Organizational	Number of interruptions detected	Fuzzy
Arrival with ambulance	AM	Environmental	Yes: the patient arrives with an ambulance No: otherwise	Crisp
Number of interruptions during the Triage process by patients	NP	Environmental	Number of interruptions detected	Fuzzy
Accuracy	OUTCOME		Difference between priority code assigned by the nurse and priority code reported on the patient's medical record (assigned by the physician after a deep assessment of the patient)	Fuzzy

The calibration phase returns the following table of relationships between cases and conditions (table 2).

Empirical Cases (EC)	Conditions						OUTCOME		Empirical Cases (EC)	Conditions						OUTCOME
	PV	AE	NP	AM	NI	NT				PV	AE	NP	AM	NI	NT	
EC1	1	0.028	0.005	0	0.005	1	0		EC51	0	0.357	0.005	0	0	0	1
EC2	1	0.028	0.005	1	0	1	0.5		EC52	0	0.357	0.005	0	0.005	0	0
EC3	1	0.028	0.005	0	0	1	0		EC53	0	0.357	0.005	0	0.005	0	0
EC4	1	0.028	0.005	0	0	1	0.5		EC54	0	0.357	0.38	0	0.005	0	0
EC5	1	0.028	0.005	0	0	1	0.5		EC55	0	0.028	0.005	0	0	1	0
EC6	1	0.028	0.005	1	0	1	0		EC56	0	0.028	0.005	0	0	1	0
EC7	0	0.05	0.005	0	0	1	0		EC57	0	0.028	0.38	0	0	1	0
EC8	0	0.028	0.005	0	0.005	1	0		EC58	0	0.028	0.38	0	0.005	1	1
EC9	1	0.028	0.38	0	0.38	1	1		EC59	0	0.028	0.934	0	0.921	1	0
EC10	0	0.028	0.005	0	0	1	0		EC60	0	0.028	0.38	0	0.38	1	0
EC11	0	0.028	0.38	0	0	1	0		EC61	0	0.028	0.005	0	0.38	1	0
EC12	1	0.028	0.005	0	0	1	0.5		EC62	0	0.028	0.005	0	0	1	0
EC13	1	0.028	0.005	0	0	1	0		EC63	0	0.028	0.005	0	0.98	1	0
EC14	1	0.028	0.005	0	0.38	1	0.5		EC64	0	0	0.005	0	0	1	1
EC15	0	0.427	0.005	0	0	1	0		EC65	0	0	0.005	0	0.005	1	1
EC16	1	0.427	0.005	0	0	1	0.5		EC66	0	0	0.38	0	0	1	0
EC17	1	0.427	0.005	1	0.005	1	0		EC67	0	0.028	0.005	0	0.005	1	0
EC18	1	0.427	0.005	0	0	1	0		EC68	0	0.028	0.005	0	0	1	0
EC19	1	0.427	0.005	0	0.005	1	0.5		EC69	0	0.028	0.005	0	0.005	1	1
EC20	1	0.427	0.005	0	0.005	1	0		EC70	0	0.028	0.005	0	0.38	1	0
EC21	1	0.427	0.005	1	0.005	1	0		EC71	0	0.028	0.38	0	0.38	1	0
EC22	1	0.427	0.005	1	0.005	1	0		EC72	0	0.028	0.005	0	0.98	1	0
EC23	1	0.427	0.005	0	0.005	1	0		EC73	0	0.028	0.005	0	0	1	0
EC24	0	0.427	0.005	0	0	1	0.5		EC74	0	0.028	0.005	0	0.98	1	0
EC25	1	0.427	0.005	0	0.005	1	0.5		EC75	1	0.028	0.005	0	0.005	1	0.5
EC26	0	0.427	0.934	0	0	1	0.5		EC76	0	0.028	0.38	0	0.005	1	0
EC27	0	0.427	0.005	0	0	1	0		EC77	0	0.028	0.005	0	0	1	0.5
EC28	0	0.028	0.38	0	0	1	0		EC78	0	0.028	0.005	0	0	1	0
EC29	1	0.921	0.38	1	0.005	1	0		EC79	0	0.028	0.005	0	0.005	1	0
EC30	0	0.921	0.005	0	0	1	0		EC80	0	0.028	0.005	0	0.005	1	1
EC31	0	0.921	0.005	0	0.005	1	0		EC81	0	0.028	0.934	0	0	1	0
EC32	0	0.921	0.934	0	0.005	1	0.5		EC82	0	0.028	0.38	0	0.005	1	0
EC33	0	0.427	0.005	0	0.005	1	0		EC83	0	0.028	0.38	0	0.005	1	0
EC34	1	0.427	0.005	0	0	1	0.5		EC84	0	0.921	0.005	0	0	1	0.5
EC35	1	0.427	0.38	0	0	1	0.5		EC85	0	0.921	0.38	0	0.38	1	0
EC36	1	0.427	0.005	0	0	1	0.5		EC86	0	0.921	0.38	0	0.005	1	0
EC37	0	0.427	0.005	0	0.38	1	0		EC87	1	0.921	0.005	0	0	1	0
EC38	0	0.427	0.005	0	0.005	1	0		EC88	0	0.427	0.38	0	0.005	1	1
EC39	0	0.427	0.005	0	0	1	0		EC89	0	0.427	0.005	0	0	1	0.5
EC40	0	0.427	0.005	0	0	1	0.5		EC90	1	0.427	0.005	1	0	1	0
EC41	0	0.427	0.005	0	0	1	0		EC91	0	0.038	0.38	0	0	1	0
EC42	0	0.427	0.38	0	0.005	1	0		EC92	0	0.038	0.38	0	0	1	0.5
EC43	1	0.427	0.38	0	0	1	0.5		EC93	0	0.427	0.005	0	0.005	1	0
EC44	0	0.427	0.005	0	0	1	0		EC94	0	0.427	0.005	0	0	1	0
EC45	0	0.427	0.005	0	0	1	0		EC95	0	0.427	0.38	0	0.38	1	0
EC46	0	0.427	0.005	0	0	1	0		EC96	0	0.427	0.005	0	0.005	1	0
EC47	1	0.427	0.005	0	0	1	0.5		EC97	0	0.427	0.005	0	0	1	0
EC48	0	0.427	0.005	0	0.005	1	1		EC98	0	0.427	0.38	0	0.005	1	0.5
EC49	1	0.427	0.38	0	0.38	1	0		EC99	0	0.427	0.934	0	0.921	1	0
EC50	0	0.357	0.005	0	0.005	0	0		EC100	0	0.427	0.005	0	0	1	0

Table 2: Calibration data and membership of conditions

Based on the calibrated data, we proceed with constructing the "truth table", which proposes a list of all possible theoretical combinations of the causal conditions, the relative outcome, and the cases conforming to each combination (Ragin, 2000). The truth table treats each case as a combination of characteristics or 'configuration' in fsQCA terminology.

Then, the truth table is compared with the raw data table. The substantial difference between the two tables is the following: the first represents all possible configurations; the second, instead, report only the configurations emerged by empirical cases. In this way, we selected all the configurations of the truth table that we found in empirical cases. Furthermore, we simplified the truth table by applying a specific algorithm of fQCA that minimizes the number of rows, eliminating those not relevant to explain the outcome. The minimization process returns the minimum number of configurations that explain the outcome (Figure 1).

Conditions	~Outcome1					
	1	2	3	4	5	6
PV		⊕		⊕	●	●
AE	●	⊕	⊕	⊕	●	
NI	⊕		⊕	●	⊕	⊕
NP	⊕	●	⊕		⊕	⊕
AM	⊕	⊕	●	⊕		●
NT	●	●	●	●	●	●
Consistency	0.934443	0.910119	0.890614	0.995636	0.996608	0.911528
Raw coverage	0.248679	0.0580879	0.0483396	0.0860881	0.103472	0.0641509
Overall solution consistency	0.939094					
Overall solution coverage	0.449371					
Cases with greater than 0.5 membership in term	Case30 (0.921,1), Case31 (0.921,1), Case84 (0.921,0.5), Case87 (0.921,1), Case85 (0.62,1), Case86 (0.62,1)	Case59 (0.934,1), Case81 (0.934,1), Case26 (0.573,0.5), Case99 (0.573,1)	Case2 (0.972,0.5), Case6 (0.972,1), Case17 (0.373,1), Case21 (0.373,1), Case22 (0.573,1), Case90 (0.573,1)	Case63 (0.972,1), Case72 (0.972,1), Case74 (0.972,1), Case59 (0.921,1), Case99 (0.573,1)	Case87 (0.921,1), Case29 (0.62,1)	Case2 (0.995,0.5), Case6 (0.995,1), Case17 (0.995,1), Case21 (0.995,1), Case22 (0.995,1), Case27 (0.62,1)

Figure 1: Overview of the solution

In Figure 1, the columns are the configurations of conditions that emerged after reducing the truth table. The analysis aims at finding a logical relationship between the lack of under assessment (that is assumed as a proxy for the accuracy of Triage) (~ Outcome1) and the six conditions considered in the model (PV, NI, NP, AM, AE, NT). The configuration of conditions related to each path represents a sufficient but not necessary condition for obtaining the result.

Six configurations were extracted, and for each configuration, we can identify if a condition is present or not in the specific term of the solution. The presence of a condition in a path is represented by the black circle, while its negation is a crossed circle.

For the overall solution (made by six terms) and for each term, we have the relative value of coverage and consistency in order to facilitate comparison. For the coverage, Ragin (2009) does not propose any threshold value as it is linked to empirical relevance of the combination (how much of the outcome the combination can explain), whereas for the consistency, the value must be around 0.8, certainly not lower than 0.75. The results show that the combinations and the solution far exceed the value of the consistency threshold. In particular, the solution has an overall consistency value equal to 0,94. Therefore, the model has a strong explanatory power of the outcome.

## 5 Discussion and practical implications

The results of the study show that the configuration presenting the highest coverage value (0.248679) and a good level of consistency (0.934) is the

configuration (AE \* ~ NP \* ~ AM \* ~ NI \* NT). This configuration considers a triage process carried out by an expert nurse (AE), with the presence of all expected nurses in the Emergency Department area in the work shift analyzed (NT), in conditions of absence of interruptions by colleagues (~ NI) and by patients (~ NP), and patients not arrived by ambulance transportation (~ AM).

We can assume that the presence of all nurses and the absence of a crowd allow nurses to focus on specific patients, avoiding interruptions. Furthermore, an expert nurse can assign the correct priority code for patients not arriving with ambulance and without a pre-evaluation made by the ambulance's crew. In fact, all cases related to this configuration are registered by the same nurse, with 26 years of experience, and always in the morning, when the maximum number of nurses assigned to Triage is in the emergency room.

The configuration with the highest consistency level (0.996) is (PV \* AE \* ~ NP \* ~ NI \* NT), but it has a lower level of coverage than the previous combination (0.103). This configuration presents the measurement of vital signs (PV) by an expert nurse (AE), the absence of interruptions by patients (~ NP) and colleagues (~ NI), and the maximum number of nurses per shift (NT). This partially confirms the result described by the previous combination. In fact, this configuration also has the presence of the measurement of vital parameters. Although many studies state that more experienced nurses tend to do not measure vital signs (Chung, 2005; Gerdtz and Bucknall, 2001), in both cases related to this configuration, the detection of vital signs (PV) has been made. We can justify this choice by analyzing specific cases. In one case, the patient had abdominal pain, a symptom that requires the measurement of vital signs. In the other one, the arrival of the patient took place in an ambulance, so the vital signs had already been detected in the ambulance, but the long waiting time in the patient queue (12'30") to access the Triage prompts the nurse to detect the vital signs again to grasp an evolution or changes in symptoms exhibited.

The other combinations confirm the presence of all nurses scheduled for the shift and the absence of interruptions by colleagues and patients. In a quiet environment, the nurse can detect the vital signs for the patients who arrived by ambulance to confirm the priority code assigned by the ambulance's crew or to capture any change in symptoms. In a quiet environment, also less expert nurses assign the correct priority code to the patient.

According to these 4 out of 6 configurations, we can infer that the Triage should be performed in a dedicated room avoiding interruptions and that the

measurement of vital signs could be a valuable support for the accuracy even for expert nurses that usually make decisions based primarily on their intuition.

The other two configurations with a lower value of coverage and consistency confirm that the presence of three nurses in the Emergency Department is an ever-present condition; unlike the other four configurations, these last two presents the lack of experience (~ AE), the scarce use of vital parameters (~ PV), and the evaluation of patients who arrived at the ED independently (~ AM). Such configurations suggest that, despite the lack of experience, the nurse relies mainly on their "intuition" rather than on vital parameters in evaluating patients arriving independently. Additionally, it seems that the presence of all scheduled nurses in a work shift can instill a greater sense of security in less expert nurses who can always rely on more experienced colleagues. However, less experienced nurses take more time to assess the patients. In fact, a more profound analysis of the cases relative to these two configurations showed a high number of questions for the attribution of the code, confirming what emerged by the literature: less experienced nurses collect more information from the patient to formulate the Triage decision (Cioffi, 1998).

These results suggest some managerial interventions on the Triage process. Firstly, the accuracy of Triage can be improved if almost an experienced nurse is devoted exclusively to the Triage. In this way, he/she can concentrate fully on the Triage process without external pressure. Furthermore, the great experience allows the nurse to make an accurate decision even for walking patients, which are not pre-assessed for their clinical conditions. This suggests a redesign of the layout of the analyzed Hospital, with a room dedicated exclusively to Triage with an expert nurse in crowded situations or less expert nurses in quiet situations since they take longer to assign the priority code. Concerning the organizations of the work shifts, our results show that the number of Triage nurses simultaneously present in the Emergency Department has to be the maximum number available and that disparities among the work shifts have to be removed.

Another interesting result concerns the vital signs that are not the main information used by nurses. These findings could encourage the Emergency Department to adopt tele-Triage or pre-Triage to better address the patient towards Emergency Departments or other structures to face the social distancing due to COVID-19.

## 6 Conclusion

The Triage process prioritizes access to health treatment in an Emergency Department. Although many scholars gave strong attention to this process to streamline the processing of patients and reduce the waiting time of more urgent ones, we propose an under-investigated perspective to analyze this process: understanding the factors that can affect the Triage accuracy. This paper presents the application of fuzzy Qualitative Comparative Analysis to the dynamic decision-making in Triage assessment. Unlike other works, this research is carried out through direct observation of the Triage process in its empirical reality; this allowed to consider also environmental factors in the study.

Findings suggest that the accuracy of the Triage process requires that an experienced nurse carries out the assignment process in a situation in which all scheduled nurses are present in the work shift with the absence of interruptions by colleagues and by patients. All configurations confirm as relevant the presence of all nurses in the work shifts, whereas the measurement of vital signs can be helpful support for the accuracy even if the nurses rely primarily on their intuition.

Following a methodological perspective, this application shows that fsQCA is an effective method for understanding the cognitive heuristic decision-making process, highlighting how individual, organizational and environmental factors interact for producing an effective Triage.

From a practical perspective, these findings can give helpful insights to managers of a hospital or an Emergency Department to improve the follow of patients starting from Triage.

The study has already been used to organize a training session for the hospital nurses involved in the research. Unfortunately, the advent of the outbreak has not allowed completing the training process and the discussion with managers of the Emergency Department to design organizational interventions on Triage. This aspect will be the object of future developments of this work.

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## **A Framework of Indicators to Evaluate the Integrated Care Pathways in a Cancer Research Centre**

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### **Abstract**

Integrated Care Pathways (ICPs) are multidisciplinary approaches designed and adopted by hospitals for achieving more efficiency and effectiveness in the care processes. Despite these advantages, it is still needed to demonstrate their economical and organizational positive effect, by taking into account specific contextual variables such as the existing resources and technologies of the hospitals (van Hove et al., 2020).

In addition, since the complexity of the care processes is high, the development of an integrated dashboard of monitoring indicators of ICPs is a critical issue in the referred literature. In particular, the framework should be holistic and designed for a large spectrum use of actors; the indicators should be easily measurable and computable.

For this reason, we design a framework of indicators measuring the effect of ICPs on multiple dimensions including quality of care, cost and productivity, and research and development. The framework was validated by a group of experts belonging to different

functional areas. Afterward, we investigate the feasibility of the proposed set of indicators to the performance of the lung and the breast cancer care pathways in a specific hospital, i.e., the Cancer Institute "IRCCS Giovanni Paolo II" (Italy).

The healthcare organization can use this tool to 1) monitor whether the pathways meet the requirements of continuity, responsiveness, and appropriateness of health services; and 2) optimize the allocation of resources.

**Keywords** – Integrated Care Pathways (ICPs), Framework, Indicators, KPIs, Multidimension.

**Paper type** – Academic Research Paper

## 1 Introduction

Integrated Care Pathways (ICPs) are multidisciplinary care plans that explain the significant steps in the care process for patients with specific health conditions (Richter et al., 2017). The ICPs help translate clinical guidelines into local protocols and clinical practice (Campbell et al., 1998) as a tool for quality improvement. They are designed and adopted by hospitals, for achieving the following main objectives: increase of care standardization (Ishiguro et al., 2008), improvement of care quality (Allen et al., 2009; Kobayashi et al., 2019), optimization of resource usage (Kobayashi et al., 2019), and cost efficiency (Everink et al., 2018). ICPs are effective for improving communication and coordination among multiple stakeholders (Allen et al., 2009).

Despite this, it is still needed to demonstrate the positive effect of the adoption of ICPs from multiple reasons. First, literature has mainly focus the attention of the effect on the quality of care (Altini et al., 2019; van Hoeve et al., 2020), while other dimensions, such as the economic one, have been less investigated. Furthermore, mixed results have been also obtained (Rotter et al., 2010). One reason for this is that the ICP protocols are designed without a specific consideration of existing capacity and resources of the hospital, are calibrated on an "ideal patient" in an "ideal health system" (van Hoeve et al., 2020). Even though the ICP protocols are designed by the healthcare professionals who know the context, they often are not be aware of management and digital tools that should be needed for the effective implementation (Berler et al., 2005; Coltart et al., 2012), so that the expected results are put in question. Most ICPs are still paper-based and not fully integrated with Health Information Systems (Alahmar et al., 2020). This is also aggravated by the complexity of the care processes involving a

large number of activities, carried out by several actors in different departments and, in some cases, organizations.

Therefore, the development of an integrated dashboard of monitoring indicators of ICPs is still a critical issue in the referred literature. This is even more true for oncological diseases which are one of the most expensive cares.

The objective of this paper is twofold. From one hand, we design a framework of indicators measuring the effect of ICPs on multiple dimensions including quality of care, cost and productivity, and research and development. From the other hand, we investigate the feasibility of the proposed set of indicators to the performance of the lung and the breast cancer care pathways in a specific hospital, i.e., the "IRCCS Istituto Tumori Giovanni Paolo II" (Italy).

The framework was designed on the basis of the literature and then validated by a group of experts belonging to different functional areas. The indicators are grouped according to three broad classes: "quality of care and health services", "use of resources", "research, development and innovations". The framework proposed is designed to be used in an interoperable manner by a large spectrum of actors (administrative staff, clinicians, clinical governance). The indicators are easily measurable and do not contain ones referenced to specialist medical concepts. In particular, they can be measured using administrative databases or hospital discharge card.

The paper is so organized. First, we discuss the classes of indicators, with some examples of KPIs' set developed in literature; then, we explain our theoretical framework. Finally, we discuss the application in a specific case and conclude introducing the next steps of the research.

## **2 Indicators to assess Integrated Care Pathways**

Indicators are measurement tools used as guides to monitor, evaluate and improve the quality of patient care, clinical support services, and organizational function that affect outcomes (Mainz, 2003). In general, the measured data is of interest to patients, payers for care, and providers who receive data for quality improvement purposes.

A care service is evaluated using both qualitative and quantitative indicators. Qualitative ones are not objectively measurable and include the results of professional practice, such as staff satisfaction, documentation quality, or patient satisfaction results. Quantitative ones include specific outcomes, such as the

length of stay, the number and types of services provided, the hospital costs and patient outcomes, such as hospital mortality, longer follow-up mortality, hospital readmissions, hospital complications and hospitalizations in intensive care (Mainz, 2003; Rotter et al., 2010; van Hoeve et al., 2020).

The ICP's KPIs can be generic or they can measure particular aspects of the care related to specific diseases. Both generic and disease-specific KPIs can focus on structure, process, or outcomes. Structural indicators concern the type and number of resources used by the healthcare system to provide programs and services and refer to the presence or number of staff, customers, money, beds, supplies and buildings (Mainz, 2003). Process indicators measure activities and tasks in patient care episodes (Mainz, 2003). Outcomes concern the health states or events following care and may be affected by healthcare (Mainz, 2003).

On the base of the type of care, indicators are classified in preventive, acute or chronic ones (Schuster et al., 1997). According the function of care, they may involve screening, diagnosis, treatment and follow-up (Schuster et al., 1997). Finally, depending by the way in which assistance can be provided, the KPIs refer to the physical examination of the patient, the laboratory or radiological study or the prescription of drugs (Schuster et al., 1997).

Recently, Altini et al., (2019) identify seven KPIs for the ICP of breast cancer. The indicators are designed to improve efficiency in resource use by monitoring the inadequacy of diagnostic tests, by measuring the inadequacy of possible interventions, and by evaluating the inadequacy of time of administration from the indication of surgery. However, the framework adopts a medical approach, takes into consideration the entire CP of breast cancer. The paper by Cafagna et al., (2018) shows the application of different indicators to the clinical pathway of heart failure (HF). The aim is to examine the potential impact of improving equity in the quality of care on financial sustainability.

### **3 The framework**

In this Section, we develop a framework of indicators to assess the ICPs based on the literature. We reviewed papers published on scientific journals but also, we included grey literature, considering some protocols written by organizations that have formally implemented the ICPs. The list of KPIs were reorganized according to common themes and then they were discussed and prioritized through interviews with experts involved in the development and delivery of the ICPs. The

prioritization criteria were "ease of interpretation", "ease of calculation", "importance to decision makers" and "innovation". This phase led to a final list of indicators covering different areas.

The proposed framework (Figure 1) is structured on three areas: 1) "Quality of Care", 2) "Use of resources" and 3) "Research, development and innovation". For each area we identify three specific dimensions, which are then translated into 31 indicators.

The "Quality of care" area includes the following dimensions (indicators) "Communication with staff" (4 KPIs), "Hospitalization" (3 KPIs) and "Service" (10 KPIs). The dimensions "Cost" (2 KPIs), "Resource Productivity" (4 KPIs) and "Wastes" (2 KPIs) refer to the "Use of Resource" area. The "Research, development and innovation" area includes the "Clinical Trials" (2 KPIs), "Continuing medical education (CME)" (2 KPIs) and "Scientific publications" (2 KPIs).

Table 1 reports all KPIs developed.

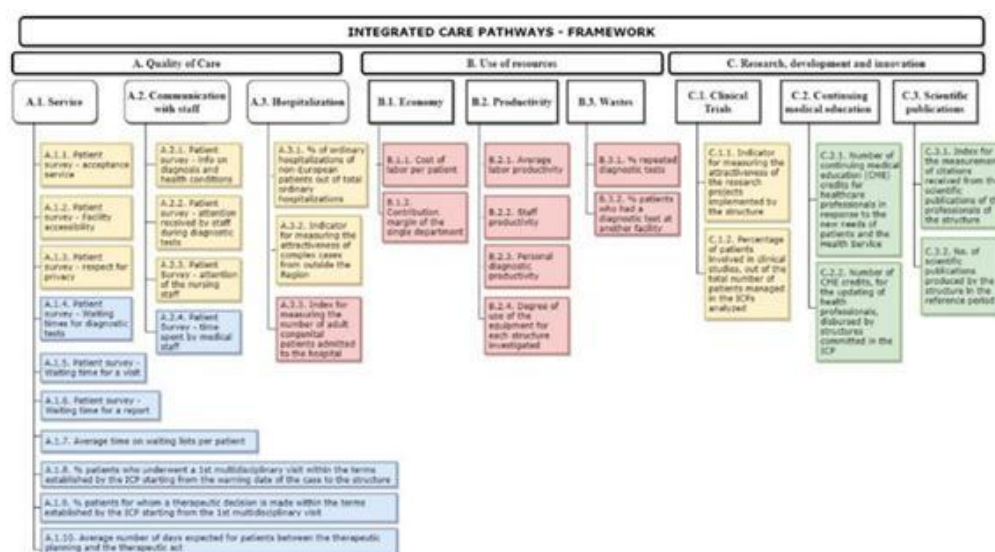


Figure 11 It is depicted the framework representing the areas of interests and related dimensions.



Table 14: Key Performance Indicators (KPIs) grouped by dimensions and area of interest.

KPI	Formula	Type	Ref.
<b>A. Quality of care – A.1. Service</b>			
A.1.1. Patient survey - acceptance service	(Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.1.2. Patient survey - Facility accessibility	(Likert 1-5)	Outcome Survey –	Adapted by A.R. (Veltri & Adamo, 2010)
A.1.3. Patient survey - respect for privacy	(Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.1.4. Patient survey - Waiting times for diagnostic tests	(Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.1.5. Patient survey - Waiting time for a visit	(Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.1.6. Patient survey - Waiting time for the report	(Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.1.7. Average time on waiting lists per patient	Total N° of waiting days / Tot patients	Process	(Berler et al., 2005)
A.1.8. % Patients who underwent a 1st multidisciplinary visit within the terms established by the ICP starting from the warning date of the case to the structure	(Patients in regular terms) / (Total Patients) x 100	Process	personal elaboration
A.1.9. % Patients for whom a therapeutic decision is made within the terms established by the ICP starting from the 1st multidisciplinary visit	(Patients in regular terms) / (Total Patients) x 100	Process	personal elaboration
A.1.10 Average number of days expected for patients between the 1st multidisciplinary visit(that corresponds to the moment of the therapeutic planning)and the therapeutic act	Tot. Waiting days / Tot. Patients	Outcome – HIS	personal elaboration
<b>A. Quality of care – A.2. Communication with the staff</b>			
A.2.1. Patient survey - info on diagnosis and health conditions	Patient evaluation (Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.2.2. Patient survey - attention received by staff during diagnostic tests	Patient evaluation (Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)
A.2.3. Patient survey - attention of the nursing staff	Patient evaluation (Likert 1-5)	Outcome Survey –	Adapted by (Veltri & Adamo, 2010)

KPI	Formula	Type	Ref.
A.2.4. Patient survey - time spent by medical staff	Patient evaluation (Likert 1-5)	Outcome – Survey	Adapted by (Veltri & Adamo, 2010)
<b>A. Quality of care – A.3. Hospitalization</b>			
A.3.1. % of ordinary hospitalizations of non-European patients out of total ordinary hospitalizations	$(\text{Extra-European ordinary hospitalizations}) / (\text{Total ordinary hospitalizations}) \times 100$	Process	(Pediatrico Bambino Gesù Ospedale, 2016)
A.3.2. Indicator for measuring the attractiveness of complex cases from outside the Region	$(\text{Extra-regional ordinary hospitalizations with weight} > 1.9) / (\text{Extra-regional ordinary total hospitalizations}) \times 100$	Process	(Pediatrico Bambino Gesù Ospedale, 2016)
A.3.3 Index for measuring the number of adult congenital patients admitted to the hospital	$(\text{Patients aged} > 18) / (\text{Total Patients}) \times 100$	Process	(Pediatrico Bambino Gesù Ospedale, 2016)
<b>B. Use of resources – B.1. Economy</b>			
B.1.1. Cost of labor per patient	$(\text{Hours worked} / \text{quantity produced}) \times \text{hourly wages}$	Outcome	(Sanna, 2012)
B.1.2. Contribution margin of the single department	$(\text{Single department revenue} - \text{Single department costs}) / \text{Total revenue}$	Outcome	(Zanella, 2011)
<b>B. Use of resources – B.2. Productivity</b>			
B.2.1. Average labour productivity per employee	$\text{Real value of production} / \text{number of workers}$	Outcome	Adapted by (M. Calderini, P. Neirotti, E. Paolucci, P. Ravazzi, 2007)
B.2.2. Staff productivity in the therapeutic phase	$\text{No. of SDOs} / \text{hours worked in the health facility}$	Outcome	personal elaboration
B.2.3. Personnel diagnostic productivity	$\text{No. of diagnostic tests} / \text{hours worked}$	Outcome	Adapted by (Zanella, 2011)
B.2.4. Use of the equipment in the reference period, in order to evaluate its efficiency	$\text{No. of examinations performed in the time interval (per device)} \times 100 / (\text{max daily examinations} \times \text{No. of days in the Timeframe})$	Outcome	Adapted by (Neri, 2009)
<b>B. Use of resources – B.3. Wastes</b>			
B.3.1. Percentage of diagnostic tests for which a retest was required	$\text{No. repeated exams} \times 100 / \text{total exams}$	Process	personal elaboration

KPI	Formula	Type	Ref.
B.3.2. Patients with diagnostic tests in another facility after being taken in charge by the facility under study	No. of patients * 100 / tot treated patients	Process	personal elaboration
C.Research, development and innovation – C.1. <i>Clinical Trials</i>			
C.1.1. Indicator for measuring the attractiveness of the research projects implemented by the structure	Funding received from external bodies for scientific research / Total funding for scientific research	Outcome	(Pediaterico Bambino Gesù Ospedale, 2016)
C.1.2. Percentage of patients involved in clinical studies, out of the total number of patients managed in the ICPs analyzed	N. Patients involved in trials / N. Total patients in the analyzed ICPs	Process	personal elaboration
C. Research, development and innovation – C.2. <i>Continuing medical education (CME)</i>			
C.2.1. Number of continuing medical education (CME) credits for healthcare professionals in response to the new needs of patients and the Health Service	Sum of CME credits gained by actors committed in the ICP	Outcome Agenas database	- personal elaboration
C.2.2. Number of CME credits, for the updating of health professionals, disbursed by structures committed in the ICP	Sum of CMEs credits disbursed	Outcome Agenas database	- personal elaboration
C.Research, development and innovation – C.3. <i>Scientific publications</i>			
C.3.1. Index for the measurement of citations received from the scientific publications of the professionals of the structure	Average impact factor per researcher	Outcome Scopus Database	- personal elaboration
C.3.2. No. of scientific publications produced by the structure in the reference period	N ° scientific publications (six-monthly data)	Outcome Scopus Database	- personal elaboration

## 4 Application

### 4.1 The Giovanni Paolo II" Cancer Institute

The "Giovanni Paolo II" Cancer Institute in Bari (Italy) is an IRCCS, i.e. "Hospitalization and Care Institute with Scientific Character". It belongs to a national network of 51 IRCCS and to a European network of Organization European Cancer Institute (OEI). It has excellent clinical and research performance; it also performs several ICPs, as many as the oncological diseases it treats.

The Table 2 reports a characterization of contextual and structural dimensions. The information is gathered by some Institution's documents.

Table 15: Features of healthcare organization

<b>Contextual dimensions</b>	
<b>Strategy</b>	<p><i>Vision:</i> The Institute is a candidate to become the Regional Reference Center for oncological pathologies, pursuing the quality of care and the rapid transfer into care practice of the tools that research makes available to clinicians to fight cancer more effectively.</p> <p><i>Mission:</i> Any waste is avoided. For this reason, the appropriateness and efficiency of care choices are constantly pursued through continuous monitoring of production, costs and results. Any potential conflicts of interest are fought. With regard to research, efficiency is also pursued in the choice of areas of medicine to be tested.</p>
<b>Context</b>	<p>It is financed on the basis of national and regional financing, in order to obtain integration between healthcare and research policies. The Institute also accepts liberal donations. On the national territory, there are 51 IRCCS, of which 21 public and 30 privates, which refer to different areas of expertise, including oncology.</p> <p>The Institute is recognized to be among the European Certified centres – OECL.</p>
<b>Geographic location</b>	The registered office of the Institute is in Viale Orazio Flacco 65 - 70124 BARI, where its administrative, assistance and research structures are located.
<b>Culture</b>	Absolute respect for the ethics and for the patient's dignity. The personalized medicine and to the individuality of the patient are very important.
<b>Dimension</b>	166 care beds
<b>Logo and motto</b>	The Institute logo is represented by the image of a tumor cell "attacked by therapy"; the logo is intended to graphically express the company mission.
<b>Technology</b>	High level of technology of machinery for clinical and research activities. Low level of interoperability of hospital information systems among the different units.
<b>Structural dimensions</b>	
<b>Hierarchy</b>	<p>The organizational structure is hierarchical.</p> <p>The Institute is divided into the following types of Organizational Structures: Departments, Complex Structures, Simple structures with departmental value, Simple Structures (S.S.) and Research Areas.</p> <p>It should be noted that the generic term Operating Unit includes both complex and simple structures.</p> <p>The Departments are aggregations of homogeneous Operating Units, similar or complementary to each other. These have common purposes and are strongly integrated with each other, while maintaining their autonomy and organizational, managerial and professional responsibility. The Director of the</p>

	Department is appointed by the Director General; he must necessarily be Director of a complex structure. He is hierarchically superordinate to the Structure Directors. The Complex Structures (CS) are internal divisions of the department with a specific specialized and organizational reference of a complex nature. The Simple Departmental Structures (S.D.S.) are structures that in a perspective of transversal support to the production process are placed hierarchically under the Department Director and not a complex structure. Simple Structures (SS) are articulations of the complex structures of which they are part. The SS is awarded a defined amount of resources by the Director of the relevant SC and specific objectives are assigned within the operational budget (objectives and resources) of the SC to which it belongs. Research Areas are areas of activity usually entrusted to professionals with professional coordination assignments whose technical-professional autonomy is exercised in compliance with operational protocols.
<b>Staff indicators</b>	Research staff is evaluated based on research outputs, but there are not other productivity indicators, except the Absence rates. Total Staff expenditure (2018): € 36.640.040. Medical Executives: € 15.770.000 Nurses / Auxiliary Health Assistant: € 12.296.040 Other personnel € 8.574.000

#### *4.2.1 Breast and Lung Cancer Integrated Pathways*

We referred our analysis to two ICPs concerning the breast and lung cancers. The related protocols have been approved and made public in 2016 (IRCCS di Bari, 2016b, 2016a). They have a similar structure consisting of epidemiological premise, purpose, core team or multidisciplinary group, description of the ICP at each stage (diagnosis, staging, treatment, intervention, follow-up), bibliography and guidelines, and accompanying documentation.

We characterize the two ICPs according to different variables (Table 3), concerning the health professionals involved in the process, the monitoring frequency and references to the indicators already considered in the protocol. Actually, the ICPs performance are not currently monitored by the clinical governance of the organization, but those sent and analyzed by the Regional Health Authority.

Table 16. Characterizations of the Breast and Lung ICPs of the Healthcare Organization.

ICP	Breast Cancer	Lung Cancer
<b>Multidisciplinary Team</b>	Radiologist, Breast Surgeon, Plastic Surgeon, Pathologist, Oncologist, Radiotherapist, Nuclear Doctor, Case Manager and, depending on the need, other specialized professionals (psycho-oncologist, onco-geneticist, gynecologist, pain therapist, Doctor of Physical and rehabilitative medicine and the physiotherapist). General practitioners, patient and volunteer associations can also be involved.	Medical Oncologist, Thoracic Surgeon, Radiologist, Interventional Radiologist, Pathologist, Molecular Biologist, Radiotherapist, Case Manager Nurse. The Anesthetist for pain therapy and palliative care, the General Practitioner, the voluntary associations collaborate with the Team.
<b>Process Monitoring</b>	The Team carries out a review of the process once a year and meetings for case discussion at least twice a month.	The Team reviews the process once a semester, with case discussion meetings at least twice a month.
<b>ProtocolKPIs</b>	The breast cancer protocol includes specific disease indicators both of process (10 KPIs) and of diagnosis and outcome (2 KPIs). Structure indicators are absent.	For the lung ICP protocol, there are annexes: on process indicators (4 KPIs) and on Pathological Anatomy procedures (with indications on the average reporting and response times to examinations). Structure indicators are absent.
<b>Formalization</b>	The grade of formalization is medium. Actors communicate orally, but the emails are predominant.	The grade of formalization is medium. Actors communicate orally or through calls and sometimes through emails, for example to organize meetings.
<b>Digitalization of ICPs</b>	The Breast ICP is included in a project that involves others Breast Hub in Italy. For this reason, the procedure of collecting data is more formalized. These clinical data are updated and saved on a software dedicated. However, this software does not communicate with other databases of the organization, such as PACS system and administrative database. Some persons (are usually the case managers) are dedicated to activities of data-entry.	This dimension is scarcely considered. Actors used to trace data on files saved on local memory until the role of case manager was present. Now, they are collecting all documents (pdf files) for each patient in folders saved on the pc.
<b>Cross-hospital collaboration</b>	There are more specialized exams executed in other facilities, such as the Lymphoscintigraphy is an exam to be carried out in another hospital.	There are more specialized exams executed in other facilities: the Positron Emission Tomography (PET) exam in a

ICP	Breast Cancer	Lung Cancer
		Teaching Hospital of Bari and the ROSE guided navigation system used in another hospital of Bari.
Seniority	We do not consider all units committed in these ICPs, but those that are particularly important.	
	<i>General surgery hospitalization for breast cancer.</i> It includes 32 healthcare professions. 6 medical managers, 20 professional healthcare collaborators (1 physiotherapist, 18 nurses, 1 expert nurse), 2 specialized auxiliaries, 3 socio-health operators. Average career time in the Institute is 18 years.	<i>Thoracic surgery hospitalization.</i> It includes 28 healthcare professions. 8 medical managers, 17 professional healthcare collaborators - nurses, 3 social health workers. Average career time in the Institute is approximately 7 years.
Cases a year	502 surgeries in the 2020	356 surgeries in the 2020

#### 4.2.2 Process explanation

The process is initiated by the first symptom in the patient, who books a first specialist visit privately or by request of the General Practitioner (GP). At the same time, he/she carries out a first level diagnostic examination (e.g., an X-ray). During the first visit, the medical oncologist assesses the patient's performance status and can request further diagnostic tests by evaluating hospitalization (ordinary or day hospital) or orsend it back to the GP successfully.

The first event starts the diagnosis-staging phase, in which the goal is to assess the type and extent of the tumor. At this stage, the medical oncologist decides whether to present the case to the multidisciplinary team or not. This choice causes the effect known in the literature as "exclusion" for patients not referred to the integrated pathway. This condition could lead to longer waiting times, violating the fundamental principle of providing good health care on equal terms for the entire population(Smeds & Poksinska, 2019).

When the patient is taken care of by the team, the various medical specializations meet to discuss the specific case and evaluate the subsequent steps, namely the indication of intervention and the type of treatment. At the end of the therapeutic phase, the patient is discharged, and the follow-up phase begins. If necessary, the case is referred to the multidisciplinary team for discussion. Throughout the process, the patient is managed by the case manager,

who coordinates and follows all the activities planned across the various departments.

## 4.2 Discussion

This paragraph evaluates whether the proposed framework of indicators is suitable for the IRCCS of Bari. It is checked whether the indicators are measurable and what data sources (professional roles and information systems) they need.

We noticed that currently it is possible to compute 19 KPIs in both the ICPs considered. Respectively for the Breast and Lung cancer, others 6 KPIs and 1 KPI are computable with a proxy, while 6 and 11 KPIs are not measurable. The information about which KPIs are measurable or not, grouped by dimensions (see Paragraph 3 "The Framework"), are reported in the Table 4. The Table 5,6 and 7 evaluate each KPI application.

Table 17: Results of the KPIs applicability

<b>Breast Cancer ICP</b>	<b>A.1</b>	<b>A.2</b>	<b>A.3</b>	<b>B.1</b>	<b>B.2</b>	<b>B.3</b>	<b>C.1</b>	<b>C.2</b>	<b>C.3</b>	
N° Measurable KPIs	4	0	3	2	3	1	2	2	2	19
N° Not Measurable KPIs	4	1	0	0	1	0	0	0	0	6
N° KPIs Measurable with a proxy	2	3	0	0	0	1	0	0	0	6
<b>Lung Cancer ICPs</b>	<b>A.1</b>	<b>A.2</b>	<b>A.3</b>	<b>B.1</b>	<b>B.2</b>	<b>B.3</b>	<b>C.1</b>	<b>C.2</b>	<b>C.3</b>	
N° Measurable KPIs	4	0	3	2	3	1	2	2	2	19
N° Not Measurable KPIs	6	4	0	0	1	0	0	0	0	11
N° KPIs Measurable with a proxy	0	0	0	0	0	1	0	0	0	1
N° KPIs for dimension	10	8	6	4	8	4	4	4	4	

Table 18. It reports the analysis of KPIs applicability belonging to the class "Quality of care".

A. Quality of care –A.1. Service					
KPI	Formula	Type	Ref.	Usable?	Notes
A.1.1. Patient survey - acceptance service	(Likert 1-5)	Outcome – Survey	Adapted by (Veltri & Adamo, 2010)	Breast ICP: The KPI isn't measurable with Likert scale. Lung ICP: Data absent	Breast ICP: The information can be collected from a questionnaire of evaluation of quality perceived by patients. Example of a proxy: "In general, how do you evaluate this treatment path, from a clinical, welfare and rehabilitation point of view? (Choose a score ranging from 0 to 10 where 0 = very bad and 10 = very good)"



A.1.2. Patient survey - Facility accessibility	(Likert 1-5)	Outcome – Survey	Adapted by A.R. (Veltri & Adamo, 2010)	Breast ICP: The KPI isn't measurable with Likert scale. Lung ICP: Data absent	Breast ICP: The information can be collected from a questionnaire of evaluation of quality perceived by patients. Example of a proxy: <i>"Where did the treatments after surgery? (More than one choice can be made)". "Where did you check after the treatments: surgical, chemotherapy, radiotherapy? (It is possible to make more than one choice)".</i>
A.1.7 Average number of waiting days per patient, starting from entering the facility up to therapeutic planning.	Total N° of waiting days / Tot patients	Process	(Berler et al., 2005)	Breast/Lung ICP: The KPI is measurable through an integration of clinical data and administrative databases. Data of the 1st visit, and data of the 1st multidisciplinary meeting are needed.	The doctors collect data on clinical outcomes and on patient's health history. They report the results of the multidisciplinary meetings in files saved on local memory in the case of the Lung cancer, or on a dedicated software for the Breast cancer. All services (in-patient or out-patient) provided to the patients are registered only in the administrative database and they are coded according to the ICD-19-CM. The information, on 1 <sup>st</sup> multidisciplinary meeting, can be deduced by the multidisciplinary reports reported in files saved on local memory in the case of the Lung cancer, or on a dedicated software for the Breast cancer. The information, on cases entering the facility, can be obtained from the administrative database.
A.1.8. % Patients who underwent a 1st multidisciplinary visit within the terms established by the ICP starting from entering the facility	(Patients in regular terms) / (Total Patients) x 100	Process	personal elaboration	Breast/Lung ICP: The KPI is measurable through an integration of clinical data and administrative databases. The information on numbers of patients underwent a 1st multidisciplinary visit within the terms isn't automatically computable.	The information, on 1 <sup>st</sup> multidisciplinary meeting, can be deduced by the multidisciplinary reports reported in files saved on local memory in the case of the Lung cancer, or on a dedicated software for the Breast cancer. The information, on cases entering the facility, can be obtained from the administrative database because it corresponds to the first performance executed for the patient by the organization.
A.1.9. % Patients for whom a therapeutic act is made within the terms established by the ICP starting from the 1st multidisciplinary visit	(Patients in regular terms) / (Total Patients) x 100	Process	personal elaboration	Breast ICP: The KPIs can be supported by the Breast Unit software Lung ICP: The KPIs can be measured manually	The moment, in which the therapeutic act is undertaken, corresponds to the first day of the therapy. It can be obtained from the administrative database.

A.1.10 Average number of days expected for patients between the 1 <sup>st</sup> multidisciplinary visit, that corresponds to the moment of the therapeutic planning, and the therapeutic act	Tot. Waiting days / Tot. Patients	Outcome - HIS	personal elaboration	Breast ICP: The KPIs can be supported by the Breast Unit software Lung ICP: The KPIs can be measured manually	The moment, in which the therapeutic decision is undertaken, corresponds to the starting of the therapy.
A. Quality of care – A.2. Communication with the staff					
Subdimension	KPI	Type	Ref.	Usable?	Notes
A.2.1. Patient survey - info on diagnosis and health conditions	Patient evaluation (Likert 1-5)	Outcome - Survey	Adapted by (Veltri & Adamo, 2010)	Breast ICP: The KPI is not measurable with Likert scale. Lung ICP: Data absent	Breast ICP: The information can be collected from a questionnaire of evaluation of quality perceived by patients. Example of a proxy: <i>"Did they explain what symptoms to keep under control?"</i> . <i>"After the follow-up exams, did you receive clear explanations of the results?"</i>
A.2.2. Patient survey - attention received by staff during diagnostic tests	Patient evaluation (Likert 1-5)	Outcome - Survey	Adapted by (Veltri & Adamo, 2010)	Breast ICP: The KPI is not measurable with Likert scale. Lung ICP: Data absent	Breast ICP: The information can be collected from a questionnaire of evaluation of quality perceived by patients. Example of a proxy: <i>"Did the health personnel book appointments for visits, exams and therapies directly? (Before / After surgery)"</i>
A.2.3. Patient survey - attention of the nursing staff	Patient evaluation (Likert 1-5)	Outcome - Survey	Adapted by (Veltri & Adamo, 2010)	Breast ICP: The KPI is not measurable with Likert scale. Lung ICP: Data absent	Breast ICP: The information can be collected from a questionnaire of evaluation of quality perceived by patients. Example of a proxy: <i>"Did the health personnel who treated and assisted you give you a sense of reliability and trust?"</i>
A. Quality of care – A.3. Hospitalization					
Subdimension	KPI	Type	Ref.	Usable?	Notes
A.3.1. % of ordinary hospitalizations of non-European patients out of total ordinary hospitalizations	(Extra-European ordinary hospitalizations) / (Total ordinary hospitalizations) x 100	Process	(Pediaterico Bambino Gesù Ospedale, 2016)	Breast/Lung ICP: It can be measured.	The nationality of patients can be obtained from administrative databases (hospital discharge form)
A.3.2. Indicator for measuring the attractiveness of complex cases from outside the Region	(Extra-regional ordinary hospitalizations with weight > 1.9) / (Extra-regional ordinary total hospitalizations) x 100	Process	(Pediaterico Bambino Gesù Ospedale, 2016)	Breast/Lung ICP: It can be measured.	The nationality of patients can be obtained from administrative databases.

A.3.3 Index for measuring the number of adult congenital patients admitted to the hospital	(Patients aged > 18) / (Total Patients) x 100	Process	(Pediaterico Bambino Gesù Ospedale, 2016)	Breast/Lung ICP: Yes, it is measurable. It is not useful because for these ICPs it corresponds to the 100%	
<b>A. Quality of care – A.1. Service - Not measurable</b>					
<ul style="list-style-type: none"> <li>– A.1.3. Patient survey - respect for privacy. <i>Measure:</i> (Likert 1-5). <i>Source:</i> Adapted by (Veltri &amp; Adamo, 2010). <i>Type:</i> Outcome – Survey.</li> <li>– A.1.4. Patient survey - Waiting times for diagnostic tests. <i>Measure:</i> (Likert 1-5). <i>Source:</i> Adapted by (Veltri &amp; Adamo, 2010). <i>Type:</i> Outcome – Survey.</li> <li>– A.1.5. Patient survey - Waiting time for a visit. <i>Measure:</i> (Likert 1-5). <i>Source:</i> Adapted by (Veltri &amp; Adamo, 2010). <i>Type:</i> Outcome – Survey</li> <li>– A.1.6. Patient survey - Waiting time for the report. <i>Measure:</i> (Likert 1-5). <i>Source:</i> Adapted by (Veltri &amp; Adamo, 2010). <i>Type:</i> Outcome – Survey</li> </ul>					
<b>A. Quality of care – A.2. Communication with the staff - Not measurable</b>					
<ul style="list-style-type: none"> <li>– A.2.4. Patient survey - time spent by medical staff. <i>Measure:</i> (Likert 1-5). <i>Source:</i> Adapted by (Veltri &amp; Adamo, 2010). <i>Type:</i> Outcome – Survey.</li> </ul>					

Table 19. It reports the analysis of KPIs applicability belonging to the class “Use of resources”

<b>B. Use of resources – B.1. Economy</b>					
Subdimension	KPI	Type	Ref.	Usable?	Notes
B.1.1. Cost of labour per patient	(Hours worked / quantity produced) X hourly wages	Outcome	(Sanna, 2012)	Breast/Lung ICP: It can be measured.	This information is retrievable from administrative and human resources databases
B.1.2. Contribution margin of the single department	(Single department revenue - Single department costs) / Total revenue	Outcome	(Zanella, 2011)	Breast/Lung ICP: It can be measured.	This information is retrievable from administrative database

<b>B. Use of resources – B.2. Productivity</b>					
Subdimension	KPI	Type	Ref.	Usable?	Notes
B.2.1. Average labour productivity per employee	Real value of production / number of workers	Outcome	Adapted by (M. Calderini, P. Neirotti, E. Paolucci, P. Ravazzi, 2007)	Breast/Lung ICP: No, it cannot be measured directly. Actually, this kind of evaluation is absent.	Other productivity assessments should be done first.
B.2.2. Staff productivity in the therapeutic phase	No. of hospital discharge forms / hours worked in the health facility	Outcome	personal elaboration	Breast/Lung ICP: It can be measured.	This information is retrievable from administrative and human resources databases

B. Use of resources – B.2. <i>Productivity</i>					
B.2.3. Personnel diagnostic productivity	No. of diagnostic tests / hours worked	Outcome	Adapted by (Zanella, 2011)	Breast/Lung ICP: It can be measured.	This information is retrievable from administrative, PACS systems and human resources databases
B.2.4. Use of the equipment in the reference period, in order to evaluate its efficiency	No. of examinations performed in the time interval (per device) * 100 / (max daily examinations * No. of days in the Timeframe)	Outcome	Adapted by (Neri, 2009)	Breast/Lung ICP: It can be measured.	This information is retrievable from the PACS systems
B. Use of resources – B.3. <i>Wastes</i>					
Subdimension	KPI	Type	Ref.	Usable?	Notes
B.3.1. Percentage of diagnostic tests for which a retest was required	No. repeated exams * 100 / total exams	Process	personal elaboration	Breast/Lung ICP: It can be measured.	The number of repeated tests can be obtained from administrative databases per patient.
B.3.2. Patients with diagnostic tests in another facility after being taken in charge by the facility under study	No. of patients * 100 / total treated patients	Process	personal elaboration	Breast/Lung ICP: No, the number of patients with diagnostic tests in another facility cannot be measured.	A qualitative information can be obtained from the questionnaire of evaluation of quality perceived by patients (Breast Unit). Example of a proxy: "Where did you carry out the checks following the treatments: surgical, chemotherapy, radiotherapy? Where did the treatments after the surgery performed? (More than one choice can be made)".

Table 7. It reports the analysis of KPIs applicability belonging to the class "Research, development and innovation"

C. Research, development and innovation – C.1. <i>Clinical Trials</i>					
Subdimension	KPI	Type	Ref.	Usable?	Notes
C.1.1. Indicator for measuring the attractiveness of the research projects implemented by the structure	Funding received from external bodies for scientific research / Total funding for scientific research	Outcome	(Pediatrico Bambino Gesù Ospedale, 2016)	Breast/Lung ICP: It can be measured manually.	
C.1.2. Percentage of patients involved in clinical studies, out of the total number of patients managed in the ICPs analyzed	N. Patients involved in trials / N. Total patients in the analyzed ICPs	Process	personal elaboration	Breast/Lung ICP: It can be measured manually.	The number of patients involved in clinical trials can be obtained by each Principal Investigators.

C. Research, development and innovation – C.2. <i>Continuing medical education (CME)</i>				
Subdimension	KPI	Type	Ref.	Usable? - Notes
C.2.1. Number of continuing medical education (CME) credits for healthcare professionals in response to the new needs of patients and the Health Service	Sum of CME credits gained by actors committed in the ICP	Outcome	personal elaboration	Breast/Lung ICP: It can be measured manually.Agenas database
C.2.2. Number of CME credits, for the updating of health professionals, disbursed by structures committed in the ICP	Sum of CMEs credits disbursed	Outcome	personal elaboration	Breast/Lung ICP: It can be measured manually.Agenas database
C. Research, development, and innovation – C.3. <i>Scientific publications</i>				
Subdimension	KPI	Type	Ref.	Usable? - Notes
C.3.1. Index for the measurement of citations received from the scientific publications of the professionals of the structure	Average impact factor per researcher	Outcome	personal elaboration	Breast/Lung ICP: It can be measured.Scopus Database
C.3.2. No. of scientific publications produced by the structure in the reference period	N ° scientific publications (six-monthly data)	Outcome	personal elaboration	Breast/Lung ICP: It can be measured.Scopus Database

## 5 Conclusions

This paper develops a theoretical framework of monitoring indicators for integrated care pathway. It can be useful for the healthcare organizations, willing to monitor the care pathways and improving its performance on multiple dimensions. The framework consists of 31 KPIs grouped in three broad areas and includes organizational aspects of the management of a care pathway – patients' perspectives, staff productivity, cost of labour per patient, staff education and research transferability in care practice. Furthermore, it introduces the attention towards indicators monitoring Research and Development, an important dimension for an IRCCS given its mission.

The framework has been then validated by a group of experts and an analysis of its applicability is done on two ICPs – lung and breast cancer-, of the Institute "Giovanni Paolo II" of Bari (Italy). For both the ICPs considered, it was possible to compute only 19 KPIs. Some can be computed only manually, by comparing information among different source of data. Others 6 KPIs and 1 KPI, respectively for the Breast and Lung cancer, are computable with a proxy; the remanent indicators are not measurable. According to the dimensions, greater than the half of the KPIs related to the "Service" and "Communication with staff" dimensions cannot to be measured currently. The impossibility to compute the indicators are mainly due to the lack of integration among the hospital databases -

administrative and clinical ones. The next steps of research will regard the measurement of the KPIs.

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## **Circular Economy in the Public Administration: the Case of Italian University at the Time of COVID 19. A Multicriteria Approach**

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### **Abstract**

In response to the Covid 19 pandemic emergency, universities found themselves to rethink the way of doing university. They have veered towards new circular economy models capable of actively involving users by strengthening the right of access to information and services through sustainable digitization. production systems with greater involvement of the territories. Our work uses multi-criteria methods to analyze the actions of universities to face the Covid 19 pandemic emergency. In particular, the study analyzes the choices on the reorganization of the main services offered to students with a particular focus on teaching. The actions considered from a digital sustainability point of view for teaching aim at the use of technologies not only to remotize the lessons but with a view that technology can be of support in the redesign of the didactic paths in their complexity.



**Keywords** – Multi-criteria methods; Circular Economy; Knowledge, Decision Analysis

**Paper Type** - Academic Research Paper

## 1 Introduction

The paper, with the use of decision support tools as in multi-criteria decision methods (MCDM), analyzes the choices made by the Public Administration, with particular focus on Italian universities, in response to the Covid 19 pandemic emergency. The pandemic due to Covid 19 has highlighted the poor capacity to contain and adapt to the systemic risks associated with a pandemic in a highly interconnected world based on rapid and borderless global flows for people, goods and information. More importantly, the pandemic has highlighted the limitations of our economic system based on the linear model linked to the inappropriate use of resources until they are exhausted (Ghorui et al., 2021). Italian universities have found themselves having to rethink the way of doing university. In this sense, universities have veered towards new models of circular economy capable of actively involving the users of the services, therefore the students, strengthening the right of access to information and services also through digitization. The goal was to define a real sharing of knowledge between the university world and students. The strategy towards a circular economy (Zhao et al., 2017) aims to pursue the following objectives: achieving economic and social benefits; increased competitiveness; introduction of a more effective technology that can achieve net cost savings, through various modalities including better use of resources, greater process efficiency, improvement of quality, logistics and so on. MCDM (Greco et al., 2016) concerns generally to models based on the explicit consideration of multiple criteria in choice problems. MCDM are oriented to describe different situations due to the structure of the problem, the nature of the knowledge and information available, the elements of uncertainty that characterize the decision-making context (Cavallo et al., 2014). Multicriteria analysis (Ishizaka & Nemery, 2013) is a tool for complex situations in which, providing the decision maker with a tool to support the identification of a solution (Roy, 1993) that represents a good compromise with respect to the different aspects of the problem. Instead of the optimal solution we refer to a set of efficient solutions, able to offer a good compromise between the different

needs posed by the problem. The multi-criteria decision support models allow improving the quality and the speed of decision-making processes by accessing the knowledge of the organization when needed. When decisions have to be made, the decision support systems facilitate access to the opinions and experiences of different people, which can contribute to the choices to be made. MCDM in particular expect that decision makers actively participate in the construction of the decision-making model; this generates greater awareness in decision-makers (D'Apuzzo et al., 2009). In this way, a knowledge management system is created that allows organizations to accelerate their learning capacity, but also their efficiency and innovation (Esposito et al., 2013). In this sense, the use of MCDA makes it possible to trigger organizational control improvement mechanisms that push to change within organizations (Lerro et al., 2014). The methodology used in this paper is PROMETHEE I-II belonging to the outranking methods. This methodology, in particular, allows the decision maker to express his preference by means of a degree of preference and to identify the indifference threshold and the preference threshold to simplify the choice process.

## **2 Literature review**

The generic MCDA problem can be defined as a particular decisional problem in which we highlight: the need to operate by choosing, ranking, sorting or describing a finite number or infinity of potential or alternative actions; the existence of at least two decision criteria; the presence of at least one decision maker (Ouerdane et al., 2010). The problems of MCDA, in relation to the objective of the decision-making process, without claiming to exhaustiveness, can be classified into the following four categories: Choosing problems; Sorting problems; Ranking problems; Description problems (Roy, 2013). In the real world, the most common problems faced with multicriteria techniques are ranking and sorting problems. Based on how the problem is characterized and how the DM wants to approach it, different methodologies can be used. Among the most used are two families of methods: Outranking Methods (Roy, 1990; Vincke, 1999) and Hierarchical methods (Saaty, 1990). The Outranking Methods are based on binary relations of preference (called outranking), do not present axiomatic bases and are computationally onerous as the number of alternatives increases. Among them the most used are the ELECTRE and PROMETHEE I-II methods. Hierarchical methods, defined as the main objective of the decision problem, allow the

ordered classification of potential alternatives with respect to a multitude of criteria. Among the most used methods are Macbeth (Costa et al., 1999) and the Analytic Hierarchy Process (AHP) method (Saaty, 1990). The use of multi criteria decision making techniques in the public sector is not new. Massam, already in the second half of the 1980s, identified a first set of multi-criteria applications aimed at strategic planning in the PA (Massam, 1988). The first applications of MCDMs in the PA are mainly oriented to the strategic evaluation of service location options and not to the decisions of merit characterizing their management. Several authors have used multicriteria methodologies in PA, in particular the most commonly used method is AHP. Takamura and Tone (2003), make a proposal for a consensus-making method for the reallocation of government agencies outside the city of Tokyo; based on a combination of the analytic hierarchy process (AHP) and the Assurance Region model of data envelopment analysis (DEA). The study of Jackson and Keys (1984) is concerned with problem-solving methodologies, and the criteria for classifying problem contexts must therefore identify relevant similarities an contexts which are important with respect to problem-solving methodologies. Specifically the authors have as their main objective the choice of the best marine environment development plan given 3 alternatives and 5 evaluation criteria, using the PATTERN as a multi-criteria technique. In Rivett (1977), the author aim to select the "best" policies given different alternatives in which each policy is evaluated in terms of the degree of achievement of a series of objectives. The proposed method is based on multidimensional scaling techniques further developed by Kendall to draw maps based on fragmentary information. Brans et al (1986) present the PROMETHEE methods, which is a new class of outranking methods in multicriteria analysis. Two treatment modalities are proposed: PROMETHEE I to obtain a partial pre-order and PROMETHEE II for the final classification, both on a finite set of feasible actions. This technique is then compared with the ELECTRE III method. The final objective is the choice of the best allocation for a hydroelectric plant given 6 alternatives and 6 evaluation criteria. The stability of the results provided by the two methods is then analyzed. According to (Brans et al., 1986), in the paper we use the PROMETHEE I-II methods described in the methodology section. These methodologies allow, like hierarchical methods, a good interaction with decision makers and are reliable in the results thanks to the scenario analysis for the verification of the method.

### 3 Methodology

The PROMETHEE method (Ishizaka & Nemery, 2011) belongs to the family of outclassing multicriteria (Vincke, 1992). For each criterion  $g_i$ , and for each pair of ordered alternatives, the decision maker expresses his preference by a degree of preference. The degree of preference  $P_i(a, b)$  indicates whether or not an action  $a$  is preferred over  $b$  on the criteria  $g_i$  based on the difference between their evaluation  $d_i(a, b)$ . This degree of preference is achieved by using the preference function which may require various parameters such as the indifference threshold  $q_i$  and the preference threshold  $p_i$ . If the difference  $d_i(a, b)$  between the score of action  $a$  and  $b$  on criterion  $g_i$  is greater than  $p_i$ , action  $a$  is preferred over  $b$ . If  $d_i(a, b) < q_i$ , then action  $a$  and  $b$  are indifferent. Formally, we will have:

$$\begin{aligned} P_i(a, b) &= 0 && \text{if } d_i(a, b) < q_i && \text{(Action } a \text{ is indifferent to } b) \\ P_i(a, b) &= 1 && \text{if } d_i(a, b) > p_i && \text{(Action } a \text{ is preferred to } b) \end{aligned}$$

Several typical forms are proposed (Brans & Mareschal, 1995) for the preference functions as linear step or Gaussian preference function (see Fig. 3 for the linear function).

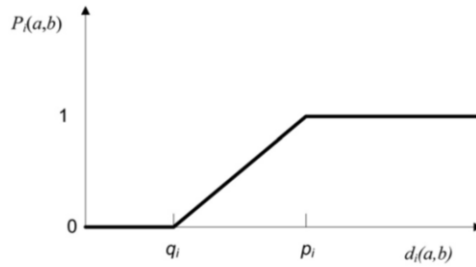


Fig. 3

Source: Ishizaka, A., & Nemery, P. (2011).

To evaluate to what extent action  $a$  is preferred over  $b$  on all criteria, the preference index  $\pi(a, b)$  calculated as the weighted sum of the degrees of preference  $P_i(a, b)$  is constructed. The weights  $w_i$  represent the importance of each criterion in the decision:

$$\pi(a, b) = \sum_{i=1}^n P_i(a, b)w_i \quad (9)$$

where:

$P_i(a, b)$  is the degree of preference on criterion  $i$ .

$w_i$  is the weight of each criterion  $i$ .

$n$  is the number of criteria

If  $\pi(a, b) = 0$  implies a weak preference or global indifference of  $a$  over  $b$

If  $\pi(a, b) = 1$  implies a strong global preference of  $a$  over  $b$ .

Since each action is compared to  $m-1$  other actions, two flows can be constructed, the positive flow (10) representing the overall preference of the action over all other actions (this score must be maximized) and the negative flow (11) which represents the overall weakness of  $a$  with respect to all other actions (this score must be minimized):

$$\phi^+(a, b) = \frac{1}{m-1} \sum_{x \in A} \pi(a, x) \quad (10)$$

$$\phi^-(a, b) = \frac{1}{m-1} \sum_{x \in A} \pi(x, a) \quad (11)$$

where:

$m$ : number of actions

$A$ : the set of the actions  $m$ .

Based on the positive and negative flows, the partial classification according to PROMETHEE I is defined as follows:

$a$  is preferred to  $b$  if  $\phi^+(a) \geq \phi^+(b)$  e  $\phi^-(a) < \phi^-(b)$   
or  $\phi^+(a) > \phi^+(b)$  e  $\phi^-(a) \leq \phi^-(b)$

$a$  is indifferent to  $b$  if  $\phi^+(a) = \phi^+(b)$  e  $\phi^-(a) = \phi^-(b)$

$a$  is incomparable to  $b$  in the other cases

However, these two flows are generally combined to obtain the net flows (12) defined as follows:

$$\phi(a) = \phi^+(a) - \phi^-(a) \quad (12)$$

This leads to the complete ranking using PROMETHEE II. The higher the flow, the better the degree of an action. A deeper discussion of net flow scores can be found in (Brans & Mareschal, 1995) and (Mareschal et al., 2008).

#### **4 Case study**

The paper aims to analyze the choices of the Public Administration, with particular attention to Italian universities, in response to the Covid 19 pandemic emergency. In particular, the research question that guided the work was to understand whether the actions taken by public administration in the management of university activities for the provision of teaching and management of student services could be framed in a circular economy perspective.

In particular, among the different multicriteria methods we have chosen to use the PROMETHEE I-II methods (Brans & Vincke, 1985) that is a well-established decision support system that deals with the evaluation and selection of a set of options based on different criteria, with the aim to identify the pros and cons of the alternatives and to obtain a ranking among them. In evaluating the decision alternatives, the key question is whether there is sufficient information to assert that one alternative is comparable to another in terms of the quality of the information. Based on the so-called outranking relationships, which are constructed in a first phase, it is possible to draw up a ranking of alternatives (Ishizaka & Nemery, 2011).

MCDM takes on particular relevance the ways in which, for the purpose of the evaluation, the performance of all potential actions or alternatives and contributions of all criteria; two potential actions or alternatives can in fact present conflicting performances with reference to one or more of the criteria rating. The great value of MCDM techniques in general, but even more so in the public sector, is the constructive approach of these techniques in which the definition of criteria and the identification of alternatives allows the different actors of the decision-making process to confront each other by fielding the different one's objectives and different needs (Norese, 2017). For the analysis of the main actions undertaken by universities to deal with the covid-19 epidemic, 4 criteria are taken into consideration:

- Suitability: applicability in the public administration;

- Economic: describes the extent to which time, effort or cost is well used for the intended task or purpose;
- Usability: ease to use and learnability of tools;
- Utility: utility of tools.

The actions considered in the case study mainly concern the analysis and understanding of how universities have had to rethink and reorganize teaching using a series of new tools. The provision of teaching is one of the most important issues that universities have had to face in the pandemic situation as the impacts of the solutions identified have a systemic dimension, affecting the daily life of millions of families, mobility in cities, and the dynamics of diffusion of the contagion. Addressing the problem from the point of view of a circular economy and from a sustainable point of view means looking at the phenomenon in its direct and indirect impacts, considering the role of the actors involved. The decision support tools, such as PROMETHEE, can concretely support the DMs by analyzing the pros and cons of choices. These choices can only be taken in the awareness that each of them will impact on numerous other areas. In this sense, the actions considered from a digital sustainability point of view for teaching aim at the use of technologies not only the lessons remotely but with a view that technology can be a support in the redesign of the didactic paths in their complexity. Among the actions considered there are:

- a) Provision of remote lessons. In this action the best tools are also evaluated to meet the need such as the choice of the best platform to support teaching and so on.
- b) Provision of teaching with dynamic balancing in presence and remotely. In this sense, all the strategic actions aimed at ensuring the safety of the structures and access to them are considered. In this sense, we consider the redefinition of adequate didactic models to best deliver lessons while maintaining the quality of teaching.
- c) Provision of teaching with new training models such as the use of webinars.

The use of the PROMETHEE I-II method makes it possible to express a degree of preference and indifference for each action considered and for each sub-action, with the possibility of identifying thresholds that allow the decision-maker to attribute his preference with more awareness. The application of this methodology in the Public Administration, with a view to identifying the best solutions from the perspective of a circular economy aiming at digital

sustainability, is particularly adequate because it allows for scenario analyzes. These analyzes allow us to understand what happens when the variables considered or the degrees of preference considered vary.

## 5 Conclusions

Rethinking the university from a circular economy perspective and therefore considering teaching in the perspective of digital sustainability does not only mean looking at the need to ensure quality education, but also taking into account that education must be fair and inclusive. In a pandemic scenario, universities have found themselves having to reorganize their activities by rethinking digital teaching also on the basis of accessibility criteria that allow everyone to benefit from teaching activities. In this work, we propose the use of a multi-criteria methodology that can allow the DM to take into consideration more criteria and more alternatives in such a delicate process of choice. The use of the PROMETHEE I-II method concentrates in particular to express degrees of preference on the alternatives, which will then be classified from most to least preferred. The strength of this methodology is to allow you to carry out scenario analyzes that in this sense can allow the DM to reconsider their decisions in relation to their needs or circumstances.

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## **MEC – An Eco-Friendly Marketplace in Agri-Food Sector**

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### **Abstract**

The issues of food losses and food waste have reached such proportions that global economies are looking for solutions to limit their impacts. In this work, we describe an innovative e-marketplace for the agri-food supply chain (ASC), designed in the context of a R&D project (MEC) aimed at supporting the operators in reducing waste products and finding new sales channels. The MEC project involves the development of new knowledge

management methods and technologies aimed at the design, modelling and experimentation of a new logistics network. Within the MEC project our purpose is to create a virtual commercial and logistics network, also functional to open the market to small businesses; to reduce the food products losses and waste; to extend the value to the uneaten food, waste and otherwise lost products; to strengthen the market of agricultural and agri-food specialties with a strong local/regional connotation through product management and control systems that allow for an improvement in the chemical, physical, organoleptic and nutritional qualities of the products at the time of consumption; to create a technological platforms for the integrated management of logistics for various commercial channels and the use of models for decisions based on the integration of "field" information with those acquired directly from the customer/final consumer, in the order and purchase and after-sales assistance. The system will be implemented as a web-based platform aimed to offer users: a decision support systems to aid sales services, also through demand forecasting algorithms that will allow optimization of the processes for locating goods with consequent maximization of consumption and reduction of waste; a route optimization systems, to strengthen distribution logistics services that will allow the selection of the best itineraries, also from the point of view of environmental sustainability; a systems for the valorisation of scraps, lost and wasted products through the definition of models of optimal use for energy production purposes of products no longer destined for food consumption; an ecosystem and social services related to the reduction of waste, production of energy from renewable sources, reduction of greenhouse gases linked to the optimization of the distribution phase, support to the third sector for the procurement of food for people in need. The expected results is the improvement in the competitiveness and sustainability of national agri-food supply chain linked to a reduction in the amount of product lost and/or wasted and pursued through a coherent set of innovative measures.

**Keywords** – Food losses, Food wastes, Sustainability, Decision Support System, Sustainable marketplace

**Paper type** – Practical Paper

## 1 Introduction

The agri-food sector plays a crucial role for society, as the production sector is dedicated to the production of food. The continuous economic growth has also marked the development policies of the primary sector and the industry linked to it, prompting producers to raise the quality standards of food also in terms of purely hedonistic as well as organoleptic and health characteristics. This has had an impact on the growth of food waste still suitable for human consumption or, in any case, that can be used in other areas. According to FAO estimates, 1.3 billion food waste, of which about 80% is still edible, is sent for disposal. Food waste therefore represents one of the most important issues related to the concept of

sustainability. In economic terms, food waste on the planet costs 1,000 billion dollars every year, a figure that rises to 2,600 billion if we consider the "hidden" costs related to water and environmental impact. The European Union alone throws away 90 million tons of food, just as domestic waste is worth a total of 8.4 billion euros per year in Italy (Waste Watcher Report 2015). The phenomenon of food waste and food loss has now acquired global significance and there are various initiatives to tackle the problem.

In Europe, there are over one hundred initiatives aiming at reducing the accumulation of food waste. The strategies include raising awareness through campaigns, information, education, waste measurement and logistics improvement. For example, in some Belgian municipalities regulations have been enacted requiring supermarkets to donate unsold products that are still good to voluntary associations that redistribute them to poor people. Same approach used in Portugal, where a network of volunteers collects food from restaurants and grocery stores and then redistributes it (Refood Project).

An expanded food-sharing system is implemented by CropMobster™, a tool that allows San Francisco Bay Area farmers, merchants, restaurateurs to post notices offering surplus food for sale, donation, or trade. Messages are immediately sent to various social media, including Facebook and Twitter. Since its launch in March 2013, CropMobster has put £ 500,000 worth of food back into circulation, around one million servings for people, food banks, schools and other groups in need. In Italy, the first and most important experiment is Last Minute Market, a virtuous network of operators in the agri-food sector for the redistribution of products that are still edible but discarded from large supermarkets chains.

All the initiatives mentioned have in common a "restorative" type approach, that is, they aim to solve the problem once this has happened. In some European countries that have adopted intervention measures, the reduction of waste is already visible: for example in Great Britain from 2007 to 2012 a 21% decrease in waste was highlighted, and in Denmark 19% of respondents report wasting much less food than before the corrective intervention. In Italy, a Law of 2016 "Provisions concerning the donation and distribution of food and pharmaceutical products for social solidarity purposes and for the limitation of waste" provides for interventions to reduce waste in the stages of production, transformation, distribution and administration of food products.

It is also important to outline that the agri-food sector has undergone profound structural transformations over the years to meet the changes in demand due to new consumption needs. At first, the development of globalization generated a process of "de-territorialization" for which consumers have lost interest in the origin of the products consumed (Rossi et al., 2008). In addition, due to the expansion of distribution chains, there has been an extension of the agri-food supply chains (Corrado et al., 2018). All this has led to the homologation process of productive crops and to the deterioration of biological and cultural diversity. The subsequent evolution in the needs and preferences of consumers, increasingly attentive to their well-being and the environment, has led to interest in new and alternative business models. Thus, new alternative networks of a collaborative nature to support the agri-food sector, the Alternative Agrifood Networks (AAFNs) (Goodman, 2003; Watts et al., 2005), are arising as a response to the growing demand for safer and quality food.

The AAFNs are born as a solution opposed to the conventional system, characterized by a deep industrialization of agriculture and the expansion of large-scale distribution, held responsible for a multiplicity of negative socio-economic effects and environmental issues including social inequity, environmental non-sustainability as well as the possible negative consequences that agro-industrial products can have on the health of individuals (Dansero and Puttilli, 2013).

The AAFNs have been widely analysed by North American and European literature. The first pays particular attention to the social, ethical, environmental, safety and social equity values connected with these particular forms of collaborative networks (Harris, 2009). On the other hand, European scholars focus mainly on the production of quality products, on the processes of re-localization of food webs and on attempts to incorporate a sense of place or geographical origin in food products through short supply chains. These latter characteristics are perceived as an economic added value (Holloway et al., 2006).

According to different relationships that can be established between producers and consumers, four different forms of AAFNs are proposed (Venn et al., 2006):

- Producers as consumers, that is food is grown by the same subjects who will then consume it;
- Producer–consumer partnerships, a relation between farmers and consumers, where the risks and benefits are shared between the two

parties, on the basis of different types of agreement, such as subscription to a service, joint investments, etc;

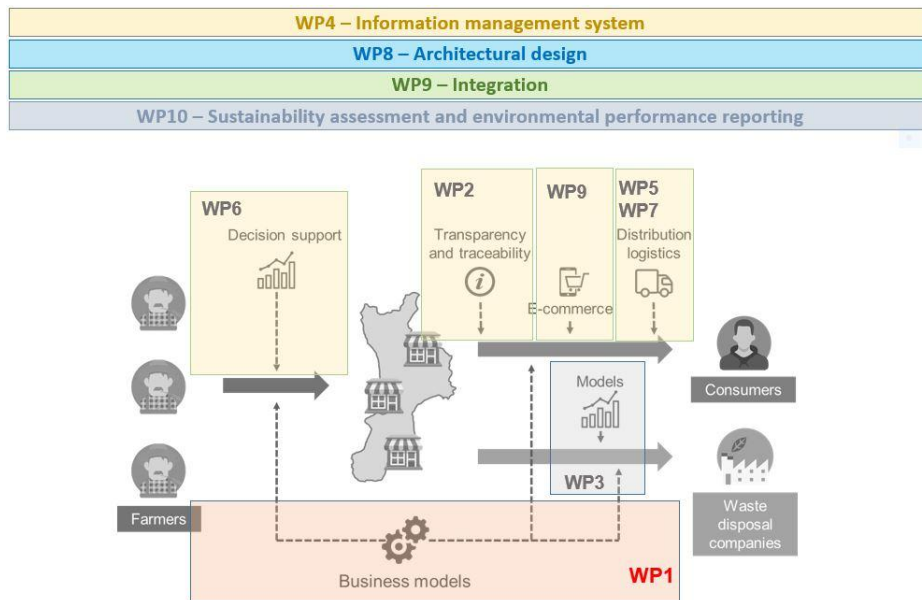
- Direct sell initiatives, where farmers or producers "cut" the intermediary and sell directly to consumers;
- Specialist retailers, producers can sell to consumers through specialized markets aimed at selling quality products, typical and local specialties.

In recent years, with the spread of new digital technologies, decision support systems have been introduced to provide effective services to operators at different levels of the supply chain. Particular attention is paid to the emerging sector of platforms that promote sustainable local development actions in the agri-food context, with positive environmental, economic and social effects. Several e-commerce giants have expanded their business by entering this sector, such as Amazon Fresh, which is Amazon's service dedicated to online grocery shopping.

In this work, we describe an innovative e-marketplace for the agri-food supply chain (ASC), designed in the context of a R&D project (MEC) aimed at supporting the operators in reducing waste products and finding new sales channels. The MEC project involves the development of new knowledge management methods and technologies aimed at the design, modelling and experimentation of a new logistics network. The main aim is the design and development of a wide and integrated action in all phases of the supply chain in order to act on the various problems that generate the phenomenon of food waste. The rest of the paper introduces the main building blocks, both from a functional and technical point of view, and the main results of the project.

## **2 Materials and methods**

The MEC project is organized in 10 work packages (WP), independent but strictly correlated, in order to ensure integrated action to obtain the results envisaged by the project (Fig. 1).



*Fig. 1 – Work Breakdown Structure of MEC project*

A first WP will aim to propose organizational models and cooperation mechanisms that can promote the creation of a "long-term" collaborative network within the Calabrian agri-food chain. On the one hand, this network will include agricultural producers (eg direct farmers) and processing companies, and consumers of agricultural products on the other. The latter, depending on the type of product to be purchased, may be:

- Individual consumers and purchasing groups, interested in purchasing local agricultural products directly from the producer without the intermediation of retail markets;
- Third sector operators, interested in food near to expiry, for distribution to disadvantaged social groups;
- Companies that deal with the recovery of food waste for energy production.

The components of the resulting collaborative network will be characterized by a common business culture, a shared sense of community and a common adherence to eco-sustainability issues. The characteristics of the most suitable organizational model for the case study will then be defined and the methods for managing the network creation process in the Calabrian area will be studied. For



the network partners, roles and relationships will also be defined within the new collaborative system to which it is intended. Therefore, the analysis of the processes and information flows that will be supported by the platform will be carried out. For this purpose, an intermediation model will be introduced and the role of a third party (intermediary subject) in support of the network partners acting as Trusted Service Manager (TSM): the Trusted 3rd Party (TTP), whose main function will be the generation of value through the management of the collaborative network.

Once the business model has been defined, it will be necessary to act at a technological level on the products in order to prevent the phenomenon of food loss and waste. Due to their perishable characteristics, food products have to be managed respecting their shelf life. The latter, defined as the period of time within which the food retains an appreciable level of quality, has a duration that depends on the kinetics with which the degradation phenomena run. In the case of fresh products, the evolution of degradation phenomena is strongly influenced by the development of phytopathogenic microorganisms capable of infecting and colonizing plant tissues. These microorganisms can be bacteria and especially phytopathogenic fungi. In order to manage the warehouse, with the aim of minimizing food waste, the consumption of the food must take place before its expiration date or its minimum conservation term. Knowledge of these time intervals depends on:

- a) intrinsic characteristics of the food;
- b) conservation methods;
- c) initial level of the quality marker;
- d) kinetics of degradation of the phenomenon;
- e) development of phytopathogenic microorganisms.

The use of intelligent packaging systems is one of the main aims of the project and plans to include devices in the package that allow to identify the approach of reaching the end of the shelf-life. For this reason, the following actions will be carried on:

- Development a monitoring system that allows the identification of the shelf-life term both as an expiration date and a minimum storage term, in order to optimize warehouse management;
- Reduction of food waste following the notice of approaching the end of shelf life and the possibility of using batches with the characteristics still suitable for their consumption.

However, the adoption of such devices will not be enough to face the phenomenon of food loss and waste. In this context, the enhancement of food products no longer suitable for consumption and their conversion into clean energy will represent strategies for maintaining the value chain and reducing the phenomenon of waste generation.

At this aim, the third WP deals with the definition of strategies for the enhancement of non-edible products, with the main objective of biogas production. In particular, the attention will focus on:

- The assessment of the biogas production capacity from a series of food products no longer fit for consumption;
- The identification of the ideal composition of the mixture for a higher biogas yield through the optimization of the parameters of the fermentation process (operating temperature, hydraulic retention time, organic load reduction rate and biogas yield, etc.).

The methodology is based on the BMP (Biochemical Methane Potential) biomethanation test in laboratory or batch scale, for the different matrices, both in mesophilic and thermophilic conditions.

On the basis of the above mentioned research activities and of an analysis of the detailed requirements, which will be carried out within the preliminary phases of the project, the data structures and the main management procedures will be created in order to prototype the system storage. Since the data archives will be subject to incremental updates, efficient mechanisms must be designed for the insertion of new data as well as for the correlation of these with the reference source. Finally, a database population activity will be carried out through the insertion of data necessary for the testing and production start-up phases of the resulting platform.

The last part of the chain, from the producer to the consumer, will be carried out through the definition and modeling of processes for distribution logistics, suitable for the new commercial channels of the short circuit. In particular, new optimization models and methods aimed at optimizing the short-range transport process will be defined, starting Capacitated Vehicle Routing and Capacitated Vehicle Routing with Time Windows algorithms. Through the subsequent implementation of the models, the platform will be able to offer optimized delivery plans to any actors who provide the delivery service. The goal of the optimization will be to maximize the quantity of goods delivered, while reducing

the number of vehicles used and the distances traveled, with significant benefits from the point of view of environmental impact.

As regards the disposal phases, it will be possible to calculate performance indicators, such as the correct balancing of the goods that are no longer consumable, in order to support the interested parties in the related process. Furthermore, the platform will be able to calculate, on the basis of historical data and information related to the goods sold and their shelf-life, estimates on the quantity of goods that must be disposed of. These indicators will offer valid decision support to implement actions within the business model aimed at mitigating waste and maximizing both consumption and the value obtained by producers.

As regards the knowledge representation, an ad hoc software model will be created. In particular, the domain model should not only faithfully represent the results of the analysis of the literature, but also effectively support subsequent processing. The opportunity to create self-contained modules independent of pre-existing frameworks will be evaluated based on the assessments that will be carried out during the analysis of the proposed algorithms. An architecture oriented to the management of data, processes that the system must be able to manage will be evaluated, and the most critical application components will be designed, in the prototype phase, in order to be able to perform benchmarks. The design of the architecture, as well as the implementation, may include refactoring phases since it is intended to conduct the development phases with agile methodologies and an incremental approach (SCRUM).

Finally, the impact in terms of sustainability of the new logistic model with respect to conventional ones will be evaluated by means of Life Cycle Management methodologies. In particular, some specific analysis of the processes that make up the individual links of the supply chain (eg production, storage, distribution, marketing, home purchase and storage, disposal, management of by-products) will be carried out and the results, expressed according to different units of measurement functional to the process studied, will be implemented in the platform. These will be used as inputs in the optimization models, evaluating in real time the impacts generated by the innovative business models (eg variation of CO<sub>2</sub> emissions due to the improvement of distribution paths). All the optimization processes will therefore be implemented according to an eco-design logic that will also take into account the benefit. Just to name a few, the reduction of waste and, therefore, all those processes necessary for their management

(reduction of waste treatment) as well as the effects positive due to the production of renewable energies such as the reduction of consumption of fossil fuels.

### **3 Expected results**

The research activities that will be carried out within MEC project aim at achieving an overall innovation of the production-consumption system that involves both the product and the process in a coherent and synergistic way. Specifically, the research and the new technologies that derive from it are aimed at:

- The creation of a virtual commercial and logistics network, also functional to open the market to small businesses, located in marginal areas and with a strong territorial connotation, favoring the marketing of agricultural products at "km 0" through a direct interface between producers and consumer;
- The reduction of product losses and food waste;
- The valorisation both for food consumption and for energy purposes of the remaining waste and otherwise lost products;
- The commercial enhancement of agricultural and agri-food products with a strong local/regional connotation through product management and control systems that allow for an improvement in the chemical, physical, organoleptic and nutritional qualities of the products at the time of consumption;
- The creation of technological platforms for the integrated management of logistics for various commercial channels and the use of models for decisions based on the integration of "field" information with those acquired directly from the customer / final consumer, in the order and purchase and after-sales assistance.

The platform that will be implemented will offer services to various actors of the supply chain:

- Producers, who will have a new, more transparent and interactive short-range sales channel at their disposal. It is planned, in fact, to offer manufacturers a software platform for monitoring the sales process and select the best store for each type of product, on the basis of analytical data that support the user's decision. The producer, in fact,

will be assisted in order to maximize sales and therefore reduce waste. Among the users of this segment, the following are preliminarily recognized:

- Direct farmers,
  - Food processing operators.
- Consumers, who will have the opportunity to purchase local products directly from points of sale or from the internet. The goal of the platform, in addition to provide a sales channel, will be to provide traceability and quality level of the goods through the data collected from the models and technologies used. Among the users of this segment, the following are preliminarily recognized:
  - Private consumers;
  - Purchasing groups;
  - Entities operating in the third sector in favor of weaker social groups.

The new paradigm, together with the functionalities offered by the platform, will affect the following processes:

- Sale and purchase of goods, including online transactions;
- Delivery of the goods, through a sales network which will be supported by optimization models and algorithms;
- Disposal of products no longer intended for consumption, with the support of scientific models aimed at maximizing the energy enhancement of the process.

At this aim, several ad hoc effective services will be provided, in particular:

- A decision support systems aimed at supporting sales services, also through demand forecasting algorithms that will allow optimization of the processes for locating goods with consequent maximization of consumption and reduction of waste;
- A route optimization systems, aimed at strengthening distribution logistics services. In this way, the distribution of goods can take place based on the outputs of optimization algorithms that will allow the selection of the best itineraries, also from the point of view of environmental sustainability;
- Systems for the valorisation of scraps, lost and wasted products through the establishment of a short-range logistics network and the

definition of models of optimal use for energy purposes of products no longer destined for food consumption;

- Eco-systemic and social services related to the reduction of waste produced, production of energy from renewable sources, reduction of climate-altering gases related to the optimization of the distribution phase, support to the third sector for finding food for vulnerable groups.

The final goal of the project is the creation of a new logistics network aimed at reducing food waste, through the construction of an economic / organizational model coordinated with a platform of decision support services and the integrated management of "short" production chains. The expected results for the MEC project are consistent with National strategies, borrowing their priority objectives and addressing their achievement through innovative and effective models that can be easily implemented in a real-life context

#### **4 Conclusions**

The innovations proposed in the project deal with the problem of reducing waste and lost food products with a multi-level approach, aimed at first to prevent the problem of waste from occurring. A new product/service will be generated, a software ecosystem, which will allow the improvement of both food products and production and distribution processes, in order to avoid that the food goods are exposed to the risk of deterioration and can therefore be discarded or lost. At present, no virtual environment has been identified created with the aim of reducing food waste, which acts at all stages of the supply chain and which aims to improve production, logistics and commercial processes, increasing the level of economic, environmental and social sustainability. MEC therefore stands as a completely innovative solution that implements a bottom-up approach aimed at reducing the phenomenon of food waste even before this has been achieved. The new business model will also integrate the possibility of redistributing products that will in any case be subject to deterioration, while enhancing what already exists thanks to the shortening of the steps to which food is subject, directly networking producers, distributors and traders with associations operating in the third sector. In addition, products that are no longer suitable for food consumption will also be managed in a completely innovative

way, favoring their use for energy production purposes, with a view to sustainable development and circular economy.

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## **The Transformative Leadership Assessment Framework**

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## Abstract

Organizations today live in a complex business landscape that requires them to be increasingly resilient, resourceful, intuitive, and flexible. Organizations must confront increasing complexity, turbulence, unpredictability, and the speed of change in the competitive environment. Many different forces and trends are shaping the new business landscape, and rapidly evolving digital technologies are forcing breakthrough and disruptive innovations. For companies to survive and thrive, they must transform their business and behaviours to respond to the evolving business landscape and turn challenges into opportunities for development and growth. Unlike change management, transformation aims to reinvent the organization and encourage the adoption of new approaches and discover new or revised business models that shape the perceived vision of the future. In particular, it is a digital transformation: the current business landscape is characterized by a continuous and inevitable digital evolution, so any type of organization should adopt the transformation considering digital factors.

In this perspective, companies need to generate, manage and leverage tacit, explicit and practical knowledge to drive transformation and remain competitive. Creating a transformation culture is not easy and many factors contribute to this outcome. Leadership represents one of the critical catalysts of a transformation-focused organizational culture. Transformative leaders today are responsible for fostering an organizational cultural mindset that aims to support and encourage transformation. For this reason, it is important to attempt to identify and measure the critical competences that drive and facilitate the generation, management, and use of knowledge for continuous innovation.

The study is at a preliminary stage and focuses on the following imperative research question, "How are the competences assessed that lead a Transformative Leader managing an organization to continuously innovate and drive transformation considering the digital age?". Proposed is the Transformative Leadership Assessment Framework, a first draft of a competency model to assess the characteristics of leaders who drive organizational transformation in today's complex business landscape. It lays the foundation for defining the specific skills, knowledge, and behavioural requirements that enable a leader to be transformative and lead an organization toward continuous innovation.

Competences provide individuals with exemplary performance that has an appropriate impact on business outcomes. This analysis helps specify a set of useful behaviours of transformative leaders, provides a tool that individuals can use for self-development, and outlines a leadership framework that can be used by to select, develop, and understand the effectiveness of transformative leaders in transformative organizations. To develop the Transformative Leadership Assessment Framework, the principles of grounded theory were adopted and, using secondary data such as recorded interviews, the authors examined the profiles of some of the most influential and inspirational modern tech leaders.

**Keywords** – transformative organizations, leadership competences, transformative leadership, assessment framework, digital transformation (max 5 words)

**Paper Type** - Academic Research Paper

## 1 Introduction

Technology innovation is increasingly influencing organizations evolution in today's competitive scenario: today's businesses have to respond to evolving trends. A global change towards a fully networked society is in progress all over the world: technology is omnipresent, and in particular the access to digital services is playing an increasing role in everything that is done (Bauer, W., Hämmerle, M., Schlund, S., & Vocke, C., 2015). One of the most impactful **transformation** that characterizes organization is **digital**: the impact of emergent technologies such as AI, machine learning, chatbots, big data and the Internet of Things are disrupting all aspects of operations and disrupting all established business practices. All types of organizations are influenced by digital transformation. Microsoft CEO Satya Nadella, says that by now every company is a software company, that has to start thinking and operating like a digital company (Microsoft Asia Digital Transformation Study, 2018). Thinking to the concept of Digital Darwinism, organizations incapable of embracing digital transformation to implement new business solution are destined to fail (Goodwin, 2018; Vollmer, 2019). It is important to point out that digital transformation is not only about technology innovation: is an accelerator for new business models (Castorena et al., 2014), products, services and experiences, so it is more about the creation of renewed knowledge and cultural viewpoints (Tabrizi et al., 2019). Digital transformation is about technology and people (Frankiewicz and Chamorro-Premuzic, 2020), so it is possible to talk about a really cultural transformation, affecting the majority of the people working. In order to deal with a complexity context and to stimulate or create a digital transformation culture, organizations are challenged to be more and more flexible, resilient and creative (Schiuma et al., 2012, Santarsiero et al., 2019; 2020) but flexibility is not enough (Bauer W., et al., 2015).

Flexibility, in the sense of capacity flexibility, as utilizing available existing elements of a system to satisfy short terms needs, is no longer adequate. The concept of **transformability**, that steams from discussions on flexibility (Bauer W., et al., 2015), refers to structural changes to any system and it seems to be more appropriate to talk about current transformation organizations are living. Indeed, transformability refers to the capacity to make rapid and lasting changes to an existing system. Considering organizations as systems, people have a key

role in this act: they are the essential link in organizational initiatives and provide transformable responses in rapid process changes (Hirsch-Kreinsen, H., 2016).

Following these reflections, absolutely **transformative organizations**, which we understand as organizations applying transformability, needs leaders able to explore the behavioural shifts that are needed to bring about lasting change: **leadership** represents one of the critical catalysers of an organization-culture oriented to transformation, particularly in the digital era (Li et al., 2016).

Considering the transformability factor, this paper considers **transformative leaders** as the key figures able to embrace digital transformation and it aims to understand how assess the vital competences to lead an organization towards a disruptive innovation.

The paper is structured as follows: the second section briefly illustrates the competences of the Transformative Leadership Compass (Schiuma G. et al., 2021), the reference model used to generate the Transformative Leadership Assessment Framework. The third section describes how are applied the principles of Grounded Theory, the methodology used to start defining the Transformative Leadership Assessment Framework, and presents a first draft of the Framework, localizing some key items for each sub-competence identified. Finally, research limitations and future development are discussed.

## 2 The Transformative Leadership Compass: an overview

This research considers a descriptive model identifying the essential competences distinguish a Digital Transformative Leader, called The **Transformative Leadership Compass** (Schiuma G. et al., 2021*b*). The Digital Transformative Leader is considered as a leader capable of shaping a sustainable value-oriented organization focusing on digital knowledge generation, acquisition and application.

The model has been developed from the authors by drawing from the literature on leadership and Digital Transformation. It originates from the combination of theoretical insights on three leadership's strands considered for this study: wise, transformative and leadership views.

**Wise leadership**, linked to Nonaka and Takeuchi's study (2011, 2019), proposes a practical wisdom called "phronesis" in addition to explicit and tacit knowledge to drive organizational transformation and value creation (Schiuma G. et al., 2021*a*).

**Transformative leadership** has been addressed by several scholars in different contexts with different interpretations (Bass 1985; Montuori A., Donnelly G., 2017; Shields, 2017), many of which have been reconsidered by Caldwell's studies (Caldwell et al., 2010, 2012). Generalizing, transformative leadership can be said to be ethical leadership that combines creativity, accountability and a willingness to change, drawing largely on the idea of transformational leadership (Bass and Riggio, 2006; Burns, 2004).

**Digital leadership** is a newer strand that requires further investigation (Imran et al., 2020). According to El Sawy et al. (2016), it is about the ability to do the right things for organizations in the context of digital transformation.

Considering the theoretical background of these three leadership types and transformative leadership as the primary reference strand, the Transformative Leadership Compass was developed, characterized by six critical competences that characterize the practice of a transformative leader (see below, figure 1).

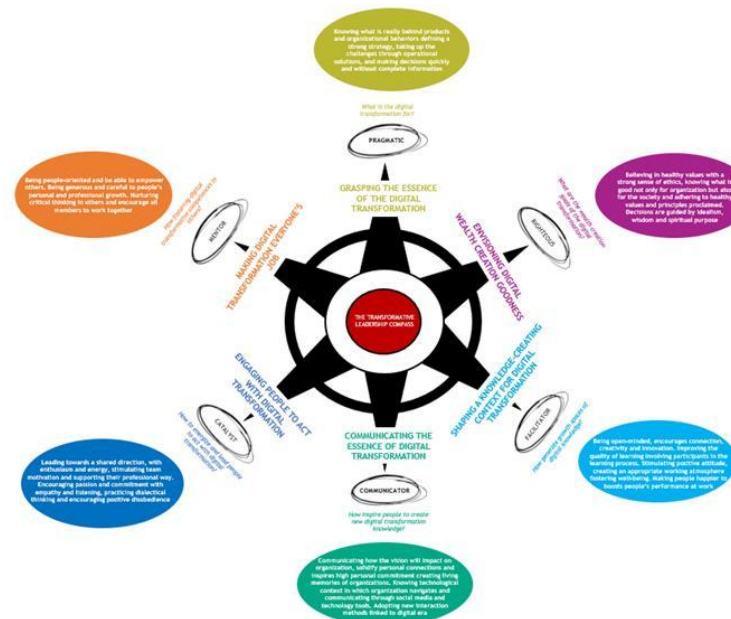


Figure 1 - The Transformative Leadership Compass

The first competence is **"Grasping the essence of the digital transformation"**, and is the capacity of connecting digital knowledge with business challenges to resolve problems, aligning dilemmas and solutions

knowing what the digital transformation is for and the knowledge foundations at the basis of the technology. The critical question characterising this competence is: *what is the digital transformation for?* This competence is linked to a leader considered *Pragmatic*, oriented to achieve the target objectives and take decision to solve problems. Different abilities and behaviours can characterize a leader with this competence: knowing what is really behind products and organizational behaviours (Nonaka and Takeuchi, 2011; 2019), defining a strong strategy, (Larjovuori et al., 2018), taking up the challenges through operational solutions, and make decisions quickly and without complete information (Lynn Pulley, M. and Sessa, V.I., 2001; Horner-Long, P. and Schoenberg, R. (2002).

**The second competence is “*Envisioning digital wealth creation goodness*”**, namely the capacity of taking decisions based on the goodness that the digital transformation will entail, considering the positive impact of goals and processes on organisation and society, to support sustainable growth. The question linked to this competence is: *what are the wealth creation goals of the digital transformation?* A leader able to answer this question with concrete actions is a *Righteous* leader. He is guided by healthy values and a strong sense of ethics, knowing what is good not only for organization but also for the society (Nonaka and Takeuchi, 2011; 2019) and adhering to healthy values and principles proclaimed (Ladkin D., 2008). Additionally, his decisions are guided by idealism, wisdom and spiritual purpose (Fry, 2003).

**The third competence is “*Shaping a knowledge-creating context for digital transformation*”**, namely the organisational capacity of creating a prolific context to nurture digital knowledge generating virtual and real growth spaces of digital and knowledge exchange. The critical question characterising this competence is: *How generate growth spaces of digital knowledge?* A leader acquiring this competence is a *Facilitator*, able to create or nurture cultural context and growth spaces, in which is possible stimulate comparisons and learn in innovative ways.

A leader with this ability is open-minded, encourages connection, creativity and innovation. He helps to improve the quality of learning involving participants in the learning process (Sousa et al., 2019). He is committed to stimulate positive attitude, to create an appropriate working atmosphere fostering well-being. Moreover, he contributes to make people happier to boosts people's performance at work (Salas-Vallina et al., 2018).

**The fourth competence is “Communicating the essence of digital transformation”** and relates the capacity to share the organisation’s purpose through a universal language, inspiring people towards storytelling tool using metaphors, stories and rhetoric. The question guide for this competence is: *how inspire people to create new digital transformation knowledge?*

A leader who implements this ability is a *Communicator*, able to create a leader-follower relationship through a strong personal bond. He communicates how the vision will impact on organization (Ismail et al., 2017), solidifies personal connections and inspires high personal commitment creating living memories of organizations. Moreover, he knows technological context in which organization navigates and is able to communicate through social media and technology tools. Finally, he adopts new interaction methods linked to digital era, and choose the right approach and tools based on his target and different situations (Cortellazzo et al., 2019).

**The fifth competence is “Engaging people to act with digital transformation”**, the capacity to engage people and overcome the barriers, inspiring and holding together—given a common purpose—people from different generations, cultures, roles and primarily digital backgrounds. The critical question characterising this competence is: *how to energise and lead people to act with digital transformation?* A leader who leads a group towards a shared direction, with enthusiasm and energy, stimulating team motivation and supporting their professional way. He is a charismatic guide who encourages passion and commitment (Senge, 2006), developed empathy and listening, practicing dialectical thinking and encouraging positive disobedience.

**The sixth competence is “Making digital transformation everyone’s job”**: the capacity to spread digital transformation, supporting people to enhance their leadership skills and digital knowledge competences. The critical question characterising this competence is: *how fostering digital transformative competences in others?* A leader who implements this ability is a *Mentor*, people-oriented and able to empower others (Rappaport J., 1981) generous and careful to people’s personal and professional growth. He nurtures critical thinking in others and encourage all members to work together (Blanchard, 2010).

This paper explores the Transformative Leadership Compass illustrated by considering the leadership profiles of some of the most influential and inspirational modern tech leaders as case studies, using an analytical approach linked to the general principles of grounded theory (Glaser and Strauss, 1967) to

outline the basic guidelines for the development of the Transformative Leadership Assessment Framework. This is a first draft of a competency model for assessing the characteristics of leaders who drive organizational change in today's complex business landscape.

### **3 Research to define the guidelines of the Transformative Leadership Assessment Framework**

#### **3.1 Methodology**

In terms of methodology applied, reference was made to the principles of Grounded Theory (Glaser and Strauss, 1967; Strauss & Corbin, 1990; Turner, 1981), considering that it is also applied in organisational research (Lansisalmi et al., 2000; Lowe, 1995; Gersick, 1998), producing a description of organisational reality. Grounded Theory refers to a style of conducting qualitative data analysis and assumes revealing elements that are analysed in a contextual way without a predetermined theoretical or conceptual framework.

Between the two main approaches to the application of Grounded Theory in organizational research (Cassel C. and Symon G., 2004), this study aims to stimulate comparison and generate new hypotheses around a specific topic area (Lansisami et al., 2000). The use of the Grounded Theory methodology is justified because the perspectives considered often do not result in large amounts of structured data that occur in rather atypical and unpredictable formats (Martin & Turner, 1986; Turner, 1981).

This research started from the following research question: *"How are the competences assessed that lead a Transformative Leader managing an organization to continuously innovate and drive transformation considering the digital age?"*.

The main research phases implemented are discussed below.

#### **3.2 Case studies and data collection**

Grounded Theory approach often combines different types of data collected through interviews, participant observation, and document analysis. To explore how the competences of a Transformative Leader company operating in the digital age are assessed, the first starting point was to analyse the competences

of Transformative Leadership Compass considering YouTube interviews of some of the most influential and inspirational modern tech leaders as case studies. The starting point was to look at the most influential tech leaders of our time according to Industry Expert, based on research conducted by Forbes Technology Council (Forbes Technology Council, 2020).

Data are collected through theoretical sampling: sample selection is guided by concept development. At this early stage, the most prominent of the 16 tech leaders considered by the members of Forbes Technology Council were selected as the initial sample: Elon Musk, Jeff Bezos, Jack Ma and Steve Jobs, with the aim of expanding the sample to other leaders in the next research step.

For data collection, YouTube interviews of the cited leaders were considered, taking into account speeches from international forums, companies, experts or television channels related to leadership. Other researchers have used YouTube as a qualitative data analysis tool to understand phenomena or analyse reference samples (e.g.; Duncum, 2014; Strangelove, 2010, Gao X. et al., 2013). In this research, the collected data is used as secondary data by using information collected from other researchers or sources for other purposes (Hox, J. J., & Boeije, H. R., 2005).

To obtain relevant information, YouTube is searched using keywords such as "leadership", "leadership style", "employee leadership", "interview", "leadership principles". Detailed testimonials and reports on YouTube are useful sources of data to study leadership behaviour and style as they provide additional information (Gao, X et al., 2013). Some new or relatively neglected topics may emerge, deepening our understanding of how Transformative Leader competences are examined by presenting to the Transformative Leadership Compass.

### **3.3 Analysis**

An inductive analysis of the data was conducted following the basic principles of the Grounded Theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990; Turner, 1981), so themes emerged from the data. The applied procedure for the data collection is "open coding" (Strauss and Corbin, 1990). An extrapolation of the data process is shown in figure 2, reporting a part of the analysis carried out as understanding example, for reasons of limited space.



Leader	a) Quote	b) Code in open coding (Keywords selected)	c) Concepts (Sub-Competences)	d) Dimensions of the Transformative Leadership Compass (Competences)
Jeff Bezos	"...the cultural thread that runs thorough all this things is the same: we only have a few principles of the Amazon kind of core values that we go back to over and over again...so the first one and by far the most important on is customer obsession...."	Customer obsession	Client oriented	1.PRAGMATIC LEADER PROFILE <i>who grasps the essence of the digital transformation</i>
Elon Musk	"...if you are joining a company, the most important think is to make sure to attract great people so either view would join a group that is amazing that you really respect...and I mean all the company is a group of people that have gathered togehter to create a product or service...adn so depending upon how talented and hardworking back group is and the greeter wich they are focused cohesively in a good direction that will determine the success of the company ..."	Working hard together, attract great people	Engagement	5. CATALYST LEADER PROFILE who engages people to act with digital transformation
Jack Ma	" I told the investors: we have been believing customer at number one...because I believe if the customer is happy, enployee are happy, and the shareholders are happy..."	Customer at number one	Client oriented	1.PRAGMATIC LEADER PROFILE <i>who grasps the essence of the digital transformation</i>

Steve Jobs	"There's a temptation in our network age to think that ideas can be developed by email and iChat. That's crazy, creativity comes from spontaneous meetings, from random discussions, you run into someone you ask what they're doing you say 'wow' and soon you're cooking up all sorts of ideas"	Creativity comes from spontaneous meeting and random discussion	innovation and creativity	3. FACILITATOR LEADER PROFILE <i>who shapes a knowledge-creating context for digital transformation</i>
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Figure 2- Extrapolation of the data process

The interviews were analysed by extrapolating keywords associated with the behaviours or leadership style of the sample under consideration. The data were first read and transcribed into quotes (a), then categorised into codes (b), which were suggested by the data and not imposed from outside. All codes were then clustered into categories representing leaders' sub-competences (c). Identification of sub-competences often required multiple rounds of analysis by a panel of three engineering experts. Each expert individually identified some keywords, and after a group discussion, the final keywords were selected by all experts. Then, considering the most frequently listed sub-competences, a final list of 5 sub-competences associated with each profile dimension (d) of the Transformative Leadership Compass was defined, according to the characteristics of each dimension previously presented in section two.

### 3.4 Results

The following is a list of the 30 sub-competences that emerged after an inductive procedure and the analysis process outlined above. The partial competences are categorised according to the dimensions Transformative Leadership Compass':

- Dimension 1 – *Pragmatic Leader profile who grasps the essence of the digital transformation*: problem solving, solution oriented, client oriented, excellence oriented, decision making;

- Dimension 2 – *Righteous Leader profile who envisions digital wealth creation goodness*: responsibility, healthy values/ethics orientation, practical-wise oriented, sustainability oriented, well-being oriented;
- Dimension 3 – *Facilitator Leader profile who shapes a knowledge-creating context for digital transformation*: happiness orientation, innovation and creativity, growth spaces creation, teamworking, networking;
- Dimension 4 – *Communicator Leader profile who communicate the essence of digital transformation*: cultural awareness, effective communication, storytelling, social media savvy, digital awareness;
- Dimension 5 – *Catalyst Leader Profile who engages people to act with digital transformation*: listening, positive influence, empathy, engagement, coherence;
- Dimension 6 – *Mentor Leader Profile who makes digital transformation everyone's job*: mentorship, empowerment, critical thinking, transparency, team leadership.

As also illustrated in figure 3, in this early-research stage every 5 sub-competences group is linked to the six competences of the Transformative Leadership Compass, through an inductive process.

These sub-competences help to define *The Transformative Leadership Assessment Framework*, a first draft of a competency model to assess the characteristics of leaders who drive organizational transformation in today's complex business landscape.

To build the first draft of the framework, the sub-competencies has been expressed through some statements (items) largely guided by an induction analysis, to allow for a future step research the construction of questionnaire, based on Likert Scale model (Arcuri, L., & d'Arcais, G. B. F., 1974), or other psychometric techniques.

Indeed, in a subsequent research phase, a questionnaire assigning a score to each item can be created, and all the scores of the questionnaire will be combined (sum) to generate a composite score, which logically in totality measures an uni-dimensional trait (Johns, R., 2010). Therefore, the items created could be related to a scale of evaluation point for create a questionnaire assigning a score to each element. This tool will allow to understand about the behaviours of the participants related with 'latent' or "clear" variable expressed by

several 'manifested' items, for example in a Scale Likert questionnaire (Marradi A. et al., 2002; Joshi A. et al., 2015).

The Framework obtained thus allows to understand how asset the critical competence of a Transformative Leader in a digital era, considered as any actor (manager, leader, entrepreneur, etc.) possessing the capabilities to lead organization towards transformation and sustainability, thinking digital context.

	SUB COMPETENCES	ITEMS
<b>1.PRAGMATIC LEADER PROFILE who grasps the essence of the digital transformation</b>	problem solving	1. I analyse the problem and break it down into sub-problems in order to find targeted innovative solutions
	solution oriented	2. I take action to promote initiatives to identify innovative solutions to future problems
	client oriented	3. I carry out concrete actions aimed at meeting or anticipating the needs of the customer
	excellence oriented	4. I take action to make the company achieve high standards of excellence and quality in innovation
	decision making	5. I make decisions immediately and consciously in an innovative context where complexity is part of the decision
<b>2. RIGHTEOUS LEADER PROFILE who envisions digital wealth creation goodness</b>	responsibility	1. I take responsibility for the objectives set, assuming full responsibility for the positive or negative consequences on the organisational result
	healthy values e ethics orientation	2. I implement decisions based on strong professional ethics and healthy organisational values
	practical wise oriented	3. I make wise decisions, which can have a long-term positive impact on the organisation
	sustainability oriented	4. I make wise decisions, which can have a long-term positive impact on society
	well-being oriented	5. I put in place transparent and authentic actions that stimulate optimism and well-being in the organisation
<b>3. FACILITATOR LEADER PROFILE</b>	happiness orientation	1. I actively contribute to create spaces for discussion and sharing where people can work happily

<b>who shapes a knowledge-creating context for digital transformation</b>	innovation e creativity	2. I put in place actions that encourage creativity and continuous innovation
	growth spaces creation	3. I actively contribute to the creation of learning and growth spaces for the exchange of knowledge and new ideas
	team working	4. I encourage teamwork and collaboration to achieve a common result
	networking	5. I promote interactions between people by adopting an openness and sharing approach
<b>4. COMMUNICATOR LEADER PROFILE who communicate the essence of digital transformation</b>	cultural awareness	1. I share clearly mission, vision and organisational values
	effective communication	2. I employ an universal language through metaphors, examples or analogies to facilitate understanding
	storytelling	3. I employ the tool of storytelling and imagination to share the organisational culture
	social media savvy	4. I communicate through social media and technological tools
	digital awareness	5. I choose the most appropriate technological tools according to my target audience
<b>5. CATALYST LEADER PROFILE who engages people to act with digital transformation</b>	listening	1. I listen carefully to the people who work with me and talk with them politely
	positive influence	2. I instill passion and energy even in the most difficult moments
	empathy	3. I often put myself in the other person's shoes, even if I disagree with him/her
	engagement	4. I promote concrete actions to attract top talent into the company
	coherence	5. I lead the organization through adversity with resilience and tenacity
<b>6. MENTOR LEADER PROFILE who makes digital transformation</b>	mentorship	1. I support people's growth through training and coaching
	empowerment	2. I encourage delegation and empowerment of people

<b>everyone's job</b>	critical thinking	3. I encourage comparison and dialogue, even if someone has a different idea from mine
	trasparency	4. I share with trasparency objectives achieved or organisational results
	team leadership	5. I involve people who work with me, respecting differences, especially in the most critical moments

*Figure 3 - The Transformative Leadership Assessment Framework*

#### 4 Conclusions

This is a preliminary research that proposes a draft model, the Transformative Assessment Framework, as a tool of 30 sub-competences assessing behaviours of a Transformative Leader able to navigate innovation and digital transformation.

The Framework is based on an analysis of the six competences of the Transformative Leadership Compass, re-exploring them considering the case studies of some of the most influence leaders that had created the most successful enterprises in the world: Jeff Bezos, Jack Ma, Elon Musk and Steve Jobs. The principles of the grounded-theory and secondary data collected have been adopted, to formulate the hypothesis of how assess competences and strengthen the Compass model.

The paper addresses the emergent need of enterprises to have figures with a mindset prone to navigate transformation in the digital era and apply transformability, to develop organizational behaviours oriented to innovation and evolution. It is relevant understanding how are the critical competences these figures should nurture and how assess them.

The Framework proposed offers important managerial implications. It can be considered a practical guide to build a questionnaire or a self-assessment tool to measure the fundamental abilities to nurture transformative leadership in digital context. In an environment changing rapidly, the fast development of new capacities linked to innovation is critical to surviving. HR Departments or Business Consulting company could use the Framework to understand how measure specific behaviours that a leader should catalyses within organizations navigating transformation and digital evolution. A helpful model for scholars and practitioners it is also proposed, to deepen studies on leadership practices, suggesting the key items questions to explore the required capabilities.

However, the Framework presents some limitations. In developing future research, it can be considered other cases studies linked to new tech success leaders, and a series of semi-structured interviews to leaders engaged in transformation journeys in digital contexts will be gathered. A more in-depth qualitative analysis and rigorous grounded-theory application will provide further information to test and refine the framework.

Finally, defining how to measure items can be built a questionnaire or a survey to collect data valuable to also design a training growth course to prepare Transformative Leaders in organizations aim to innovate.

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## Planning for Strategic Shift in Shaping a Transformed Business World – Introducing Digital Entrepreneurship in Retail Sector of Punjab Region (Pakistan) in Face of COVID-19

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### Abstract

Intended study aims to identify the challenges and opportunities mature and emergent entrepreneurs faced for adoption of digital entrepreneurship in face of COVID-19 in research industry of Lahore, Pakistan in view of the Technology Affordances and Constraints Theory. A descriptive research design was executed whereby, sample was chosen using purposive sampling technique and data were collected from start-up owners and their managerial teams using a Likert scale questionnaire. A total of 253 valid responses were recovered. The study results revealed that entrepreneurial teams were engrained in the fierce challenges for adoption of the digital entrepreneurship due to the absence of an approximate framework and support infrastructure. Based on the analysis' results, a framework for digital ecosystem integration considering the life cycle of the business has been proposed along with robust digital entrepreneurship framework for the retail industry.

**Keywords** – Digital entrepreneurship, covid-19 pandemic, retail sector, business transformation, business continuity

**Paper Type** – Academic Research Paper

## 1 Introduction

The recent outbreak of COVID-19 pandemic globally has taught us a big lesson that uncertain crises and uncertainties are inevitable and as many occurred in the past, catastrophes will likely keep on occurring in future. These perilous disasters like COVID-19 although cannot be prohibited yet economies need to be proactively prepared to diminish their all-encompassing consequences on the socio-economic stability of a country. We have witnessed the unavoidable and austere economic and financial penalties of this viral outbreak at global level, keeping none of the countries unmoved. Dramatic transformation are set to occur in how retail businesses such as entrepreneurial startups will act in wake of this external environmental disturbance particularly with respect to South Asian content, more specifically Pakistan. The lockdown imposed by the Government of Pakistan amid the pandemic forced several retail businesses to shut for a longer time period. This resulted in unprecedented interruption of selling and buying pattern in the retail sector. Retail entrepreneurs faced a lot of challenges reaching their customer and consumer. It has been moreover, seen that short-term navigations of the posed challenges and problems will not actually guarantee a hopeful future. Life and ways of doing the businesses after outbreak have taken a radical shift and are different today compared to what they used to be before. Lack of financial and policy infrastructure support from the Government left the entrepreneurs with suspension of their business services. Many of them due to absence of any disaster preparedness response plan could not create any alternative market offering, resultantly many businesses remained unadjusted with the changing environment's pace.

An increased economic turbulence in wake this black swan (pandemic outbreak) forced numerous local entrepreneurial ventures to take a move toward strategic rethink. Leaders of modern tech-enabled firms are transforming their teams to proactively prepare for bouncing forward any substantial prospective disturbance. Entrepreneurs are now planning to take step toward digital shift by bootstrapping and sustaining their existing resource base for their endured survival. Unfortunately, entrepreneurial startups with a nominal investment and humble infrastructure went under pressures of downsizing, trimming their expenditures, optimizing their cost structures, deferring their business activities and processes, and also imposing an infinite suspension on new hiring. Nevertheless, it was also seen that online business processes came into play in

order to sustain the continuity of organizations. In the near future of transformed business era, we would witness an unprecedented evolution of most of retail startups switching from brick & mortar to online merchandizing systems. Lockdown resulted closure of economic and social activities and consequently, entrepreneurs and customers increased their reliance on the digital communication platforms.

Seeing the other side of the coin, this outbreak crisis also served an apex for catalysing the tech supported entrepreneurial processes in the mainstream thereby, creating multiple opportunities for them to sustain the continuity of the ventures. During this period, internet usage surged to manifolds with greater reliance on digital media, online communication & payment platforms and mobile applications' consumption. Entrepreneurs can gain opportunity with heavy reliance on internet connectivity due increase in desire for being contactless yet approachable. There is therefore, a greater need for Pakistani startups to go digital for their future growth and long term survival. A prior emergent and already existing trend has now got swiftly accelerated for digital entrepreneurial activities. New digital ventures can be an important contribution for bringing a steady stability to the shaken socio-economic balance of the country with an eminent focus on innovative tech-enabled venturing called the Digital Entrepreneurship. Uplift of the existing business landscape of emerging startups of Pakistan calls for revamping and transforming their entrepreneurial processes, agency and outcomes through digitization.

I am keenly interested in exploring how to inculcate post-pandemic Digital Entrepreneurship in Pakistan especially in Punjab region through development and implementation of suitable plan of action and policy infrastructure. Adapting to and proactively implementing digitization in commerce and trade of entrepreneurial firms' processes will likely help them sustain their financial growth. Digital transformation mechanism of entrepreneurial startups will help businessmen endure long term business continuity in face of future vulnerabilities and unprecedented crisis occurrences. Intended research study would identify the current challenges faced by entrepreneurs during and after pandemic, and plan an effective action plan for assessing the vulnerabilities associated with introducing digital entrepreneurship in the region under prevailing circumstances. The study will also provide a guideline and framework on how to address the challenges of digital transformation of entrepreneurial ventures and consider

these ventures for investment decisions that can result in sustainable system for digital entrepreneurship in Pakistan.

### ***1.1 Scope of the Research Study***

The study will comprehensively review and assess the consequences and impacts of COVID-19 pandemic on existing emerging entrepreneurial ventures. The challenges to adaptation of these startups to environmental business pressures and adoption of new digital technological platforms in the business processes and systems through probing driving and restraining forces will be explored systematically in detail. A cross-country comparative analysis will be conducted against a set of these external forces and avenues for adoption of digitization by startups. In addition to the challenges posed as a result of adopting digitization, this study will explore and plan a most appropriate decision and investment plan that can be considered for digital entrepreneurship execution and sustenance. Resultantly, intended study aims to explore following research questions:

1. What are the challenges and issues inherent to the existing entrepreneurial ventures amidst COVID-19 pandemic in Punjab?
2. What are the impacts of COVID-19 pandemic on entrepreneurial ventures (businesses)?
3. What is the most suitable plan for the adoption and implementation of digital entrepreneurship in Punjab region?

Nevertheless, considering the study and resource limitations, my research study is particularly focused on digital entrepreneurship of retail sector in Lahore district of Punjab region, whereas, a universal digitization framework for retail startups can be suggested in future.

### ***1.2 Objectives of Research Study***

The research objectives of my study involve:

1. To diagnose the challenges and issues inherent to the existing entrepreneurial ventures amidst COVID-19 pandemic in Punjab
2. To analyze the impacts of COVID-19 pandemic on entrepreneurial ventures (businesses) in retail sector

3. Develop a most suitable and optimized plan for the adoption and implementation of digital entrepreneurship in the retail sector in Punjab region

### ***1.3 Significance and Novelty of the Research Study***

The novelty and significance contributed by the intended research include:

1. Formulate and provide a comprehensive optimization agenda to the emerging entrepreneurs and organizational leaders in adopting digital entrepreneurship during turbulent business circumstances.
2. Incorporate a resilient digital entrepreneurship model through which business continuity can be navigated through identification of most suitable decision option for executing digital entrepreneurship within the content of South Asian retail sector.

This research will help retail sector to capitalize upon digital entrepreneurship framework and contribute to economic growth of the region in the country through increased job creation and assistance to new online business startups. It will also help to make further development in connotation of digital entrepreneurship with respect to retail sector of services industry. In this way sufficient and useful investment choices can be proposed to Ministry of Information Technology of Pakistan to influence the emerging trend of digitization in development and optimization of traditional small businesses for increasing business resilience. The proposed model of digital entrepreneurship can be incorporated in the policy framework of well established companies, governmental policy reform system, accelerator, incubation centers, and investors. The new proposed framework will recommend an agile and proactive action plan embedded in the risk & crisis management, resilience and business continuity management infrastructure and can also serve as resilience preparedness and adaptive response capacity development tool to help digitally enabled start-up originators navigate their businesses through any unprecedented crisis occurring in the global business environment. The new proposed framework on digital entrepreneurship and its investment decision will be a guided model for future entrepreneurs to adopt it in effectual and successful way using low cost and limited resources. This study will be used in assisting the entrepreneurs sustain their long-term business journey by incorporating digital ecosystem in their

venturing, employment, trade and contracting in order to bounce back any uncertainty such as pandemic or other crises.

Moreover, established organizations and companies, investors, government, accelerators, merchants and service providers can take insights from this research and use innovative framework of digital entrepreneurship for providing individualized solutions and services to end users. Digital Entrepreneurship is an emerging concept in Pakistan and this study can provide excellent lead to the stakeholders of our emerging market so as to close the gap of digital entrepreneurship. COVID-19 has changed the global business landscape and future of our Country's socio-economic integration and balance lies in augmenting the dependency of entrepreneurs on digital platforms. These initiatives could eventually add to digitization of economy and contribute to the GDP of Pakistan. Surging penetration of internet usage with rising 4G & incoming 5G technologies on smartphones in Pakistan evidently justifies the need for an implementation framework on digital entrepreneurship and thus upgrade the value chain of digital economy of our retail sector ventures.

Entrepreneurs of Pakistan need veracious support from investors and Government, in order to establish vigorous digital clusters in their business ecosystem. This study will be effectual in assisting entrepreneurs scale up their businesses in face of any adversary and remove any hindrances that stand in their way to reach and serve their end users. This study provides an impetus to the local small and medium sized entrepreneurs in embracing digital technology in order to create a new vibrant and dynamic market alongside enhancing the economic productivity of Pakistan. This research study will be helpful in providing a roadmap for adopting digital entrepreneurship in retail sector of industry, which would eventually lead to enhanced exports, creation of jobs to millions of graduates and strengthened economy. A sustainable digital entrepreneurial ecosystem will support a cost efficient and outsourcing of talented IT expertise. Through this, the digital service market would become more integrated and mature not only limited to ecommerce but spreading in all diverse marketplaces. Figures annexed in the appendix provide a concise yet comprehensive view of the opportunities and avenues for advancement of digital entrepreneurship ecosystem in Pakistan business climate.



## 2 Literature Review

COVID-19 pandemic was an unparalleled pandemic spread at global level, and recently it impacted millions of lives all over the world. We could see countries limiting the flux of their citizens by sealing their national borders for an infinite time period. People were quarantined to their homes due state enforced curfew and lockdown extended up to several months. Together with being vulnerable to life threats, people were also found terrified due to high job insecurity, thus this viral outbreak adversely affected our society through multiple angles leaving even the developed countries in state of chaos and socioeconomic disorderliness (Blackhurst, Dunn, & Craighead, 2011; Papadopoulos et al., 2017; Papadopoulos, Baltas & Balta, 2020). Various industrial sectors and businesses were disrupted due to immobility occurred in the economic activity, resulting in flooded unemployment. Most of the businesses based on brick and mortar model were ceased with their almost dependency on physical presence and interaction with the customers such as physical retail outlets, tourism, entertainment, hospitality, household and food etc. In face of this large scale turbulence, governments of all especially the developing countries tried hard to fuel their economic systems within constrained resources and limited infrastructure. Loss of business and jobs was another major challenge faced by states in addition to dealing with life security amid pandemic eruption (Aly, 2020).

Considering the other side of the coin, there was certain opportunism consequential to the lockdown situation i.e. an exciting escalation in internet usage, social media in particular. Due to minimal socialization of people and being confined to homes for an infinite time period, there was observed a huge inclination towards usage of social media over physical one-to-one interactions (Nowland, Necka, & Cacioppo, 2018). In essence, internet was the only source to avail essential facilities through online product and service delivery modes such as online education, online health care consultancy from doctors, online financial business transactions any so on so forth. Likewise it has been found that, developed economies such as USA, Europe and China etc. navigated their businesses from brick-and-mortar to click-and-mortar and finally to online stores under high uncertainty and complex circumstances so as to sustain their competitive position in the market (Rapoza, 2020).

Conventional, reactive, vulnerable and rigid businesses were left struggling, while agile, adaptable and resilient businesses were found thriving i.e. all those

internet enabled and supported businesses survived the setbacks triggered by the pandemic outburst. These businesses involved but were not limited to online teaching in academic sector, ecommerce reliant selling and buying of goods, work from home business models, entertainment, healthcare, banking, food and other grocery items' delivery and IT services and solutions (Senyo, Liu, & Effah, 2019; Hughes et al., 2019). Businesses took advantage of high internet and smartphone usage of customers and transformed their purchase, consumption, demand and reordering patterns. Resultantly COVID-19 plague created an exclusive opportunity to differentiate reactive and proactive businesses in regard of their continuity, it could be witnessed that dynamic businesses sustained their competitiveness and thrived in the market; contrarily, static businesses could not adjust their sails with the changing tides in the competitive and difficult waters (Jaworski, Kohli, & Sahay, 2000). Abandonment of one business was replaced with a new value creating solution/business in the market. Dynamic businesses transformed with a rapid pace in accord with the changing demands and perceptions of market stakeholders. Hence, pandemic outspread brought into play the idea of value creating 'dynamic ecosystem' (Vargo & Lusch, 2011).

Based on the recently endured COVID-19 pandemic, securing the continuity of small and medium firms has been considered to be the most critical concern chiefly for the less developed economies. Fortunately, use of digital technology can help secure business endurance and continuity of the small entrepreneurial firms, hence mitigates the risks by proactive risk identification and recovery of the business services and processes (Gibb & Buchanan, 2006). Regardless of the implications of applying digital technologies in securing the continuity of firms under circumstances of thrilling disruptions such as COVID-19, still there is dearth of the framework or an appropriate framework or a roadmap for emergent startups, small entrepreneurial ventures and IT experts and information system teams for such crisis preparedness. Earlier research studies emphasized safeguarding information security, technology strategy and tech-enabled functions of the organizations (Niemimaa, 2015). Recent incidence raised another major concern over how can small entrepreneurial firms shape and optimize their work and operations around integration of digital technological platforms as an adaptive response to uncertain and intense catastrophic event? Organizing digital technology in the strategic intent of small ventures in order to tackle the complications caused as a result of COVID-19 establishes a demand for a new research avenues (Giones et al., 2020).

"Digital entrepreneurship is a subcategory of entrepreneurship in which some or all of what would be physical in a traditional organization has been digitized" (Hull et al., 2007). Le Din et al. (2018) defined digital entrepreneurship as "the reconciliation of traditional entrepreneurship with the new way of creating and doing business in the digital era."

Considering 'Digital Entrepreneurship' as an organization's capability to respond to the external environmental adversaries (Teece, Peteraf & Leih, 2016) such as in case of COVID-19 outbreak can in order to gain long term competitiveness and sustenance can be related in the light of 'Dynamic Capability View' (Teece, 2018). Thus, for an organization to safeguard its permanence in wake of high velocity turbulence in the external environment of the business (Coronavirus pandemic), it must take into account the 'sensing', 'seizing' and 'reconfiguring' of its capabilities and resources (Teece, 2018). Another theory that links the organization's capability to foresee and predict uncertainties and complexities that can threaten its survival (exploration) and accordingly, use its resource capabilities to proactively respond to them (exploitation) is the idea of "Organizational Ambidexterity" (Gulati & Puranam, 2009; Cao et al., 2009; O'Reilly & Tushman, 2013). According to Papadopoulos et al. (2020), ambidextrous organizations possess dynamic capabilities to exploit 'sensing, seizing and transforming' actions for tactfully dealing with challenges posed by COVID-19 pandemic inherent to the continuity of the business (Papadopoulos, Baltasb & Baltac, 2020). There is therefore, now an important need for studying research on new entrepreneurial actions and practices under ambiguous and uncertain business circumstances (Bylund & McCaffrey, 2017).

Additionally, the Technology Affordances and Constraints Theory (Gibson, 1979) is critical to understand how fueling of digital ecosystems into the entrepreneurial ventures can impact and shape the processes and actions of the actors i.e. entrepreneurs. (Majchrzak & Markus, 2014; Nambisan, 2017). This offers a favoring and auspicious opportunity lens to investigate this. For sustaining their survival, organizations irrespective of any turmoil or crisis driven instability, undertake either productive or fruitless entrepreneurial actions for exploring and exploiting resources and developing a rational adaptive response (Kuckertz et al., 2020). In regard of this, an unanswered question arises, how entrepreneurial ventures can adapt their businesses to the continuing crisis of COVID-19 outbreak.

Deployment of digitization into entrepreneurial business practices is now considered critical to innovation and commercialization of the business processes. These platforms are denoted as 'digital space' and provide prospects for the businesses to interact and connect with their customers and end users of their products and services (Hsieh & Wu, 2018; Kraus et al., 2018). These digital spaces i.e. technology assisted contents to reach customers comprise of three forms that encompass 'innovation platforms' for designing corresponding services and products by the business using advanced technologies, 'transaction platforms' that entail online retailing and services to be delivered to the customers on their demands, and lastly, 'integration platforms' that are a hybrid model of the first 2, i.e. integrated business model of innovating and developing new products and services and delivering them to the customers as and when they demand (Hsieh & Wu, 2018). Therefore, digital entrepreneurship requires firms to use unique and differentiated strategies for placing their products and providing their services to a wide range of customers through online interconnected network involving multiple vendors and businesses (Srinivasan & Venkatraman, 2018). Such scheming and application platform integration strategy helps support digital ecosystem of the entrepreneurial ventures and accelerates the growth of the businesses (Sahut, landoli & Teulon, 2019). Likewise, rapid advancement in technology business ecosystem also tends to pose serious threats and risks in the form of increased competitive rivalry or breach of information security leading to the devastation of the entire business model (Giones & Brem, 2017). Entrepreneurs, therefore can pursue distinctive innovations in their ventures by capitalizing on the opportunities offered by digital system that outline and guide their decisions, transform the capabilities of their businesses and improve their performance given any disaster or crisis occurs (Nambisan, 2017; Ghezzi & Cavallo, 2018; Kraus et al., 2018; Senyo, Liu & Effah, 2019).

It is inevitable to recognise potentially appropriate digital entrepreneurship framework based on an ecosystem characterized by a multifaceted sociotechnical architectural system that embraces extended and secure participation of heterogeneous stakeholders in the digital ecosystems so as to efficaciously commence digital entrepreneurship based projects. Beginning from an abstract and broader digitization to digitalization and then incorporating digital architectures within the digital corporate business models. This shall eventually indorse optimization of sustainable business models functional on digital ecosystems, thereby, developing the grounds for digital environment and

platforms to be developed. Such innovations and transformations through digitalization in business processes is a profound prerequisite for development of sustainable model of breakthrough businesses. This is how digital entrepreneurs can broadly enjoy the freedom of interaction in new entrepreneurial undercurrents and uncertain business environment.

### **3 Research Design**

Besides using the traditional and conventional approaches of researching the intuitionism and its impact, this study will adopt a positive approach to propose the Digital Entrepreneurship Framework by applying Dynamic Capability View in the retail sector medium sized entrepreneurial firms. The reason behind this is that organization's dynamic capabilities play instrumental role for innovation and continuity of businesses in face of any adverse crisis occurrence. A quantitative approach has been used to test the opportunities and challenges for digital entrepreneurship in the retail sector. An adaptive questionnaire based on Likert Scale (1 – Strongly Disagree and 5 – Strongly Agree) was sent to the middle level management, including entrepreneurs, IT specialists, knowledge workers, software engineers etc. to get the purposeful data. A descriptive procedure was conducted to find the nature and extent of avenues of digital entrepreneurship (Zikmund & Babin, 2012). For quantitative analysis questionnaires were distributed to gather data on Likert scale. Purposive sampling technique was used in the intended study for individuals for the special purpose of getting information required in the questions. The selection of the sample was entirely judgmental as the study required (Patton, 2002; Lawrence & Tar, 2013). The key identifiers were selected after seeing their position at the company, their prior qualification and experience in digital ecosystem in start-up venturing and innovation oriented processes in the retail businesses dealing in Lahore, Pakistan.

### **4 Results**

#### **4.1 Demographics**

A total of 253 valid responses were gathered upon data collection and data were analysed. The demographic section of the data collected showed that 17% of the participants were females, whereas, 83% males were entrepreneurs

involved in digital business ecosystem. According to the age group segregation, the highest 46% respondents belonged to the age bracket of 33 to 42 years, followed by 38% for participants falling in 23 to 32 years of age stream, 11% of them accounted to having ages between 43 to 53 years and only 5% of the participants were of the age bracket of 53 to 62 years. The results declared that majority of the managers were 16 years Bachelor's (Hons) qualified, followed by Masters/MSc with 33% presence, the post graduate diploma holders accounted for 22% of the sample, while only 8% of them had completed MS/MPhil education. Likewise, mainstream entrepreneurs and managers working in the start-ups held degree related to IT/SE/CS fields i.e. 57%, whereas 47% respondents accounted for other qualification backgrounds. Based on working experience in start-up entrepreneurial firms, the highest proportion accounted for 42% having experience of 5 to 9 years. 23% of the study participants has working tenure of 10 to 14 years, 20% of them accounted for working experience of 15 to 19 years, 11% were having an initial starting working experience of maximum 4 years. Whereas, only 4% of the sample respondents had vast working experience of 20 years or more in their belt. With regard to the industrial segregation, it was found that majority of start-ups belonged to food industry with 18% representation in the sample selection, 16% for fashion and apparel accessories, 15% for IT and consumer goods, 13% for professional services, 11% for banking and financial institutions 8% in real estate industry, 7% for consultancy firms, and 2% each for transportation and healthcare. The results can be seen below in Table 1

Table-1. Demographics showing percentages and frequencies of participants from various industry start-ups

Sr. #	Demographic Items		
		Frequency	Percentage
1	Gender		
		Female	43
		Male	210
2	Age Group (yrs)		
		23 to 32	96
		33 to 42	116
		43 to 52	28
		53 to 62	13
		63 and above	0
3	Qualification		

	Bachelor's (Hons)	94	37%
	Master/MSc (Hons)	83	33%
	MS/MPhil	20	8%
	PhD	0	0%
	PGD	56	22%
<b>4</b>	<b>Having IT/CS/SE Degree</b>		
	Yes	144	57%
	No	109	43%
<b>5</b>	<b>Experience (yrs)</b>		
	0-4	28	11%
	5-9	106	42%
	10-14	58	23%
	15-19	51	20%
	20 and above	10	4%
<b>6</b>	<b>Industry</b>		
	Healthcare	5	2%
	Information & Technology	38	15%
	Banking and Finance	28	11%
	Transportation	5	2%
	Real Estate	20	8%
	Consumer / Grocery	38	15%
	Food	46	18%
	Fashion and Accessories	40	16%
	Professional Services	33	13%
<b>7</b>	<b>Best growth strategy over next 5 years of the business</b>		
	To sustain my business in its existing size for making income out of it	36	14%
	To grow my business at stable pace for offering growing opportunities for my employees and new job creation	58	23%
	To grow my business as a large business organization and trade shares in market	119	47%
	To organise for sell or closing my business	10	4%
	To apply succession while passing my business and ownership of my business to my children	30	12%
	Total (N)	253	100%

## 4.2 Descriptive Analysis

Based on the descriptive nature of the study, it aims to elaborate the characteristics of the sample population in order to explain the extent of the opportunities and challenges faced by the start-up managers. The study has utilized descriptive statistical analysis verifying the mean and the standard deviation (SD) values of each indicator as exhibited in Table 2 given below.

Table-2. Mean and Standard Deviation of the Evaluation of the Digital Entrepreneurship Opportunities and Impediments

#	Item Indicator	Mean	SD
<b>Problems/Impediments Confronted in Start-up Business Initiation in Face of COVID-19</b>			
1	Huge and fierce competition	3.765	0.642
2	Lack of Technical and Analytical Skills	4.531	0.819
3	Lack of Experience	3.912	0.741
4	Stringent Regulations	3.887	0.530
5	Lack of Opportunities	4.215	0.676
6	Lack of Resources	4.578	0.790
7	Time Constraints	3.769	0.401
<b>Technological Opportunities that Facilitated Start-up Initiation in Face of COVID-19</b>			
8	Robust competitor analysis	2.560	0.328
9	Facilitation in filling skills gap	1.367	0.132
10	Enhanced communication	2.873	0.365
11	Experiential learning	3.564	0.462
12	Online data access	2.790	0.348
13	Better know-how of Govt. regulations	3.084	0.500
14	Building of competitive team with required expertise	2.169	0.298
15	Adaptability of the consumers towards technological platforms	3.793	0.529
<b>Problem/Impediments Confronted Against Human Resource Practices in Face of COVID-19</b>			
16	Difficulty in hiring qualified and expert team	4.534	0.875
17	Absence of suitable and safe working conditions for workforce	3.590	0.651
18	Absence of team work and cohesiveness	4.179	0.739
19	Absence of team leadership and accountability	4.865	0.842
20	Difficulty in ensuring employee participation and work engagement	4.610	0.763
21	Absence of capacity to ensure smooth business transformation	4.489	0.528
22	Absence of competitive pay plan i.e. upgrading salaries and incentives	4.357	0.737
<b>Technological Opportunities in Managing Human Resource</b>			



<b>Practices in Face of COVID-19</b>			
<b>23</b>	ease in search of required talent	0.219	0.329
<b>24</b>	ease for employees working in online mode	0.288	0.287
<b>25</b>	availability of online attendance systems	0.379	0.436
<b>26</b>	Availability of security surveillance system for continuous mentoring of business operations	0.345	0.281
<b>27</b>	Availability of sophisticated ERP systems	0.225	0.193
<b>28</b>	Easy and fast communication within teams using online platforms	0.156	0.184
<b>29</b>	Continuous monitoring of teams' performance using online platforms	0.339	0.273
<b>Problems/Challenges Confronted Against Easy Access Financial Resources in Face of COVID-19</b>			
<b>30</b>	Difficulty in securing internal financial resource fund	4.583	0.860
<b>31</b>	Difficulty in borrowing external fund as loan	4.990	0.913
<b>32</b>	Difficulty in gaining monetary support from family and close acquaintances	3.879	0.784
<b>33</b>	Absence of financial and fund management skills	4.872	0.837
<b>34</b>	Inability to remain updated with ongoing market dynamics and economic cycles	4.369	0.691
<b>35</b>	Incurring high cost in guaranteeing continuous improvement in work processes and products and services as demanded by customers	4.793	0.793
<b>Technological Opportunities to Facilitate Financial Fund Sourcing in Face of COVID-19</b>			
<b>36</b>	Availability and use of digital tools to conduct financial analysis	2.650	0.264
<b>37</b>	Ease in finding and winning investors	1.371	0.195
<b>38</b>	Facilitation regarding applying for the financial loan borrowing using online platforms	2.865	0.321
<b>39</b>	Facilitation in optimizing crowdfunding strategy	2.317	0.187
<b>Problems/Challenges Harming KSAs of Teams in Face of COVID-19</b>			
<b>40</b>	Unavailability of coaching and training resource facilities	4.859	0.681
<b>41</b>	Unavailability of the resources and tools for skill and knowledge enhancement	4.713	0.692
<b>42</b>	Absence of a clear vision and roadmap to achieve company's strategic goals	3.990	0.509
<b>43</b>	Inability to identify gaps in skills and knowledge by conducting comprehensive need analysis	4.794	0.873
<b>44</b>	Absence of motivation to promote learning and growth	4.519	0.719
<b>Technological Opportunities for Supporting KSA Enhancement in Face of COVID-19</b>			
<b>45</b>	Inculcating creative culture by supporting innovation and application of new techniques	2.019	0.462
<b>46</b>	Continuous improvement and development of innovative	1.081	0.324

	processes, services and products		
47	Supporting new knowledge creation	2.093	0.357
48	Developing teams' core skills and competencies	2.185	0.410
49	Periodic training for continuous team development	2.002	0.229
<b>Problem/Challenges in Managing Start-ups' Operations During COVID-19</b>			
50	Difficulty in reaching customers	3.581	0.464
51	Difficulty in delivering services and products to the final customers	4.520	0.732
52	Difficulty in reaching suppliers due to an availability of logistics	4.674	0.801
53	Inconvenience in ensuring regularity in process of payments	4.792	0.832
54	Difficulty in product & service advertising and approaching large number of customers	3.850	0.528
55	Inconsistent external communication system	3.774	0.540
56	Inconsistent internal communication system	3.468	0.493
<b>57 Technological Opportunities Managing Start-ups' Operations During COVID19</b>			
58	Ease in communicating and maintaining customers via official websites, social media platforms and emails	2.795	0.346
59	Ease in using modern technology in designing products & services	1.191	0.209
60	Facilitation in managing raw material supplies and distribution logistics using online platforms	1.240	0.350
61	Facilitation regarding smooth and secured e-payment systems	3.542	0.485
62	Ease in advertising and marketing of products & services via social media platforms	3.640	0.521
63	Ease in internal team communication	3.263	0.279
<b>Problems/Challenges Confronted During Maturity Phase of Businesses under COVID-19 Circumstances</b>			
64	Difficulty in keeping pace with sales' consistency	4.210	0.651
65	Difficulty in smoothly performing with efficiency and effectiveness	4.509	0.769
66	Difficulty to ensure continuous improvement	4.010	0.710
67	Absence of emergent planning and revamping of strategic goals and strategies for continuous business growth	3.956	0.430
68	Difficulty in upholding the superior quality of the products & services	3.651	0.541
69	Difficult to sustain competitive position in industry	4.113	0.703
70	Absence of satisfactory customer service	3.897	0.399
71	Difficult to retain stability in profits (increasing losses)	4.632	0.754
72	Increasing hopelessness and cynicism in attitudes of myself and my team	3.609	0.598
73	Incompetence to sustain performance of business	3.820	0.563
<b>Technological Opportunities Facilitating During Maturity Phase of Business under COVID-19 Circumstances</b>			
74	Higher value for selling the start-up business	2.561	0.324
75	Ease transferring or selling the start-up	2.346	0.465

<b>76</b>	Ease in managing the communication of transference of start-up	2.981	0.434
<b>77</b>	Offering higher innovation to seek another business opportunity	2.569	0.397
<b>78</b>	Facilitation for continuing same business using improved ideas	4.158	0.781
<b>79</b>	Facilitation for continuing to grow same business through capitalizing on new strategic horizons	4.327	0.692

It can be inferred that the start-up stream in retail industry of Pakistan is entrenched under huge burden of existing challenges due to the absence of a solid framework of digital framework in face of pandemic crises. The challenges and opportunities have been analysed different dimensions such as new business initiation, managing HR practices, ability to raise financial resources, knowledge and skill based development, managing business operations, managing business at its maturity stage. The result show that there are lesser opportunities for capitalizing on the avenues of digital ecosystem to be incorporated in entrepreneurial ventures. Table 2 shows that the indicators of challenges on digital entrepreneurship faced by start-ups having mean values above ranging from 3 to 5 are adversaries for the survival and endurance of these businesses to severe lack of a secure and systematic framework of digital entrepreneurship. Contrarily, the indicators evaluating the opportunity landscape of digital entrepreneurship in start-up businesses in face of COVID-19, showed mean values ranging from 1 to 3 reflecting a stark lack of a robust digital ecosystem and technological infrastructure for automating and transforming the retail start-ups.

## 5 Conclusion & Discussion and Digital Entrepreneurship Framework

The findings of the study reach to the conclusion that there exists a threatening and fierce competition in industry; start-ups are facing dearth of technical and analytical skill availability and well experienced team of professionals; the regulations imposed by state are stringent enough to provide a breathing room for navigating digitized business strategies, hence lesser opportunities. The respondents advocated the fact that their business strategy was short of the view to incorporate technology supportive opportunities in order to bounce forward violent competitors' moves, replenishing the existing skill gaps, enhancing communication; promoting experiential learning, gaining better know-how of Govt. regulations, building of competitive team with required expertise, and converging existing and new customers towards adopting new technological platforms.

The study also highlights the impediments witnessed by the start-up firm with respect to their HR Practices. Since, the merciless incidence of COVID-19 resulted in difficulty in hiring qualified and expert teams. There was absence of a suitable and safe working conditions for workforce. There lacked team work and cohesiveness due to absence of team leadership and accountability. The start-up owners fought with the difficulty in ensuring employee participation and work engagement due to incapacity to ensure smooth business transformation and absence of competitive pay plan i.e. upgrading salaries and incentives. Likewise, due to absence of a sound digital entrepreneurship platform, HR management practices were ill-conceived to make entrepreneurs confront never-ending problems such as difficulty in search of required talent, no appropriate planning for employees working on online mode and security surveillance system for continuous mentoring of business operations, ineffective team communication using online platforms and lack of continuous monitoring of teams' performance using online platforms.

Financial resource funding also acted as a huge impediment owing to the inaccessibility and deployment of the digital ecosystem as a proactive crisis response. The problem included difficulty in securing internal as well as external financial funding, absence of financial and fund management skills, inability to remain updated with ongoing market dynamics and economic cycles, incurring high cost in guaranteeing continuous improvement in work processes and products and services as demanded by customers. Likewise, the nonappearance of the technological systems to facilitate financial fund sourcing was quite evident such that it was determined from the results that there persisted an unavailability of digital tools to conduct financial analysis, challenging obstacles in finding and winning investors, no facilitation or support from the state regarding applying for the financial loan borrowing using online platforms or optimizing crowdfunding strategy.

Scarcity of knowledge base and up-to-date skills and abilities also came to be one of the antagonists faced by the start-ups during COVID-19 incidence in view of the non-existence digital entrepreneurship framework being exercised. The problems highlighted were unavailability of coaching and training resource facilities for skill and knowledge enhancement, absence of a clear vision and roadmap to achieve company's strategic goals, inability to identify gaps in skills and knowledge by conducting comprehensive need analysis, absence of motivation to promote learning and growth. The avenues were least explored in

terms of inculcating creative culture by supporting innovation and application of new techniques, continuous improvement and development of innovative processes, services and products, supporting new knowledge creation, developing teams' core skills and competencies, periodic training for continuous team development

The operational efficiency and conformance of retail start-ups as also highly conceded due to massive difficulty in reaching customers, delivering services and products to the final customers and reaching suppliers due to an availability of logistics. Immense inconvenience was consequential in ensuring regularity in process of payments. There was an insignificant possibility with technological support for managing start-ups' operations during COVID19 where the businesses lacked harshly in ease of communicating and maintaining customers via official websites, social media platforms and emails and using modern technology in designing products & services. Start-ups deficient in sophisticated tech-enabled platforms found it hard to manage raw material supplies and distribution logistics using online platforms, and ensure smooth and secured e-payment systems.

Lastly, those entrepreneurial firms reaching the maturity stage of their business life cycle were at total risk of having no planning to transform their business processes incorporating digital entrepreneurial passion and essence of the tech-ecosystem development. The obstacles identified included high level troubles in keeping pace with sales' consistency, smoothly performing with efficiency and effectiveness and ensuring continuous improvement. It was revealed that emergent planning and revamping of strategic goals and strategies for continuous business growth were not proactively devised, hence these businesses were unable to uphold the superior quality of the products & services and sustain competitive position in industry due to increased customer complaints and dissatisfaction, consequently failure to retain stability in profits and sustain performance of business. It was established that most of the entrepreneurs having their businesses troubled against not being able to capitalize on digital entrepreneurship in pandemic crisis are positive for technology adoption for higher innovation to seek another business opportunity.

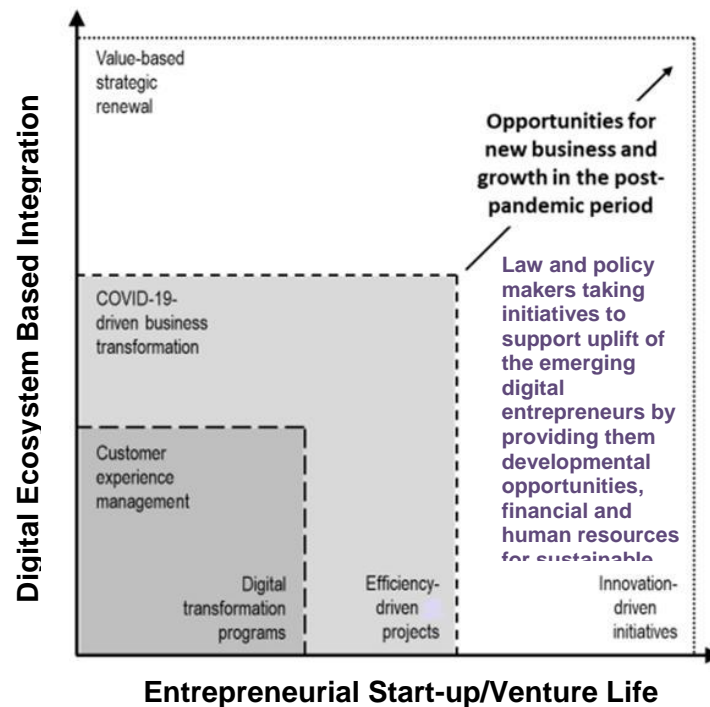


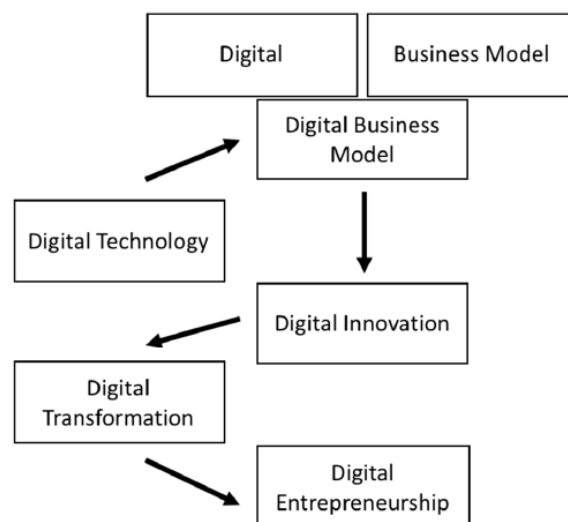
Figure 1: Framework for digital system integration in start-up business model

This backs the idea that for digital entrepreneurs to shape their enterprise around a technological platform it is essential to align their businesses' models rightly with the technological standing of the digital ecosystem. High-tech advancement of their business platforms will require a rapid improvement in business technology. Moreover, it is also an important lesson for the digital entrepreneurs to innovate and distinguish on continual basis among their competitors by seeking forthcoming technological prospects presented by the digital entrepreneurship framework (Srinivasan & Venkatraman, 2018).

These research findings also lead to a significant danger digital entrepreneurs could face i.e. progressively difficult for them to keep pace with rapid technological advancement, not only within platforms (Srinivasan and Venkatraman, 2018). To be and young digital entrepreneurs need to establish and deploy secured technological platforms for inculcating trust and confidence among the market players. As well as customers by taking continuous feedback (Hair et al., 2012).

Another critical underpinning to be taken into consideration is the decisions regarding the architectural configuration of the placement and positioning of the digital ecosystem and adoption of the tech-platform in order to reap the profitable yield of the start-up. Moreover, it also emphasizes the need for conscientiousness of the digital entrepreneurs to foresee ever-changing preferences of the customers, emerging competition and forthcoming market dynamics such as technological advancement, varying regulations imposed by the government on legal and tax related matters. This highlights the essentiality of the adaptive response & flexibility, motivation, commitment and depth as well as breadth of the current knowledge entrepreneurs need to build and maintain for ensuring team devotion and participation, eventually innovation in the business.

Finally, environmental uncertainties such as unprecedented crunch should be grasped through a positive angle where retail start-ups can actually yield substantial profits upon discovering and developing on novel opportunities systematically (Paunov 2012; Evan & Rivera 2020). This leads my research to propose a framework for digital entrepreneurship to support exploring positive and developmental avenues and endure business growth and sustenance beyond the management of crises. It may be enlighten the canvas of the entrepreneurs to search for and effortlessly exercise unceasing optimization of their businesses and safeguard their continuity under the repercussion of COVID-19 pandemic crisis.



*Figure 2: Digital entrepreneurship framework*

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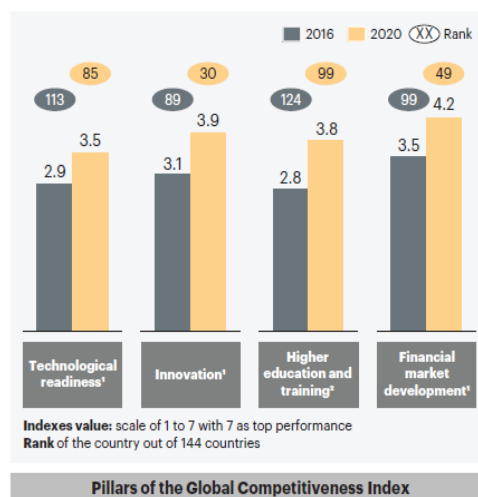
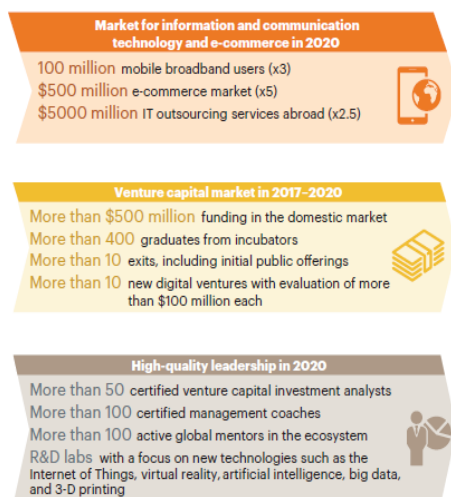
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## Appendix

### Pakistan's digital ecosystem could improve dramatically

#### Ecosystem targets

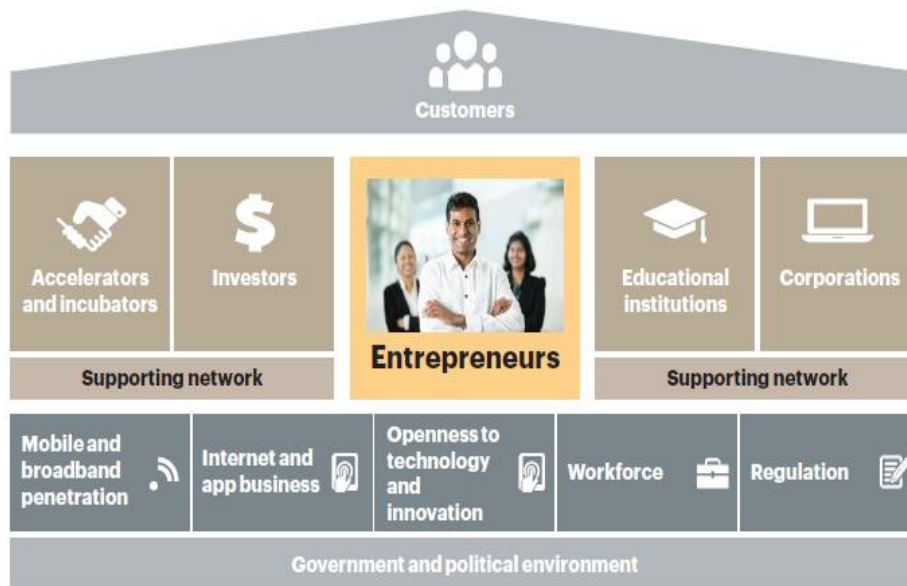


<sup>1</sup> The target for 2020 is the value of the respective index for Indonesia 2015-16.

<sup>2</sup> The target for 2020 is the value of the respective index for the Middle East and North Africa in 2015-16.

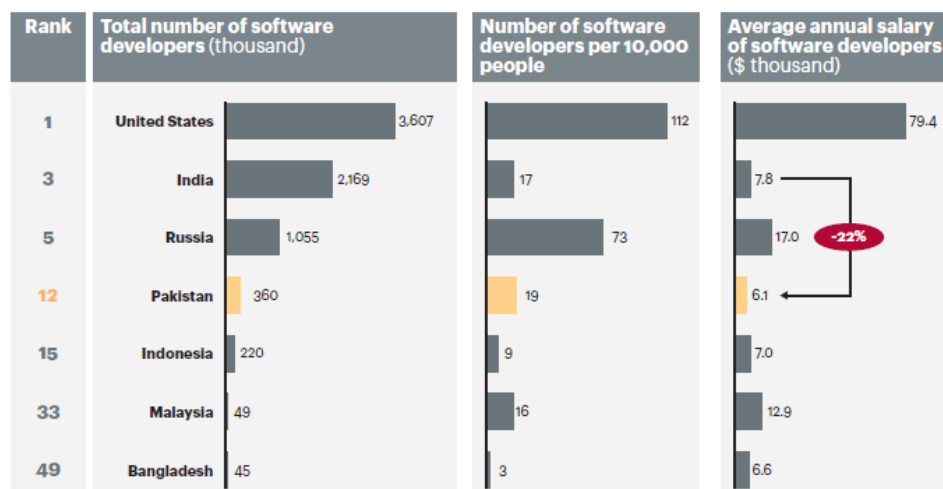
Sources: World Economic Forum Global Competitiveness Index 2015-2016; A.T. Kearney analysis

## Entrepreneurs are at the heart of the digital ecosystem



Sources: A.T. Kearney analysis

## Pakistan ranks high among world leaders for low-cost IT experts

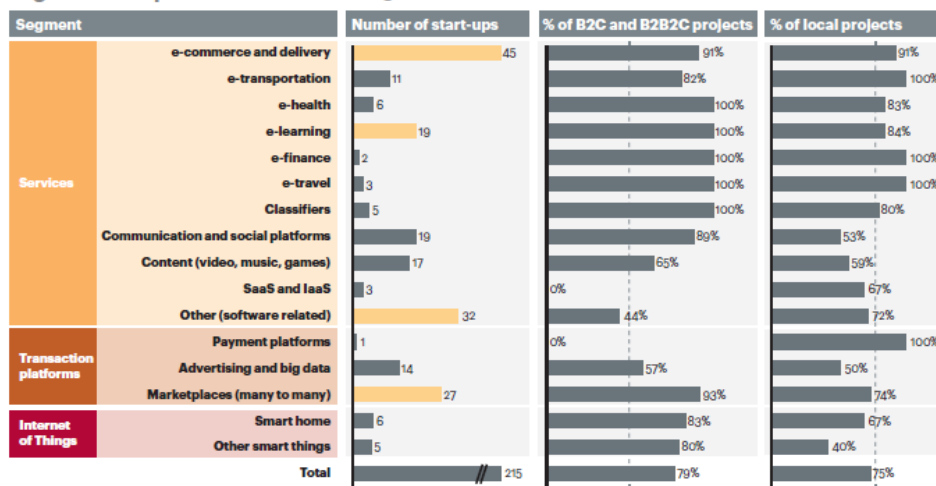


Note: Rank is equivalent to a specialist with one to three years of professional experience.

Sources: The Tech Salary Guide, International Data Corporation, Tech in Asia, market expert interviews; A.T. Kearney analysis

## Most start-ups in Pakistan focus on consumer segments

### Digital start-ups launched since 2013



Note: Data covers 215 digital start-ups that received institutional investment or participated in the local incubating or accelerating program in 2013-2015 and partially in 2016. B2B is business to business. B2B2C is business to business to consumer. SaaS is software as a service. IaaS is infrastructure as a service. Sources: crunchbase, portfolio of local incubators; A.T. Kearney analysis

## Pakistan's digital market is immature

Digital segment		Maturity	Description	Examples
Soft	ICT services	<div><div></div></div>	The most mature ICT segment with huge IT outsourcing market	
Internet Services	e-commerce and delivery	<div><div></div></div>	The biggest online business, high fragmentation, cash on delivery in 95%	Kaymu, Daraz.pk
	e-transportation	<div><div></div></div>	E-parking, rickshaw ordering, e-taxi, and other services for private transport	ShashiSawari, Rixi
	e-health	<div><div></div></div>	Early-stage companies, distribution of healthcare services via mobile in focus	DocHers, Healthwire
	e-learning	<div><div></div></div>	Early-stage companies focusing on primary and secondary education	Interactive Solutions
	e-finance	<div><div></div></div>	Low penetration of banking accounts, high potential of mobile financial services	Jazz Cash, Easypaisa
	e-travel	<div><div></div></div>	Low level of development	Chutti.pk
	Classifiers	<div><div></div></div>	Very popular segment in several industries (property, cars, education, jobs)	Educative, Zameen.com
	Communication and social platforms	<div><div></div></div>	Popular international platforms and several local platforms	Facebook, Whatsapp, Viber
	Content (video, music, games)	<div><div></div></div>	Fast-developing segment with focus on global markets	Wonderful, Soundcloud
Transaction platforms	Payment platforms	<div><div></div></div>	High need but several legal barriers, PayPal not present	Easypaisa
	Advertising and big data	<div><div></div></div>	Emerging segment with a few local companies	Interacta
	Marketplaces (many to many)	<div><div></div></div>	Very popular segment in all industries (education, jobs, cars, commerce)	Rozee.pk, OLX
Internet of Things	Smart home	<div><div></div></div>	Emerging segment, technical capabilities (robotics programs, mechanical engineering in universities)	E4 Technologies
	Other smart things	<div><div></div></div>		Cricflex

○ Nonexistent   ● Emerging   ● Peaking   ● Maturing   ● Saturated

Note: ICT is information and communication technology. Sources: market experts interviews; A.T. Kearney analysis

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## **Creative Neighbourhoods between Creatives and Public Administration**

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### **Abstract**

Creative neighbourhoods are the subject of increased discussions and concerns, both in the academic and the professional communities, having various cultural, social, economic, and policy implications. Nevertheless, the theorising in the field is at the beginning. Various interdisciplinary approaches highlight especially social, economic, and urban implications. The study aims to investigate the dynamic of creative neighbourhoods in Romania to understand which are the factors leading to success stories both for the creative communities and for urban development. The dynamics associated with the local administrations in two main Romanian cities are explored: Bucharest and Cluj. The findings are shading lights on the inner dynamics of creative communities in creative neighbourhoods in relationship with public administration for better cooperation.

**Keywords** – creative neighbourhood, creative community, cultural entrepreneurship, local administration and culture

**Paper type** – Academic Research Paper

## 1 Introduction

The way culture and creative industries could contribute to sustainable local development has generated extensive discussions (Duxbury, Cullen and Pascual, 2012; Sacco, Blessi and Nuccio, 2009; Van der Borg, Russo, Lavanga and Mingardo, 2005). A main aspect to consider is the impact of culture on urban regeneration (Della Spina, Giorno and Casmiro, 2019; Gaetan and Zheer, 2017; Russo and Van der Borg, 2010; Paddison and Miles, 2020; Sasaki, 2010), as well as on community wellbeing (Stern and Seifert, 2017). Some very visible and much-acclaimed success stories as Guggenheim Bilbao are always mentioned in such contexts (Gazura, 2018; Lange-Valdés, 2018). Nevertheless, not all support of cultural and creative industries leads to local economic development and social development (Jarvis, Lambie and Berkeley, 2009). Therefore, public bodies should wisely integrate culture and creative industry as part of their development strategy.

A possible approach would be to create and/or sponsor creative communities and quarters. Designing /supporting creative neighbourhoods is a topic of interest both for local public administration which targets sustainable development, as well as for the creative communities themselves which count on a multiplying and networking effect. Although such initiatives are always praised, limitations and challenges should also be considered (Jakob, 2010). Several dimensions are to be kept in mind in the context of creative neighbourhoods: the specific cultural setting, the local cultural organisms, the cultural infrastructure, and the cultural and creative tourism in the area. The digital age added some additional factors to consider, opening these communities to the outside world (Evans, 2009).

Considering this framework, the present study aims to investigate the dynamic of creative neighbourhoods to understand which are the factors leading to success stories both for the creative communities and for urban development. To achieve this goal, a narrative literature review focused on conceptual understanding is considered, followed by a qualitative investigation. The qualitative investigation comprises two parts aiming to uncover explore the role

of public administrations in the development of creative neighbourhoods in Bucharest in Cluj, the largest and most dynamic cultural Romanian cities. Firstly, to gain a broader understanding of how local authorities are positioning their interventions as strategic planners as well as main regulatory bodies, we conducted a content analysis comprising a series of documents elaborated by local authorities Bucharest and Cluj (see Table 3). Secondly, a thematic analysis was conducted on a corpus comprising a series of written that describe four different initiatives involved in the construction and active communication about various concepts of creative quarters in Romania: Cartierul Creativ (2021), Centrul Cultural Clujean (2019).

While creative quarters might be a common encounter in many developed countries, in Romania they are a reality in the making. Therefore, understanding the associated evolution might help to find and implement effective development strategies. We have chosen two main cities in Romania, particularly relevant for our research. The findings are relevant through shading lights on the inner dynamics of creative communities grouped in creative neighbourhoods. It maps the specific networks and reveals the role that public administration might play in supporting creative neighbourhoods.

## 2 Creative neighbourhoods – mapping the concept

The term creative quarter/neighbourhood/district is increasingly more present in discussions related to urban development and community wellbeing. It seems that several concepts are used interchangeably, with the largest popularity registered by the creative district as presented in Table 1.

Table 1. The concept popularity (no. of entries)

Concept	Google	Google Scholar	WoS
Creative neighbourhood	30.600	170	1
Creative neighbourhood	131.000	267	2
Creative quarter	201.000	778	10
Creative district	262.000	810	14

Another term extensively used is a creative cluster, but this has a wider significance, not necessarily referring to specific spatial surroundings. A recent review (Chapain and Sagot-Duvaurox, 2020) shows each academic discipline investigating the concept presents its own perspective and stresses some specific

cultural, economic, social aspects. At the same time, studies seem to limit some case studies and tend to contribute to transferring approaches from Western countries to the rest of the world. Nevertheless, most of the research comes from Europe (62%), followed by the US (14%) (Chapain and Sagot-Duvaouroux, 2020). Especially in the past 10 years, the concepts of creative/cultural districts/quarters/neighbourhoods are overlapping in academic research. It seems to be a certain geographic preference for these concepts – for instance, “cultural district” seems to be preferred in the US and Italy, or “cultural quarter” in the UK and Ireland (Chapain, and Sagot-Duvaouroux, 2020).

This literature review also documents a lack of theorization of the concept, which might be related both to the complexity of phenomena associated and diversity of perspectives that could be considered (geographic, cultural, economic, urban planning, etc.). One of the definitions, of Walter Santagata, developed in 2002 for cultural district, is considered as the most influential: “Cultural districts are defined by the production of idiosyncratic goods based on creativity and intellectual property. The movie industry, the audio-visual sector, the extensive domain of industrial design and the production of arts and crafts, museum services and the ethno-gastronomic complex all draw their inspiration from some cultural link with their original community” (Chapain and Sagot-Duvaouroux, 2020). At the same time, the cultural quarter seems to be more tightly associated with a specific location, a section of a city.

The present paper takes into account a synonymy of the concepts creative district, creative quarter, and creative neighbourhood. It defines the concept as a network of places and happenings within the territory of a town/city which is developing as an urban collaborative space and encompasses a creative community and the associated means of producing cultural and creative goods and services, with place-bound characteristics and value-chains, offered to a wider public either by creatives themselves or mediated by organizations specialized in a creative and cultural offer (theatres, museums, etc.) or which integrate into their business models features defined as innovative / creative / cultural (restaurants, shops, etc.).

This is a working definition, which for sure can be improved considering the complexity of the phenomenon. We also stress that we prefer the term creative neighbourhood due to its human dimension, stressing the capital relevance of the people involved – either creatives or the beneficiaries of their work. It also seems to encompass the importance of communities, both considering the relationships



between creatives and the wider communities for which they are relevant. In such spaces, creatives are mixed with residents and visitors, all contributing to developing a creative milieu supporting different lifestyles, innovative architecture and urban planning, the development of cultural organizations, and various types of businesses.

Cultural organizations and creatives could be connected in three types of creative spaces: scenes, quarters, and clusters (Wen, 2012). The first term refers to the cultural content and human bonding. The second one includes an urban connection. The third one refers to the industry, putting the focus on organizations. We will concentrate on the second type, trying to better understand the diversity of approaches.

The typology of creative neighbourhoods seems to be wide, related mainly to the inner structure and the cooperation networks developed inside the district, portfolio, and organizational framework (Moomaas, 2004; Redaelli, 2019). Considering the sponsor of a creative quarter, we identify two main approaches: the bottom-up and the top-down strategies. The first one is developed by artists and local organizations informally, while the second is planned formally by public administration (Chapple, Jackson and Martin, 2010). Nevertheless, cooperation among all stakeholders and active creative communities are key for the success of such initiatives (Romanelli and Zbucheá, 2020).

Another typology stresses the characteristics of the offer. Three types have been identified (Lavanga, 2020). Some are more production-oriented, encompassing businesses creating cultural and creative products and services, while others are oriented towards consumption such as museum districts. The third type is a mixture of the two.

Based on the relationship between property development and cluster formation, there are four types of cultural quarters: scene-consolidating quarter, scene-displacing development, scene-spatializing quarter, and scene-imitating development (Sonn and Liu, 2014). The scene refers to "a collection of activities related to the production and consumption of cultural products". In the case of scene-consolidating neighbourhoods, the scene's spatial core existed before cultural cluster development. In the case of the scene-displacing development, one can observe a potentiality for cultural neighbourhood development in the context of the spatial existence of a cultural scene. In the case of the scene-specialising cluster, there is no spatial cultural scene before the development of the cultural cluster. In the case of scene-imitating development, there is a sponsor

of a cultural cluster who simulates the existence of a scene, hoping for cultural consumption to occur.

A typology of creative cities considering the three main reasons of intervention (social inclusion, urban planning, and economic development) identified the “natural born” approach, the culture-led social inclusion approach, the business approach, the bulldozer-business approach, the European Capital of Culture approach, the enhancing approach and the phoenix approach (Rato, Roldão and Mühlhan, 2009). This could be transferred to creative neighbourhoods.

Table 2 synthesizes types of creative neighbourhoods, discussed by various researchers (Chapple, Jackson and Martin, 2010; Cinti, 2008; Lavanga, 2020; Moomaas, 2004; Rato, Roldão and Mühlhan, 2009; Redaelli, 2019; Santagata, 2002; Wen, 2012).

Table 2. Taxonomy of creative neighbourhoods

Criteria	Typology
Developmental path	bottom-up top-down
Development strategy	formal approach informal approach
Cohesion	aggregations of organizations and individuals well-planned strategy
Main actors and scale	industrial cultural district institutional cultural district museum cultural district metropolitan cultural district
Reasons of intervention	“natural born” culture-led social inclusion business-oriented bulldozer-business-oriented European Capital of Culture enhancing approach phoenix approach
Relationship between property development and cluster formation	scene-consolidating neighbourhood scene-displacing development scene-spatialising neighbourhood scene-imitating development
Horizontal portfolio	production-centred production-consumption mixed consumption-centred
Vertical portfolio	one dominating industry multiple industries contributing

Focus	art-oriented entertainment-oriented
Financial support	public sector financed business-oriented mixed public and private support
Location	city centres marginal location
Level of openness	exclusive membership completely open to members

Independent of the evolution and type of cultural neighbourhoods, there are some joint components they display (Santagata, 2011, p.148): *"a) a local community, which is cohesive in its cultural traditions and in the accumulation of technical knowledge and social capital (trust and cooperation); b) a significant development of increasing returns to scale and increasing returns to scope; c) accumulation of savings; strongly entrepreneurial cooperative local banking; d) a bent towards open international markets; e) public financial support along the entire chain of the creation of value; f) a high rate of birth of new firms, often of household size, as a result of social capability and interactive learning; the ability to be district minded, to become a system, and to produce positive externalities."* At the same time, three distinct conditions are defining a creative quarter: specific activities, personalized built form, and cultural meaning (Montgomery apud Wen, 2012, p. 29).

The combination of these aspects contributes to the level of development of such districts as well as to the degree of creativity and innovation they display. The developed and functional creative districts could have a significant impact on urban regeneration, leading also to innovative cities and culture-led development (Pourzakarya and Bahramjerdi, 2019). Nevertheless, culture-led development has also been criticized due to some inequalities it might generate (Pourzakarya and Bahramjerdi, 2019). All these aspects stress the special attention that public administration should place on cultural districts and offer significant points of reference to cautious and strategic planning.

### **3 Public administration and governance for creative neighbourhoods**

Supporting creative neighbourhoods as public and urban innovation develops in a *plural and pluralist state* where multiple inter-dependent actors and

processes contribute to the effectiveness of public services and inform the policy-making system (Osborne, 2006). Within a networked governance, multilevel institutions are involved within civil society (Bevir, 2006), policy-makers are leaders and interpreters, and public managers act as *explorers* in interacting with people as co-producers in the pathway leading to urban value creation and innovation (Hartley, 2005).

Following a 'state-centric' view, neighbourhood governance relies on governments re-connecting with citizens and stakeholders for better decision-making and services delivery, while a 'bottom-up' view is opening to new governance spaces that enable citizens to decide how to contribute to governing according to a community-based decision-making process in a multi-actor and multi-level governance (Lowndes and Sullivan, 2008). Urban spaces enable collaborative and multi-actor involvement as governance innovation, whereas private and public organisations co-initiate the collaboration process and develop collaborative and public innovation (Sørensen and Törfing, 2018; Hartley, Sørensen and Törfing, 2013). Supporting creative neighbourhoods requires to develop urban governance which concerns the cooperation among public and private actors, and civil society (Swyngendouw, 2005), by strengthening collaboration and partnership between public and private actors as drivers of effective managerial capacity (Kort and Klijn, 2011), that contribute to value co-creation at neighbourhood level, promoting collaborative arenas within a community (Törfing, Kristjansen and Sørensen, 2021).

Governments promote long-term collaboration, voluntary participation and active public-private partnerships, strengthening the central role of stakeholders and community-led organizations (Jung, Lee, Yap and Ineson, 2015). Public authorities play a key role in giving creative entrepreneurs a chance to experiment and engage the community in reinventing a future-oriented and sustainable urban future (Della Lucia and Trunfio, 2018), promoting a vision of the neighbourhood as a driver of urban renewal and social change within communities, and identifying new ways of participation to redefine the urban culture-led and renewal processes, enabling public and private actors to shape the neighbourhood as a creative space that supports urban development and fosters a multi-cultural perspective, by involving the local community (Pradel-Miquel, 2017).

Collective actors transform urban spaces as creative places by supporting public debate and strengthening the partnership between public administration

and civil society organizations to reinforce urban and cultural renewal, social cohesion, and community life (García, Eizaguirre, and Pradel, 2015). Public administration can drive 'bottom-linked' social innovation and creative strategy for renewal of neighbourhoods promoting multi-level governance, connecting government and civil society (Pradel-Miquel, García and Eizaguirre, 2013). Culture-driven urban regeneration processes develop through collaborative spaces that foster multi-actor stakeholder collaboration and enhance the quality of life within urban communities (Sørensen and Törfing, 2011), and driving social innovation and governance through collaborative practices between civil society organizations and public actors that develop solutions meeting social needs (Galego, Moulaert, Brans and Santihna, 2021). Urban innovation by collaboration implies that public leaders and managers act as *mediators* who facilitate collaboration between stakeholders. Public sector leaders have to set the agenda, defining policies, and supporting dialogue with a plurality of actors. Public managers act as meta-governors managing collaborative arenas (Hartley, Sørensen, and Törfing, 2013).

## 4 Developing creative neighbourhoods in dynamic cities. Bucharest and Cluj

### 4.1 Methodology

The local authorities' perspective on their involvement with creative districts is investigated through content analysis, of a corpus of official policy documents elaborated by or commissioned by the public administrations in the two cities. Table 3 presents all the documents we identified as such. When this research was conducted, not all of them were publicly available (online) and, therefore, we could not include them all in the analysis.

Table 3. The body of documents regulating city-policies in the sample

Document	Date, info
Strategia de dezvoltare urbană integrată a Municipiului București și a teritoriului său de susținere și influență - Concept strategic București 2035/ Strategy for integrated urban development of the	2012 The document was commissioned by the Municipality of Bucharest and elaborated by a research center within the National University of Architecture (in Bucharest) as the main contributor and two other business partners,

Municipality of Bucharest and its hinterland – Strategic Concept Bucharest 2035	consultancies operating under an LLC regime.
Strategie Integrată de Dezvoltare Urbană (SIDU) 2021-2030 / Integrated strategy of urban development 2021-2030	Currently, the document is in public consultation (throughout 2021). The PR campaign accompanying the project describes it as a project that “takes into consideration citizen needs, to guide the urban development inclusively, strategical, sustainable and on the long term”. No draft versions of the document are available to the public on official sites or Facebook. The project is developed by the Municipality of Bucharest and the World Bank.
Bucharest Cultural Strategy 2016-2026	2016 Commissioned by ARCUB (the Center for Cultural Projects of Bucharest) – a structure within the Municipality of Bucharest; The document is the result of previous analysis implemented by a network of NGOs, as well as consultation with an impressive number of stakeholders. It was coordinated by ARCUB together with an independent team.
Strategia de dezvoltare a Municipiului Cluj-Napoca 2014-2020/ The development strategy of the Cluj-Napoca Municipality 2014-2020	2015 Developed by a larger group comprised of working groups coagulated, in their turn, around a series of problems concerning the community. The working groups were constituted chiefly by university staff, other local experts and ordinary citizens. The resulting document, adopted by the municipality is presented, in a bid to foster unity as a strategy of the entire community, not only as a strategy of the mayor’s office.

#### **4.2 Findings: local authorities on creative industries and creativity**

The Development Strategy for Bucharest 2035 (UAUIM/PMB, 2012), and awarded strategy, visions the city as “an influential and integrated European metropolis through sustainability and character, reinvented intelligently and sensitively, an open and evolved community, a dynamic and creative capital.” Nevertheless, the cultural and creative dimension is considered only through the city’s built heritage. The strategy proposes interventions considering the living conditions, the green areas, and transport. Several poles are proposed, considering competitiveness development, transport, research, and leisure. The

strategy proposed both large-scale and focused urban interventions. Culture and creativity are mentioned together in this strategy, without actually being defined; creative management of cultural landscape and creative management of the built heritage is proposed, but a definition for a “cultural landscape” is not provided, nor it is very clear what exactly “creative management” implies.

The Cultural strategy of Bucharest (2016) proposes five major development axes. In this framework, the city’s neighbourhoods are strategic centres for activating “proximity” culture and increased cohesion. The strategy registers the weak cultural infrastructure in various neighbourhoods and its continuous degradation in the past decades. At the same time, it also registered increased interest in cultural activation and raising the identity profile of various neighbourhoods, as a joint result of public cultural organizations as well as NGOs, either cultural or social. The strategy also registers small “creative quarters” – limited areas where some specialized cultural shops and initiatives tend to gather (ARCUB, 2016, p.21). Overall, the strategy proposes to support the development of local neighbourhood identities, citizen initiatives, and local cultural events, rather than more formalized “creative neighbourhoods”. The strategy pinpoints that “by raising the quality of life, the vision aims for Bucharest to become a city in which I love to live, structured on neighbourhoods of a specific nature, full of vitality and dynamism, which will ensure the inhabitants’ urban comfort, a diversified offer of places to work, public spaces for entertainment and culture” (ARCUB, 2016, p.47). Even if creative quarters are not excluded, they are suggested to be cultural hubs developed organically within larger historical neighbourhoods. Nevertheless, the public administration should provide a balanced distribution of public equipment, infrastructure, and transportation, to ensure the development of neighbourhood centers, aimed to facilitate and stimulate sustainable development (ARCUB, 2016, p.48). It would be cooperation between the central-local administration and district administrations (for details on “Culture in proximity” see ARCUB, 2016, pp.54-56). In parallel, it proposes the development of specialized cultural quarters by public investment, such as Cultural City, City of Music, Radio House, meant to be “strategic development areas” (ARCUB, 2016, p.65). The first one would have a wide area covering the city center, while the other two seem to be small areas developed around major cultural venues (ARCUB, 2016, p.48).

The development strategy of Cluj-Napoca municipality is presented as the result of a “permanent partnership between local government and the

community" and it was documented on a public online platform. Several working groups, which comprised many representatives of the prestigious university in the city, as well as representatives of the non-profit sector, were active in the process of planning of the strategy, some of them being directly connected to cultural and creative fields: People and community; Innovative, creative, competitive city; Culture and local identity (PMCN, 2015). The vision reserves to culture the following status: "Cluj will be a European landmark through its dynamic, vibrant cultural life, which supports experimentation and initiative. Culture will be a cross-cutting factor community organisation, becoming the engine of social transformation and urban regeneration" (PMCN, 2015, p. vi). Stimulating the creative industries is considered a factor of economic development, as well as communities' wellbeing (PMCN, 2015, p. x). Creativity, in general, is a keyword in the strategy, being used more than 300 times. "Creative quarters" appears seven times, being considered as facilitators of the implementation of the development strategy. Creativity is also tightly related to the idea of innovation and competition. The creative industries are part of the intelligent specialization strategy (PMCN, 2015, p. 64).

The strategy defines as an aim "stimulating entrepreneurship in creative industries by creating incubators/clusters/accelerators and by supporting the development and establishment of firms in the field of cultural and creative" (PMCN, 2015, p.71). Considering the overall strategy, which does not specifically elaborate on the development of creative neighbourhoods, the creative clusters proposed in the strategy refer to sectorial and organizational clusters, rather than geographic creative areas. The strategies of the development of creative industries are based on relationship extension and connection (PMCN, 2015, p.275). Cultural megaprojects are also proposed, such as Transylvania Cultural Center, Center for Cultural Industries, etc. These are probably in connection with the identification of the "lack of cultural/community/creative spaces in different areas of the city" (PMCN, 2015, p.552). In spatial terms, the strategy proposed the development and design of various creative spaces (PMCN, 2015, pp.552-553), but no specific area is identified by the strategy. The development of creative neighbourhoods is open, specifying a "Program for activating peripheral spaces for cultural and community activities" (PMCN, 2015, p.557). The settlement of at least one creative quartier was projected for 2020, in the context of preparing the application process of Cluj for 2021 European Cultural Capital. Although the competition was won by Timisoara, all the effort poured into preparing the



documentation was coagulated around Centrul Cultural Clujean (Cluj Culture Center), an NGO for culture and sustainable development, comprising a network of 112 members, cultural organizations and institutions, universities, associations of the business sector and the civil society, and the local and regional administration. Further steps into developing an infrastructure specific to creative districts (co-working spaces, studios, micro-production workshops, etc.) were taken during the competition for the title of the European Capital of Innovation when the city of Cluj made some strategic choices (e.g. Cluj Innovation City).

#### **4.3. Findings: creatives about public institutions and local authorities**

Using thematic analysis to inquire on how creative industries' promoters are seeing the impact of their activities on the city's cultural vitality (mainly in terms of developing creativity and innovation) as well as how they understand their relationship with public institutions and local authorities - has revealed a series of insights related to the ongoing process of constructing cooperation and cohabitation within one given space (e.g. the creative district).

*Building cohesion* and *fostering local creativity* are the most frequent themes developed throughout all the analysed corpus. They are declined either in terms of network, platform, instruments, and community and accompanied by verbs such as: to coagulate, to build, to developing (in Bucharest) or they are constructed around the divide between the individual and the collective (in Cluj).

However, when the relationship with the city itself is implied, a variety of themes emerge as secondary themes. Amongst them: *urban regeneration, empowerment, diversity, quality of life, and sustainability*.

The creative quartier in Bucharest consider its role within the broader life of the city as an opportunity to change the narrative about Bucharest (without mentioning what this narrative is supposed to be), an alternative to the city's "old town" as well as an opportunity to construct a creative city branding. The orientation to Bucharest inner "problems" seem to dominate the creative quartier projections, meanwhile at Cluj culture seems to act like an instrument enabling the city to reach out to its ambitions as local/regional pole of influence, "a leading European city in arts and culture" (CCC, 2020). Surprisingly, *diversity* - is only briefly and marginally considered by the creative quartier in Bucharest (in relation to diverse cultural experiences and to build heritage) and not at all in Cluj - a city that is almost a cliché for diversity in Romanian collective representations. Also,

*the quality of life* is only mentioned in texts related to Bucharest creative quartier, meanwhile in Cluj, although never mentioned as such is declined in terms of "collective well-being, sustainable society, common good".

All in all, the main difference between the promoters of cultural and creative industries as they are discussed by leading initiatives belonging to both cities resides in the way they position themselves in relation to other actors within the same field of interest. The creative quartier in Bucharest gravitates towards being a part of a creative ecosystem, together with other cultural organisations and (public) institutions, meanwhile in Cluj, the main perspective is emphasizing culture as a driving force for innovation and creativity / creative industry amongst others.

## **5 Conclusions**

Several concepts are referring to the area structured within a city that is credited with thriving creative communities and cultural organizations: creative neighbourhoods, creative quarters, creative districts, or even creative clusters. Preferences for various terms are related either with some geographic context or with the desire to stress a specific aspect of that area. Previous studies have highlighted especially aspects related to their social, economic, and urban implications. Inner dynamics, in relation to local administration, are main factors which influence the success of creative neighbourhoods, therefore, they require more focused attention.

The creative neighbourhood is a topic of increased concern in academia, especially due to its continued practical relevance. It is credited with contributing to the sustainable development of cities, even if some studies also pinpoint some debatable aspects. Nevertheless, there are many different stakeholders interested in this space, therefore, one registered a multitude of situations, approaches, and implications.

The rise of creative neighbourhoods as urban and culture-led spaces relies on public administration that supports creative-led and bottom-up citizens' and civil society associations' initiatives, promoting networked public governance through collaborative spaces that involve public and private actors to share ideas and information, to build decision-making processes that make urban governance as a socially innovative space engaging the whole local community.

Considering the city of Bucharest, some creative neighbourhoods have been organically developed, with no public involvement or actual support. The public strategy acknowledges some of these efforts and considers their support, including through cooperation and investments, but no specific actions have been undertaken. The city cultural strategy seems to be independent of the sustainable development strategy of Bucharest, although the one does not necessarily exclude the other. Nevertheless, up to date, there are no clear signs of implementing the strategy related to the cultural development of neighbourhoods. In the case of Cluj, considered by some the "cultural capital" of Romania, the public administration includes in its strategic development plans the concept and creative neighbourhoods and their support. Nevertheless, it seems to be no actual strategic approach in this sense. Cultural and creative initiatives might be supported by the municipality along with other social projects, within larger financing schemes.

On their part, the creative organizations and communities which support the cultural and creative development of the cities, including shaping creative neighbourhoods and clusters do not expect too much support from the part of public administration. They do not include public-private cooperation as a main pillar of their development. Nevertheless, they rely on networking and cooperation with all stakeholders which prove to be open and dynamic. The approach in both investigated cases is bottom-up (even if in Cluj de strategic documents could suggest also some interest in top-down approaches), informal, organically aggregating organizations and individuals, being a combination between "natural born" and enhancement. The public administrations in both cases seem to be optional, a desired stakeholder, but, at least in the present moment, their status floats as discretionary stakeholders.

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## Rethinking Sustainable and Smart Working Public Organisations

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### Abstract

Information technology is driving public organisations as smart and sustainable working organisations that facilitate processes of public value creation. Technology is opening to public collaborative innovation. As organisations seeking sustainability as a vision for strategy and action, public organisations evolve by developing strategic, managerial and technological sources to enable public value creation within society. Smart working is emerging as a new way to shape the work relationship as both collaborative space and innovation. Public organisations achieve sustainability adopting a service logic view as strategic orientation by developing the potential of information technology in order to drive innovation by building digital, smart, lean and open platforms for value creation, innovation and networking. Smart and sustainable working public organisations contribute to value creation processes and promoting collaborative innovation as a key source of public innovation. They support innovation as enabled by digital platforms, and adopt the smart working as a way to enhance collaborative innovation, enhancing the role of public managers, and strengthening the social and human factor in smart work relationships by developing the potential offered by information technology.

**Keywords** – public organisations, information technology, sustainability, smart working, collaborative innovation.

**Paper type** – Academic Research Paper



## 1 Introduction

Today, the advent of emerging information and communication technology is driving modernisation and innovation in public administration, leading to digital, smart, agile and sustainable government. Following both a service logic view to public value creation (Osborne, 2018) and a public value management view (Stoker, 2006), public organisations are rethinking how to develop a smart view in order to achieve sustainability as a vision for change, driving public decision-making, management and governance (Goodsell, 2006; Fiorino, 2010), promoting cooperation and social exchange with civil society and governance networks within social ecosystems (Dumay, Guthrie and Farneti, 2010), driving innovative collaboration as a key source of public innovation (Törfing, 2019; Törfing, 2016).

Smart and sustainable organisations perform better (Matheson and Matheson, 2001), placing the development of human capital at the heart of their strategic approach (Pfeffer, 1996; Pfeffer, 2010), promoting collaborative relationships and innovation within work environments (Aggerholm, Esmann, Andersen and Thomsen, 2011). Sustainable competitive advantage relies on promoting the role of people within the organisation, working with people, empowering them and enhancing their participation at work (Pfeffer, 1995). Sustainable companies empower the employees and enable the managers to promote collaborative and cooperative spaces within the organisation (Leon, 2013). Sustainable future refers to long term strategic and organisational orientation and requires that «managers need to embrace a process that identifies, prioritizes and processes sustainability issues» (Perrott, 2015, p. 50). Embedding sustainability in the organisation implies to support the continuous learning and organisational capacity in order to develop the orientation to change and the commitment to improvement and innovation (Haugh and Talwar, 2010).

Smartness has become a desirable outcome and key source for sustainability. Innovation is rising at the top of public agenda reform, offering a satisfying solution to emerging problems. Information and communication technology (ICT) is opening up the way to public organisations which are becoming smarter in order to drive sustainable growth and development (Gil-Garcia, Zhang and Puron-Cid, 2016). Public organisations serve the public interest as the result of dialogue with citizens (Denhardt and Denhardt, 2000), promoting public innovation through collaborative processes that involve private and public organisations in order to support value creation (Ansell and Törfing, 2014). The

advent of ICT supports open and public innovation within a networked governance (Hartley, 2005; Mergel, 2018), and helps public organisations to communicate with citizens and enable them as active co-producers of social, democratic and public value (Moore, 1995).

Smart government helps to drive successful modernisation in the public sector, rethinking the way by which government works by digitalising processes (Schendler, Guenduez and Frischknecht, 2019). Technology is opening up to digital and smart public organisations as enablers of social and public value creation. It is time to rethink the role of public organisations as smart and sustainable organisations which contribute to developing continuous innovation, facilitating the processes of public value creation, promoting multilateral and collaborative relationships between public and private actors within society, and driving smart working as a collaborative innovation and space that benefits both wealth and performance of employees within work environments. Advanced smart technology and digitalisation in government is leading public organisations to becoming smart organisations which support innovation as a key dimension that enables smartness in government as a way to continuously work by efficiency and effectiveness, and deliver services and operations (Gil-Garcia, Zhang and Puron-Cid, 2016). Public managers as agents of change should exercise leadership in interacting within organisations and with external stakeholders, acting to realize rights and responsibilities, meeting citizen preferences and interacting with community (Stoker, 2006; O'Flynn, 2007; Moore, 1995).

The advent of pandemic Covid-19, originated by the rise of a new *coronavirus* (Sars-Cov2) as a virus of the species severe acute respiratory syndrome-related coronavirus (SARSr-CoV) which is able to infect also the humans, causing, in particular, many cases of pneumonia, has led to a worldwide health crisis which impacted on the life of people and organisations, leading companies to redesigning the organisational arrangements, accelerating digitalisation, and enabling information technology as a key source for driving and managing changes, a means for driving innovation. The use of information technology at work opens to a space of collaboration by revisiting the work organisation and leading to an increase of remote working, teleworking and online working, supporting smart working practices. During the most acute phase of the emergence from Covid-19, for example, smart working involved the 97% of large companies, the 94% of Italian public administrations and the 58% of Small and Medium Enterprises (SMEs), for a total of 6.58 million agile workers, about one

third of Italian employees, more than ten times more than the 570 thousand surveyed in 2019 (Politecnico di Milano, 2021).

Employees in private, small, medium and large companies and public employees have therefore experienced a different way of working as enabled by ICT in transition from telework and remote working to smart working coherently with an organisational view to rethinking both work organisation and the role of organisation becoming smart developing the potential of ICT (Viceconte, 2020). During pandemic Covid-19 health crisis, the information technology has increasingly impacted on life of people and organisations leading to considering the smart working as an emerging and innovative phenomenon and work design experiment, becoming part of a process of profound cultural and organisational changes (Torre and Sarti, 2018), empowering managers and followers in improving the ICT-enabled work relationships (Harris, 2003). While teleworking refers to a work organisation that involves working at a distance from the company's main office and the use of information technology (Dambrin, 2004) in response to energy crisis in the early '70s (Munir *et al.*, 2018), in virtue of the acceleration provided by pandemic crisis, the developments of technology and digitalisation are leading to promoting smartness at work and within organisations are opening to smart working and driving a new way for work organisation, leading to innovation in work processes, environments and behaviours of people at work that concern and involve the relationships between employees and managers. Smart working requires that managers have to assume new behaviours in order to make more collaborative and productive the work relationships, improving cooperation with employees. While managers utilise and control human resources, leaders should motivate people, inspire, develop and innovate (Bennis, 1989). Public managers play a key role in driving the organisation to achieve the desired objectives (Van Wart, 2013), promoting collaborative practices, behaviours and management styles across governmental boundaries (McGuire, 2006), supporting public service motivation of employees to public service value, enhancing the commitments to public mission, fostering job satisfaction, work performance and quality (Van der Voet, 2014; Moynihan, Pandey and Wright, 2009; Park and Rainey, 2008).

The aim of this study is to elucidate how public organisations are becoming smart and sustainable working organisations, strengthening managerial and technological capabilities. As sustainability-oriented and value-oriented organisations, public organisations adopt a service logic view enabling the service

users to actively contribute to value creation (Osborne, 2018), driving the service co-production within communities as a means to support innovation (Osborne, 2010, Hartley, 2005; Granier and Kudo, 2016). Technology helps public organisations to develop open innovation that enables better processes and performance. ICT helps public organisations to work through networks that involve private and public actors, developing knowledge and capabilities in the pursuit of public goals (Janowski, Pardo and Davies, 2012), strengthening collaboration for service innovation (Lips, 2012). ICT is driving public organisations to become digital and smart institutions that support public value creation processes within communities and open ecosystems (Larrson and Grönlund, 2014). Public managers should construct community shared values, interacting with citizens, enhancing effectiveness and accountability within society (Bryson, Crosby and Bloomberg, 2014).

The paper is structured in sixth sections. Following the introduction and methodological section, in the third paragraph, the debate on public innovation is conducted through the lens of collaborative innovation as theoretical background. In the fourth paragraph, the role of information technology leading to smart and sustainable public organisations is elucidated. In the fifth paragraph, the smart working is conceived as collaborative innovation enabling collaborative spaces and enhancing the employee-manager relationships, following a social, interactive and relational dimension. Finally, discussion and conclusions are outlined.

## **2 Methodological section**

The study is theoretical and relies on a literature review and analysis relating to public organisations that aim to drive innovation by embracing information technology in order to develop smartness and sustainability, by opening to smart working as collaborative innovation and strengthening digital and smart platforms to contribute to value creation for public wealth. The selected contributions are drawn by literature related to smart and sustainable public organisations in relationship with the use of ICT that enables both smart working practices as innovative and collaborative approach to work organisation and digital and smart platforms as evolution of advanced information technology in government. The selected contributions are interpreted in a narrative synthesis in order to elucidate new perspectives and advance theoretical frameworks on

emerging issues (Denyer and Tranfield, 2006; Dixon-Woods, Agarwall, Young, Jones and Sutton, 2004).

### **3 Driving public and collaborative innovation**

Innovation refers to the introduction of new elements into a public service to be considered as discontinuity with the past (Osborne and Brown 2005). Public innovation is viewed as a continuous improvement. Innovation refers to development and implementation of new ideas that disrupt the common wisdom (Osborne and Brown, 2011). Innovation refers to a new practice to ensure continuous improvement of existing practice (Hartley, 2005) but also «involves a step change that problematizes and transforms the way that things are usually imagined and done» (Törting, 2019, p. 1). It is about «embracing new ways of thinking about problems and solutions and doing new thing in new ways» (Crosby, t Hart and Törting, 2017, pp. 656-657). Innovation refers to an «intentional and proactive process that involves the generation and practical adoption and spread of new and creative ideas, which aim to produce a qualitative change in a specific context» (Sørensen and Törting, 2011, p. 849). In public sector innovation develops through collaborative processes that involve public and private organisations, and facilitate value co-creation processes (Ansell and Törting, 2014), coherently with a service logic view (Osborne, 2018). Collaborative interaction becomes a source of public innovation (Törting, 2016) and value creation (Osborne, 210). Collaborative innovation helps to transform government in a significant way (Nambisan, 2008) and to bring together two opposite concepts: collaboration implies a similarity of education and values among the actors; instead, innovation relies on diversity of views and ideas as necessary sources to stimulate creative problem solving (Törting, 2019). Ensuring trust and legitimacy of government is an important driver for public sector innovation (De Vries, Bekkers and Tummers, 2016). Collaborative innovation implies that the innovation process is opened up to actors from within the organisation, other organisations, the private and third sector and citizens that are integrated in the innovation cycle (Bommert, 2010).

Collaborative innovation is enabled by the «willingness and capacity of a diverse group of actors to engage in a trust-based dialogue through which they can construct a common ground for exploiting their differences in order to produce innovative solutions» (Törting, 2019, p. 5). Multi-actor collaboration is a

key driver of public innovation and helps to develop and implement innovative solutions (Törfig, 2019). Innovation is a not linear and iterative process. The role of public managers is to enable open and flexible spaces for collaborative interaction with relevant actors. Collaborative innovation for public value creation requires that «managers should develop a pragmatic understanding of when and how different government and nongovernment actors should be a part of the collaborative endeavour» (Crosby, t Hart and Törfig, 2017, p. 663). In particular, the leadership role enables innovation and value creation. «People in leadership roles have a special responsibility and opportunity to frame and reframe public problems in ways that foster innovation and create public value» (Crosby, t Hart and Törfig, 2017, p. 663).

Public sector innovation relates to collaborative interaction among public and private actors such as politicians, civil servants, private firms and community-based association (Sørensen and Törfig, 2011). Digital public service innovation as a collaborative process helps to drive co-creation and support the development of public-private partnerships (Bertot, Estevez and Janowski, 2018). The advent of digital and interactive information technology helps to strengthen collaborative public co-production and co-creation, leading to open public innovation (Criado *et al.*, 2021).

As Scupola and Zanferi (2016) have stated, the potential offered by information technology is opening to unexpected and favourable organisational and behavioural issues. Digital government systems are driving collaborative processes (Dawes and Pardo, ). Digital public innovation and digitalisation processes develop in a collaborative way, and enable more actors who are proactively involved in collaboration, and rely on employees as explorers of new innovation opportunities, meeting the users able to play an active role in the innovation process. Technology helps public organisations to develop open innovation by including external knowledge in decision-making processes (Mergel, 2018). Digital public service innovation helps the development of public-private partnerships by engaging the citizens and the community (Bertot, Estevez and Janowski, 2018).

#### **4 Information technology is driving sustainable and smart public organisations**

Public organisations achieve sustainability as a source for strategy, action and change, as a new way to improve the internal functioning and workings, as a vision for interpreting public values and managing *res publica*, using the potential of information technology within communities and facilitating the value creation within social and economic ecosystems (Fiorino, 2010; Goodsell, 2006; Larsson and Grönlund, 2014; Larsson and Grönlund, 2016; Dumay, Guthrie and Farneti, 2010). Sustainable public organisations use digital technology in order to transform the relationship with public service users, enhancing the co-production within the service delivery system as a relational process (Osborne, Radnor, Vidal and Kinder, 2014).

Digitalisation is leading to building smart organisations able to manage complexity by using simplicity, intelligence and collaboration (Viceconte, 2020). Public organisations are using the potential of information technology to drive public organisations as digital and smart platforms and collaborative spaces in order to enable value creation processes within social ecosystems (Osborne, 2018; Bryson, Crosby and Bloomberg, 2014; Harrison, Pardo and Cook, 2012). Digital transformation in public sector organisations implies to use technology for driving change and innovation in organisational design, work processes, cultural orientation to results and customer satisfaction, relying on skills and competences of employees and managers (Buonocore, 2020). Technology helps public organisations to become more agile, flexible and adaptive organisations (Mergel, Gong and Bertot, 2018). The advent of digitalisation processes in government helps to strengthen cooperation, engagement and participation in policy-making and services design (OECD, 2014). Technology helps to drive a community/citizen centred approach to public services design (Dunleavy, Margetts, Bastow and Tinkler, 2005), empowering the citizen as a responsible partner in co-production of public services (Linders, 2012), developing digital platforms and spaces, and virtual communities that contribute to networked co-production and value co-creation (Fishenden and Thompson, 2013).

As using information technology, public organisations are becoming smart and innovative in creating new services to their citizens in order to improve their quality of life, interacting with citizens and engaging them to participate (Mellouli, Luna-Reyes and Zhang, 2014). Smart government means rethinking the way

governments works by digitalising processes through the use of emerging technology and relying also on perceptions and expectation of public managers for success or failure. Smart government initiatives require both innovativeness and collaboration (Schendler, Guenduez and Frischknecht, 2019). Information technology catalyses innovations in government, leading to public administration as a smart organisation able to achieve agile and resilient government and governance infrastructure (Gil Garcia, Helbig and Ojo, 2014). «Smart is not an end state, but can be an enabling condition that may or may not lead to other desirable outcomes» (Gil-Garcia, Helbig and Ojo, 2014, p. 12). Sustainability is a key dimension characterizing smartness in government (Gil-Garcia, Zhang and Puron-Cid, 2016). «Innovation is a key dimension characterizing smartness in government. Innovation enables a government to become smarter by continuously incorporating new and improved ways to deliver services and conduct government operations» (Gil-Garcia, Zhang and Puron-Cid, 2016, p. 526). As key components of government administrative reform, information technologies are leading to a smart State, by strengthening inter-organisational collaboration, information sharing and integration (Gil-Garcia, 2012). The advent of information, interactive and digital technology helps public organisations to become sustainable organisations which are encouraging private-public collaborations and partnerships, strengthening a community/citizen and smart approach, by involving citizens in policy-making for sustaining public values, equity and development (Larsson and Grönlund, 2014; Dunleavy, Margetts, Bastow and Tinkler, 2005).

The use of information technology in government is leading to sustainable, digital and smart public organisations (Larsson and Grönlund, 2014; Granier and Kudo, 2016; Janowski, 2015). Public organisations support public value creation, promoting driven e-governance platforms, multiple relationships with interdependent actors and co-construction and co-innovation where the locus of co-production is the service system (Osborne, 2006; Osborne, Radnor and Strokosch, 2016). Digital technology is driving the transformation of the relationships between sustainability-oriented public organisations and public services users (Osborne, Radnor and Strokosch, 2016).

Technology opens up to digital and smart public organisations as enablers of social and public value creation by involving civil society, following a service logic and public value view, promoting interaction and citizen-centred services effectiveness (Osborne, 2018; Dumay, Guthrie and Farneti, 2010; Stoker, 2006;



O'Flynn, 2007; Moore, 1995). ICT helps public organisations to drive networks that involve private and public actors, developing knowledge and capabilities in the pursuit of public goals (Janowski, Pardo and Davies, 2012). Smart government initiatives involve government and non-government actors to improve quality of life for people and communities (Gil-Garcia, Zhang, Puron-Cid, 2016).

## **5 Smart working as form of collaborative innovation between employees and managers**

Today, working by developing the potential offered by information technology refers to smart working or agile working. The work as enabled by technology should be always smart. Smart working is emerging as an innovative approach to work organisation and human resource management (Decastri, Galiarducci, Previtali and Scarozza, 2020). Public organisations are experimenting the widespread usage of technological advancements in order to offer their employees new ways of working, overcoming physical and time barriers, designing work organisation modes based on telework, home-based telework, mobile work (Reina and Scarozza, 2020), and embracing a smart working approach in redefining the work organisation in order to ensure efficiency, effectiveness, and to enhance flexibility and autonomy, promoting collaboration (Ravarini, Cuel and Varriale, 2020). Public organisations are driving smart working practices, by embracing the potential of information technology, giving value to the relationship between the administration and the employees (Reina and Scarozza, 2020; Ravarini, Cuel and Varriale, 2020). Driving smart working helps to promote a results-driven and collaboration-oriented organisation, strengthening the role of managers in empowering the employees at work and sharing with them the organisational goals by following a collaborative approach (Politecnico di Milano, 2018).

As Harris has stated (2003) «taking work into home environment challenges and changes the responsibilities of employers accustomed to a traditional employment relationship» (p. 435). Butera (2020) has defined the smart and agile work or *ubiquitous working* as a way that enables a new view to work organisation which may benefit both the employee, ensuring a smart work-life balance, and the organisation, improving costs reduction and driving productivity improvement. Smart work is results-oriented, social and collaborative, and refers to a networked way of operating. Smart working refers to an organisational

model that shapes the relationship between the individual and the organisation, which proposes autonomy in working methods in exchange for the achievement of results. It relies on an intelligent rethinking of the way by which work activities are carried out, even within company spaces, removing constraints and inadequate models linked to the concepts of fixed workstations, open spaces and single offices that are ill-suited to the principles of personalisation, flexibility and virtuality (Gastaldi, Corso, Raguseo, Neirotti, Paolucci and Martini, 2014).

Digitalisation is leading to enhancing collaborative spaces at work, promoting blended forms of work between physical, digital and relational side (Montanari, 2020). Smart working helps to support cultural change and requires organisational innovation for which a detailed roadmap must be provided (Torre and Sarti, 2018). Smart working is defined as a new management philosophy based on providing employees with freedom and flexibility in choosing the place, time and tools used in their work, in conditions of greater responsibility and accountability for results. Smart working requires social collaboration and managers who are able to promote sense of community, empowerment, flexibility and virtuality. Organisational policies, technology, physical layout and leadership behaviour and styles exert influence on the success of smart working practices and approaches (Crespi, 2016). Adopting smart working practices helps to support larger autonomy and foster confidence and propensity towards innovation (Langé and Gastaldi, 2020). Smart working practices are agile, dynamic and emergent, as the outcomes of designed organisational systems that facilitate customer-focused, value creating relationships that benefit the organisation and people (McEwan, 2016).

The rise and widespread diffusion of smart working-oriented practices opens up to a new smart workplace as a collaborative space which is driving employees to look at technology as a mean for strengthening interaction and collaboration, reinforcing shared norms, goals and identification. Smart working helps to foster an openness-driven and knowledge-exchange-oriented smart organisational culture in work environment. Promoting smart working practices helps to rethink a new workplace which is deliberately designed to produce changing attitudes and behaviours of both employees and their managers, by overcoming obstacles that refer to employees' social isolation and managers' resistance toward remote working (Errichiello and Pianese, 2019). Smart working is emerging as a collaborative space for flexible work: «the adoption of smart working implies that employees can choose when and where to work and select among various

workspaces both outside (e.g. home and coffee shop) and inside (e.g. open spaces and concentration areas) the organizations» (Errichiello and Pianese, 2019, p. 299). Smart working helps to drive organisational innovation as a means to support cultural change (Torre and Sarti, 2018). As a new way of interpreting the work, the smart working allows a better balance between quality of life and individual productivity and focuses on integration and collaboration between people, in particular, and between organisations, in general. It is an intrinsically multidisciplinary revolution, which requires integrated governance among the players involved (Hur, Cho, Lee, and Bickerton, 2019).

The role of management is central to driving high performance and satisfaction of employees working, dealing with technology between home and office. In particular, managers have a delicate task in recalibrating perceptions of the boundaries between home and work to develop positive employee relationships (Harris, 2003). Working by technology enhances the role of middle managers: «telework contributes to develop the manager's coaching role and leads to shift middle managers' role towards more monitoring and less close supervision» (Dambrin, 2004, p. 364). Telework helps to foster autonomy, leading to self-management of employees and driving managers to redefine their role in terms of coaching than control. Promoting leadership for smart working helps to ensure flexibility, coherence and integration (Iannotta and Meret, 2020).

## **6 Discussion and conclusions**

Technological advancements and developments are driving innovation in public organisations and changing the way employees and organisations relate to workplace management. Digital transformation in public sector implies to drive processes that concern work organisation and the relationship between employees and managers as enabled by the potential of technology that fosters collaboration, smartness and empowerment at work. As sustainability-oriented and smart-driven organisations, public organisations develop and integrate strategic, managerial and technological capabilities in order to gain the benefits of technological innovation as a source that enable organisations and employees to contribute to value creation processes.

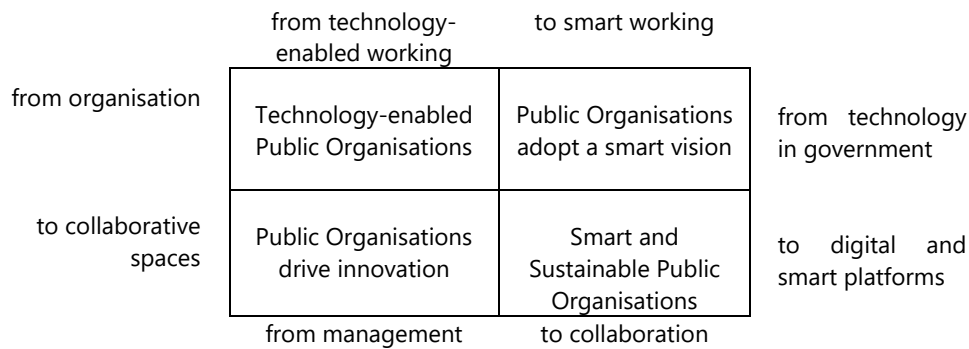
Public organisations should strengthen the potential of digital and smart government and platforms in order to involve civil society within networked governance where public managers attend to value community, interacting with

citizens to build shared partnerships. Innovation always concern the life and development of sustainability-oriented public organisations. The advent of information and digital technology offers public organisations the chance to embrace smartness as a way to redesign work organisation and develop the human capital and resources as drivers for sustainability. Public organisations consider the sustainability as a source that helps value creation processes and enables the wealth of people and business by ensuring social, financial, economic and democratic performances.

Smart and sustainable public organisations to contribute to value creation processes developing both the potential of information technology and empowering people, by managing human resources and rediscovering the leadership role of public managers in managing the relationship with employees. Smart working is becoming a new collaborative arena and space that enable innovation in work processes, behaviours and attitudes of employees, managers, citizens and other stakeholders involved in the collaborative processes.

Public organisations evolve as smart and sustainable organisation investing in human, behavioural and technological sources in order to develop capabilities for promoting healthy and wealthy work environments and relationships which involve, in particular, the cooperation among employees and managers. The pathway leading to smart and sustainable organisation requires to use information technology as a key source that drives smart working, collaboration and digital platforms. Smart and sustainable working public organisations support innovation and drive digital platforms, adopt the smart working as a way to enhance collaborative innovation and processes, and enable public managers as leaders who strengthen the potential of the social and human relationship as sustained by the potential offered by information technology.

As shown in Figure 1, the main contribution of this study is to identify some pathways that enable public organisations to use the potential of information technology in order to become a smart and sustainable organisation which is able to contribute to public value creation and support the development of communities in long-term horizon, promoting the transition from technology-enabled working to smart working, implementing the digitalisation processes, and identifying an innovation orientation to processes and services in order to promote a sustainable organisational and cultural change in long-terms.



*Figure 1 – Towards smart and sustainable public organisations*

Public organisations have to rethink a smart and sustainable vision to work processes and services delivery and production, following a service logic view to public services delivery and design within communities, strengthening the role of public managers as effective and ethical leaders able to promote collaborative processes within and between organisation and society, by developing smart and lean platforms and communities within ecosystems. Technology helps to drive collaborative innovation, enhancing organisational and human factor, enabling managers and employees to develop collaboration, knowledge sharing and empowerment. Thereby, public managers play a key role in driving cultural change in supporting behaviours and driving innovation process in order to feel themselves more identified within organisational goals, being motivated to lead employees in their work and commitment.

In this study, there are some limitations. This study identifies only a theoretical framework of analysis in order to identify the pathway leading to smart and sustainable public organisations promoting innovation by using the potential of information technology in order to both strengthen digital platform that enhance and support cooperative and collaborative processes and promote public-private partnerships, and drive smart working as a change vision to work processes and work innovation that enhances collaborative aspects of the employee-managers relationships. Thereby, any empirical research and case studies are provided in the analysis because public organisations are still in infancy in rethinking and reshaping a smart mind set and planning about how to dealing with smartness and sustainability as key drivers and sources for organisational and work change

and innovation. Further research perspectives and investigations will consider how the hypothesized propositions can be applied within local autonomies and be translated in managerial and leadership training programs, human resources policies and practices, technological advancements and digital platforms that contribute to enhancing the community and collaborative spaces development within public organisations which more and more interact with civil society in order to develop knowledge sources, organisational frameworks, strategies, value-oriented processes, and shared culture within social and economic ecosystems.

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## **Atmosphere of Collaboration during Social Distancing - Adopting Collaboration Workspace during the Corona Pandemic**

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### **Abstract**

Times of emergency and confusion may pose a need to introduce and implement information systems in organizations, or to greatly hasten an ongoing implementation project. The purpose of this article is to recommend effective methods and practices that will improve implementation in times of emergency. In this article, we will discuss how organizations can deal with the challenges of implementing technological solutions for knowledge management and collaboration during crises, addressing issues such as technology selection, user capacity building, organizational trends that encourage or hinder technology adoption and organizational policies that can facilitate these solutions. The article discusses a case study of a national defence organization introducing the 'Microsoft 365' cloud-based suite, and particularly the 'Teams' service, to improve work performance during the Covid-19 crisis, while adhering to social distancing guidelines. This article will discuss the need that was generated, and the approach chosen, as well as the theoretical foundation for assimilation, focusing on motivational problems, change agents, and assimilation models. The method of gathering information and analyzing the data is then explained in depth, including surveys, participant evaluation in work teams, and data on system use. Finally, after reviewing the data and drawing various direct conclusions from it, ensuring that the final criteria ('bottom lines') are met in response to the need for functional consistency, commander preferences, and user satisfaction. In the discussion section we build on the observations made in the above case and examine the implications and perspectives of assimilation in a crisis and uncertain situation. A successful implementation of an information system can be boosted by

following three main components, particularly in times of crisis: 1. Characteristics of the technology: effective, integrated, user-friendly, scalable, and generalizable. 2. The technical efficacy of users and management 3. Using a methodical framework for implementation as a flexible contingency plan.

**Keywords** – Knowledge management, Collaboration workspace, Technology adoption, Technology implementation, MIDI model

**Paper type** – Academic Research Paper

## 1 Introduction

### ***1.1 The situation and character of the case - The COVID-19 period and the need for continuity of the military organization***

Adapting to the Corona pandemic (Covid-19) and the social confinements devised to prevent its spread has forced organizations and armies to find new ways to operate and achieve their missions. Social distancing, required to deal with the Corona pandemic, made it difficult to maintain organizational routines. It was therefore imperative to develop an effective solution to overcome these limitations.

During the Corona period (in this article, it is the first two outbreaks of widespread transmission and illness in Israel, from March 2020 to August 2020), it was necessary to allow operational continuity, but maintain an accessible environment wherever people could work from. The goal was to reduce physical presence and interaction between people in office workplaces while still allowing people in mandatory preventative isolation to continue working without risking themselves or others.

Worldwide, various organizations have focused on how to bridge the gaps that have resulted. Different technologies have been found to allow for organizational collaboration and functional continuity while maintaining social distancing (Gardner & Matviak, 2020; Shen, 2020). The sudden appearance of the pandemic, along with its specific need for social distance as well as the patterns of action that emerged from it, forced humanity to change and adapt rapidly, which is a great case study for investigating how an organization can adapt to new realities? How can we accelerate this process of adaptation? Learning from this unique

situation, however, comes with limitations that we will address at the end of this article.

## **1.2 Organizational characteristics**

Military and security organizations have unique characteristics. The IDF is the largest organization in Israel, consisting more than 100,000 personnel (formal numbers are classified). It is unlike other armies and other organizations in Israel and around the world, due to the following differences: The volume and types of combat activities; its workforce (most of them in mandatory service); as the largest employer in the Israeli economy and the related effect on the labor market (Ben Ari, 2018).

The Israeli Air Force (IAF) operates as the aerial warfare branch of the Israel Defense Forces, and its members are almost a third of the entire IDF corps.

Information security is a major and still growing concern for many organizations. There are significant limitations to the IAF's information security capabilities, since their operating characteristics demand strict conduct while separating networks and types of information passing through them. However, a technology is likely to be developed that will meet some of these requirements in the long run, as others have done. When embarking on a Microsoft Teams Web Implementation Project, an organizational policy regarding information security needed to be formalized.

IDF maintains a dialogue with various technologies and is at the forefront of some of them, while others are probably lagging behind the civilian world. It uses collaborative technologies, but sometimes adopts them in a way that does not allow them to realize the inherent potential in them.

Almost ten years prior to creating the Teams environment, there was an earlier digital work environment, accessed via a "civilian" internet network called "People Portal". The People Portal was used to store files and inform members in various groups about previous and forthcoming organizational activities. At the end of its life, the People Portal system became obsolete - it was unsuitable for browsing on mobile devices and limited end users to only textual correspondence. As far as connectivity and knowledge management is concerned, it has become a barrier to the flow of information.

In addition, IDF's motives for adopting technology differ from those of other organizations. A study by Gartner that assessed the motives for implementing MS

Teams on organizations uncovered that the five most common reasons are: 1. Innovative methods of accomplishing tasks; 2. Moving workloads to the cloud from internal networks; 3. Reducing Microsoft licensing costs; 4. Connect to the Microsoft Roadmap; 5. A better customer experience with Microsoft (Cannell, 2019). With regard to the factors we outlined above, except for factor # 1 - new ways of working - the other motives are not related to the IDF, which develops the service in parallel with its existing networks.

The IDF chose to use cloud-based technologies to maintain continuity of operations under the guidelines of social distancing, but those still were not particularly developed or took into account the demands of the Corona period, for example, widespread use of "Zoom" in favor of fast and reliable video conferencing.

### ***1.3 Teams as a collaborative working environment***

Different technological solutions are not simply different formats through which remote discussions and work are conducted, but a broader environment (ecosystem) of different services and work environments that enable new work processes and make knowledge workers more productive. In these work environments, there are many more options to improve the discussion culture and bridge the time/space divide in online work: discussion forums, discussion groups, whiteboards, recording discussions for those who cannot participate, assigning tasks to perform and managing them, and more (Cannell, 2019). Another recent Gartner study found that most organizations implement Office 365 (Microsoft has rebranded Office365 for Microsoft365) environments because of the collaborative capabilities they enable and the integration capabilities (a.k.a "integration"). Office 365's collaborative workspace lets users connect multiple applications through a dedicated multi-modal interface. The use of this interface can allow access to a very wide range of services and there are even some who claim it is the key to success (Tarzey, 2017). The degree of integration is determined by the licensing model (number of applications included) and the organization's policy for enabling connectivity to third-party applications.

#### **1.4 Theoretical lenses**

The ability of organizations to select, develop, and adopt new technologies in a way that substantially impacts the organization is limited. The reasons are numerous, chiefly a gap in organizational attention and management's commitment to incorporating technology and leading the change process. Afterwards, there is a gap in employees' ability to handle new technologies and other reasons that we will discuss later in this article (Roupas, 2008). Based on these gaps, only 16% of organizations report successful adoption of technology (e Hortense de la Boutetière et al. 2018). As a result of the significant organizational effort and large resources invested in technology, many studies have been conducted to identify the key factors that influence the successful absorption of technology, allowing an organization to become more effective and efficient at completing its various tasks. In these studies, a number of influential factors are identified, including attitudes and characteristics of managers in the organization (Pabst von Ohain, 2019); leadership and ability to lead change (Bughin et al., 2019); Sociocultural factors (Rogers, 1983); structural-environmental relationships (Christensen & Overdorf, 2000). We have selected just a few of these factors as they will provide us with a better illustration of our findings.

##### *1.4.1 Motivation to adopt technology*

In the field of technology adoption, motivation plays a significant role (Hortense de la Boutetière et al., 2018; Roberts & Flin, 2020; D. L. Rogers, 2016; Roupas, 2008; Stahlbrost & Kareborn, 2011). The IAF prides itself on being a task-oriented organization, one that sanctifies the execution of the task using the available tools. To meet the guidelines of social distancing, it was essential to find new ways to accomplish existing tasks during the Corona period, which was a key reason for change.

##### *1.4.2 The role of change leaders*

It has been well documented in literature and professional articles how technology leaders in the organization ('product champions'), contribute to change by fostering a positive environment and contributing social norms that shift the workforce to adopt new technology. Technological leaders are characterized by high technological proficiency, entrepreneurial awareness, a desire to learn from different experiences, and the desire to share their findings



with their organizations (Rogers, 1983). The presence of these leaders does not eliminate the need for an orderly organizational response but represents a temporary local response until the organization's policy is determined and implemented. Furthermore, their presence makes it possible to use the organizational response more effectively when it is implemented in the field and to promote it more rapidly. Despite familiarity with the literature in the field, it is surprising to see how the presence of personally driven leaders contributes to the degree of development and technological progress of the units.

### ***1.5 The MIDI (Model for Implementing Digital Information Systems)***

The IAF's Digital System Adoption Model, 'MIDI', aims to help implementers efficiently and effectively manage the implementation process. The framework includes a highly organized management job aid, that details roles and tasks required during the implementation process, along with a supplementary methodological document that elaborates on the given roles and helps the implementer decide the manner and importance of their execution. The framework allows the implementation leader to analyze the tasks he has to perform in accordance with the project timeline, such as: writing usage theory and instructions, user training, organizational change management, and support (Spiegler & Vardi, 2019).

While the military develops and purchases dozens of applications, software and information systems a year and puts them to use, sometimes the act of connecting users to technology comes too late ("the system is here already. We need an implementation plan") or without the necessary resources ("A few PowerPoint presentations for the users is enough, it's an intuitive system). The Framework was developed to assist implementation leaders, many of whom held middle-level operational and professional positions but did not have previous experience implementing information systems. Role holders who understand the system, usually professionally, should bridge the gap between the technological factors (the developer or implementer) and the users, as part of a standard project for a domain and data resource schedule. During the Corona period, the model completed its "baptism by fire" when used semi-structured because of an accelerated integration during a crisis. At the same time, along with adhering to the principles of the model, it was an opportunity to examine its components and see which part contributed to the adaption process.

## 2 Methodology

The **usage data** was collected using the built-in admin panel within the Teams environment, over two dates. During the first, in August 2020, a review of the system implementation was undertaken. The second was held in November 2020 in order to determine trends in usage, following the "second wave" of the Corona in Israel, as part of evaluations for further assimilation of the environment. Based on the usage data, we were able to determine whether or not the implementation and adoption of the product was successful.

The IDF Survey Center at the Applied Research Institute for Behavioral Sciences in the IDF conducted regular online surveys during the Corona period. Surveys were conducted to explore various aspects of how the IDF was addressing the corona epidemic. Among these were remote work, digital needs of servants, ways of communicating and learning, and more. In total, there were 14 surveys with over 15,000 respondents (Bar-Gil, 2020; Nadam & Hamenachem, 2020).

A major source of information used to prepare this article is the collaboration among the authors of the article in working groups relevant to the topic: discussion summaries, meetings, and personal records were used. These summaries will not be explicitly cited as is customary in organizational research through participatory observation (Clegg, 2010).

By analyzing these surveys and our participatory observations, we were able to identify places and uses where the work environment was successful and beneficial for users. And identify the factors that contributed to the good or bad performance of the implementation

## 3 The key findings

### 3.1 *the bottom line*

During the Corona period, the use of the Teams collaborative workspace enabled and streamlined work, and employees expressed great hope that their use would increase, and their long-term benefits would be realized. The surveys conducted in the Corona era stated: "I wish we understood that fewer people are needed in meetings and time management will be as efficient as it is now, and the crisis will bring less bureaucracy" (Tiargan-Orr et al. 2020). This statement

implies that the technology itself is already here and enables the change and that the servicemen expect the organization to make progress in that direction.

There has been a dramatic increase in the number of unique users accessing the Teams work environment services during the first wave of the Corona: from 4,000 users to almost 17,000 users. However, it is important to qualify and note that the experience of many unique users, was superficial and consisted only of initial identification and receiving a single verification email from the system. The use of the various accompanying applications was extremely low, especially for the flagship service, "Channels", which saw only 3,400 users. Using usage data, it can be seen that after a short period of enthusiasm, the trend soon waned and returned to the level of activity that existed prior to the first wave. According to the second wave of activity, the usage threshold for continued activity is very low.

Analyzing this data, it is concluded that the Teams environment was adopted, but not assimilated into the use routines and work processes. Despite the formal availability of the system, most users do not use it frequently as a primary means of performing tasks.

### **3.2 Users satisfaction**

As measured by adoption rate and penetration, there is considerable growth, but in terms of user satisfaction, the results are mixed. On the one hand, the abandonment of the system upon returning to non-Corona work schedules and practices, proves that assimilation was not rooted in routine and did not alter the working habits of the majority of the Corona period "adapters". Even at the height of the increase in the Teams use, only a few "formal" requests for support were made (less than 100 requests). Additionally, the support teams reported that help requests in so-called informal channels were of negligible volume, so it is reasonable to conclude that user satisfaction wasn't a major problem. Issues that were nonetheless opened reveal that users enjoyed the system's accessibility to new and unfamiliar digital spaces, but encountered difficulty editing files, especially in Hebrew, by combining separate sources, and failed to see Teams as a practical alternative to Learning Management System (LMS). Further, advanced services, premium applications, and their work environment integrations, such as PowerBI, were not widely used. The conclusion can be reached that despite scarcely major issues raised to support staff and despite seemingly appearing to

be satisfactory, the way the technology was used did not meet the needs and expectations of users.

### ***3.3 Resolving the needs of IAF operational continuity***

The expectations for functional continuity, by using the new platform were met. A senior General proclaimed the product adoption as a success, identifying great potential within a short period of time. Another significant response was the move of training processes online, allowing for a continuity of work process in this sector as well, in a very significant way.

### ***3.4 Where did there seem to be greater success?***

Following other researchers, we believe that implementing a system, especially a collaborative work environment, does not amount to a binary assessment - successful or unsuccessful (Levy, 2013). The purpose of this study was to examine the differences between the places where we identified success in implementing the system, by examining system use data and examining user satisfaction.

Some of the more frequent uses of places are to provide training and to support users. There is a common denominator in our view with processes that are highly standardized and repetitive, or that are characterized by Self Service / Self Assist on the part of users. Military trainers took advantage of the collaborative training environment in an innovative way. In addition to providing comprehensive training, the IAFs' computing unit offered a number of courses. Another interesting use was in an operational Group, where professional development and personal growth courses were delivered to dozens of permanent personnel.

The implementation of the environment allowed for the creation of an internal support application using **Flow** and **PowerAutomate** features. It took two days to set up a beta version and a week later, it was already available as a full version. When a user requested support, they entered their data in a form that provided information to the app and from there a process of support began with continuous control via a dashboard. Standard methods of knowledge gathering, and accessibility have also been implemented, especially in sites that have evolved into collaborative work, and the process has been found to be effective and efficient for responding to users.

### ***3.5 What can we learn from successful places?***

Upon examining the places where higher success can be seen in the assimilation of the environment, the main variable we identify is the effect of use on the effectiveness of the task, or in other words - how significant the "need" and organizational motivation for the unit was. Inability to execute military missions in a traditional manner, which relies on physical convergence in a military unit, has led commanders and users to try the new environment without giving up. We believe that the best implementation plan, even if it comes with other powerful parameters (shown below), will not succeed without significant value to users and the organization as a whole.

The second significant variable is technological capability. efficacy is the collection of skills that must be specified and their application, just as technological self-generating reflects the users' belief in their competence with the technology that they are provided (Pan, 2020). Capability and efficacy are separate because in most cases, the environment does not need high-level programming or operation. For some, it is a new system with unfamiliar nuances - so it presents a barrier. There were leaders in units where the technology was widely used, and they presented an expectation of success and a sense that 'it is not a problem to use the system', and even provided important support to colleagues if needed - thus strengthening both the efficacy and technological capabilities.

We can sum up both of these variables in a simple way: "whoever wants and can succeeds". Nevertheless, we find the "want and can" test in the context of a military organization, which does not necessarily hire its people according to their technological capability - to be interesting and important, so we will continue the discussion in the discussion section.

The following are other factors we identified that may impact implementation:

1. **Support from management** is important for two reasons. The first is formal resource allocation and paying attention to those users who have taken the lead. The second reason is the opening of bureaucratic bottlenecks, for example, information security, which poses a practical but also perceptual (and might as well be imaginary) barrier to the IDF's use of information systems.
2. In units with a good first connection between knowledge management department it's agents in the field, implementation has been successful. Through this connection, communication channels have opened up for personal consultations. This

communication enjoys a high level of trust from both parties: the unit representative has a safe place to ask questions and receive information that he can relay to the unit and be recognized as an "expert", while the matter of knowledge management is resolved or escalated to the senior or professional.

A topic that we were surprised about and did not expect in the field was the importance of personal example as an assimilation factor. In an organization, managing change processes involving technology and digitization is a specific case of leading change processes. Changing attitudes, culture, processes, and organizational practices can be some of these processes, as with the above example of changing the culture of discussion and sharing information or incorporating technological tools and integrating units. Numerous studies have supported these findings, with study data showing that the leadership abilities required to lead organizational transformation are similar to those required to lead broad organizational changes. At the center is the ability to build an effective team and provide leadership by example (Pring et al., 2020; Walsh). The issue surprised us mainly due to the importance that the IDF places on the issue of personal example among commanders and the extent to which this expectation is ingrained in the organizational command chain.

### ***3.6 From units that seldom use technology, what can be learned?***

The well-known military adage states that "what doesn't work routinely won't work in a crisis.". Our view is that the same applies to knowledge management and technological implementation, and we have identified a clear connection between willingness and ability to engage in knowledge management and improving the use of digital media routinely and success in implementation during an emergency. Basically, this involves the organizational maturity of the organizational bodies for absorbing and assimilating technology that develops mainly through routine. In organizations with no organizational infrastructure to rely on, it is difficult to realise the various technological options in times of crisis. While it's possible in some cases to make a step forward that will improve the process **and** incorporate technology, this more complex move has few chances of succeeding.

Let's look at an example from a department where there is a lot of emphasis on knowledge management. Implementation followed a clear pattern, which was also repeated elsewhere: 1. Ignoring or not responding to organizational

communication. 2. Under the pressure of senior executives, deciding to explore the environment. 3. Assigning a task to a medium-level leader with a general interest in information systems. 4. Obtaining information about capabilities from the leader. 5. A very high entry threshold was set by the manager - a very well-designed site was a prerequisite, excessive concern was expressed about information security, and the request was made to develop "applications." In general, the end of the pattern was marked by a waning enthusiasm for the project, a return to routine, and a lack of managerial support.

Units that routinely carry out processes of technology development and implementation will have an in-depth dialogue about the various needs and means, recognizing limitations in existing solutions, and the like, reducing such occurrences. As an example, during the first wave of deployment, the service had the ability to view up to four users simultaneously, i.e., there was a significant inferiority in the user experience compared to the competitor, 'zoom', not adopted by the organization. As a result, a manager who wanted to "see them all" switched to the "Zoom" app, thus compromising the implementation of the service. However, even if the needs of the manager are understandable and he can choose another service, this reduces the long-term implementation effectiveness and undercuts the effectiveness of digital solutions over time. Researchers Klein and others have examined the relationship between quality and characteristics of a digital service and its long-term implementation, but found only a weak link (2001, Klein et al), so we think there is still room for an improved organizational support message. It is our belief that department heads who are constantly involved in implementing technologies are better able to identify and manage these tensions.

Based on the corporate policy on the subject, a shared environment on the civilian Internet cannot address the needs of departments and processes with high classification requirements. Although it makes sense to discuss this as well, it is outside the scope of this article.

### ***3.6 Implement an absorption and assimilation framework***

In this case, the implementation of MIDI framework for digital management proved inadequate. The project management method suggested by the model was not workable, primarily because the system was already in existence.

Therefore, they were used as guidelines for tailoring support, both to the situation and to organizational structures.

### ***3.7 Is there anything else about the process worth getting to know? Communities***

"There are many fathers to success, but failure is an orphan" is truer than ever. In cases where organizational fit rates have improved, we can be certain that a significant networking organization is behind it. Communities are defined as groups of people with a common purpose that allows a person to feel less alone in dealing with the obstacles, problems, and complexities in the field of practice (Wegner, 2002; Etienne, 2002). Even if they are from different units, community members are interested and motivated to work toward a common goal, so they learn, are updated, and lend a hand to one another. This process was made possible by setting up a dedicated community for process leaders to realize the benefits of transitioning to digital, while at the same time, developing a community for users and implementation leaders to receive training in various issues involving recognition, recognition and solution development. Interestingly, we found the most vibrant community of the Teams was actually conducted on... 'WhatsApp'. While the Teams has a built-in chat capability, no app in the 365 environment has the option of multi-participant chat in one click.

## **4 Discussion**

### ***4.1 Uniqueness and inclusivity***

The characteristics of the military organization and the characteristics of the corona crisis may seem unique, but numerous conversations indicate that the findings we present are fairly similar to those found in other organizations that face similar crises; therefore, the discussion presented here could be generalized to other organizations.

### ***4.2 Success is a combination of motivation and ability***

**Motivation?** - Our research has characterized a wide scope of possible reasons for organizational change among commanders in units, apart from the need to continue operating effectively. Motivations included among others experimenting



with new technologies and tools then, identifying the situation as an opportunity for the commanders to bring about a change they wanted to make earlier, as well as curiosity about the new technologies. In addition to this, there is covert competition for positioning the unit at the "knowledge front" and promoting it as a more advanced and technological part of the organization, both among servicemen and within the organization as a whole.

**Ability?** - Although mastery of technology is not necessary for advancing and assimilating technology in the unit, we found that the commanders' attitudes and their sense of efficacy have a great impact on the infiltration of this technology in their unit. There are numerous factors determining willingness to adapt to change by units and leaders; willingness to take risk generally, when technology is only one expression of it; and tendency to adopt technology, as reflected in the accomplishments of the commanders in maintaining innovation processes and adopting technology. Sometimes these tendencies were perceived as contrary to conservatism within the unit; "The technological touch" - the understanding and technological skill of the commander; the sense of technological capability of the commanders in the unit - both their own sense and their sense of their unit's technological capability. This is partly explained by the fact that in a practical way, "motivation and ability" helps users and management to view a system through a positive lens and find solutions instead of despair.

#### ***4.3 One of the predictors of success - the link between assimilation (of product) and adoption (in departments)***

The more you adapt an existing product / service to users, requiring the product to change and be developed in order to better meet their needs, the harder it will be to assimilate it into their lives (Pillai, 1979).

Rogers (1983), who investigated processes of technological innovation infiltration in organizations, found that the better the product is adapted to the nature of use and the processes followed by users, the easier it is to integrate it. As it is evident, adapting a product to dozens of units and processes requires a lot of effort on the part of the product managers, and it is questionable whether there is the time and resources to accomplish this. A variety of existing technologies and solutions are used to develop products that are tailored to the needs of specific consumers. You can adapt a service that works with dedicated

software for analyzing and displaying data, for training units you can adapt dedicated and readymade training solutions, etc.

The use of a shelf product and user assimilation in this case was less successful. In units that have succeeded in adapting products to their needs through characterization processes and relevant representatives, they have been more successfully assimilated, for example in a greater number of operational processes and users. It also illustrates the importance of those technological leaders in the units, who were able to make the necessary adjustments to increase the likelihood of implementing the products in their units.

Gartner's technology adoption model known as the hype cycle supports this viewpoint (Gartner, 2019). When a product is introduced as the 'solution', there is a rapid rise in expectations and adoption among those who have waited for this and promoted it within the organization. It is when a product is put to use that its pros and cons become apparent and it enters the valley of disillusionment (underestimated expectations), units that were motivating or inspirational could cross the valley of sobriety and achieve maturity (the plane of productivity). Users learn how to use the product (implement) correctly, while at the same time the service learns to adapt itself to meet the needs of users.

#### ***4.4 What can we learn about implementation in general***

After detailing the key findings, we'll attempt to generalize what can be learned from the process carried out in the organization during this complex period to other organizations and routine periods when they prepare for situations and are not experiencing them.

##### ***4.4.1 An Implementation contingency plan - Would it be possible to turn a routine implementation into a crisis solution?***

Considering the implementation MIDI framework has helped a lot at the organization level. As a rule of thumb, it is recommended that an organization have at least a general, applicable contingency plan for implementation. The organization has handled crisis, light and material in a very short period of time. In an emergency, it is still necessary to implement systems in a relatively orderly manner in order to focus on time and other resources. We recommend keeping the central framework in place together with significant components, such as: delineating the concept and the system's objectives; identifying the user and

group management; risk management in terms of privacy and information security.

In a crisis situation, what remained of our absorption and assimilation model, the MIDI, were largely issues of support and training, whereas the organizational 'macro' stages, that demand careful planning up to months prior to the actual delivery to the end user, were not addressed, and the success of the assimilation was accordingly low.

#### *4.4.2 Should any system be implemented?*

The expected benefits of using a new information system should be evident right from the start. An organization's goals must be mapped out in advance in order to reap these benefits. In both the research literature and the popular management literature, there are dozens of different criteria that are used to ensure the adoption of a system. Some of these criteria relate to the actions of management, sociological and anthropological characteristics of the organization and its members, or to the relationship between investing time and money resources and the process (Christensen & Overdorf, 2000). Few refer to the system properties itself:

***Does the system "do what it's supposed to"? Is it effective in the sense that*** it allows for the existence of the processes and goals that led to its entry into the organization?

Is the system Technology ***reliable?*** without technical "crashes" or "bugs."

***Integration*** - Does the system integrate with other systems within the organization, or does it require a separate login / environment? Are data files and processes, managed by another information system already in use, available to the users?

***User-Friendly - What is the quality of user experience in the system?*** Is the 'user journey' pleasant and clear, and is the visual language helping the system to please the user and do what it is expected to do? Can the system generate a desire to work with it and explore its capabilities?

***Expandable and scalable*** - Will the system be able to handle the complexity of many users, processes, and timings? *Will the system hold limits if its' implementation will be even more successful than planned?*

#### *4.4.3 Centralization or decentralization?*

**The tension between decentralization and centralization** is expressed at two levels: first, upwards - at the level of project management at the top. This formulates the overall strategy created by the organization for the implementation of information systems and implementation management. Is there a centralized body responsible for the effort and does senior management oversee it? Is the implementation at the strategic level carried out with a high degree of decentralization in contrast to the degree of organizational centralization that characterizes the control of projects in the organization. The second level is the tension between the project management team and the leaders and knowledge officers deployed in units and bases. Considering the characteristics of the Corona period, there was considerable freedom granted, as a continuation of decisions taken before the Corona period and due to the inability to enforce tight regulation. The decentralization of these operations has been found to adversely affect the course of implementation, as the ratio of benefit to the investment in learning to use the system has shifted from positive to negative. In general, we recommend that the implementation efforts be more closely centralized in light of the relationship between decentralization and concentration.

**Organizational pace** - Organizations considering emergency deployment must take their internal pace into account. Based on the process we carried out, we recognize that the primary characteristic of the rhythm is the number of significant meetings led by leader of the organization (chief executive or senior manager). The slower this rate, the longer the implementation will take. Rapid implementation requires daily or frequent monitoring. Organizations that are not able to maintain administrative control at this frequency are likely to be left behind in the event of a crisis.

#### *4.5 What can we learn about implementation in times of emergency?*

If you are planning to implement a system in times of crisis, we recommend that the organization examines whether the system meets the expectations of the system as shown above, that it can set itself to action according to the organizational implementation model, and that the organizational pace will be appropriate. It is advisable not to move forward when the "prediction" of success

is not adequate, because it will be hard to invest the time and resources possible in a more relaxed situation.

## 5 Conclusions

The question arises as a result of the view that the implementation of an important information system is a significant organizational change - is a time of crisis the right time for such a change? The answer is intuitively no; however, some organizations utilize emergencies as an opportunity to acquire new capabilities, either through the acceleration of a preplanned initiative or a forced acquisition. Armies and other emergency organizations distinguish between deployment and implementation. No matter how successful a deployment may be, it does not lead to a successful implementation if the organization moves to a state where the embedded system is no longer needed, or if the organization readjusts to a state of crisis.

Our intention in this article was to learn from the IAF's adoption of collaborative work services during the Corona crisis how to assimilate shared work environments better. We believe that despite the uniqueness of this case, there are many lessons to be learned about the deployment of information systems, especially in times of emergency.

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## Resilience in Healthcare: an Investigation into the State of the Art

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### Abstract

**Background:** Recent major health shocks like the 2014-16 Ebola outbreak, the Zika outbreak, and, last but not least, the Covid-19 pandemic have strongly contributed to drawing attention to the issue of resilience of health systems, because health authorities and organizations experienced severe difficulties in managing these crises. The concept of resilience is assuming a central role also in the scientific debate about healthcare management. Nevertheless, the lack of clarity on how to systematize and deal with this topic led to a highly fragmented scientific literature, which creates difficulties in the development and assimilation of incremental research in this relevant field. This study provides a comprehensive map of the extant literature and identifies the main themes and future research needs.

**Methods:** A systematic literature review was carried out. We used the database ISI Web of Science (WoS) to extract the dataset. The material search was conducted in December 2020, using keywords derived from the literature. The final sample, obtained from the

application of exclusion and inclusion criteria on the initial dataset, comprises 89 articles that are the object of this analysis.

**Results:** The 89 articles in the final sample range from 2001 to 2020. The research on resilience in healthcare appears fragmented and linked to different research streams. Hence, effective framing existing contributions could be beneficial and help at identifying the most investigated areas and the main gaps to fill. At this aim, we proposed a novel theoretical framework, to systematize the papers dealing with the topic of 'resilience in healthcare' and to provide a clear picture of the state of the art in this field.

**Conclusions:** The content analysis allowed identifying the significant dimensions defining the scope of investigation on the topic under analysis. Scrutinizing articles along these dimensions, several gaps emerge, which opens interesting paths for future research.

**Keywords** – Resilience, Healthcare, Flexibility, Literature review, COVID-19

**Paper type** – Academic Research Paper

## 1 Introduction

The concept of resilience is assuming a growing central role in the debates about healthcare systems (Blanchet et al., 2017; Biddle et al., 2020). Recent major health shocks like the 2014-16 Ebola outbreak, the Zika outbreak, and, last but not least, the Covid-19 pandemic have strongly contributed to drawing attention to such issue, because health authorities and organizations experienced severe difficulties in managing these crises.

However, these emergencies have just raised a problem that tends to be systemic in the healthcare sector (de Vries et al., 2011; Barasa et al., 2017). Indeed, the lack of flexibility of health systems implies a poor ability to adapt to conditions other than the standard ones and leads to a decline in health performance, as soon as an unexpected change occurs. Such vulnerability has an impact not only when a serious crisis occurs, but also when systems face routine stressors. In such a context, resilience is gaining momentum since it is the only answer for health authorities to this issue.

Numerous definitions and concepts of health systems resilience were proposed in the scientific literature, with different perspectives and aims (Blanchet et al., 2017; Fridell et al., 2020; Biddle et al., 2020), reflecting the rich facets that the term can take on in the healthcare environment. Since the presence of numerous different potential conceptualizations, resilience in health systems remains a very fragmented and broad concept (Turenne et al., 2019). The theoretical and



empirical cases in literature tend to be very different from each other, without also the use of a common terminology.

The lack of clarity on how to systematize and deal with this topic in managerial literature leads to a highly fragmented scientific literature, which creates difficulties in the development and assimilation of incremental research in this relevant field. This arises the need for an extensive review of the literature to systematize the managerial research referred to this topic.

The majority of available reviews in literature tend to be scoping reviews, thus not systematic ones, and generally have a narrow scope – e.g. answer to shocks, everyday resilience, Ebola outbreak in West Africa, developing countries (Biddle et al., 2020). In addition, they seem to look only at the articles that expressly refer to the resilience concept, without considering associated terms (e.g. flexibility, agility, readiness), which are often used to describe methods and concepts that are coincident or strongly related to health system resilience. Some limits also emerge considering the extent of the analyses that frequently consider a small number of articles (e.g. Fridell et al., 2020; Iflaifel et al., 2020). This lead to a shortage of a comprehensive framework able to guide the development of literature in the field. To fill this gap, this research aims to provide a clear picture of the current state of the art about resilience in the healthcare domain, by applying a systematic literature review methodology.

The contribution of this work, also in light of previous reviews in this area, is in being comprehensive of all the literature streams that have addressed the topic of resilience in healthcare and in proposing and placing papers in a multi-dimensional framework that can streamline such literature. In this effort to be broad, this review also examines contributions that describe methods and concepts coincident or strongly related to health system resilience though they do not expressly involve the term resilience. In addition, the content analysis was more extensive, both in terms of the number of articles analysed and in terms of dimensions assessed, which is highly needed to drive the further development of healthcare resilience literature.

## **2 Methodology**

To reach our purpose, we followed a systematic and transparent method based on Pittaway et al. (2004), meant to guide the literature review. As a first step, we aimed at identifying the intellectual core of a field (McCain, 1990), with the final

purpose of determining its underlying structure. This implies beginning from a broad dataset to be reduced progressively in later steps. The starting database was defined by combining the keyword health\*, searched in the title, with the keywords resilien\* or flexib\* or adapt\* or readiness\* or agil\*, searched in the topic, in the scientific database ISI Web of Science (WoS) Core Collection in December 2020. The choice of keywords is based on the conceptualization of resilience provided by Wiig et al. (2020), who stress that the definitions differ across disciplinary fields, complemented by the fact that different constructs are used with a similar meaning. However, despite variations, "some common core mechanisms of resilience have been identified as the ability that individuals, communities, organisational units or larger systems have to return to some 'normal' condition or state of functioning after a disruptive event; to cope with pressure and problems by being flexible without compromising system performance; or to adapt to a new normal state, where system functioning is reorganised or enhanced in some way in response to the disruption they face" (Wiig et al, 2020, p. 3). We added the keywords readiness\* or agil\* that are more used when speaking about routine stressors instead of disruptive events (e.g. ...).

This searching produced 29,306 results. After refining the query by WoS category (i.e. Operations Research Management Science, Economics, Management or Business), by document type (i.e. Article, Review, Early Access, or Editorial Material), and language (i.e. English), we ended up with 556 articles. However, while reading these articles and looking at forward and backward references to be sure we had captured all relevant contributions, we realized some contributions were missing. We noticed they were published in a bundle of journals pertaining to the WoS categories *Healthcare Sciences & Services* and *Health Policy and Services*. Consequently, we performed the search mentioned above within these categories, applying the same filters, thus obtaining 510 additional results.

As a second step, we read the abstracts, establishing specific exclusion criteria to leave not pertinent articles out of the analysis. In particular, when the concept of resilience was not considered at all or not with reference to a health organization or service, the article was excluded from the sample (e.g. resilience of the patient, health intended as improving air quality or reducing soil consumption). When collateral subjects (e.g. lean principles, complex adaptive systems) were the main topic of the article, we retained it only if there was mention of resilience in some way. We maintained the same criteria also for the

third step, i.e. full article reading of those contributions requiring further examination because the abstract was not sufficiently informative. After authors cross-checked the inclusion/exclusion of articles in the final pool during several sessions, we obtained 89 articles that are the object of investigation of this analysis.

As a final step, we analysed those articles carefully and mapped in a spreadsheet the main fields of interest, namely the purpose of the research, the methodology employed, the context of analysis, the research questions/hypotheses, the theoretical background, the main construct and associated definition (when provided), the key findings and future research.

While reading and mapping articles, we realized that other dimensions deserved particular attention because they were present in most articles, explicitly or implicitly, and they seemed to define the features surrounding the concept of resilience in healthcare, thus contributing to identifying the scope of investigation. These are the relevant dimensions we used to organize the literature, which is the main focus of the content analysis presented in the following section.

### **3 Results**

#### ***3.1 Descriptive analysis***

The 89 articles of the sample have been published from 2001 to 2020 (Figure 1). As shown in Fig.1, the biggest increase has occurred in the last 5 years (about 80% of documents sourced) and, in particular, in 2020, when the number of publications was more than double compared to 2019, and triple compared to 2015.

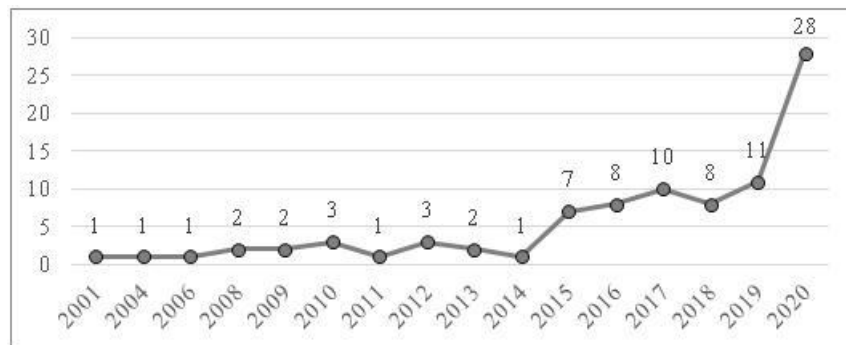


Figure 1: Annual scientific production

The variety of outlets that published articles on the topic of resilience in healthcare is wide (i.e. 51 journals). In Table 1, we show the scientific journals that published more than two articles in the sample. Among the 13 journals listed in the table, 8 belong to the first quartile of SJR classification and 3 to the second quartile.

The most productive journals contain approximately the 57% of the total number of documents retrieved (51 out of 89); they belong to different areas of research – including “Engineering, Industrial; Operations Research & Management Science”, “Development Studies; Economics, Health Policy & Services” according to WoS categories. The two top journals (i.e. Health policy and planning and BMC health services research) fall within the category of “Health Care Sciences & Services”. Table 1 reports, for each journal, the mean value of citations received by the manuscripts of our sample. In particular, “BMJ Quality & Safety” and “International Journal for Quality in Health Care” are the journals with the highest value of citations per document, i.e. 64.6 and 59.6 respectively.

Table 1. Most productive Journals

Scientific Journal	N. of Articles	SJR	Citations per document
Health policy and planning	13	Q1	14.4
BMC health services research	8	Q1	15.5
Safety Science	7	Q1	17.2
BMJ Quality & Safety	3	Q1	64.6
International Journal for Quality in Health Care	3	Q2	59.6
World Development	3	Q1	5.0

Australian Health Review	2	Q2	5.5
Disaster Prevention and Management: An International Journal	2	N/A	4.5
Health research policy and systems	2	Q1	3.0
International journal of health policy and management	2	Q1	28.0
Journal of evaluation in clinical practice	2	Q2	4.5
Journal of Health Management	2	N/A	0.5
Medical teacher	2	Q1	12.5

### 3.2 Content analysis

In this section, we propose a novel theoretical framework, to systematize the papers dealing with the topic of ‘resilience in healthcare’ and to provide a clear picture of the state of the art in this field. As recalled above, the research on resilience in healthcare is fragmented and roots back in different research areas and streams. Hence, an effective framing of existing contributions could be beneficial and help at identifying the most investigated areas and the main gaps to fill.

The framework proposed in this article is based on the dimensions listed below:

1. The typology of stressor to deal with;
2. The organizational level;
3. The geographical context;
4. The resilience strategy;
5. The resources to nurture resilience.

In the following paragraphs, the single dimensions will be detailed and discussed.

#### 3.2.1 The typology of stressor to deal with

*Resilience* is traditionally intended as the capacity of a system to respond to acute shocks, but it may refer also to the response to chronic stressors and everyday challenges (Barasa et al, 2017). In this regard, Gilson et al. (2017) introduced the concept of everyday resilience to indicate the capacity to cope with a different category of adverse events that may affect the system daily or in the long run. In this study, we have adopted a holistic view of resilience that focuses on both perspectives. Hence, we classified articles in the sample according to the typology of stressor under analysis (acute shocks vs. chronic

challenges). Most of the contributions dealing with *acute shocks* focus on infectious disease outbreaks. In this context, many authors analyzed the case of the Ebola outbreak (Gizelis et al., 2017; Ling et al., 2017), while, more recently, flourishing literature has started to appear about the COVID-19 pandemic, which has provided a fruitful case of analysis for scholars (Sharma and Sharma, 2020; Van Nguyen et al., 2020). Further examples of acute shocks are natural disasters, as earthquakes and tsunamis (Raven et al., 2018) and military conflicts (Odhiambo et al., 2020). The articles dealing with *chronic stressors* focus on different sources of uncertainties that may put the normal functioning of the systems at risk. Many contributions concentrate on internal sources of uncertainties, with the aim to minimize potential operational failures and/or harms on patients (Sujan et al., 2015; O'Hara et al., 2019). Others focus on external sources, as demand fluctuations (Restrepo et al., 2020), economic crisis (Thomas et al., 2013), demographic changes (Chen and Chen, 2015). Due to the high variability of the environment and the variety of chronic stressors that may occur, health systems have to develop appropriate strategies to respond and to be resilient every day, beyond disruptive events.

### 3.2.2 The organizational level

The contributions analysing the system response to a crisis event (shock or stressor) differ on the basis of the organizational level they focus on. On the one hand, some authors analyse the phenomenon from a *macroscopic* point of view, by focusing on the response of entire national health systems (Thomas et al., 2013; Van Nguyen et al., 2020) or of regional and urban health networks (Crowe et al., 2014). In this context, the policies undertaken by single governments or health organizations and/or the service reconfiguration strategies during a crisis are the most investigated aspects. On the other hand, there is a big quota of contributions focusing on a *microscopic level*, i.e. on the capacity of single organizations (i.e. hospitals, health units) to respond to adverse events (Sujan et al., 2015; Sharma and Sharma, 2020). In this case, the focus is on the internal processes and resources.

### 3.2.3 The geographical context

The crisis that put at risk the functioning of the health systems may range from events that have global impacts (i.e. pandemics) and those with local and limited consequences (i.e., natural disaster, epidemic). In this latter case, it is useful to

distinguish articles according to the geographical context they set their analysis on, to understand if there are threats affecting health systems in specific contexts.

It emerges that low and middle-income countries are affected by specific diseases (e.g. Ebola) and environmental conditions (e.g. military conflicts); hence, most of the studies on the developing countries focus on a specific class of adverse events (Gizelis et al., 2017; Raven et al., 2018). On the other hand, different difficulties have affected high-income countries, such as the 2008-2009 financial crisis that forced multiple health systems in Europe to reorganize to increase efficiency and make cutbacks in health budgets (Thomas et al., 2013). Further challenges are slowly emerging worldwide, causing progressive stress to systems; for instance, the continued threat of antibiotic resistance, which is predicted to become one of the largest challenges to health systems in the future, the climate change, that poses serious challenges to human health (Araos et al., 2016).

#### *3.2.4 The resilience strategy*

The approach towards resilience can be proactive or reactive, where proactive refers to preparedness and reactive refers to the recovery from turbulence (Chowdhury and Quaddus, 2017). Accordingly, we classified articles based on the undertaken strategy, distinguishing between:

- *proactive strategies*, aimed at reducing the likelihood of occurrence of adverse events and/or at anticipating the future threats, before they are actually experienced.
- *reactive strategies*, aimed at reducing the consequences of the adverse events, once they have already occurred.

Most of the articles focus on reactive strategies (Ling et al., 2017; Van Nguyen et al., 2020), being empirical studies focusing on the ex-post analysis of response to real crisis events, already occurred. Less attention has been devoted to proactive strategies. Some studies focus on the development of tools and management practices, which help to monitor processes and to recognize, anticipate and defend against the risk before adverse consequences occur. To cite a few, Crowe et al. (2014) develop Operations Research techniques for supporting strategic decisions concerning service reconfiguration during a crisis; Maunder et al. (2010) develop a computer-assisted course to train health workers and

improve their preparedness during pandemics, thus minimizing the stress and its negative impact on the health systems (i.e. absenteeism).

### *3.2.5 The resources to nurture resilience*

Complex health systems are comprised of both hardware and software resources (Sheikh et al., 2011). Hardware resources include infrastructure, medical devices, human resources and finances, while software resources include the tangible software of management knowledge and skills, organizational systems and procedures, as well as the intangible software of values and norms, relationships and power (Barasa et al., 2017). Most of the articles focus on hardware elements; specifically, on the pivotal role played by health workforce in the response to a crisis (Mauder et al., 2010); on the engagement of patients and families in the process delivery to minimize variability and risks (O'Hara et al., 2019); on the exploitation of digital technologies (Rubbio et al., 2019) and on the availability of equipment, materials and infrastructure (Kumar et al., 2020). The contributions focusing on the software elements are mostly devoted to investigate the impact of governance and leadership on the system response at different organizational levels (Thomas et al., 2013; Gizelis et al., 2017) or to the development of flexible and robust managerial tools that may support resource allocation decisions (Crowe et al., 2014).

## **4 Conclusions**

The purpose of this article was to carry out a literature review on the theme of resilience in healthcare in an attempt to systematize the existing, broad and fragmented literature into a multi-dimensional framework.

The content analysis allowed identifying the significant dimensions defining the scope of investigation of the topic object of study, namely the typology of crisis to deal with, the organizational level, the geographical context, the resilience strategy, and the selected resources to nurture resilience. Scrutinising articles along these dimensions made a number of gaps emerge, which opens interesting paths for future research, among which we would like to put attention on some main points. First, research on how to be prepared to prevent shortcomings of and deal with stressors and disruptive events, which means having a proactive approach towards resilience in healthcare, is still scant. Second, the resources required to foster resilience have disregarded software resources in favour of



hardware ones. In particular, intangible software resources related to relational aspects of agent interactions (e.g. norms, power, trust, culture) are unexplored. Instead, among the hardware resources, authors frequently mention information technology in general terms, whereas nowadays specific studies on how digital technologies may contribute to increasing resilience would be appropriate. Third, the interplay among these dimensions could be a stimulating evolution of this study. For example, looking at whether resilience at different organizational levels or different resilience strategies benefit from different resources or could reveal interesting insights.

Finally, beyond the dimensions, we had a further confirmation that authors still do not converge towards a shared definition of resilience in healthcare, which has relevant implications because using a multiplicity of definitions for a single construct or using constructs with a similar meaning as a basis for theorizing could lead to biases in the field, because the development of a consistent, strong and generalizable theory necessitates a base of well-defined constructs. This calls for the standardization of the definition of resilience in healthcare in an attempt to provide a common language to describe and explain resilience (e.g. Huey and Palaganas, 2020; Wiig et al., 2020).

From a theoretical perspective, this article contributes to the creation of a comprehensive framework able to guide the development of the literature in the field. But it has also a relevant practical contribution, as it provides a knowledge base supporting decision-making in healthcare. For a health care organization to be truly prepared for unexpected events, leaders can be supported and facilitated in their decision-making if they have solid knowledge and a basic understanding of the principles that can guide the resilient management of health care systems. Overall, the study offered a demonstration of the importance of developing specific knowledge for fostering a proper conceptualization of resilience in healthcare. In this regard, it calls for a new research agenda.

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## Sustainability-Oriented Innovation, Open Innovation and Performance: an Agent-Based Approach

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### Abstract

The mounting pressure from governments and investors has imposed companies to think “green”, “sustainable” and be “social compliant”. In this paper, an investigation to understand the joint impact that Sustainable Oriented Innovation (SOI) and Open Innovation (OI) may have on companies' performance is presented. In particular, the study aims to see if these practices, i.e. OI and SOI, impact in terms of innovation, sustainable and economic performance that have been described in the literature as different but often correlated outcomes. The model proposed a setting in which it is possible to test the joined effect of developing SOI and the sharing of knowledge considering open and closed OI strategies. Results show that the most convenient strategy is to develop SOI technologies, but the use of an open setting should be evaluated according to the life cycle stage and dynamicity of the technological environment.

**Keywords** – sustainability-oriented innovation, open innovation, agent-based model, performance, patent. (*max 5 words*)

**Paper type** – Academic Research Paper

## 1 Introduction

The mounting pressure from governments and investors has imposed companies to think “green”, “sustainable” and be “social compliant”. In the last years, sustainability-oriented innovation (SOI) has largely been considered as one of the most important drivers to cope with regulation and be competitive in the market. Although SOI is not a new concept, many large multinational corporations but also small enterprises are increasing their attention toward SOI practices. SOI is defined as “realized ideas that improve environmental and/or social performance compared with the current situation” (Arnold and Hockerts, 2011, 394) and it can be considered either a practice or an output of a process. It concerns several aspects of a company, ranging from the efficient use of resource inputs to the creation of totally new products and services that need to be aligned with the traditional business (Adams et al., 2016; Nidumolu et al., 2009). One of the main questions regards the impact that SOI may generate and its effect on the company’s final performance. Nowadays, SOI is seen also as a source of opportunities that drives businesses to gain a competitive advantage and simultaneously improve their performance (Hall, Wagner, 2012). However, for a long time, sustainability has been seen as a cost of doing business to be compliant with governmental laws and as an economic externality or as a cost infringed by effective legal enforcement (Porter and Van der Linde, 1995).

In this context, explorative studies suggest that sharing knowledge and resource can be fundamental for improving company’s results. The fact to share knowledge with others can be characterized as an Open Innovation (OI). This may support the development of a sustainable, timely, commercially viable innovation and improve company’s performance. Over the past decade, innovation literature emphasized the importance of going beyond the firm’s boundaries when creating and developing innovation in order to increase the firms’ performance (Chesbrough, 2003). For example, external technology acquisition positively affects firm performance. Moreover, the collaborative approach when developing SOI products or processes may enable the innovation team to harness the opportunities offered by adopting a sustainability strategy. It seems that a proactive SOI strategy harnessed the benefits of OI. As Keskin et al.’s (2013) study the “network” is a critical practice and sharing knowledge with other actors facilitates the engagement with like-minded external actors (such as industry experts, universities and formal innovation partners) (Adams et al., 2016). Thus,

collaborating with other actors may realize a synergic result (Slotegraaf, 2012) because OI creates a combined internal and external space for organizational practices, enabling an externally-oriented approach to their respective execution that reduces the risk and uncertainty of SOI. Nevertheless, it is not clear what the impact may be and sometimes also the sharing of knowledge does not lead to the expected results. Current studies are mainly based on a specific case study and, for example, empirical evidence suggests that SOI processes coupled with OI lead to more radical products without providing a more complete understanding (Kennedy et al., 2017) about how these two practices may work synergically and how they may impact companies' performance.

Relying on this background, the paper aims to understand the joint impact that SOI and OI may have on companies' performance and answer the following research question:

*How does the synergic use of SOI and OI impact on company's performance?*

In particular, the study aims to see if these practices, i.e. OI and SOI, impact in terms of innovation and economic performance that has been described in the literature as different but correlated outcomes. To answer the research question outlined above, many different methodologies can be applied. Among them, the agent-based models are very powerful tools as they let to create a sort of computational laboratory where to make experiments through simulations (Landolfi et al., 2012, Ponta et al., 2018, Albino et al. 2006). In this paper, the PABIM model and simulator have been enriched to address the research question underlined above (Ponta et al., 2020b). Results show that the most convenient strategy is to develop SOI technologies. However, the synergic use of an open environment should be evaluated according to the life cycle stage and dynamicity of the technological environment.

The paper is organized as follows: Section 2 presents the model, Section 3 shows the results of the computational experiments and Section 4 provides the discussions and conclusion of the study.

## **2 The model**

To investigate the main objective of the study outlined above, the agent-based model and simulator (PABIM) has been used (Ponta et al., 2020b).

The agent-based model developed is characterized by heterogeneous firms that are organized as a directed random graph. The graphical representation of the PABIM model in terms of firms and interactions is shown in Figure 2.

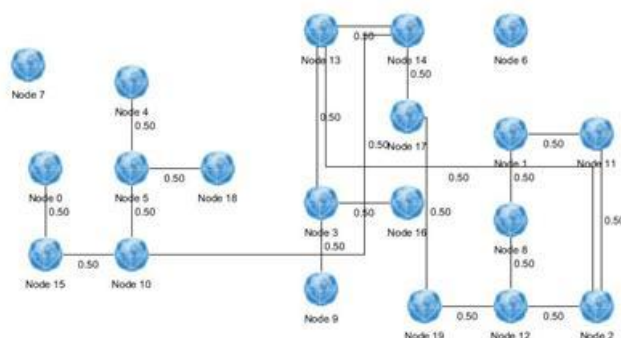


Figure 2 – Graphical representation of PABIM model in terms of firms (circles) and interactions (lines) at time step 0.

At the beginning of the simulation, all the firms have the same output node degree, defined as the number of outgoing arrows, and are endowed with the same quantity of cash and the same number of employees. During the simulation, the output node degree of each firm is directly proportional to the firm's size, i.e., it increases if the firm's size increases and decreases if the firm's size decreases, thus the number of employees, proportional to the firms' size, varies during the simulation.

Each firm  $i$  is characterized by an identifier  $id_i$ , a number of employees  $N_i$ , a list of its filed patents  $P_i$ , an amount of cash  $C_i$ , the turnover  $Tu_i$ , the percentage of turnover invested in R&D  $\alpha_i$ , an industrial sector  $IS_i$  and a probability to patent  $\rho_i$ .

The percentage of turnover invested in R&D research is different for each firm and proportional to the firms' dimension.

In this enriched version of PABIM, firms are also characterized by two R&D divisions: the SOI and NO SOI divisions. The SOI division makes research finalized to file SOI patents, whereas NO SOI division to file patent not specifically related to sustainability.

At each iteration step, each firm invests a fraction of the turnover in R&D research, that is divided between the SOI and NO SOI division, necessary to file patents. All the R&D expenses are finalized to patent.



The probability  $\rho_{i,s}$  of firm  $i$  to file for a SOI patent is set to depend on the cumulated R&D research investment  $Mc_{i,s}$  employed by the SOI division of firm  $i$  since the latest SOI patent filed, as follows:

$$\rho_{i,s}^t = 1 - \frac{1}{1 + \eta Mc_{i,s}^t} \quad (1)$$

where  $\eta$  is a shape parameter, homogenous across all firms, setting the sector innovation intensity, i.e., the higher is  $\eta$ , the higher is the probability to file for a patent, for any level of cumulated R&D research investment  $Mc_{i,s}$  employed.

The probability to make a SOI patent using shared knowledge between firm  $i$  and  $j$  (co-patent between firm  $i$  and  $j$ ) is given by Eq. 2

$$\rho_{ij,s}^t = 1 - \frac{1}{1 + \eta (Mc_{i,s}^t + Mc_{j,s}^t)} \quad (2)$$

If firm  $j$  cannot patent alone, it chooses from among all the firms' requests, to make a patent using shared knowledge with the firm with the greatest connection strength.

Analogously, the probability  $\rho_{i,ns}$  of firm  $i$  to file for a NO SOI patent is set to depend on the cumulated R&D research investment  $Mc_{i,ns}$  employed by the NO SOI division of firm  $i$  since the latest NO SOI patent filed, as follows:

$$\rho_{i,ns}^t = 1 - \frac{1}{1 + \eta Mc_{i,ns}^t} \quad (3)$$

The probability to make a NO SOI patent using shared knowledge between firm  $i$  and  $j$  (co-patent between firm  $i$  and  $j$ ) is given by Eq. 4

$$\begin{aligned} &\rho_{ij,ns}^t \\ &= 1 - \frac{1}{1 + \eta (Mc_{i,ns}^t + Mc_{j,ns}^t)} \end{aligned} \quad (4)$$

Thus, at each iteration step a firm can file a SOI patent and a NO SOI patent.

If a patent is not possible at time  $t$ , the firm can extend a patent issued at time step  $t-1$ . If firm  $i$  did not file for a patent at time step  $t-1$  no patent is extended.

The patent is characterized by an identifier, an IP class, one or more countries in which the patent is extended, the number of forward and backward citations. It is worth remembering that the backward citations are the patents cited when the new patent is issued, whereas the forward citations are the ones received by the patent. Moreover, a patent is characterized by a cost composed of a part that represents the cumulated (discounted) cost of filing and maintaining a patent and

another part that depends on the R&D investment done until the year of filing. Moreover, a patent is also characterized by an extensions cost which represents the cumulated (discounted) cost of extending and maintaining the extensions of a patent. Management costs have also been considered.

The value of the SOI and NO SOI patent, intended as the cumulated (discounted) turnover generated by the patent is defined by firms proportional to costs, through the multipliers  $\mu_{sp,i}$  and  $\mu_{nsp,i}$ , respectively, defined at the beginning of simulation and constant during the simulation.  $\mu_{sp,i}$  and  $\mu_{nsp,i}$  are a positive real number to consider both the case of success and failure of a patent. In particular,  $0 < \mu_{p,i} \leq 1$  represents the failure case, whereas  $\mu_{p,i} > 1$  represents the success case.

The revenues for firm  $i$  of a patent  $p$  filed at time  $t$  is:

$$R_{p,i,t+2} = \begin{cases} V_{p,i}^t & \text{if firm } i \text{ files a patent alone at time step } t \\ V_{p,i}^t \nu \frac{Mc_i^t}{Mc_i^t + Mc_j^t} & \text{if firm } i \text{ files a patent at time step } t \text{ using shared knowledge with firm } j \text{ (copatent)} \end{cases} \quad (5)$$

where  $\nu$  is a coefficient positive and less than 1, which simulates the management costs between firm  $i$  and  $j$ .

In general, a SOI patent is more expensive in term of research but also the revenues are larger (Whelan et al., 2016). Following Whelan et al. (2016), this assumption mimics the benefit of a SOI patent.

Furthermore, the turnover of firms is updated. and firms determine the number of employees to hire or fire at each iteration step, according to their revenues. In particular, if the variation of turnover,  $\Delta Tu_i$ , is larger than zero firm  $i$  will hire a number of employees directly proportional to  $\Delta Tu_i$ , whereas if  $\Delta Tu_i$  is smaller than zero firm  $i$  will fire. Furthermore, if  $\Delta Tu_i$  is equal to zero no hiring or layoffs are implemented.

Finally, at each time step, the economic and innovative performances are evaluated. It is worth remarking that at each time step  $t$ , each firm checks if it can make a patent alone, and if not, the firm can try to share knowledge with the connected firms.

At each iteration step, the economic performance  $Pe_i^t$  of firm  $i$  is evaluated as its turnover  $Tu_i^t$ . Concerning the firms' innovation performance, among the traditional measure based on secondary data, the number of patents is considered. Moreover, also the patents' features that combined define the Innovation Patent Index (IPI), have been taken into account (Ponta et. al. (2021),

Ponta et. al. (2020a). Finally, the sustainability innovation performance is evaluated measuring the number of SOI patents.

### 3 Computational Experiment

#### 3.1 Design of experiments

In order to investigate the research question described above four scenarios have been considered. In the scenario (i) each firm can only create knowledge about NO SOI, in the scenario (ii) the knowledge's share strategy is allowed about NO SOI, in the scenario (iii) each firm can only create knowledge alone about SOI and NO SOI and in the scenario (iv) the knowledge's share strategy is allowed for both SOI and NO SOI. Table 1 summarizes the characteristics of the four scenarios.

Table 8: Scenario description

Scenario	Description	Color
i	Firms can develop alone only NO SOI technologies	Blue
ii	Firms can develop alone the technology or share the knowledge only NO SOI technologies	Red
iii	Firms can develop alone SOI and NO SOI technologies	Green
iv	Firms can develop alone or share the knowledge for SOI and NO SOI technologies	Magenta

Simulations have been performed *ceteris paribus*, meaning that all the parameters are identical with the exception of the strategy. In particular, twenty firms, working in eight different sectors have been simulated. Each firm can file two patents maximum per year. The four cases previously described and summarized in Table 1, are explored with six different values of  $\eta$ , the parameter which controls the probability to translate the R&D investment into patents, see Eq. 1; in this way twenty-four different scenarios are obtained. The methodology used is based on Monte Carlo computational experiments: each scenario is simulated with fifty different seeds of the pseudorandom number generator. So, a

total of 480 simulations were considered in order to conduct the investigation. The computational results are presented in the form of boxplots. In particular, each boxplot shows the distribution of the time averages of relevant variables over a twenty-year time interval, concerning the twenty simulations characterized by different seeds. Boxes enclose the values from the first to the third quartile; they also include whiskers that extend up to the minimum and maximum data points that are not considered outliers; the horizontal segments inside boxes represent the median of the distribution. The analysis aims to investigate the impact of sharing knowledge and of sustainability on firm performance, considering economic innovation and sustainability performance. Table 2 summarizes the simulations' initialization data. The data used in the simulations were estimated from the Orbit Intelligence database provided by Questel<sup>1</sup>, collecting patents that are published by firms with a registered office in Italy, or by an inventor with a residence in Italy from 2000 to 2018.

Table 9 - Simulation Parameters

Symbol	Description	Value
T	Years	20
I	Number firms	20
ES	number economic sector	8
do	number of initial output connection	0, 2
$n_d$	Number of divisions	1,2
$T_u$	Initial Turnover	20000
$\eta$	Sector innovation intensity	0.00001 to 0.005
$\alpha$	% of turnover invested in R&D	[2 - 17]
$\mu$	Multiplicator	[0.5 - 2]
$\mu_G$	Multiplicator SOI	[0.9 - 1.7]
$v$	coeff management cost	0.9
$C_e$	patent extension cost	350
$C_f$	patent filed fixed cost	500

### 3.2 Results

Figure 3 shows the economic and innovation performance in scenario (i) (blue), scenario (ii) (red), scenario (iii) (green) and scenario (iv) (magenta). Scenario (i) is

<sup>1</sup> [www.questel.com](http://www.questel.com)

characterized by a no share of knowledge strategy for only NO SOI. Firms patent only alone and do not cooperate to achieve technological improvement more quickly. Scenario (ii) is characterized by the possibility to share knowledge for NO SOI research, that is, firms cooperate to reach the issue of a NO SOI patent. Scenario (iii) is characterized by the possibility to file both SOI and NO SOI patents but with no share of knowledge. Finally, in scenario (iv) both SOI and NO SOI patents are allowed and also the share of knowledge among firms. In particular, Figure 3 (a) shows the economic performance approximated with the turnover. It can be noted that for all the values of  $\eta$ , the turnover in scenario (i) and (iii) is larger than in scenario (ii) and (iv), meaning that firms can convert R&D investment into patents without sharing knowledge, and making patents alone saves the management costs. For a firm, it is more remunerative to reach enough knowledge to patent rather than to use shared knowledge. Moreover, for very large  $\eta$  the two scenarios are similar because, even in the case of shared knowledge, firms file for patents alone. Furthermore, in both scenarios, the maximum value of economic performance is reached for an intermediate value of  $\eta$  meaning that either a low or a large number of patents does not permit to reach the optimal value of economic performance. Moreover, it is worth noting that the economic performance is largest for scenario (iii) for all  $\eta$  meaning that SOI patents can produce higher economic performance. Figure 3 (b) shows the innovation performance evaluated with the number of patents. For all  $\eta$  the innovation performance is larger in scenarios (iii) and (iv), i.e. when firms can file SOI patents. Moreover, for small  $\eta$  the innovation performance is larger when firms share knowledge (scenario (iv)), whereas, for large  $\eta$  it is larger in scenario (iii), that is when firms do not share knowledge. This behaviour is also shown by the sustainability performance as clear in Figure 2 (c). In order to investigate innovation performance deeply, Figure 4 shows the five patent features mentioned in Section 2. In each subfigure, all scenarios are plotted for easy comparison. Figure 4(a) shows the normalized number of patents with respect the firm size. It is possible to observe that for all  $\eta$  it is larger in scenario (iv), i.e., firms that file also SOI patents and share knowledge are able to file for a larger number of patents compared to the no share case and the cases of NO SOI research. Thus, independently of the ability of firms to transform R&D research into patents, the possibility to use sharing knowledge increases the innovation performance of firms. It is even more evident in the case of SOI.

Figure 3 (b) shows the number of IPC classes. It is possible to observe that for small  $\eta$  the feature is larger in scenario (ii) whereas for large  $\eta$  in scenario (iv). Concerning the backward citations, as shown in Figure 3 (c) for all  $\eta$  the features is large in scenario (iv).

Finally, Figure 4 (d) and (e) show the number of extensions and the number of months between the publication date of the youngest and the oldest patent of the family. It can be observed that for larger  $\eta$  in scenario (iii) and in scenario (iv) these patents features are larger than in scenarios (i) and (ii). It is worth noting that in both scenarios the maximum number of these features is for  $\eta$  not very small nor very large. Summarizing the results of the innovation performance, in scenarios (iii) and (iv), i.e. when firms file also SOI patents, firms reach better performance compared to scenario (i) and (ii). Moreover, it is worth noting that if firms file also SOI patents the best innovation performance is reached if firms do not share knowledge, whereas if firms file only NO SOI patents the best innovation performance is reached if firms share knowledge.

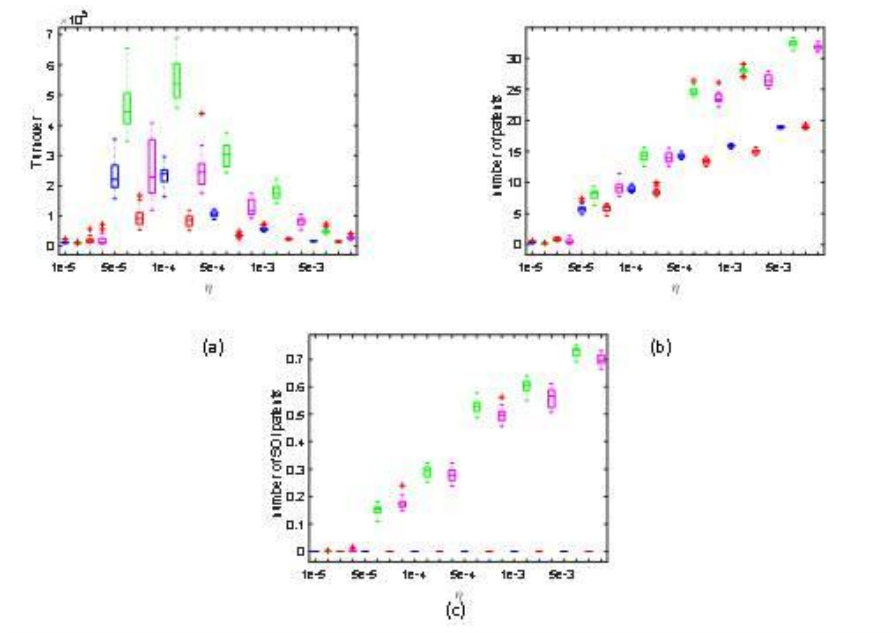


Figure 3 – Distribution of the economic (a), innovation (b) and sustainability (c) performance of firms for scenario(i) (no share of knowledge, NO SOI) in blue, scenario (ii) (share of knowledge, NO SOI) in red, scenario(iii) (no share of knowledge, SOI) in green and scenario (iv) (share of knowledge, SOI) in magenta.

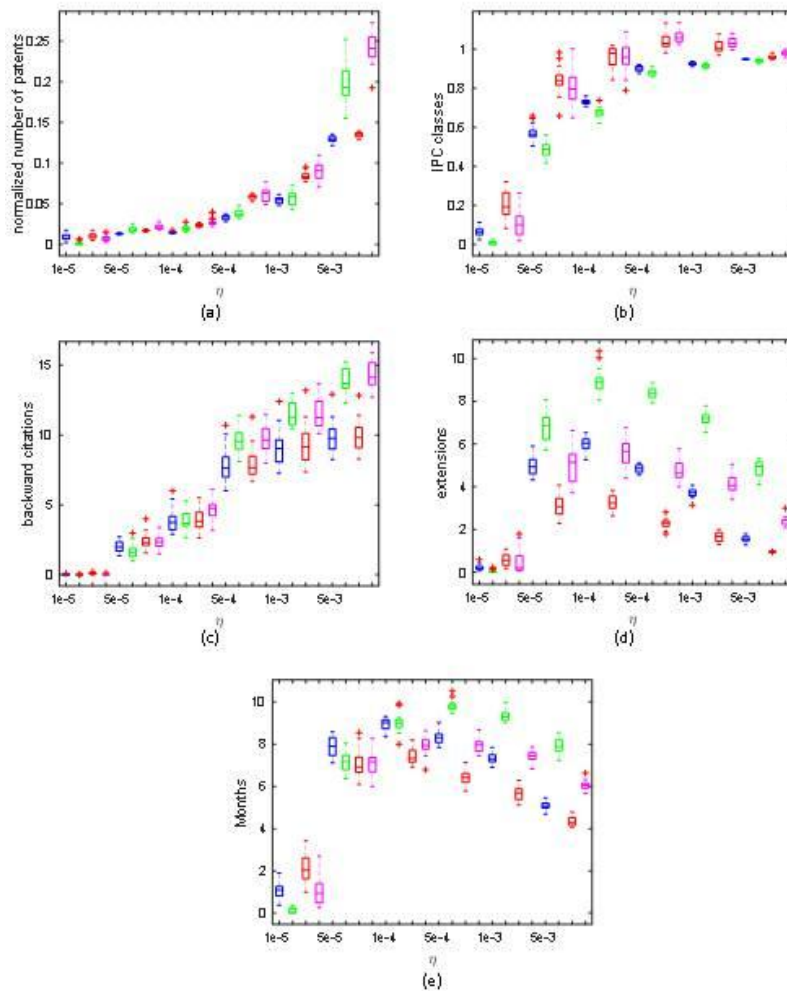


Figure 4 - Distribution of the following patents features: the normalized number of patents (a), the number of extensions (b), the number of IPC classes (c), the number of backward citations (d) and the number of months between the publication date of the youngest and the oldest patent of the family (e) for scenario(i) in blue, scenario (ii) in red, scenario (iii) in green and scenario (iv) in magenta.

#### 4 Discussion and Conclusion

This model contributes to both SOI and OI literature, trying to merge these two main paradigms beyond the innovation management literature. Recently, SOI has developed impressively, with a surprising steep rise and accounting for a variety of nuances, showing also high complexities and a large variety of actors and

interests involved in transformation processes. Moreover, the importance of sharing knowledge in challenging and uncertain environments to create a complete knowledge chain towards successful innovation (Kennedy et al., 2017) has always been a main point for scholars. The study suggests to innovation management scholars the importance of combining both practices (Van den Ende et al., 2015) to reduce issues and complexity and when the combination of these strategies maximize the value of the effort.

Thus, in this complex environment the model simulates the possibility to develop SOI or NO SOI leveraging two opposite collaboration strategies: i.e. open or closed (Chesbrough, 2003). The study suggests that the innovation process must be seen from different perspectives and performance should be measured with different indicators. The impact of SOI and knowledge sharing on innovation, economic and sustainable performance may be different according to the performance measured and assume different meanings according to the dynamicity of the environment. In particular, the sharing of knowledge leads to lower turnover results when developed with other actors. When managing the development of new products, and probably even more when developing sustainable related innovations, the collaboration and sharing of knowledge between firms presents challenges. Indeed, the turnover should be split among the companies that help in developing the technology (Wang et al., 2021). However, it should be noticed that for a low intensity of the external context, the turnover is more or less the same when collaborating or not, probably because the market does not lead to splitting the revenues among companies. Innovation performance differ according to the different scenarios. In general, for medium level of context dynamicity, the sharing of knowledge to develop new innovations may provide fruitful results. If the company aims to develop a high number of innovations, with respect to the number of employees (a measure of the efficiency of the firms (Ponta et al., 2021) an open strategy helps to split risks and costs. Moreover, this strategy lets also having a higher quality (measured in terms of backward citations) (Ponta et al., 2021) because it allows using the previous knowledge of multiple actors. In general, the sharing of knowledge is even more fruitful if the company is developing NO SOI innovation. Moreover, an open approach does not really help in entering new markets (number of extensions) probably because in this case it would be more helpful to search for partners that support the sales channels and that own higher marketing competencies instead of technical ones.



Based on the findings, the study delineates a practical guidance for firms. It suggests that SOI permits to achieve superior performance both using the two possible collaboration strategies analysed: open or closed. As Markad et al. (2012), sustainability has high relevance for society and industry, given the magnitude and pervasiveness of sustainability issues that we have to cope with today and we are beginning to understand the practical implications of the shifts in established socio-technical systems. Managers should invest in SOI-related performance because on average they permit having better innovation and economic performance. This implies making intentional changes to firms' culture, philosophy and values and consequently to products, processes or practices to be compliant with the social and external environment to finally generate higher economic returns (Adams et al., 2016). However, in highly competitive environments, probably, a high sharing of knowledge should be avoided. Then, when the environment is more stable, as suggested by the innovation cycle of Utterback and Abernathy (1975), companies can share the knowledge and managers should decide to have a more open collaboration strategy. It is also worth noting that probably companies should also think in terms of sales channels and invest not only in terms of technological development but they should also invest in competencies that allow making the new product, in particular the SOI one, valued by the market. In addition, the results suggest to both managers and policy-makers, how the innovation process should be conceived with a comprehensive view and has a continuous evolution that embraces different stages, including the understanding not only of the technical knowledge of the product or process produced (sustainable or not) but also the resources that need to be used or acquired to make it.

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## Determinants of Customers' Propensity to Plan Purchases during Sales: the Role of Customer Knowledge

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### Abstract

In this paper we address the limited understanding of how the amount of sales used by retailers changes the customers' propensity to plan purchases. We investigate the effects of shopping motivation, buying behavior, marketing skepticism, and marketing literacy on the propensity to plan purchases by customers and how they comply with this purchase plan. A classification of sales into short-, missile- and long-run is developed. Based on in-depth interviews and an online survey we identify the abovementioned factors perform differently depending on sales types. Overall, utilitarian shopping motivation that positively affects shopping planning and compliance with the shopping plan during sales, and sales buyers experience more hedonic value and have a higher level of marketing literacy at sales than non-buyers. It was also found that the less often the sale is held, the more unplanned purchases buyers make. During regular sales, buyers show a lower level of marketing skepticism than those who do not buy.

**Keywords** – Shopping planning, Buying behavior, Marketing skepticism, Marketing literacy, Consumer knowledge

**Paper type** – Academic Research Paper

## **1 Introduction**

The sales volume for promotions in stores of the modern format in different categories is continually growing worldwide. Constant innovations, new trends, and events are changing customers' needs and increasing their interest in the shopping experience, raising the level of competition within and between retail formats, which have a significant impact on how retailers conduct sales in such an environment.

The demand from customers for promotional products is becoming more intense. The industry is actively responding to this request, and retailers are increasing their offer of products at discounts from year to year. As a result, the volume of promotions increases due to three key parameters: the number of product positions on the promo, the number of stores where promotions are held, and the discount price. The abovementioned customer reactions make companies organize sales promotions on a regular basis, and as those become predictable for customers that changes their shopping behavior.

In this paper we are trying to address the limited understanding of how the amount of sales used by retailers changes the customers' propensity to plan purchases. To address the research problem, this study aims to investigate the effects of shopping motivation, buying behavior, marketing skepticism, and marketing literacy on the propensity to plan purchases by customers. In addition, we want to check whether customers who plan their purchases tend to comply with this purchase plan.

## **2 Defining the effect of sales promotions on consumer behaviour**

### ***2.1 Three types of sales promotions and shopping planning***

Sales are one of the most popular tools for trade marketing. They are held for different purposes. The most popular goal is to increase sales and get rid of old products. However, this discount campaign can be called successful when it not only sells out inventory but also helps to improve the company's image or at least does not harm it (Gedenk, Neslin and Ailawadi, 2009). There is an extensive amount of research on sales promotion in the context of different sciences, such as economics, psychology, and marketing. Over the past 35 years, much research has been done to study the impact of promotions (Blattberg and Briesch, 2012).

The definition of the term “sales promotion” is quite complex due to the presence of many interrelated methods and tactics. In general, sales promotion refers to the actions of advertising activities in order to increase the interest of regular customers and attract new ones. They are temporary and most often focus on encouraging shoppers or retailers to take short-term actions (Cannon, Perreault and McCarthy, 2016).

For the purposes of the research, we consider only scheduled (known, predictable) sales and introduce a classification of all sales into three types based on their regularity and frequency: short-run, middle-run and long-run sales. Short-run sales are held to correct stock management and increase profit (Shyan, 2003). Middle-run sales are mainly seasonal sales. The purpose of these sales promotions is to attract as many customers as possible, in addition to selling off the stock (Shyan, 2003). Long-run sales are holiday or events based and normally can be expected only once a year. This type of sale is characterized by a short period, in which there is a rush of demand (e.g., Christmas sales or Black Friday).

Researchers who study the impact of sales promotion on the buying behaviour, not very often focus on the customers’ attitude to shopping planning and how they adhere to this plan. Lennon, Johnson and Lee (2011) showed that shoppers spend significant effort in preparing and shopping during Black Friday, such as making a plan for their purchases in advance. Buyers who plan their purchases experience the convenience and “smart shopper feeling”, which has hedonic and utilitarian aspects. Connection between the feelings of a smart buyer and planning is significant and represents a group of buyers who manage to get advertised products at discounts. Additionally, the results of the study showed that buyers who spend effort on planning their purchases are also prone to impulsive purchases. Authors explain this by the fact that buyers plan their activities during sales and fulfill their plan, after which they can take advantage of unplanned transactions on their shopping path.

Laroche et al. (2003) determined that there are buyers characterized by their expertise in shopping, their planning of shopping trips and expenses. They can also provide information about favorable offers to other customers. Moreover, customers who continuously make purchases in the stores they know will be better aware of the environment and the range of products in these stores. Thus, they will properly plan their purchases and buy what they need. Another study confirms that shoppers are engaged in strategic planning for shopping on Black Friday. Such planning on Black Friday is consistent with traditional holiday rituals

and can be the same as planning to buy gifts before Christmas (Thomas and Peters, 2011).

All these results of various studies indirectly confirm that people plan their purchases before going to the store and try to stick to their plan during sales. Further, we will focus on different shopping motivations and buying behaviors of customers, which can influence their shopping trip.

## ***2.2 Shopping motivation***

Sales promotion offers the benefits of various advantages to which the consumer responds (Shimp and Andrews, 2012). The various advantages offered by sales promotion affect the consumer's psychological assessment, after which the consumer evaluates and makes conclusions about how profitable this offer is. However, the evaluation of profitability is not the only thing that determines the buyer's decision to buy; it also affects the buyer's emotional and internal feelings (Sinha and Verma, 2020).

There are two significant shopping motivations and two types of buying behaviors. Each shopping experience allows customers a combination of compulsive and impulsive buying, as well as hedonic and utilitarian shopping values (Gohary and Hanzaee, 2014).

Hedonic purchases are usually motivated by a desire for fun and pleasure, sensory stimulation, and often include products that are thoughtless or luxurious. When we spend money on hedonic products or services, there is often an internal conflict between the necessity to save money and encourage our desires. It is happening because spending money on the second option reduces the monetary resources needed to meet basic life needs (Kivetz and Zheng, 2017).

In contrast, utilitarian shopping is based on the principle of rational purchases, which is usually based on the motivation of the need and regularly involve practical product. There are utilitarian goods and services without which it is impossible to do, and spending money on them has a natural justification. Babin, Darden and Griffin (1994) determined that utilitarian value can arise from a situationally engaged consumer who collects information as needed, so a purchase is not a necessary precursor to utilitarian purchasing value.

There is a direct link between shopping motivation and its consequences such as loyalty, retail satisfaction, and assessment of the utilitarian and hedonic value of purchases, which has been proven by research in retail (Arnold and Reynolds,

2003). It has also been confirmed that retailers can provide both hedonic and utilitarian values while the customer is shopping (Sherry, 1990). For instance, the customer may be motivated to buy a particular item and go shopping for it, and when s/he finds that item in the first store (utilitarian value), it can be at a reduced price (hedonic value) (Carpenter and Moore, 2009).

Drawing from the discussion above, it could be stated that:

*H1: Customers who take advantage of sales offers will be more prone to have a utilitarian shopping motivation than a hedonic one.*

*H2: A tendency to utilitarian shopping motivation has a positive effect on (a) a propensity for shopping planning, (b) compliance with a prepared shopping plan during sales.*

According to Beatty and Ferrell (1998), impulsivity is the degree to which an individual can make unintended, spontaneous, and non-reflexive purchases with no pre-shopping intentions either to buy a specific product or to perform a specific purchasing task. Most customers at least occasionally make purchases on impulse, which is essential for marketers, since this is a form of purchasing action (Prashar et al, 2015).

Price is a crucial factor that affects an impulsive purchase. The number of unpredictable purchases increases if a person's mood rises at the sight of unexpected savings. According to Liao et al. (2009), customer's impulsive behavior is especially evident when they are offered an instant-reward promotion, such as a reduced price or free goods. Thus, the impact of sales promotion strategies is significant on buyers' impulsive purchases.

Another buying behavior is compulsive buying, which is defined as the consumer's tendency to be concerned about a purchase. It can be manifested through the lack of impulse control over the purchase or regularly recurring purchases (Ridgway, Kukar-Kinney and Monroe, 2008). These people cannot control this behavior (Mowen and Spears, 1999), and the aforementioned is often due to internal stress or problems in which buyers have little regard for financial, social, or personal consequences (Flight, Rountree and Beatty, 2012). Also, compulsive buying can be associated with shopaholic or excessive purchases (Lim et al., 2020).

Drawing from the discussion above, it could be stated that:

*H3: Customers who take advantage of sales offers will be more prone to have impulsive buying behavior than compulsive buying behavior.*

*H4: A tendency to impulsive buying behavior has a negative effect on (a) a propensity to plan purchases, (b) compliance with a prepared shopping plan during sales.*

### **2.3 Marketing literacy and marketing skepticism**

Marketing skepticism and marketing literacy is the most popular and discussed topic in recent years. It is confirmed by an increase in the number of publications in this area (Golovacheva, 2016). Research in the field of knowledge about persuasion usually focuses on two factors that affect the perception of marketing messages. The first factor comes from people's knowledge of attempts to persuade, and the second factor is the distrust felt for the marketing message, which is also often called skepticism (Isaac and Grayson, 2019).

The knowledge about marketing persuasion is the basis for the formation of marketing skepticism and marketing literacy of consumers. In research, marketing skepticism is defined as distrust, which is sometimes experienced by the customers concerning the market and marketing tools (Isaac and Grayson, 2019). According to Obermiller and Spangenberg (1998), the factors that shape skepticism can be very different such as social interactions, customers' experiences related to the market, or media comments and discussions about how people are affected by marketing and advertisement.

It has been found that people who are skeptical of advertising are conservative about it and less likely to be convinced. Fong Yee Chan (2019) proved that people with a low level of skepticism and perceived credibility of advertising could positively affect the results of product promotion. On the contrary, a high level of skepticism leads to a more negative perception of the brand in advertising since such buyers do not like it when they are intentionally manipulated or sold something.

Marketing literacy not only applies to people whose education or professional activities are related to marketing or those who have studied marketing closely at university and conducted research on it. Today, consumers who are familiar with the ideas, goals, and marketing methods and advertising also belong to the group of marketing-literate consumers. It was determined that the consumers' expression of skepticism about the techniques used by marketers and their confidence in evaluating advertising statements and making judgments is proof



that consumers are becoming literate in the field of marketing (Macdonald & Uncles, 2007).

Drawing from the discussion above, it could be stated that:

*H5: Customers with a low level of marketing skepticism will be more prone to make purchases during sales than customers with a high level of marketing skepticism.*

*H6: A low level of marketing skepticism has a positive effect on (a) the propensity to plan purchases, (b) compliance with a prepared shopping plan during sales.*

*H7: Customers with a high level of marketing literacy will be more prone to make purchases during sales than customers with a low level of marketing literacy.*

*H8: A high level of marketing literacy has a positive effect on (a) the propensity to plan purchases, (b) compliance with a prepared shopping plan during sales.*

## **2.4 Conceptual model**

Earlier we introduced a typology of sales based on the frequency of sales holding per year. We assume that the above effects (formulated in hypotheses) will also differ depending on the type of sale. Purchase planning and compliance with the purchase plan will be adjusted during sales, depending on the type of sale. These outcomes are based on indirect indications about planning purchases, which were found during the literature analysis. Thus, we can make the following proposition:

*P. The effects mentioned above (H1- H8) will differ depending on the type of sales.*

Based on the literature analysis and research hypotheses, a conceptual model of the current study was formed (Figure 2.1). Shopping planning and compliance with the purchase plan were divided into two resulting variables, which will be influenced by factors such as customers' hedonic and utilitarian shopping motivation, impulsive and compulsive buying behavior, marketing skepticism, and marketing literacy. Since we assume that the main effects will vary under the influence of different types of sales, we have been marked this influence with dashed lines.

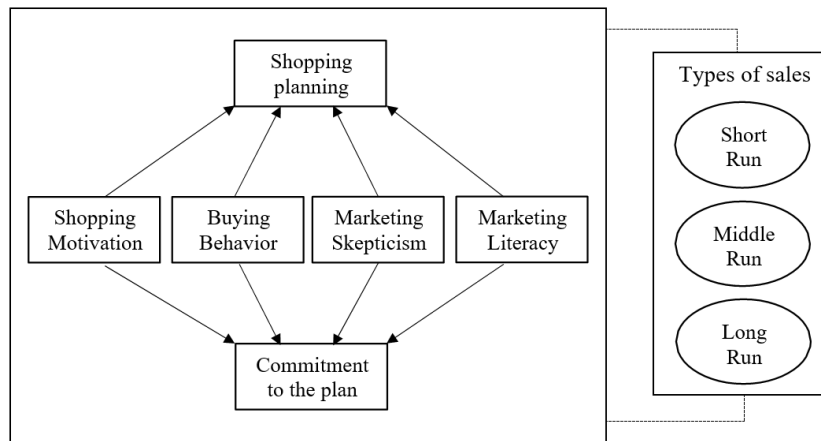


Figure 2.1 Conceptual model of the research

### 3 Empirical study

#### 3.1 Research organization

The empirical study was performed in a mixed format and consists of a qualitative and quantitative study. The qualitative study aimed to identify and confirm the factors that influence whether the customer will shop during short-, middle- and long-run sales and the process of planning purchases and compliance with the purchase plan during these types of sales. The quantitative study's objective was to identify the extent of the influence of factors that affect the behavior of buyers during the three types of sales identified at the stage of in-depth interviews.

As Study 1, a series of in-depth interviews were conducted to identify and confirm factors that determine the attitude and behavior of customers during sales periods. Black Friday sale was chosen as the main topic of the interview. Firstly, this sale was chosen as a "universal" sale, in which almost all Russian retailers participate and provide a different set of products at discounts. Secondly, this sale is not timed to any event or holiday and is designed to fit any category of customers. Thirdly, in-depth interviews were conducted in November 2019. In 2019, Black Friday in Russia was officially held for 3 days – from November 29 to December 1. Therefore, it was essential for us to understand how well Russian buyers are aware of this sale, whether they are going to take advantage of buying products at discounts and whether they are preparing for it by making a

shopping list. The respondents were selected from 18 to 55 years, as this category is not only the most active in terms of Internet use but also can independently make decisions about buying goods at sales. The interview guide included five groups of questions: (1) about different types of sales; (2) about Black Friday; (3) on taking advantage of discount offers during Black Friday the previous year (in 2018); (4) on taking advantage of discount offers during the upcoming Black Friday (in 2019); (5) specific questions for those who do not use discount offers during Black Friday sales.


As Study 2, an online survey was conducted. The survey was developed based on a conceptual research model and the results of in-depth interviews. The structured online questionnaire was used for the survey. The first part of the questionnaire was introductory and devoted to overall shopping planning behaviour and tendency to rely on discounts. The second part contained three sets of questions regarding shopping behaviour during short-, middle- and long-run sales. The third part of the questionnaire was based on scales from (Macdonald and Uncles, 2007) for (Obermiller and Spangenberg, 1998) for marketing scepticism and marketing literacy respectively, we also adopted impulsive/compulsive buying behaviour scales from (Flight, Rountree and Beatty, 2012) and shopping motivation scales from (Babin, Darden and Griffin, 1994). The questionnaire ended with socio-demographic questions. The data was collected in May 2020, and respondents were recruited among active users of two social online platforms popular in Russia according to "DIGITAL 2020: THE RUSSIAN FEDERATION" report, i.e. VK.com and Instagram (Datareportal, 2020).

### **3.2 Study 1. In-depth interviews**

The respondents were selected according to their personal desire to participate in the interview. All of them received a mini-questionnaire before the in-depth discussion, with questions that determined their age, marital status, having children, and their occupation. Respondents were chosen in such order that their age, marital status, and profession did not recur with other respondents to obtain the relevant information for the research.

A total of 13 respondents took part in the in-depth interviews. All interviews were recorded on a voice recorder with the verbal permission of the respondents. After that, the voice recordings were transcribed into written text based on which

the content analysis was performed. The results of content analysis are presented in the Figure 3.1.



Memory	<p>Most respondents participate in sales at least twice a year. However, they do not always remember when certain sales take place and react only to ads about them</p> <p>Most respondents do not remember what kind of impulsive purchases they made during the Black Friday sale</p>	<ul style="list-style-type: none"> <li>• "I participate four times per year, during seasonal sales, and such big sales as Black Friday and Cyber Monday."</li> <li>• "I do not remember, but it was probably some clothing..."</li> </ul>
Planning	<p>Some respondents were not going to shop without a pre-made list in the upcoming Black Friday sale</p> <p>Usually, respondents make a shopping plan of what they want to buy but do not adjust it to particular sales</p> <p>After completing the purchase plan, respondents can make additional "small" purchases</p>	<ul style="list-style-type: none"> <li>• "At the moment, I do not have a well-thought-out list of what I need. Although I might have looked at New Year's items or gifts, however, I think that if I go now without a list, I will spend more than planned on things that will later turn out to be unnecessary."</li> <li>• "I keep a list of what I need to buy, but it is not timed for sales..."</li> <li>• "When I was buying 3-5 shirts, I could buy a few extra ties that in non-sale periods I would have been unlikely to buy..."</li> </ul>
Attitude	<p>Respondents mentioned that they do not believe in Black Friday discount offers in Russia.</p> <p>Even though respondents are skeptical, they continue to monitor the prices of their favorite products on Black Friday sale.</p> <p>All respondents would recommend taking advantage of Black Friday discount offers for their friends because it can be profitable.</p>	<ul style="list-style-type: none"> <li>• "I feel more neutral emotions, closer to skepticism, because this event has gained popularity in Russia, there is a comment with which I agree that there cannot be quiet discounts of 70-80% for a group of some electrical equipment..."</li> <li>• "I really wanted LEGO, and I looked at the prices because I knew it would be Black Friday sale... Also, I followed the price of the cream that I use every day; maybe there will be a discount..."</li> <li>• "I will advise my friend to take advantage of discount offers during Black Friday sale because he can profitably buy the thing he likes."</li> </ul>

Figure 3.1 Findings from in-depth interviews

Thus, Study 1 confirmed shopping motivation, purchasing behavior, marketing skepticism, and marketing literacy among Russian buyers who make purchases at sales. It was also found that respondents remember many sales held by retailers, such as seasonal sales and regular sales, in addition to describing their shopping experience at the Black Friday sale. Based on these results and the literature review, a questionnaire for quantitative research was compiled.

### 3.3 Study 2. Online survey results

A sample of 553 responses was collected. After the screening we obtained a sample of 493 respondents. Sample profile is presented in Table 3.1.

In order to test the stated hypotheses first factor analysis was performed to check for validity and reliability of the scales utilised, as a result, utilitarian value and marketing literacy were divided into two factors each (see Table 3.2 for details). Further, an analysis was conducted for each type of sales, namely short-run, middle-run and long-run sales. A Mann-Whitney U-test, binary logistic regressions and multiple linear regressions were performed for each sale.

Table 3.1 Sample profile

Male 18.7%		Female 81.3%	
18–25 years old	31.6%	46–55 years old	18.5%
26–35 years old	20.5%	56–65 years old	5.3%
36–45 years old	23.1%	66–75 years old	1.0%
Secondary degree	3.9%	Unemployed	7.5%
Specialized secondary degree	7.3%	Students	21.3%
Incomplete higher degree	14.6%	Business workers	36.3%
Higher degree	72.2%	Budget institution workers	20.5%
Academic degree	2.0%	Entrepreneurs	8.7%
		Retirement	3.0%
Married	44.2%	No children	45.6%
Have a relationship	21.9%	1 child	26.2%
Single	21.5%	2 children	22.7%
Divorced	9.7%	3+ children	5.5%
Widowed	2.6%		
There is not enough money even for food			0.2%
There is enough money only to buy food			2.8%
There is enough money to buy food and clothing			47.1%
Buying durable goods does not cause difficulties			32.7%
There is enough money for a new car			12.2%
We have no financial difficulties			5.1%

Table 3.2 Scale reliability, and abbreviations further used in the analysis

Factors	CR	Alpha
Hedonic shopping motivation (HV)	0,913	0,914
Utilitarian shopping motivation associated with rational buying during shopping (UV1)	0,762	0,690
Utilitarian shopping motivation related to shopping productivity (UV2) ( <i>single item variable</i> )	N/a	N/a
Impulsive buying behavior (IB)	0,870	0,861
Compulsive buying behavior (CB)	0,797	0,750
Marketing skepticism (MS)	0,916	0,899
Marketing literacy concerning advertisement (ML1)	0,840	0,800
Marketing literacy demonstrated during shopping (ML2)	0,705	0,799

Based on the U-test results, buyers who take advantage of the **short-run sales** offers experience more shopping enjoyment during this type of sales than those who do not buy during these periods. Also, these buyers are less skeptical concerning commercials about upcoming sales or advertised products. Moreover,

buyers' level of marketing literacy is much higher than that of non-buyers at regular sales. These customers can find benefit deals while shopping. Linear regression results are shown on Figure 3.2. Summing up the results about short-run sales, there is a 55% probability that buyers will purchase products at regular sales. According to the analysis, they experience more pleasure from shopping with discounts during these sales, show less marketing skepticism about advertising. They are entirely marketing literate about shopping, which allows them to find the best price for the product and receive benefit offers.

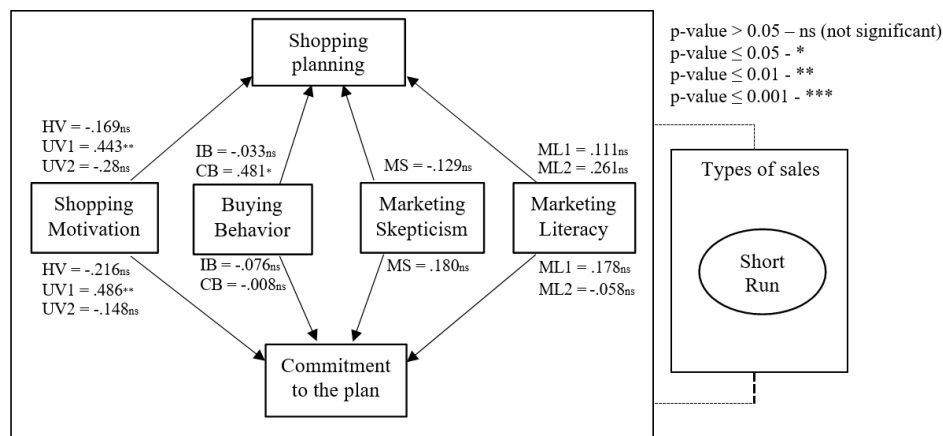


Figure 3.2 Model testing for short-run sales

For the **middle-run (or seasonal) sales**, there is a statistically significant difference between buyers and non-buyers in terms of hedonic shopping motivation, impulsive buying behavior, and marketing literacy regarding shopping. The U-test results showed that shoppers experience a higher level of shopping pleasure while shopping at seasonal sales. They are more likely to make unplanned purchases, and their level of marketing literacy regarding shopping is much higher than that of non-buyers. They know when most sales are held and can find the best price for the product. Linear regression results are shown on Figure 3.3. The analysis findings showed that, unlike non-buyers, buyers of seasonal sales experience the enjoyment of shopping and a tendency to unplanned purchases. They can find favorable offers for products during the seasonal sale, which shows their high level of marketing literacy regarding shopping.

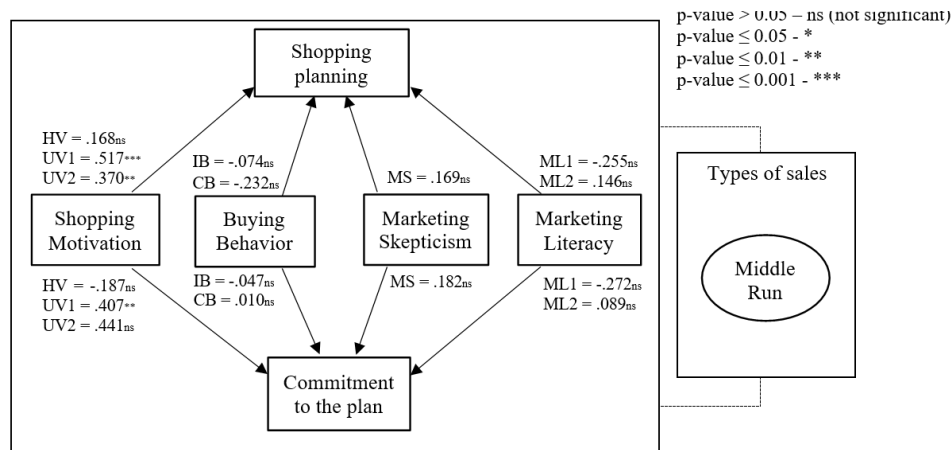


Figure 3.3 Model testing for middle-run sales

In case of the **long-run sales**, the U-test results showed that shoppers who use these sales are more likely to make unplanned purchases and more likely related to choosing the right product or brand at an attractive price. Their level of marketing literacy regarding shopping is much higher than that of non-buyers. They can find the best price for the product and make a profitable deal. Linear regression results are shown on Figure 3.4. It was found that buyers of these sales experience hedonic value from purchases and make more unplanned purchases under the influence of impulsive and compulsive purchasing behavior. Also, they are more marketing literate about shopping during these periods, in contrast to non-buyers. For buyers of event sales, unplanned purchases can happen on the spur-of-the-moment or depending on their emotional state. Despite this, they can find great deals and know when most sales are taking place. Utilitarian value influences the propensity to make a purchase plan, but at the same time, the hedonic value will be reduced. Following a shopping plan during event sales, customers are guided by the level of marketing literacy with the advertisement. They can determine the information provided by promotion. Additionally, utilitarian value has a role in the case of commitment, which is evident for such actions.

Overall, we may thus summarize that hypotheses 2 and 7 are fully supported, hypotheses 3, 5 and 8 are partially supported and hypotheses 1, 4 and 6 are not confirmed. The analysis results confirmed that shopping motivation, buying behavior, marketing skepticism, and marketing literacy have different extents of

influence during short-, middle- and long-run sales. Thus, the proposition made in this study can be confirmed.

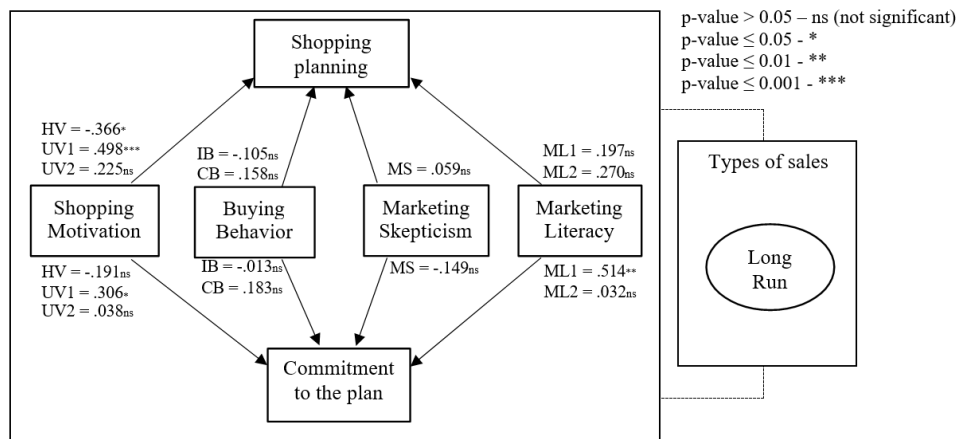


Figure 3.4 Model testing for long-run sales

#### 4 Conclusions and discussion

The results obtained are of interest to researchers and management practitioners to form a deeper understanding of consumers' behaviour during sales periods. As the results show, planning purchases for sales is a healthy choice of a rational buyer who wants to optimize the budget for everyday expenses. This research helps retailers understand how greatly shoppers plan their purchases and how fully they commit to their shopping plan during various types of sales.

Theoretically, the results of the current study contribute to an understanding of what are the behavioral patterns of customers' behavior that form the plan of purchases when it comes to sales.

As it was found, utilitarian shopping motivation affects the propensity to plan and comply with the shopping plan, which looks quite reasonable. Previously, other studies confirm that utilitarian value is acquired by completing a practical task (such as completing a shopping plan) (Babin, Darden and Griffin, 1994) and saving money (Chandon, Wansink and Laurent, 2000).

Also, shopping planning leads to a sense of convenience and smart shopper feeling, so this study confirms all the beforehand found results on utilitarian value by other researchers. It should be added that research conducted in the United States about Black Friday sale has determined that buyers receive hedonic and



utilitarian value when planning their purchases for this sale. The current study also confirmed that results that hedonic shopping motivation has its significance when customers plan their purchases (Lennon, Johnson and Lee, 2011).

It was found that the level of marketing skepticism does not affect the planning of purchases or compliance with the purchase plan. However, a statistically significant difference is observed between buyers and non-buyers of regular sales. Buyers who buy at this type of sale have a lower level of marketing skepticism than non-buyers. The same results were obtained in the study of Fong Yee Chan (2019), showing that people who have a positive attitude to advertising will be more likely to make purchases.

Moreover, since sales were classified into three types in this study, this typology can be used in further research and become a considerable contribution to the theory. In this paper, the proposition made that the effects of factors affecting buyers' shopping planning vary depending on the types of sales - were confirmed. Thus, this typology can be used for future researches and identify other differences between all market participants depending on the short-, middle- and long-run type of sale.

As for managerial implications, our findings can be used by retailers. According to the quantitative study, all buyers experience utilitarian shopping motivation during sales. However, the hedonic value is more substantial in shoppers who buy at sales than those who do not buy. Therefore, it makes sense for retailers to increase customer satisfaction by bringing them hedonic values. Moreover, hedonic motivation was also mentioned by respondents in in-depth interviews who said they enjoyed shopping during the holiday sales, as they are attracted to the beauty and festive atmosphere in stores.

Also, as the results of the analysis show, sales are a source of pleasure for customers, which is one of the factors of loyalty that affects the long-term relationship between the buyer and the retailer (Arnold & Reynolds, 2003). Therefore, retailers should not refuse to use promotions at all. They can initially include the cost of promotions in the product price that there will be an opportunity to reduce the price during sales periods.

If buyers and non-buyers of all three types of sales are compared, the less often the sale is held, the more unplanned purchases buyers make. Thus, buyers of seasonal sales tend to make purchases under the spur-of-the-moment, and buyers of event sales can not only buy under the influence of the situation but also because their emotional state pushes them to buy the product at a discount.

Therefore, retailers may consider event sales as a profitable opportunity to increase their sales.

In a regular type of sale, buyers show a lower level of marketing skepticism than those who do not buy. This may be related to a commercial that advertises regular sales or promotional goods. To attract new customers, it is necessary to reduce the level of marketing skepticism among those who do not buy at this type of sale. Retailers can do this by providing complete and truthful information about the benefits that customers can receive when choosing their store. Often, when conducting promo offers, it should be advertised not only a temporary price reduction of some goods but also the opportunity to get a gift, sweepstakes, etc. For example, if a customer purchases items in one store for a certain amount of money, they may receive a gift. In this case, the conditions for receiving additional goods for the purchase should be informative and explain clearly what kind of gift the buyer can get and on what conditions. It will help to reduce the level of marketing skepticism and attract new customers during regular sales.

Retailers may be offered a more technological approach to attracting customers to the store. Smart technologies allow the buyer to attract better and work more effectively for the benefit of the company. This way, retailers could use electronic price tags on their store shelves. It would be practical since it would allow retailers to quickly change prices for certain products or adjust them to a specific target group. Given all of the above, the results of the study can be applied by retailers and bring them significant benefits if implemented and maintained.

This study had some limitations that may be covered in future studies. The sample of the current research was significantly skewed towards female customers which may be due to the fact that stereotypically in the Russian culture women are responsible for family shopping. Future research could conduct in-depth comparisons of women's and men's shopping behaviour at sales, and examine their differences in planning their purchases and how they adhere to their shopping plan. Such results could provide new ways for retailers to attract target customers. Also, this study did not distinguish between purchases in an online store or a brick-and-mortar store. Further research may benefit from examining the relationships between shopping motivation, buying behaviour, marketing skepticism, and marketing literacy in both online and offline shopping. The research was carried out in May 2020 in Russia, amid the peak of the first

wave of COVID-19 pandemic and two months after the lockdown was announced. COVID-19 pandemic brought in a substantial amount of instability to customers everyday life which might have affected the judgements of the customers. Replication of the study and comparison with our results would shed light on possible effects of the pandemic on consumers' judgements related to shopping planning.

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## **Eco-Design in the Dairy Industry to Reduce Food Losses in a Circular Economy Perspective**

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## Abstract

Food production represents today an environmental cost, boosting scientific community and food companies searching innovative solutions to reduce environmental impacts and wastes. Among all agri-food supply chains, 65% of global agricultural emissions of CO<sub>2</sub> equivalent are produced by livestock and connected activities. Dairy industry produces a multiplier effect of impacts, using a large amount of primary products to obtain relatively little quantity of cheese.

In this context, it is clear that food loss is not only a socio-economic problem, but also represents an additional environmental burden to be attributed to the production process. The adoption of circular economy strategies could represent the right way to reduce the issue of food waste and food losses, not only by reusing and/or recycling expired products but also extending the shelf life of edible products, that finally would mean reducing waste and increasing production efficiency (Stillitano et al., 2021).

However, the effort of adopting circular strategies risks to become vain if the degree of circularity achieved is not measured, so that a process of continuous improvement can be adopted in a circular design logic.

The aim of this study is to evaluate, from a circular, environmental and economic perspective, techniques for the shelf life extension (SLE) of Lacto-Fermented Mozzarella Cheese.

Life Cycle Assessment, Circularity Assessment and Life Cycle Costing methodologies were applied to evaluate the effects of SLE implementation, taking also into account the potential reduction of food loss and returned goods.

Results showed that despite a minimal increase of impacts and costs due to the introduction of the innovation, the SLE could allow reducing the share of losses up to 50%. Expressing results in terms of days of product shelf life, the innovative solution is more sustainable from both the environmental and the economic point of view and allows an improve

**Keywords** – Circular Economy, Sustainability, Food losses, Life Cycle Assessment, Life Cycle Costing

**Paper type** – Academic Research Paper

## 1 Introduction

Food represents the principal requirement for every biological activity of every organism, above all for human, who, in function of food resources, shaped the geographical conformation of the planet and influenced the history of humanity (Kiple and Ornelas, 2000; Diamond, 2002).

In a global scenario of exponential growth of the earth's population, food production system plays a continuous challenge to respond to food requirement of people, also providing an answer to other emerging needs linked to the food,

for example cultural or aesthetic ones (Notarnicola et al., 2017). The wild rush to produce ever larger quantities of ever better quality food, in particular in the rich countries, generated as a correlated issue the food losses, producing, according to FAO estimation, 1.3 billion of edible food wastes (Gustavsson et al., 2011; Corrado et al., 2017). Because of its close connection with natural ecosystems, the agrifood system, that represents the basis of food supply chain, can be defined as a syneresis of different economic activities which involve both natural processes managed by anthropic actions and industrial processes, fully under human control (Gulisano et al., 2018).

According to Garrone et al. (2016), food production, represents today an environmental cost, boosting scientific community and food companies searching innovative solutions to reduce environmental impacts and wastes. Food production sector is also recognised to be one of most impacting environmental sectors. About 65% of global agricultural emissions of CO<sub>2</sub> equivalent are produced by livestock and connected activities. The dairy industry produces a multiplier effect of impacts, using a large amount of primary products to make little quantity of cheese.

In this context, it is clear that food loss, in addition to being a socio-economic problem, represents an additional environmental burden to be attributed to the production process.

The adoption of circular economy strategies could represent the right way to reduce the issue of food waste and food losses, not only by reusing and/or recycling of expired products but also extending the shelf life of edible products thus reducing waste and thus increasing production efficiency (Stillitano et al., 2021).

However, the effort to adopt circular strategies risks becoming vain if the degree of circularity achieved is not measured, so that a process of continuous improvement can be adopted in a circular design thinking.

On the other hand, the modelling of circular strategies must necessarily take into account the environmental, economic and social impacts they produce, so that the sustainability of these strategies can be assessed.

According to the Ellen MacArthur Foundation (Goddin et al., 2019) the evaluation of circular strategies should be assessed considering as complementary elements of circularity other risk factors, such as environmental impacts resulting from the adoption of these strategies, proposing as reference methodologies those of life cycle thinking.



Life Cycle Assessment - LCA, Life Cycle Costing - LCC and Social Life Cycle Assessment – sLCA are the three reference tools for the assessment of the three pillars of sustainability: environmental, economic and social (De Luca et al., 2015).

These instruments used individually (eg. Nicolò et al., 2018; Strano et al., 2015; Iofrida et al., 2019) or in combination (De Luca et al., 2018) have been applied to the main agricultural and agri-food sectors, as well as for the evaluation of some circular strategies for the valorisation of production waste (Benalia et al., 2021).

The aim of this study is to evaluate, from a circular, environmental and economic perspective, techniques for the shelf life extension (SLE) of Lacto-Fermented Mozzarella Cheese.

Life Cycle Assessment, Circularity Assessment and Life Cycle Costing methodologies were applied to evaluate the effects of SLE implementation, taking also into account the potential reduction of food loss and returned goods.

## **2 Materials and methods**

### ***2.1 Case study description***

The object of analysis in this study is a new mozzarella cheese production technique that allows the shelf life of the product to be extended. The study represents a continuation of research presented in Falcone et al. (2017). The technique involves the use of an alternative governing liquid, so it is a solution that can be easily implemented in any dairy without new investment. The new technique has been tested in a firm located in Reggio Calabria, southern Italy, specialised in high quality cheese production. In particular, The lacto-fermented mozzarella cheeses were manufactured from cow's milk. About four mozzarella cheeses (weighting 125 g each) were then packaged in polypropylene trays with tap water (control) and an alternative governing liquid consisting of 0.6% calcium lactate (CL). The samples were stored at 5 °C and several microbiological and chemical-physical indexes were monitored to 18 days in order to assess the hygienic, physical, chemical and organoleptic quality characteristics of the product as its shelf life increases. All the analyses were conducted in triplicate and variance has been analysed through one-way ANOVA.

## **2.2 Environmental and economic assessment**

Once the technological feasibility of the innovative solution had been assessed, the sustainability of the innovative process was compared to the control scenario. The environmental analysis was made through the LCA methodology (ISO, 2006a and 2006b). The first methodological step concerned the definition of the functions of the system under study. Since the function of the system is linked to the production of high quality mozzarella, and since the latter is characterised by certain chemical, physical and organoleptic parameters, it was decided to evaluate the Shelf life of the product as Functional Unit (FU), understood as the time during which the product maintains its qualitative characteristics. So "1 day of shelf life of packaged product" was defined as FU, however, as the production function is a key aspect of any food production, the impacts were also assessed according to the mass produced, so "1 kg of packaged product" was chosen as secondary FU.

The study was extended from cradle to grave in order to include in the system boundaries also the unsold products (Figure 1) in accordance also with Gobbin et al. (2019) for the assessment of circularity.

Data were collected from different primary, secondary and tertiary sources. In particular data on upstream processes were directly collected from three different dairy farms which confer the milk to the cheese factory where the experimentation was made. Data on animal feeds composition were directly collected as well as data on feed production, water and energy consumption and waste production and treatment. Data on methane, ammonia, nitrogen and carbon dioxide emissions were taken from Agri-footprint (Blonk Agri-footprint BV, 2015) and Ecoinvent V3.3 (Frischknecht et al., 2007) database.

Data on core processes were directly collected from partner firm: energy use in the cheese factory were measured through Fluke 179 True RMS Digital Multimeter instruments; data on water use were measured through a Water Flow Meter and data on methane gas used for heating were measured through the Flow Meter installed to the plant.

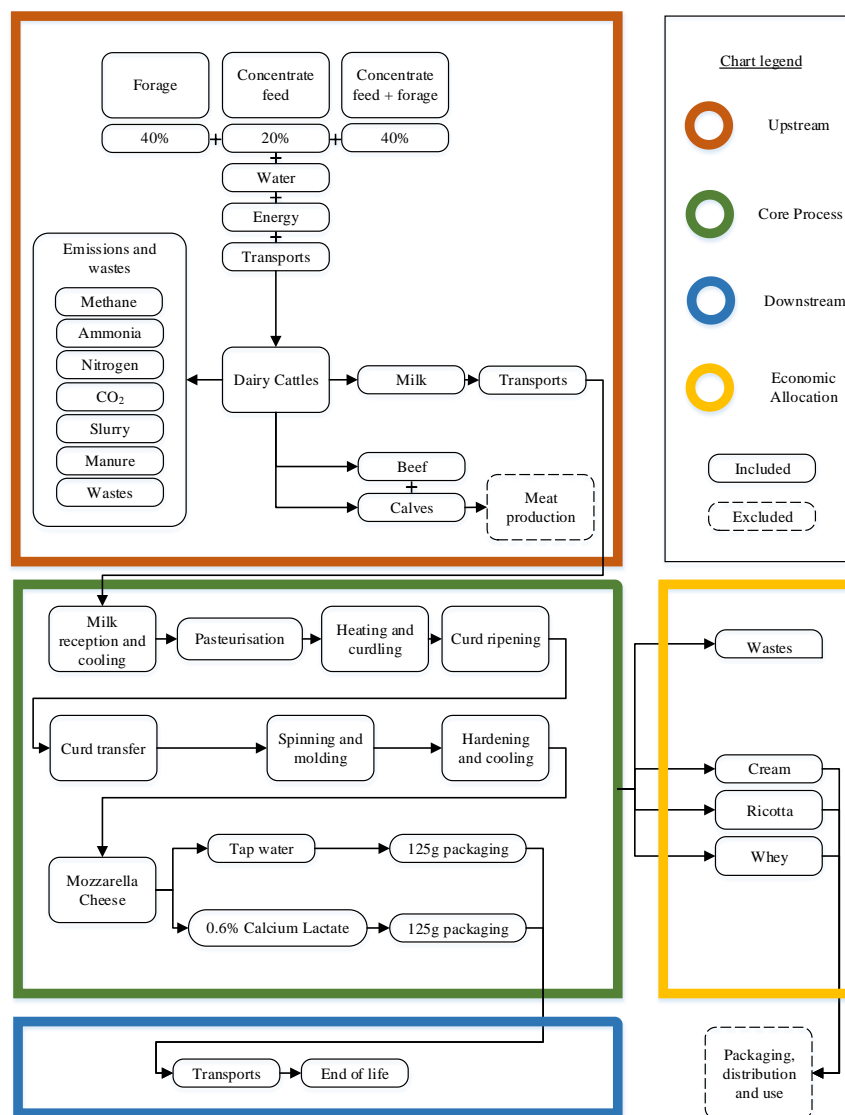


Figure 1: System boundary flow chart

Transports distances from cheese factory and selling locations were measured, and classified according to the typology of means of transport. Data on distance travelled by the final consumers were estimated. Wastewater treatment was included using the waste scenario included in Ecoinvent 3.3 and all the packaging was considered as waste disposed to the municipal landfill (both consumed and unsold ones). Input and output data from both dairy farms and cheese factory

were allocated in function of economic value of products (Thomassen et al., 2008). Data were processed through the ReCiPe midpoint impact method (Goedkoop et al., 2013).

Economic assessment was performed by Life Cycle Costing methodology following an approach LCA-based (Hunkeler et al., 2008) in which the same criteria described for LCA were used for LCC. All all material and energy inputs and outputs accounted for in the environmental analysis were monetised and some specific items of cost analysis were added to them, such as wages, the quotas and other duties, interests, land capital use and externalized services (Falcone et al., 2020). The computational framework proposed by Moreau and Weidema (2015) was implemented as described in Figure 2.

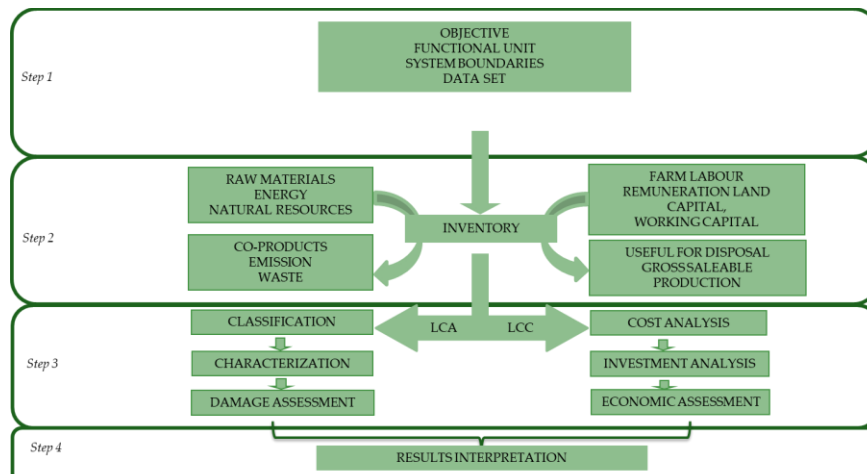


Figure 2. Methodological implementation  
(Source: Benalia et al., 2021)

The Added Value (AV) was determined for control and CL scenarios, by considering the same selling price for both. The cost related to the main FU determined per day of SL also considers the costs for unsold returned goods, as lost value (Buzby et al., 2014).

The circularity assessment was performed calculating the Material Circularity Indicator (MCI) by the Ellen MacArthur Foundation (Goddin et al., 2019) expressed by the following equation:

$$MCI_p = LFI-1 \cdot F(X)$$

where LFI represents the Linear Flow Index, i.e. the percentage of material flow originating from virgin sources and ending up as non-recoverable waste, while  $F(X)$  represents the utility factor of the linear component of material flows and is represented by the product of the intensity of use measure and the product life length.

For the calculation of circularity, it was considered that the whey obtained during cheese making is reused in dairy cow farming, representing a reused product share of 22%. This applies equally to both scenarios.

It was then considered that the product returned to the dairy can also be reused in animal feed (pig farming). This represents 9% of the realised product in the case of the control scenario and 3% of the realised product in the case of the CL scenario.

The utility factor was considered equal to 1 for the control scenario, while a Lifespan of 1.5x and a Functional Unit of 1.1x were considered for the CL scenario due to the longer shelf life and a higher amount of product being used (resulting in less loss). The MCI calculation was performed using the Dynamic Modelling Tool developed by the Ellen MacArthur Foundation and Granta Design Ltd.

### 3 Results and discussion

The results attested a shelf life extension of 6 days (+50%) in the mozzarella cheeses packed in 0.6% of Calcium Lactate (CL) solution ( $p < 0.05$ ) compared to the control scenario (12 days), with significant differences for the total microbial count, pH, NaCl% and textural properties. Analysing the findings related to the environmental impact of "1 day of shelf life of packaged product", the CL scenario resulted being better than the Control, with a ratio that overtakes the 45% (Table 1).

Table 1 – Characterisation of impacts per "1 day of shelf life of packaged product"

Impact category	Unità	Control	CL
Climate change	kg CO <sub>2</sub> eq	7.99E-01	5.36E-01
Ozone depletion	kg CFC-11 eq	4.58E-08	3.14E-08
Terrestrial acidification	kg SO <sub>2</sub> eq	9.92E-03	6.64E-03
Freshwater eutrophication	kg P eq	8.81E-05	5.91E-05
Marine eutrophication	kg N eq	2.16E-03	1.44E-03
Human toxicity	kg 1,4-DB eq	7.23E-02	4.88E-02
Photochemical oxidant formation	kg NMVOC	1.28E-03	8.93E-04

Particulate matter formation	kg PM10 eq	1.71E-03	1.15E-03
Terrestrial ecotoxicity	kg 1,4-DB eq	1.97E-03	1.31E-03
Freshwater ecotoxicity	kg 1,4-DB eq	4.92E-03	3.33E-03
Marine ecotoxicity	kg 1,4-DB eq	4.20E-03	2.85E-03
Ionising radiation	kBq U235 eq	3.07E-02	2.07E-02
Agricultural land occupation	m <sup>2</sup> a	3.64E-01	2.43E-01
Urban land occupation	m <sup>2</sup> a	6.21E-03	4.15E-03
Natural land transformation	m <sup>2</sup>	9.15E-04	6.11E-04
Water depletion	m <sup>3</sup>	2.42E-02	1.61E-02
Metal depletion	kg Fe eq	1.45E-02	9.77E-03
Fossil depletion	kg oil eq	1.19E-01	8.02E-02

The improvement over the control scenario can be attributed to each impact category and is easily explained by the significant shelf life extension generated by the new technology, which consists simply of adding calcium lactate to the governing liquid. The addition is very moderate and does not cause an environmental impact that would compromise the benefits generated by SLE.

This is easiest to understand when looking at the results for "1 kg of packaged product".

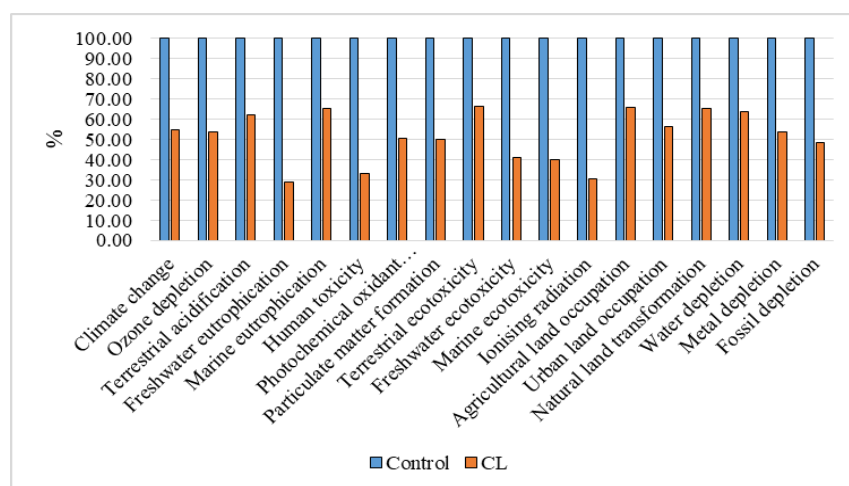


Figure 3 – Comparison of impacts per "1 day of shelf life of packaged product"

The improvement of the mozzarella shelf life corresponds, in fact, from an environmental point of view, to a minimal increase of impacts in all categories. However, this increase did not exceed the 1% (see the ratio CL/Control).

Table 2 – Characterisation of impacts per “1 kg of packaged product”

Impact Category	Unità	Control	CL	CL/Control
Climate Change	kg CO <sub>2</sub> eq	9.61E+00	9.63E+00	0.14%
Ozone Depletion	kg CFC-11 eq	5.21E-07	5.22E-07	0.33%
Terrestrial Acidification	kg SO <sub>2</sub> eq	1.18E-01	1.18E-01	0.05%
Freshwater Eutrophication	kg P eq	1.04E-03	1.04E-03	0.37%
Marine Eutrophication	kg N eq	2.58E-02	2.58E-02	0.04%
Human Toxicity	kg 1,4-DB eq	8.43E-01	8.48E-01	0.54%
Photochemical Oxidant Formation	kg NMVOC	1.45E-02	1.45E-02	0.27%
Particulate Matter Formation	kg PM10 eq	2.00E-02	2.00E-02	0.12%
Terrestrial Ecotoxicity	kg 1,4-DB eq	2.36E-02	2.36E-02	0.01%
Freshwater Ecotoxicity	kg 1,4-DB eq	5.70E-02	5.71E-02	0.29%
Marine Ecotoxicity	kg 1,4-DB eq	4.85E-02	4.87E-02	0.34%
Ionising Radiation	kBq U235 eq	3.57E-01	3.58E-01	0.29%
Agricultural Land Occupation	m <sup>2</sup> a	4.37E+00	4.37E+00	0.01%
Urban Land Occupation	m <sup>2</sup> a	7.37E-02	7.37E-02	0.11%
Natural Land Transformation	m <sup>2</sup>	1.09E-02	1.09E-02	0.01%
Water Depletion	m <sup>3</sup>	2.91E-01	2.91E-01	0.08%
Metal Depletion	kg Fe eq	1.69E-01	1.70E-01	0.41%
Fossil Depletion	kg oil eq	1.51E+00	1.52E+00	0.37%

According with other studies (e.g. Falcone et al., 2017), milk production represents the most important hotspot, contributing for each impact category on average for the 50% of environmental burdens, whereas for Terrestrial Acidification, Marine Eutrophication, Terrestrial Ecotoxicity, Agricultural Land Occupation, Natural Land Transformation and Water Depletion generate over the 90% of total impact. However, according to Fantin et al. (2012), impact of milk production can vary effectively. For other impact categories as Ozone depletion, Urban land occupation and Fossil depletion transportations and energy used during cheese-making processes are the main causes of impact.

Also in term of costs, considering as FU “1 day of shelf life of packaged product”, the CL scenario achieves better results than Control one. The improvement corresponds to about 30% for all cost factors except the cost of returned products, which is 76% lower in the CL scenario. In fact, while for the control scenario the food loss is 9% by product weight, for the CL scenario it drops to 3% (Table 3).

Also from an economic perspective, milk represents the higher burden. Wages and packaging are also two important cost items, confirming the findings by Durham et al. (2015).

Table 3: Results of the economic analysis per “1 day of shelf life of packaged product”

<b>Cost factors</b>	<b>Control</b>	<b>CL</b>
Quotas and other duties	0.0559	0.0372
Milk	0.1604	0.1069
Rennet	0.0037	0.0025
Water	0.0013	0.0009
Electricity	0.0056	0.0037
Other energy sources	0.0377	0.0251
General cost	0.0013	0.0009
Wages	0.1153	0.0769
Externalized services	0.0103	0.0069
Packaging	0.0667	0.0648
Returned goods	0.0412	0.0098
Total	0.4994	0.3355

The analysis of results per kg of packaged product returns more obvious conclusions. In fact, the cost profile of two different scenarios differs only for the packaging, as the innovative solution is obviously more expensive (Table 4). The cost factor that tends to balance the results is the cost related to food losses represented as returned product, because, as already mentioned, the longer shelf life means that less food is lost. In this context, considering the same selling price for both solutions (6.5 €) the Control scenario had a higher added value (Figure 4).

Table 4: Results of the economic analysis per “1 kg of packaged product”

<b>Cost factors</b>	<b>Control</b>	<b>CL</b>
Quotas and other duties	0.6703	0.6703
Milk	1.9250	1.9250
Rennet	0.0443	0.0443
Water	0.0158	0.0158



Electricity	0.0668	0.0668
Other energy sources	0.4525	0.4525
General cost	0.0154	0.0154
Wages	1.3839	1.3839
Externalized services	0.1234	0.1234
Packaging	0.8003	1.1663
Returned goods	0.4948	0.1759
Total	5.9925	6.0396



Figure 4: Added value per "1 kg of packaged product" considering a selling price equal to 6.5€

The use of calcium lactate in the governing liquid corresponds, of course, to a higher production cost, however, the insignificant increase in cost generates a strong extension of the shelf life of the product. In this study, we have assumed that a 50% increase in shelf life generates a reduction of product loss of 9% to 3%, however, one could also consider a total reduction in food loss. In fact, considering a shelf life of 12 days, the company produces every other day and obtains a 9% waste, while with a shelf life of 18 days the company could produce every 3 or 4 days and bring the returned product to zero.

Evaluation of the circularity of the two scenarios returned an MCI of 0.24 for the Control scenario and 0.52 for the CL scenario.

The improved circularity performance of the CL scenario can be attributed primarily to the longer product life and greater intensity of use realized through increased shelf life (Figure 5).

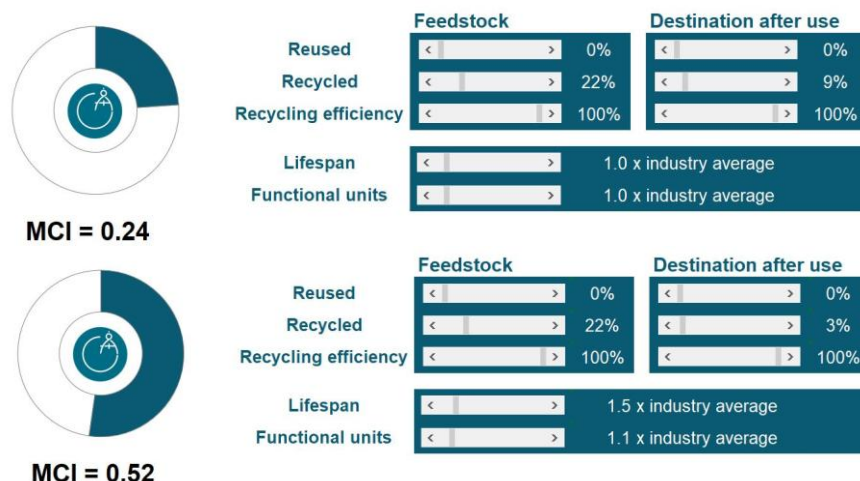


Figure 5: Circularity evaluation of Control (above) and CL (below) scenarios.

Regarding the percentage of resources deriving from reuse or recycling, there are no differences since the product differs only in the addition of a small quantity of calcium lactate in the governing liquid, which is however irrelevant for the purposes of calculating the MCI.

#### 4 Conclusions

The aim of this study was to assess how effective was a technological innovation to reduce food losses, from both an economic and an environmental point of view.

Using LCA and LCC methodologies, the technological innovation tested, based on a 0.6% calcium lactate solution, was compared with current technology in order to evaluate the effectiveness of the innovation.

It improved the shelf life of the product, lacto-fermented mozzarella, from 12 days to 18 days.

The innovation, with very small changes in the production process, does not require any investment, and generates both economic and environmental improvements without compromising product quality but helping to reduce product losses. Extending the useful life of the product allows its value to be maintained for longer, reducing product wastes and thus helping to make the production process more circular and mitigating the phenomena of increasing waste and food losses.

## Acknowledgement

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## **Telemedicine and COVID-19 Pandemic: the Case of T-CUBE Digital Technology**

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## Abstract

Due to COVID-19, telemedicine solutions, in general, have played a crucial role, with their ability to minimize physical physician-patient contacts, and to optimize healthcare system capacity, during demand surges, guaranteeing the taking in charge of the patients and the continuity of care.

The present study aims at investigating the feasibility and economic/organizational sustainability of an innovative telemedicine platform, as an example of telemonitoring care programs for patients with or without COVID-19, integrated with telerehabilitation and tele-supporting activities (whose name is T-CUBE), by addressing the following research questions: i) Which are the main benefits related to T-CUBE introduction in the clinical practice, from a clinical and an economic perspectives?; ii) Which are the key factors determining the intention to use T-CUBE in the clinical practice?

A Health Technology Assessment (HTA) was conducted in the year 2020, thus examining all the dimensions proposed by the Model for Assessment of Telemedicine (MAST), thus comparing T-CUBE implementation, with the usual care consisting of on-site monitoring and rehabilitative activities. The HTA was then integrated with an in-depth analysis of all the factors that could predict T-CUBE individual's acceptance, focusing on social and cognitive instrumental factors, and based on the Technology Acceptance Model framework.

Literature declared that telemonitoring and tele-supporting would improve the management of patients' with or without COVID-19, optimizing the care by detecting clinical deterioration at an early stage, caused both by COVID-19 or chronic cardiac or pulmonary diseases, thus also revealing a lower hospitalization rate, as well as a shorter length of stay with respect to usual care. Furthermore, the platform would lead to a reduction of 14.11% of rehabilitative hospitalization days, with a consequent increase in the overall accessibility to care (51.6%). From an economic perspective, considering 184,792 patients potentially treated with T-CUBE in Lombardy Region, an economic saving equal to 41% emerged on annual basis. With regard to T-CUBE acceptability, its intention to use is strictly dependent from its usefulness and ease of use perceived by the healthcare professionals involved, as well as by its capability to produce a relevant job and a high-quality output.

In conclusion, T-CUBE represents an ideal strategic leverage useful to manage the current pandemic emergency, thus being a relevant example in which digital technologies gives the possibility to solve a health problem in an efficient and effective way.

**Keywords** – telemedicine, T-CUBE, sustainability, COVID-19, users' acceptability

**Paper type** – Academic Research Paper

## 1 Introduction

COVID-19 pandemic, with the implementation of severe restrictions to better control the spread of the virus (McCloskey *et al.*, 2020), has severely impacted on healthcare services, requiring processes redesign to address deficits in quality of care and create more sustainable care processes. As a result, unique and innovative solutions are necessary to address both the critical and unmet needs of patients with COVID-19, but also of the other fragile patients, using healthcare services. In this view, people who are not infected with the COVID-19, especially those who are at greater risk of developing the disease, as well as those requiring a strict monitoring given their current chronic critical clinical conditions, should receive daily care without the risk of exposure to other patients in the hospital (Smith *et al.*, 2020).

In this respect, technological advances provide new options (Wax & Christina, 2020) due to COVID-19: telemedicine has played a crucial role, with its ability to minimize physical physician-patient contact, and to optimise healthcare system capacity during demand surges (Turolla *et al.*, 2020), guaranteeing the taking in charge of the patients and the continuity of care.

Any strategies, grounding on telemedicine services, digital technologies and artificial intelligence tools, have been a key part of the European and Italian response to this sudden health threat (Langabeer *et al.*, 2016; Lurie *et al.*, 2018), for the continuous monitoring of both COVID-19 patients and those who are not COVID-19 infected, but present chronic diseases.

Despite the relevance of the topic, many digital technologies have been only empirically proposed, without being effectively available for COVID-19 public-health response, in particular because of barriers to their implementation, including legal, ethical and privacy concerns, as well as organizational and workforce limitations (Budd *et al.*, 2020). In addition, recent literature has also highlighted significant challenges in deployment and scale-up, and limitations of clinical trials that are of varied quality and design (Piovani *et al.*, 2020; Murray *et al.*, 2020).

However, evidence of the effectiveness of any innovative technologies is needed for their wider adoption and implementation in the clinical practice: as the pandemic is ongoing, many digital technologies have not yet been peer-reviewed or undergone rigorous testing or been evaluated by digital evidence frameworks (IVB, 2019).



Although it is challenging, evaluation of the effectiveness of interventions is essential. Thus, in this paper, we propose the results deriving from the implementation of an innovative telemedicine platform as an example of telemonitoring care programs for patients with or without COVID-19, integrated with telerehabilitation and tele-supporting activities. This platform, whose name is T-CUBE, was designed to offer healthcare services and psychological support to people at home, using telemedicine solutions, to proactively monitor their health conditions, both after hospital discharge, during quarantine or isolation because of COVID-19 diagnosis infection, and in case of home isolation induced by the rules of social distancing for individuals needing continuity of care, even if they are not COVID-19 infected, but suffering from cardiac and pulmonary diseases.

Hence, the present study aims at investigating the feasibility and economic/organizational sustainability of the innovative platform T-CUBE, by addressing the following research questions: *i)* Which are the main benefits related to T-CUBE introduction in the clinical practice, from a clinical and an economic perspectives?; *ii)* Which are the key factors determining the intention to use T-CUBE in the clinical practice?

## **2 Methods**

For the achievement of the above mentioned two-fold objectives, a Health Technology Assessment (HTA) was conducted by means of the Model for the Assessment of Telemedicine – MAST (MethoTelemed Team, 2010), thus being the most acknowledged framework to be used for assessing tele-medicine solutions.

The assessment focused on the comparison between T-CUBE platform (based on tele-monitoring, tele-supporting and tele-rehabilitation activities) and the usual care, based on an on-site monitoring, supporting and rehabilitation activities.

Due to the multi-dimensional nature of the evaluation, the following aspects were deeply analysed: *i)* Health problem and application's characteristics; *ii)* Safety; *iii)* Clinical effectiveness; *iv)* Patient perspectives; *v)* Economic aspects; *vi)* Organisational aspects; *vii)* Socio-cultural, ethical and legal aspects, thus being consistent with MAST framework (MethoTelemed Team, 2010).

Three different methodological approaches were utilized for the deployment of the above dimensions.

1. Systematic literature review was carried out to collect evidence-based data with regard to the efficacy and the safety profile of using tele-monitoring, tele-supporting and tele-rehabilitation activities, with respect to the standard of care. In particular, the literature review was developed according to the following PICO (P: population; I: intervention; C: comparator; O: outcome) statements, being double because referring to two different Populations: on the one hand, literature review was conducted focusing on the chronic population not-infected with COVID-19; on the other hand, literature review was conducted focusing on the specific COVID-19 patients. For both populations, the "Intervention" was tele-supporting, tele-rehabilitation and tele-monitoring activities, that was compared to the "Comparator", represented by the standard usual care. The main Outcomes were hospitalities rate, number of hospital access, mortality rate and quality of life measures.
2. Health economics tools for the economic evaluation of both healthcare pathways and for understanding the ceasing/emerging costs related to T-CUBE were also considered. In this view, at first the economic evaluation of both pathways was conducted by means of an activity-based costing approach, thus collecting all the healthcare direct costs related to the proper taking-in-charge of the patients, according to real-life data derived from Lombardy Region (Northern Italy) database. Secondly, a budget impact analysis was developed, to understand the impact of T-CUBE technology within the specific Lombardy Region setting, according to the regional population potentially eligible to such innovative digital technology. The economic analysis was performed considering a time horizon of 12 months, and according to the Italian reimbursement tariffs of outpatients and hospital admissions, valid for the years 2020-2021.
3. Qualitative questionnaires, derived from the MAST model, were administered to all the healthcare professionals directly involved in T-CUBE use, thus retrieving their perceptions. The qualitative questionnaires were used for examining equity, social, legal and organizational aspects, considering a comparative approach of the two technologies under assessment (the presence or the absence of T-CUBE platform), in accordance with a 7-item Likert scale ranging from - 3 (less performant solution) to +3 (most performant solution).

In conclusions, the assessment of the MAST dimension was integrated with the analysis of the T-CUBE ecosystem acceptability, concerning the healthcare professionals' degree of T-CUBE intention to use, through Technology Acceptance Model – TAM2 core constructs (Davis, 1989; Venkatesh & Davis, 2000), thus being one of the most popular research models to predict use, person's intention to perform a particular behaviour, and acceptance of information systems and technology by individual users (Surendran, 2013; Nadri *et al.*, 2018).

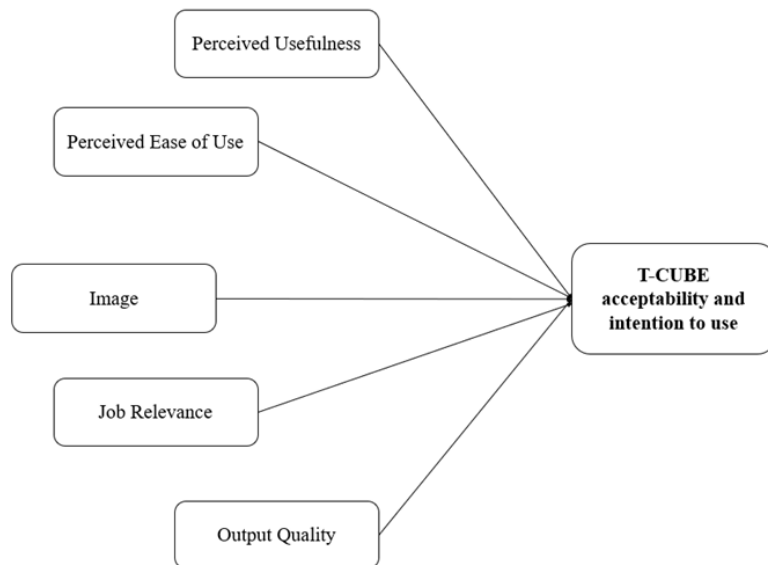
In this view, considering the importance of correctly assessing the impact of innovative healthcare technologies adoption on the existing clinical pathways, it is crucial to directly involve all the healthcare professionals in the ITs use (LeRouge *et al.*, 2007, Mantzana *et al.*, 2007). Despite the digital technologies' positive impact on the process efficiency improvement, their adoption is usually related to a professional resilience to change, because of digital technologies being perceived as disruptive innovations.

Based on the above, the following assumptions, derived from TAM 2 framework, were considered.

- Perceived usefulness has a positive impact on T-CUBE acceptability and intention to use (Davis, 1989; Holden *et al.*, 2010)
- Perceived ease of use has a positive impact on T-CUBE acceptability and intention to use (Davis, 1989; Bhattacharjee *et al.*, 2007)
- Image could have a positive impact on T-CUBE acceptability and intention to use (Venkatesh *et al.*, 2000; Holden *et al.*, 2010)
- Job relevance has a positive impact on T-CUBE acceptability and intention to use (Venkatesh *et al.*, 2000)
- Quality output has a positive impact on T-CUBE acceptability and intention to use (Venkatesh *et al.*, 2000; Yarbrough *et al.*, 2007).

In conclusion, for a more comprehensive framework, a set of control variables was investigated: i) healthcare professionals' gender; ii) healthcare professionals' working experience; iii) healthcare professionals' age; and iv) healthcare professionals' role.

A synthesis of the research framework is proposed in the following Figure 1.



*Figure 1 – Framework for assessing T-CUBE acceptability and intention to use*

Moving on from these premises, in October 2020, a qualitative questionnaire based on TAM2, was administered to clinicians, psychologists and rehabilitative professionals taking in charge both COVID-19 individuals and chronic patients, requiring strict monitoring and rehabilitative activities, in a rehabilitative research institute, normally working with chronic and fragile patients and currently using the innovative T-CUBE platform.

Besides the personal information related to each respondent (professional role, age, seniority and working experience) the questionnaire was composed by a qualitative section in which a 7-item Likert scale was implemented (7=completely agree; 1=completely disagree). In particular, the interview process aimed at getting the clinicians' insight concerning their intention to use the innovative technologies under assessment and the independent/moderator/control variables previously described that are perceived usefulness, perceived ease of use, image, quality output, and job relevance.

The above framework has been tested using inferential analyses, by means of a specific regression model, useful to define the main aspects useful to understand the factors impacting on such digital technology adoption in clinical practice. The Adjusted  $R^2$  was examined, in order to control the explanatory power of the model (Tabachnick and Fidell, 2007).

All the analyses were conducted using the Statistical Package for the Social Sciences (SPSS).

### 3 Results

#### 3.1 Results from literature review

As previously mentioned in the Methods Section, literature review was conducted according to the defined PICO and to the following search strategies, using different databases (Pubmed, Medline, Cochrane Database).

- “((NCDS) OR (NON COMMUNICABLE DISEASES) OR (chronic pulmonary diseases) OR (chronic lung diseases) OR (CHRONIC RESPIRATORY DISEASES) OR (post-COVID-19) OR (post-COVID) OR (post-SARS-COV-2) NOT (DIABETES) NOT (CANCER)) AND ((telerehabilitation) OR (tele supporting) OR (TELEMONITORING) OR (TELEMEDICINE)) AND ((USUAL CARE) OR (REHABILITATION) OR (AS IS SCENARIO)) AND ((QUALITY OF LIFE) OR (QOL) OR (COMPLICATIONS) OR (compliances) OR (PATHOLOGIES PROGRESSION) OR (DISEASE PROGRESSION) OR (ILLNESS PROGRESSION))” in order to collect evidence-based information with regard to the general chronic population, without COVID-19 infection.
- (“telemedicine”[MeSH Terms] OR “telemedicine”[All Fields] OR “mhealth”[All Fields]) AND COVID[All Fields] AND telemonitoring[All Fields]), in order to collect evidence-based information with regard COVID-19 infected patients.

The search for Mesh terms resulted in 181 records for the general chronic population, without COVID-19 infection and in 1,054 for the COVID-19 infected population. Out of them, only 16 and 21 were assessed for eligibility, respectively. In accordance with the above-mentioned search strategy and the PICO, only 13 articles met the inclusion criteria defined in the methodology section, focusing on the specific use of telemedicine services within the COVID population (Annis, 2020; Luwen, 2020; Martinez-Garcia *et al.*, 2020) or the chronic population not affected with COVID-19 (Hwang *et al.*, 2015; Chan *et al.*, 2016; Walker *et al.*, 2013; Franek, 2012; Gellis *et al.*, 2012; Martín-Lesende *et al.*, 2013; Hansen, 2020, Kessler *et al.*, 2018; Jodar Sanchez, 2013; Rehman *et al.*, 2017) comparing the innovative telemedicine solutions with the usual care.

The above scientific evidence was used to collect evidence-based information with regard to the efficacy and the safety profile of tele-monitoring, tele-supporting and tele-rehabilitation activities, compared to the usual care.

On the one hand, literature declared that telemonitoring and tele-supporting would improve the management of patients' with or without COVID-19, optimizing the care by detecting clinical deterioration at an early stage, caused both by COVID-19 or chronic cardiac or pulmonary diseases. A better perception of quality of life (48.4 versus 41.1) and fewer depression episodes (10.4 versus 18.7) were found in patients using tele-supporting activities (Gellis *et al.*, 2012).

Focusing on the chronic population not COVID-infected, but suffering from cardiac or pulmonary diseases, scientific evidence (Walker *et al.*, 2018) revealed a lower hospitalization rate for patients treated with telemonitoring for the worsening of their clinical conditions (79% versus 99%), as well as a shorter hospitalization stay with respect to usual care (1 day versus 4 days), on annual basis.

The same clinical benefits were found in COVID-19 patients: the use of telemedicine is associated with a hospitalization rate equal to 3.12% (Martinez-Garcia *et al.*, 2020), compared with 5.6% related to a condition in which such devices are not standardized (Italian Civil Protection Datawarehouse, 2020).

With regard to tele-rehabilitation, T-CUBE and usual care presented the same effectiveness and benefits for the patients (Chan *et al.*, 2016), thus presenting the same efficacy and safety profiles.

### **3.2 Results from the economic and organizational impacts**

From an economic perspective, the economic evaluation of both scenarios was conducted according to an activity-based costing approach on the basis of real-life Lombardy Region data. The following items of healthcare expenditure were deeply analysed and economically valorised: i) diagnostic and laboratory procedures; ii) drugs; iii) hospitalization; iv) rehabilitation activities; and v) specialist visits.

Table 1 reports the cost related to the management of COVID-19 or frail chronic patients (with or without COVID-19 infection), comparing T-CUBE implementation and usual care, in terms of clinical monitoring, rehabilitation and supporting activities, and considering the following populations:

- Currently COVID-19 patients.

- Post COVID-19 patients, in terms of negative patients, with a previous infection, requiring rehabilitation activities.
- Frail and Chronic patients, without COVID-19 infection.
- Frail and Chronic patients requiring an in-depth monitoring, without COVID-19 infection.
- Frail and Chronic patients, with COVID-19 infection.

Table 1 – Economic evaluation of the healthcare pathways

	COVID-patient (currently infected) Usual Care	COVID-patient (currently infected) T-CUBE	POST-COVID (COVID negative patients requiring rehabilitation) Usual Care	POST-COVID (COVID negative patients requiring rehabilitation) T-CUBE	Frail and Chronic patient, without COVID-19 infection - Usual Care	Frail and Chronic patient, without COVID-19 infection - T-CUBE	Frail and Chronic patient requiring an in-depth monitoring, without COVID-19 infection - Usual Care	Frail and Chronic patient requiring an in-depth monitoring, without COVID-19 infection - T-CUBE	Frail and Chronic patient, with COVID-19 infection - Usual Care	Frail and Chronic patient, with COVID-19 infection - T-CUBE
Clinical monitoring	295.88 €	444.94 €	- €	- €	- €	- €	2,113.03 €	1,731.65 €	2,408.91 €	2,784.55 €
Rehabilitation	- €	- €	4,331.48 €	993.32 €	2,066.22 €	1,085.83 €	- €	- €	- €	- €
Supporting Activities	137.74 €	40.64 €	137.74 €	40.64 €	92.79 €	48.35 €	92.79 €	48.35 €	230.53 €	89.00 €
<b>Total</b>	<b>433.62 €</b>	<b>485.58 €</b>	<b>4,469.22 €</b>	<b>1,033.96 €</b>	<b>2,159.01 €</b>	<b>1,134.18 €</b>	<b>2,205.82 €</b>	<b>1,780.00 €</b>	<b>2,639.44 €</b>	<b>2,873.55 €</b>
<b>Differences (%)</b>	<b>11.98%</b>		<b>-76.86%</b>		<b>-47.47%</b>		<b>-19.30%</b>		<b>8.87%</b>	

A budget impact analysis was then implemented to understand the impact of any innovative technology on the regional budget, thus defining the ceasing and the incremental costs related to its implementation, within a specific setting.

Considering 184,792 patients potentially treated with T-CUBE in Lombardy Region, an economic saving equal to 41% emerged on annual basis (Table 2). Despite marginal economic investment is required for T-CUBE adoption within the COVID-19 patients' management (+12%), significant advantages were reported in tele-rehabilitation activities devoted to negative patients (-77%).

Table 2 – Budget impact analysis

	COVID-patient (currently infected)	POST-COVID (COVID negative patients requiring rehabilitation)	Frail and Chronic patient, without COVID-19 infection	Frail and Chronic patient requiring an in-depth monitoring, without COVID-19 infection	Frail and Chronic patient, with COVID-19 infection	Total
<b>Number of regional patients</b>	81,024	23,136	33,426	45,926	1,280	184,792
<b>Total costs related to "Usual Care"</b>	35,133,626.88 €	103,399,873.9 2 €	72,167,068.26 €	101,304,489.3 2 €	3,378,483.20 €	315,383,542
<b>Total costs related to "T-CUBE introduction"</b>	39,343,633.92 €	23,921,698.56 €	37,911,100.68 €	81,748,280.00 €	3,678,144.00 €	186,602,857
<b>Difference (Euro)</b>	<b>4,210,007.04 €</b>	<b>- 79,478,175.3 6 €</b>	<b>- 34,255,967.5 8 €</b>	<b>- 19,556,209.3 2 €</b>	<b>299,660.80 €</b>	<b>- 128,780,684. 42 €</b>
<b>Difference (%)</b>	<b>11.98%</b>	<b>-76.86%</b>	<b>-47.47%</b>	<b>-19.30%</b>	<b>8.87%</b>	<b>-40.83%</b>

The above economic saving would also generate important organizational, social and environmental benefits, since T-CUBE would decrease the number of hospital visits and admissions, reducing the use of resources, optimizing healthcare organizational capacity. The platform would lead to a reduction of 14.11% of rehabilitative hospitalization days, with a consequent increase in the overall accessibility to care (51.6%).

With the decrease of hospital accesses, a significant social cost saving emerged: the potentially avoidable total cost by adopting telemedicine solutions could amount to € 14,858,731.33 € on annual basis. This would also result in an environmental benefit, in terms of CO2 emissions reductions (-3 thousand tons of CO2).

### **3.3 Results from the assessment of the qualitative MAST dimensions**

The analysis of the qualitative perceptions of the healthcare professionals involved (Table 3), considering a 7-item Likert Scale, ranging from – 3 to + 3, reported that T-CUBE platform presented higher values with regard to the social impact, as well as the equity impact, thus assuming the patients' perspective. T-



CUBE would be considered the preferable solution in particular because of its capability to decrease the patients' and the caregivers' productivity loss, due to fewer hospital accesses. On the other hand, T-CUBE would generate healthcare migration phenomena, thus being easily accessible at local level since it is based on telemedicine solutions.

From a legal perspective, legal efforts are required in particular with regard to the fulfilment of the safety requirements, as well as for regulating the use of such innovative platform.

In conclusions, from an organizational perspective, T-CUBE platform, at least in the short term, acquired a lower score than the usual care, since it required additional investments in training courses for all those who are involved in the procedure. Furthermore, an equipment updates is needed since T-CUBE grounds its application on telemedicine solutions. Despite the above drawbacks, T-CUBE implementation could significantly improve both the therapeutic and diagnostic pathway of COVID-19 infected patients and chronic patients requiring a strict monitoring and rehabilitative activities.

Table 3 – Qualitative perceptions (average values)

Social and Ethical impact	Usual care	T-CUBE platform			p-value
		Tele-supporting	Tele-monitoring	Tele-rehabilitation	
Ability of the pathway to protect the patients' autonomy	0.23	1.805	2	2.1	0.002
Ability of the pathway to protect human rights	0.295	0	0.335	0.335	0.383
Ability of the pathway to protect the patients' religion	-0.035	0.07	0.165	0.165	0.270
Impact of the pathway on the patient's productivity loss	-1.305	2.32	2.585	1.885	0.000
Impact of the pathway on the caregivers' productivity loss	-1.635	2.18	2	1.55	0.000
<b>Average value for the social and ethical impact</b>	<b>-0.49</b>	<b>1.275</b>	<b>1.417</b>	<b>1.207</b>	<b>0.023</b>
Equity Impact	Usual care	T-CUBE platform			p-value
		Tele-supporting	Tele-monitoring	Tele-rehabilitation	
Access to care on local level	-0.73	2.32	1.835	1.285	0.000

Generation of health migrations phenomena	0.135	0	-1.085	0.15	0.935
Existence of factors limiting the use of the technology for a group of patients	-0.085	0.27	0.33	0.45	0.990
Level of iniquity of the technology	-0.02	0.93	1.25	1.435	0.183
Ability of the technology to protect the patients' dignity	0.1	0.855	1.335	1.085	0.011
<b>Average value for the equity impact</b>	<b>-0.12</b>	<b>0.875</b>	<b>0.733</b>	<b>0.881</b>	<b>0.207</b>
<b>Legal impact</b>	<b>Usual care</b>	<b>T-CUBE platform</b>			<b>p-value</b>
		<b>Tele-supporting</b>	<b>Tele-monitoring</b>	<b>Tele-rehabilitation</b>	
Permission level	0.195	0	-0.25	-0.615	0.127
Fulfilment of the safety requirements	0.76	-0.145	-0.585	-0.365	0.033
Infringement of intellectual property rights	-0.125	0.445	2	1.1	0.292
Production warranties	0.035	0.395	1.665	1.065	0.043
Price control	0.335	0.195	0	0.735	0.499
Need to regulate the acquisition of technology	0	0.07	-0.085	0.565	0.471
The legislation covers the regulation of technology for all categories of patients	0.25	-0.25	-0.915	-0.985	0.397
<b>Average value for the legal impact</b>	<b>0.207</b>	<b>0.101</b>	<b>0.261</b>	<b>0.214</b>	<b>0.829</b>
<b>Organizational aspects</b>	<b>Usual care</b>	<b>T-CUBE platform</b>			<b>p-value</b>
		<b>Tele-supporting</b>	<b>Tele-monitoring</b>	<b>Tele-rehabilitation</b>	
Additional staff	-0.035	-0.715	-0.5	-0.365	0.659
Training course devoted to clinicians	-0.1	-0.785	-1.835	-1.185	0.000
Training course devoted to physiotherapists	-0.295	-0.785	-1.415	-1.2	0.036
Training for patients and caregivers	-0.23	-1.535	-1.835	-2.04	0.000
Hospital meetings	-0.1	0	-0.085	0.285	0.144
Learning curve	-0.295	-0.02	-0.085	0.2	0.584

Additional room space	-0.6	0.59	0	-0.465	0.093
Additional software	-0.66	-0.875	-1.5	-1.565	0.204
Additional equipment	-0.725	-0.27	-0.835	-1.1	0.170
Equipment update	-0.625	-0.785	-1.415	-1.465	0.124
Purchase of equipment	-0.725	-0.605	-1	-1.1	0.551
Impact of the technology on internal processes	-0.6	0.605	-0.25	-0.015	0.120
Impact of the technology on purchasing processes	0	-0.52	-0.915	-0.465	0.463
Impact of the technology on hospital processes	-0.6	0.375	-0.25	-0.015	0.280
Impact on the therapeutic pathway	1.23	2.09	1.75	1.985	0.562
Impact on the diagnostic pathway	0.96	0.395	1.085	1.235	0.171
<b>Average value for the organizational impact</b>	<b>-0.212</b>	<b>-0.177</b>	<b>-0.567</b>	<b>-0.454</b>	<b>0.493</b>

### 3.4 Results from the acceptability analysis

Table 4 demonstrates that T-CUBE acceptability and intention to use is strictly dependent from its usefulness ( $\beta=0.296$ ,  $p\text{-value}=0.003$ ) and ease of use ( $\beta=0.491$ ,  $p\text{-value}=0.021$ ) perceived by the healthcare professionals involved, as well as by its capability to produce a high-quality output ( $\beta=0.981$ ,  $p\text{-value}=0.016$ ), in terms of adequate care of patients, thus being the factors that most influence T-CUBE adoption in the routinely practice (Adjusted  $R^2=83.7\%$ ).

No statistically significant differences were found with regard to the seniority of the respondents, thus demonstrating that no digital divide exists. Furthermore, a negative relationship emerged between image and T-CUBE intention to use ( $\beta=-0.185$ ,  $p\text{-value}=0.035$ ). Healthcare professionals would not utilize T-CUBE for enhancing their "status symbol", but they voluntarily would use the innovative technology only if they are able to find a real usefulness and advantage for improving patients' health results.

Table 4 – Regression Analysis

<b>Control Variables</b>	
Gender	0.879*
Age	-0.539*

Seniority	0.048
Professional role	-0.457*
<i>Independent Variable</i>	
Perceived usefulness	0.296*
Perceived ease of use	0.491*
Image	-0.185*
Job relevance	-0.538
Output quality	0.981*
$R^2$	0.867
Adjusted $R^2$	<b>0.837</b>
F value	28,985*
$\Delta R^2$	0.481
$F(\Delta R^2)$	28,950*

#### 4 Conclusions

The use of telehealth has significantly improved the provision of health services during COVID-19 outbreak, with important consequence on hospital occupancy rate.

In this situation, remote diagnosis, treatment, and monitoring technologies have been used and developed in various countries with positive results. A Chinese study conducted on 4,589 COVID-19 patients (Liu *et al.*, 2020) who received remote diagnosis and treatment reported both a reduction in hospitals accessing and an improvement in symptoms and anxiety of patients, impacting at the same time the risks of overcrowding and contagion. An additional Spanish study, enrolling 313 patients, (Martinez-Garcia *et al.*, 2020) revealed the effectiveness in using a telemedicine approach in monitoring high-risk patients with COVID-19. A Brazilian retrospective study (Nascimento *et al.*, 2020) on 24,354 patients showed telemedicine was associated with a low rate of emergency room access and hospital admissions, suggesting a positive impact on the healthcare system.

According to the above, clinicians and patients are strongly recommended to apply telehealth tools as an appropriate option to prevent and contain COVID-19 infection.

As a result, T-CUBE has thus been created to monitor both COVID-19 patients as well as people who are not infected with the COVID-19, that should receive daily care without the risk of exposure to other patients in the hospital. Hence, the development of a monitoring decision-making algorithm, associated with the development of an integrated platform that allows the detection and recording of the vital parameters of patients, allows an efficient management of patients responding both to the need for safe care of patients and the need not to overload the hospital health system. In this view, due to the emergent occurrence of also depression and anxiety events (Xiong *et al.*, 2020), T-CUBE not only is based on tele-monitoring and tele-rehabilitation activities but could also offer tele-supporting services.

The results of the study have demonstrated that the sustainability of T-CUBE implementation of T-CUBE within the Lombardy Region setting, with important economic benefits, and an improvement in the overall accessibility to care for both COVID-19 infected patients and chronic population requiring a strict monitoring control. In this view, despite an initial investment in acquiring this platform, its routinely adoption would generate important economic savings, in particular for the proper management of frail patients (-47%) and COVID-19 negative patients requiring tele-monitoring and tele-rehabilitative activities (-77%). In addition, an improvement and an overall optimization of the patients' clinical pathway emerged, with important reduction in the onset of severe complications, thus also increasing the hospital admissions rate, freeing up economic and organizational resources that could be re-invested in taking in charge additional patients with important diseases to be managed.

On the other hand, once having demonstrated the efficacy and the sustainability of T-CUBE, it should be noted that its adoption would be accepted by all the healthcare professionals devoted to its use. To ensure the success of any digital technology, it is important to have the user's acceptance for that technology. Thus, healthcare professionals would effectively use the innovative platform T-CUBE, when it will be available, to guarantee the taking in charge and the continuity of care, for COVID-19 patients or chronic patients suffering from cardiac and pulmonary disease, both requiring tele-monitoring, tele-supporting

and tele-rehabilitative activities, thus promoting and improving the general wellbeing of the population.

In conclusion, T-Cube represents an ideal strategic leverage useful to manage the current pandemic emergency, thus being a relevant example in which digital technologies gives the possibility to solve a health problem in an efficient and effective way.

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## Intellectual Capital and Robotic Process Automation (RPA) - a Capability Perspective

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### Abstract

As a part of industrial revolution 4.0, digitalization has a major impact on organizational profitability and competitiveness (Viale and Zouari 2020). Digitalization is one of the biggest challenges organizations have been recently facing. Causing also organizations to respond to digitalization differently. Information technology plays a significant role in digitalizing organizational processes, also different automation solutions (Viale and Zouari 2020). Although RPA is a relatively new technology, it has recently gained a lot of attention among academia and industry (Gao et al. 2019; Cooper et al. 2019). Organizational management is getting increasingly interested in this new technological approach (Jimenez-Ramirez et al. 2019). While organisations have begun to implement RPA to improve process efficiency, the literature tends to examine this phenomenon from a technical perspective (Güner et al. 2020), instead of, for example, management perspective. The aim of this research is to study the required capabilities of RPA-based organizational value creation in the private healthcare sector, from an intellectual capital (IC) perspective. The practical outcome of this study will provide understanding of the IC components role

of capabilities of RPA utilization, that allow direct and indirect value creation in the private healthcare sector organizations.

The four evolution stages of IC (Secundo et al. 2017; Borin and Donato 2015; Dumay and Garanina 2013; Guthrie et al., 2012; Petty and Guthrie 2000) enriched by managerial data-driven approach (Secundo et al. 2017) are used as a framework to bring IC perspective. The research has been conducted by focusing on the enabling interest group, RPA consultants, having knowledge and experience in RPA implementations in organizations within different industries, also in the private healthcare sector. Several consulting companies in Finland were chosen for the study. This research was conducted using qualitative research methods and a case study research strategy. As an outcome, we will provide understanding on the role of IC components together with the required capabilities for RPA utilization and thus, value creation through examining different value functions in the private healthcare business industry. There are two practical outcomes of this study. First, this study will provide valuable information and understanding on the role of IC components together with capabilities required for RPA utilization in the private healthcare sector. Understanding what capabilities are required to use RPA efficiently would increase the ability of value creation in the private healthcare sector companies. Second, this study will provide information on the capabilities required for each value function.

**Keywords** – RPA, intellectual capital, capabilities, value creation, Private healthcare

**Paper type** – Academic Research Paper / Practical Paper

## 1 Introduction

As a part of industrial revolution 4.0, digitalization has a major impact on organizational profitability and competitiveness (Viale and Zouari 2020). Digitalization is one of the biggest challenges organizations have been recently facing. Also, organizations respond to digitalization differently. Some of the companies are taking it top-down and developing a digital business strategy, whereas the others are focusing on uncoordinated digital initiatives to be developed ad hoc in local business functions (Osmundsen et al. 2019). Information technology plays a significant role in digitalizing organizational processes, also different automation solutions (Viale and Zouari 2020).

Even though RPA is a relatively new technology, it has recently gained a lot of attention, among both academia and industry (Gao et al. 2019; Cooper et al. 2019). Organizational management is getting more and more interested in this new technological approach (Jimenez-Ramirez et al. 2019). Even though organisations have begun to implement RPA to improve process efficiency, the literature tends to examine this phenomenon from a technical perspective (Güner

et al. 2020). Different RPA technologies are rather a part of so-called lightweight IT, than traditional or heavyweight IT (Osmundsen et al. 2019). During the last few years many organizations, especially in the Nordic countries, have implemented or considered different automations and robotics to enhance their business operations (Kedziora and Kiviranta 2018; Syeda et al. 2020; Cooper et al. 2019).

The aim of this research is to study the required capabilities of RPA-based organizational value creation in the private healthcare business industry. The purpose of the research is to understand the different combinations of capabilities of RPA utilization that allow direct and indirect value creation in the private healthcare sector organizations. We are especially interested in analyzing what are the capabilities in different value functions.

This study is putting together the required capabilities for RPA utilization and thus, value creation through examining different value functions in the private healthcare business industry. Understanding the potential of RPA utilization, and moreover the enabling capabilities, in enhancing organizational performance, can be considered important in private healthcare, but there are not many previous studies looking at this issue. By analyzing the capabilities that enable RPA utilization in the private healthcare industry sector, the research brings a significant novel value for the private healthcare sector companies, specifying the requirements for value creating RPA utilization. There are two practical outcomes of this study. First, this study will provide valuable information as well as deep understanding on the capabilities required for RPA utilization in the private healthcare sector. Understanding what capabilities are required to use RPA efficiently would increase the ability of value creation in the private healthcare sector companies. Second, this study will provide information on the capabilities required for each value function.

In the second chapter the aim is to show a conceptual basis for RPA, capability and value creation. Chapter 3 presents an empirical setting, introducing the methodology and empirical material. Chapter 4 is of showing the results of the presentation by answering to the interview themes, based on the modified Walter et al's (2001) by Ratia et al. (2018) framework, that can also be applied to evaluate value brought by RPA utilization. Finally, in chapter 5, the conclusions and discussion conclude the paper.

## **2 A holistic overview of RPA capabilities**

### ***2.1 RPA enhancing business processes***

Digitalization sets a growing challenge towards the traditional role of the central IT function (Osmundsen et al. 2019). The software-based business and workflow processes automation in the organizations has been an emerging trend during the past few years (Davenport and Kirby 2016). The software performs typical and relatively simple tasks of office workers (Osmundsen et al. 2019). The literature describes RPA as a combination of method, system, and tool, including computer software, to automate manual organizational processes (Fernandez and Aman 2018; Bataller et al. 2017). RPA, is a technology widely used in an automation process, being based on software and algorithms to enable automation or copying employers' action in the digital process and can replace human resource in performing a specific digital process. Also called as software robots, robot or digital workers, that are being used to underline the purpose of digitalizing the automation process (Lu et al. 2017; Willcocks et al. 2015a; Willcocks et al. 2015b; Lacity et al. 2015). So, basically RPA can be described as the automation of service tasks that were previously performed using human resources, enabling the automation of repeatable business processes, eliminating lower complexity tasks currently undertaken especially by back-office teams (Asquith and Horsman 2019; Osmundsen et al. 2019).

Even though RPA is roughly process automation, it has a few distinctive features that differ it from other automation tools. First, RPA can be configured easily, so implementing or using it does not require programming skills. Second, RPA software can be considered a non-invasive solution, so RPA software functionalities are applied on the top of existing systems, as the software is accessing systems in a human-like way. Thirdly, RPA is ideal for enterprise use, so, IT requirements such as security, scalability and auditability are easily met (Osmundsen et al. 2019; Lacity and Willcocks 2015). Even though significant cost savings can appear as well as agility and quality can be improved, not all processes are suitable for automation. The process has to be highly frequent, having a low level of exceptions, involving an enclosed cognitive scope and vulnerable to errors made by human resources (Jimenez-Ramirez et al. 2019).

When the process is digital, routine and requires a lot of human resources, utilization of RPA is justifiable (Lu et al. 2017). However, the process owner is

responsible to develop the process and initiate efforts for process improvement, also processes should be routinized and standardized, to be able to imitate human behaviour (Osmundsen et al. 2019; Güner et al. 2020). RPA is often used when using human resources is costly, inefficient or the amount of data to be processed is enormous (Lu et al. 2017; Güner et al. 2020). Organizations are seeking for effective solutions that can improve the quality of deliverables, enhance efficiency, help them to meet compliance requirements, make them more agile and improve customer experience, also being cost-efficient and easy to implement. RPA can be seen as one of the potential digital enablers (Kirchmer 2017; Güner et al. 2020). As there is still a lot of routine work in organizations, it is clear that as a technology, RPA is being found very interesting by the executives, especially in the industries with a lot of manual work and expensive labor, such as the private healthcare sector in Finland.

## *2.2 1 capability perspective*

Capability as a concept has several definitions, some of them being supplementary and some interchangeable. One of the available views towards capabilities, is organizational ability in implementing and utilizing available resources in organizational processes. Often, it is a combination of organization-specific information and different knowledge processes (Amit and Schoemaker 1993). The literature suggests different combinations of capabilities for a capability framework, for example human resources, technology and organizational processes (Cosic et al. 2015; Davenport and Harris 2007). Another approach is to group capabilities, forming strategy, social, technical, quality and impact -groups of capabilities (Cosic et al. 2015; Raber et al. 2012). In addition, other capabilities, such as governance, culture and people were mentioned. Also, a leadership aspect was added, or more specifically change management (Cosic et al. 2015). So, capabilities can be roughly described as a combination of different competences (Mikalef et al. 2018). Also, capabilities can be considered as a combination of organizational core resources that are under the control of the organization. Nevertheless, requiring strong and complex interactions between organizational resources and competencies to be able to build organizational capabilities (Amit and Schoemaker 1993; Mikalef et al. 2018).

As of their complex nature, capabilities are difficult to buy, and they have to be grown within the organization (Mikalef et al. 2018). However, even though organizational capabilities can be considered to be a puzzle to solve, the

competitive advantage brought to the organization can be significant. The right combination of required capabilities can create business value. For example leadership, technology, culture, process, data and talent capabilities can be mentioned (Cosic et al. 2015). So, successful RPA implementation is more than a technological capability approach but requires a holistic capability perspective to succeed in bringing business value to the organization. After all, the goal of RPA is not to disrupt existing enterprise softwares, but to digitalize or replace a manual process with an automated one (Viale and Zouari 2020).

### **2.3 Creating business value**

The concept of value creation is not novel either in academia or among business management practitioners. However, the concept itself is multilateral, with definitions that are rather complete that exclude each other (e.g. Ojala and Helander 2014). Often the concept of value or value creation, is being referred to in business discussions, leading to business value, consisting of several elements (Ojala and Helander 2014). There are several approaches to value creation framework. The literature suggests that value can be viewed from the perspective of trade-off between benefits and sacrifices, more specifically monetary and non-monetary ones (e.g., Ojala and Helander 2014; Hugos and Hulitzky 2011; Lapierre 2000). Monetary trade-offs could be for example productivity and resource utilizations, whereas non-monetary functions could for example different competence, position of organization on market, time and effort (e.g. Walter et al 2001; Ojala and Helander 2014; Myllärniemi and Helander 2012).

When it comes to RPA utilization, the suggested value could be monetary, such as increased efficiency in the organization, by reducing human labor in the routine business processes. However, some non-monetary functions also might appear, such as quality of the work, as fewer mistakes are made (e.g. (Ratia et al. 2018; Myllärniemi and Helander 2012). In this paper, as a framework for our analysis, we use Walter et al's (2001) model, modified by Ratia et al. (2018). The model introduces direct and indirect value functions, enabling measuring the created value in private healthcare. Whereas direct functions are way easier to measure financially, as being profit, volume and safeguard functions. Whereas indirect functions require the input outside of healthcare organizations, such as innovation, market, scout and access, and thus cannot be directly measured

financially. However, this model does not provide direct answers, but rather helps us to understand functions that can create value in the private healthcare sector.

Table 1. Direct and indirect RPA utilization value functions and their measurement in the private healthcare sector (based on Ratia et al. 2018 and Walter et al 2001)

<b>Value function</b>	<b>Description of the function</b>	<b>Measurement examples for private healthcare sector</b>
<b>DIRECT</b>		
Profit	The financial value of efficiency	<ul style="list-style-type: none"> <li>- Less manual administrative work</li> <li>- Less workforce needed</li> <li>- Expensive workforce, e.g., doctors can concentrate on value creation</li> </ul>
Volume	Amount of tasks performed	<ul style="list-style-type: none"> <li>- Scalability of work</li> <li>- Resource optimization between workforce and RPA</li> <li>- Volume of performed tasks</li> </ul>
Safeguard	Better service level	<ul style="list-style-type: none"> <li>- Better quality performance</li> <li>- Better customer service</li> </ul>
<b>INDIRECT</b>		
Development	Refocusing to development	<ul style="list-style-type: none"> <li>- Allowing to focus on development of process</li> <li>- Developing new ways of work</li> </ul>
Innovation	Creating new products and services	<ul style="list-style-type: none"> <li>- Creating new digital solutions and services internally and externally</li> </ul>
Scout	External sources	<ul style="list-style-type: none"> <li>- Utilization of RPA to collect information from external data sources</li> </ul>

Function-oriented value analysis shows that issues related to performance, optimization of workforce, scalability and better quality, were the main value creating functions within direct value functions. These were focusing on reducing manual work, optimizing expensive resources, scaling work and improving quality of performance. Whereas in terms of indirect value creation the focus was on development, innovations and utilizing external sources (Ratia et al. 2018).

Clearly, enhancing productivity and lowering costs seem to be one of the key drivers for RPA utilization. However, RPA utilization is more than a technological approach, but requires a holistic socio-technical approach that includes a combination of capabilities, enabling value creation. Furthermore, it is yet unclear what are the capabilities required.

### **3 Methods**

The purpose of this paper is to study the potential value of RPA utilization and required capabilities in the private healthcare sector. The study has been conducted by focusing on the enabling interest group, more specifically on RPA consultants. The targeted interest group was selected based on the results of previous research (Ratia and Myllärniemi 2017; Ratia et al. 2017), conducted from the point of view of business intelligence and business analytics (BI/BA) utilization and data-driven value creation. Just like other data-driven approaches, also RPA has enabled the potential for value creation in the private healthcare sector. As the capabilities required for RPA utilization have not been studied previously in the private healthcare organizations, the research is focusing on identifying the capabilities required for RPA utilization and thus, business value creation. By focusing on the interest group of RPA consultants, we enable the potential value of RPA enabled potential and its' enabling capabilities to emerge, showing the impact in the private healthcare organizations.

This research was conducted using qualitative research methods and a case study research strategy. To be more specific, multiple case research strategy was used, to enable studying complex and context-dependent research topics (Yin 2003). For this research in total eight RPA consultants, who were representing several different size RPA consulting companies that had operations in Finland, were chosen. The potential value enabled by RPA utilization was approached inductively with semi-structured, thematic interviews. Upon other methods, the qualitative research method was chosen, enabling explanations and understanding on the research questions, also allowing the adjusted questions and thus, gathering more information, than if used quantitative study. However, a semi-structured interview approach can be considered to be flexible and also, allowing gathering information effectively and conveniently (Qu and Dumay 2011).



The case organizations were a part of the technology consulting sector, and they were located all over Finland, having their consulting operations at least in RPA, some also in Business Intelligence or Business Analytics. Companies involved in this study were Finnish and international companies having permanent locations in Finland. These semi-structured thematic interviews were done by skype- and phone and were recorded and transcribed, so that they could be systematically organized and analyzed. These interviewees were technology consultants, moreover from RPA functions of their companies. The list of interviewees and their role in a company is described in Table 2.

Table 2. The list of interviewees and their roles in a company

Interviewee	Role
1	Consultant
2	Consultant
3	Consultant
4	Manager
5	Consultant
6	Consultant
7	Director
8	Consultant

The interviews were conducted during spring 2018. Themes of questions included introducing questions, follow-up and probing questions as well as specifying direct and indirect questions (Qu and Dumay 2011). However, none of the background related questions cannot be specified, to ensure anonymity of the interviewees. All of the interviews were carried out in a discursive atmosphere, however, including targeted discussion themes e.g. what is RPA, what benefits and value it brings to private healthcare, what kind of organizational processes can be automatized and what are the biggest challenges of RPA. In chapter 4 we analyze the result with modified Walter et al. 's framework (Ratia et al. 2018; Walter et al 2001).

#### 4 The value creating RPA capabilities

The primary objective of this paper is to study the potential value of RPA utilization and required capabilities in the private healthcare business industry. The data gathered from RPA consultants brought up two views of RPA

capabilities, the technological and the process ones. Nevertheless, the literature shows that there are also other capabilities that are required for business value creation (e.g., Cosic et al. 2015). However, the different descriptions of capabilities in the literature were not exclusive, but rather complementary, creating a holistic overview of capability perspective (e.g., Davenport and Harris 2007; Raber et al. 2012; Cosic et al. 2015). However, also, the value enabled by RPA utilization was multidimensional. Literature together with empirical research both suggest that there are several value creating benefits of RPA utilization, such as, increasing efficiency in organization by reducing human labor in the routine business processes, improving quality of the work as fewer mistakes are being made, and good scalability towards business processes (e.g. Ratia et al. 2018; Osmundsen et al. 2019; Güner et al. 2020). Being a highly scalable business technology solution, it is easy to implement in technical matters, as it does not require integrations etc., but is operating on top of existing software (Ratia et al. 2018; Osmundsen et al. 2019; Lacity and Willcocks 2015).

The following table shows, value that could be achieved by using RPA and capabilities required for that. The modifications to the measurements are done based on earlier research of the healthcare sector (Ratia et al. 2018; Myllärniemi and Helander 2012; Ratia and Myllärniemi 2017).

Table 3. Direct and indirect RPA utilization value functions and their measurement in the private healthcare sector along with suggested required capabilities (based on Ratia et al. 2018 and Walter et al 2001)

<b>Value function</b>	<b>Description of the function</b>	<b>Measurement examples for private healthcare sector</b>	<b>Capabilities</b>
<b>DIRECT</b>			
Profit	The financial value of efficiency	<ul style="list-style-type: none"> <li>- Less manual administrative work</li> <li>- Less workforce needed</li> <li>- Expensive workforce, e.g., doctors can concentrate on value creation</li> </ul>	Technology, leadership, process, talent
Volume	Amount of tasks performed	<ul style="list-style-type: none"> <li>- Scalability of work</li> <li>- Resource optimization between workforce and RPA</li> </ul>	Technology, process, governance, leadership

		- Volume of performed tasks	
Safeguard	Better service level	- Better quality performance - Better customer service	Leadership, culture, talent
<b>INDIRECT</b>			
Development	Refocusing to development	- Allowing to focus on development of process - Developing new ways of work	Process, culture, talent
Innovation	Creating new products and services	- Creating new digital solutions and services internally and externally	Technology, culture, talent
Scout	External sources	- Utilization of RPA to collect information from external data sources	Technology, data, talent

Function-oriented value analysis together with matching required capabilities, can show value that can be enabled using RPA in the private healthcare organizations.

This analysis of the value functions showed that issues related to performance, optimization of workforce, scalability and better quality, were the key players, when creating value through direct value functions, requiring technology, leadership, process, talent, governance and culture capabilities. So, direct value can be reducing manual work, optimizing expensive resources, scaling work and improving quality of performance.

When discussing the indirect value, the primary focus areas are development, innovations and utilizing external sources, as new and innovative ways to create value, requiring process, culture, talent, technology and data capabilities. As an example, an indirect innovation function can enable creation of new digital products and services, both internally and externally, creating value using RPA. However, this model is not an absolute and exhaustive list of value-creating functions, but rather helps us to understand the activities and functions enabling RPA based value creation in the private healthcare sector.

Also, some managerial implications could be drawn, as a result of this research. First, to enable the benefits in automation of routine business processes, such as administrative routine work, for e.g., HR and finance processes and simple customer service activities, several capabilities, such as technology, leadership, process and talent capabilities are required. Second, when utilization RPA brings value by enabling clinical staff to focus more on the patient or customer, for e.g., in visit records management, where inputting multiple records is being outsourced to be performed using RPA and doctors and nurses have more time for the patient or customer, it requires technology, process, governance and leadership capabilities. Third, it can create new products or services that can bring value, requiring technology, culture, talent and data capabilities. As a summary, value creation, utilizing RPA in the private healthcare sector, requires a combination of several capabilities to succeed.

## **5 Conclusions**

This paper is introducing a fairly novel approach of capability development in discussion of RPA utilization in the private healthcare business industry. As digitalization is one of the most significant challenges organizations have been recently facing, organizations tend to approach it top-down and develop a digital business strategy or focusing on uncoordinated digital initiatives to be developed ad hoc in local business functions (Osmundsen et al. 2019). The role of information technology has expanded in digitalizing organizational processes and in different automation solutions (Viale and Zouari 2020). The significance of automation and digitalization of business processes has been also timely in the private healthcare organizations. However, aiming to gain business value out of their automation practices (Ratia et al. 2018). We analyzed the required capabilities for RPA enabled value creation through Walter et al's (2001) framework modified by Ratia et al. (2018), to gain better understanding of direct and indirect value functions in the context of the private healthcare in Finland capabilities required.

This research is putting together the capabilities required for RPA utilization and value creating functions in the private healthcare business industry in Finland. The automation potential, especially RPA utilization, in enhancing operational excellence, can be seen as a considerable opportunity in digitalization of business processes in the private healthcare, for e.g., by reducing cost and enhancing

financial performance of the organization (e.g. Ratia et al. 2018; Fernandez and Aman 2018; Kirchmer 2017). By analyzing the required capabilities of RPA utilization in the private healthcare industry, the research brings a significant novel value for the private healthcare sector companies, specifying the required capabilities and value creating functions enabled by RPA. Clearly, RPA utilization can bring value to organization, as literature review and empirical research both showed, but requiring a combination of capabilities that enable value creation. As of direct value, the main examples can be considered to be financial value of efficiency, such as reduction of manual administrative work and allowing medical staff to concentrate more on patient work and thus, value creation, requiring several capabilities, such as technology, leadership, process and talent. Whereas indirect value appearing in the empirical study was focusing on development and innovations as well as utilizing external sources, requiring technology, data, talent and culture capabilities. However, indirect value functions allow private healthcare organizations to seek for new and innovative ways to create business value, such as enabling creation of new digital products and services.

There are two practical outcomes of this study. The first outcome of this study will provide valuable information as well as deep understanding on the potential of RPA in value creation of the private healthcare sector, as digitalization is one of the most significant challenges organizations have been recently facing (Osmundsen et al. 2019). Also, the healthcare sector is seeking for new opportunities to increase quality of their operations and reduce their costs to enable maximization of created value (Laurenza et al. 2018). The second outcome of this research will provide understanding on capabilities enabling RPA driven value creation. But, in order to get a more in-depth perspective on this issue, we need to gather more empirical data from the RPA consulting organizations. Also, we need to study more from the private healthcare organizations perspective, on different organizational levels, to be able to point out the relevance of RPA utilization in the value creation process.

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## **Collaboration for Sustainability in the Agri-Food Sector: the Case MEC - Marketplace Ecosostenibile Calabria**

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### **Abstract**

Several studies have suggested that collaborative-based approaches are relevant to attain sustainability related goals in the Agri-food sector. These approaches take on even more significance in the light of the opportunities offered by the so-called *circular economy*, through innovative technologies and profitable business models based on the exploitation of agricultural wastes, byproducts and unsold products. The role of circular-based methods in conciliating social, environmental and economic objectives in the Agri-food sector is emphasized in several works, with a particular focus on approaches aimed at promoting rational use of resources and reducing food loss and waste. In this sense, Circular Economy represents an emerging and promising approach to manage the socioeconomic-growth of Agri-food Networks.



Starting from these considerations, the analysis of organizational and business models based on collaborative approaches as a tool for value chains creation in the agri-food sector seems to be a promising field to be explored. Unfortunately, the state-of-the-art picture of this field of study still appears fragmented and no specific model to design collaborative-based initiative in food sustainable chains are available. Thus, we analysed in depth the literature landscape of collaborative networks supporting the sustainable development through circular economy-based approaches in the agri-food sector, by means of a systematic literature review. Results of our systematic literature review led to the identification of a modelling framework consisting in four main elements, namely *Network structure, Participants behavior, Supply Chain Processes, Supporting tools, methods, and technologies*. We adopted this modelling framework to design a real experience of collaborative network based on the circular economy paradigm in the agri-food sector, namely MEC – Marketplace Ecosostenibile Calabria.

**Keywords** –collaborative networks; sustainability; circular economy; agri-food, case study.

**Paper type** – Academic Research Paper

## 1 Introduction

Agri-Food is an industry where sustainability related issues are more evident and pressing (Krishnan et al., 2020). This is mainly due to factors as the overexploitation of natural resources, the strong dependence of rural communities on food production, the changes in consumers' needs, and the bargaining power of big players of large-scale distribution (León-Bravo et al., 2017). To face these economical, societal and environmental challenges, agri-food companies are addressing their choices towards process and organizational investments in sustainable innovation (Nazzaro et al., 2020). Several studies have suggested that collaborative-based approaches can make the difference towards the attainment of sustainability related goals (Ramanathan et al., 2014). Collaborative Networks paradigm in the Agri-food sector are characterized by a re-connection among producers and consumers and the re-vitalisation of territory identity, in order to offer agri-food companies the opportunity to return in taking an active role in the agri-food system, improving their revenue streams and developing new market niches (Volpentesta and Ammirato, 2013). These approaches take on even more significance in the light of the opportunities offered by the so-called circular economy, through innovative technologies and profitable business models based on the exploitation of agricultural wastes, byproducts and unsold products (Toop et al., 2017). Collaboration among

organizations in the Agri-food sector is considered mandatory for rural communities to achieve sustainability goals, since companies along the supply chain pursue different objectives, often conflicting with each other (Manteghi et al., 2021). The role of circular-based methods in conciliating social, environmental and economic objectives in the Agri-food sector is emphasized in several works, with a particular focus on approaches aimed at promoting rational use of resources and reducing food loss and waste (Principato et al., 2019). In this sense, Circular Economy represents an emerging and promising approach to manage the socioeconomic-growth of Agri-food Networks.

Starting from these considerations, the analysis of organizational and business models based on collaborative approaches as a tool for value chains creation in the agri-food sector seems to be a promising field to be explored. Unfortunately, the state-of-the-art picture of this field of study still appears fragmented and no specific model to design collaborative-based initiative in food sustainable chains are available.

In order to fill this gap, we analysed in depth the literature landscape of collaborative networks supporting the sustainable development through circular economy-based approaches in the agri-food sector, by means of a systematic literature review (Denyer & Tranfield, 2009). Results of our systematic literature review led to the identification of a modelling framework that was adopted as a base to design a real experience of collaborative network based on the circular economy paradigm in the agri-food sector, namely MEC – Marketplace Ecosostenibile Calabria.

## **2 A literature review on sustainable agri-food supply chains**

According to the methodological framework proposed by Denyer and Tranfield (2009), we carried out a systematic literature review to provide a complete, exhaustive summary of relevant literature addressing the characteristics of sustainable agri-food supply chains. We selected Scopus and Web of Science (WoS) as scientific databases where to perform our search. We defined two sets of keywords including, , terms related to the sustainability field of study and terms related to organizational approaches for agri-food supply chains, respectively. The search results must contain at least one keyword for each set. We limited our search to research works published in journal indexed on the following subject areas: "Business, Management and Accounting; Decision

Sciences; Economics, Econometrics and Finance". At the end of this process, we obtained a final set P of 287 papers.

We carried out a quantitative analysis based on the Latent Dirichlet Allocation (LDA) in order to identify main topics. The process led to the identification of four topics. Then, we carried out a human-based review of representative and relevant papers, to provide a meaningful description of each topic. In order to select relevant papers, we followed suggestions provided in Ammirato et al., (2020): we selected papers with a topic proportion value of 0,25 or higher that were published in journals ranked with a ISI Impact Factor greater than 0,7.

**Supply-chain governance.** Some works addressed the definition of governance rules, policies and principles driving the behavior of members in agri-food supply chains. The definition of appropriate policies aiming to govern the behavior of the members within an agri-food supply chains is fundamental to reduce their opportunistic and individualistic behavior (Schuster and Maertens, 2013). In this context, standards for food safety and quality have a huge impact on internal organization of firms, the organization of the whole supply chain, the distribution of profits and the welfare of all stakeholders (Hammoudi et al., 2009).

Another relevant aspect influencing supply-chain governance deals with transparency and trust along the food supply chain (Qu and Yang, 2015). The last decades' strive towards ecologically and socially sound supply chains emphasize the role of trust as an important asset in an exchange relationship between food supply chain members and between supply chain and consumers (Leon-Bravo et al., 2017).

**Organizational structure.** Several papers emphasized the need of coordination and collaboration in agri-food supply chains. This is mainly due to the high dynamicity of the food industry and the need to face sustainability challenges (Wiengarten et al., 2012). Some works systematized collaborative approaches based on territorial embeddedness and reconnection with consumers (Volpentesta et al., 2013, Sacchi et al., 2019). Such initiatives have been labelled either as Alternative Food Networks or Short Food Supply Chains (Mardsen et al., 2000).

Other studies faced the impact of the intensity of collaboration (i.e., the mutual engagement of participants) on agri-food supply chain operations (Marqui et al., 2013). Several authors (Moharana et al., 2012; Volpentesta and Ammirato, 2013) agree that collaboration in agri-food supply chains can be classified in four coalition types, ranging from a purely transactional approach to a long-term

partnership. As the level of integration among supply chain members increases, it increases the amount of common goal-oriented risk taking, commitment, and resources that participants must invest into the joint endeavor (Camarinha-Matos and Afsarmanesh, 2008). This implies mutual trust and thus takes time, effort and dedication of participants towards the achievement of shared goals.

**Actors and roles.** Some works are devoted to the identification of actors and the definition of roles within sustainable food chains. Sustainability issues in food supply chains call for integrative approaches including several types of partners, stakeholders and consumers (Singh et al., 2018). Successful experiences of sustainable food supply chains highlight the importance of identifying right participants in a collaborative setting (Sarpong, 2014). Volpentesta and Ammirato (2013) defined main actors and roles needed to build up an alternative agri-food network. The number and the type of participants depends on the strategic objectives of the networks, the competence needed to carry out network activities and the specific characteristics of the supply chain (e.g., fresh vs. processed food). Besides typical players that characterize food supply chain (e.g., growers, food processors, logistics service suppliers, retailers, and specialty shops), sustainable collaborative networks are characterized by the presence of trusted third parties able to manage typical issues in bottom-up networks. These entities usually play an intermediate role among networks members, as collaboration catalyst, technology intermediary and guarantee authority.

**Agri-food supply chain digitalisation.** Digitalisation led to a new phase in sustainable agri-food supply chains. A wide range of literature on the role of ICTs applications addressing several issues of agri-food chains, e.g., data monitoring (Coley et al., 2011), precision agriculture (Van Evert et al., 2017), traceability (Accorsi et al., 2018). Digital based solutions allow the monitoring of food supply chain more efficient, reducing delivery time, costs and waste due to food products expiring warehouses (Jagtap and Rahimifard, 2019) representing a suitable tool to make the supply chain capable of quick response and performance improvement (Thöni and Tjoa, 2017). Supply chain's actors can communicate at a faster rate, reducing variability and uncertainty in the system (Kataike et al., 2019). Recently, the adoption of electronic grocery (e-grocery) platform among food consumers is gaining momentum. Several benefits, such as shopping convenience, time savings, as well as 24-hour accessibility to a wide variety of products and virtual stores contribute in making the popularity of e-grocery platform increasing (Caniato et al., 2017). However, the real jolt to the

food distribution industry came from the COVID-19 pandemic that radically changed the way consumers approach food shopping (Ellison et al., 2021).

The critical reading of the results of our systematic literature review led to the identification of four topics that, from an operational perspective, represent main aspects characterizing organizational and business features of sustainable collaborative networks in the Agri-food sector. This framework represents a useful tool to characterize the foundational aspects, principles, and practices of Sustainable Collaborative Networks and thus can be useful to help practitioners in the analysis and design of Sustainable Supply Chains in the Agri-food sector.

Many works highlighted limiting and enabling context factors potentially affecting the establishment and performance of agri-food supply chain initiatives. In these studies, authors agree that the ambition of having a universal organisational model that is valid for any reference territory is almost unreal. We found that successful cases of sustainable agri-food supply chains strictly depends on the cultural, social and economic characteristics of a territory (Knickel et al. 2008). In order to taking into account economic, social and technological factors characterising a specific regional area, we identified some constrains whose satisfaction is necessary for the establishment of a sustainable agri-food chain:

- presence of a high number of agri-food companies aiming to overcome the large retail scale and directly control an alternative distribution channel;
- presence of a community of potential consumers manifesting the need to purchase local and 'secured' agri-food products;
- emergence of interorganizational relationships characterised by trustworthiness, fine-grained knowledge transfer and joint problem-solving arrangements.

### **3 A case Study: MEC - Marketplace Ecosostenibile Calabria**

In what follows we provide an application of the proposed modelling framework, as emerged from the literature review, to design a real experience of collaborative network based on the circular economy paradigm in the agri-food sector, namely *MEC – Marketplace Ecosostenibile Calabria*.

Calabria is a southern Italy region with socio-economic problems that are broadly characterised by geographical remoteness, low population density, low

income levels, limited employment opportunities, dependency on agriculture, poor service provision, poor development capacities. The region is very rich of agrifood products which are strictly connected to the territory. Most of them have characteristics which fit the nine attributes identifying a 'typical product' connotation: territory, commodity economics, legal regulation, industrial nature, time, tradition, specificity, identity and nutritional surplus (Volpentesta and Ammirato, 2013). In particular, the Metropolitan City of Reggio Calabria is a province located in the extreme southern tip of mainland Italy, accounting a population of over 550.000 inhabitants. Among the list of typical food products indexed by Italian Minister of Agriculture, the Metropolitan City of Reggio Calabria accounts for a total of 195 typical food product. According to Cafiero et al. (2020), 89 out 195 of those products are hosted only in the province of Reggio Calabria. In that area, traditional foods are mainly produced by small-sized producers who rarely engage with others in pursuing joint marketing activities. Most of their products are secured by Protected Designation of Origin and Protected Geographical Indication status for typical regional food; all of them belonging to the sectors wine, olive, fruit and vegetable and dairy productions.

The above socioeconomic scenario satisfies the constraints listed in Section 2. For this reason, the Calabria Region and in particular the Metropolitan City of Reggio Calabria was selected to develop the MISE funded project MEC.

### ***3.1 Towards a multi-side platform for MEC Network***

In what follows we aim to define the business and governance model of a multi-side platform providing a value proposition to the actors belonging to the MEC network. The definition of such a platform takes into account the four elements identified in the previous section, namely: actors and roles, supply-chain governance, organizational structure, digital platform.

On the one side, the platform provides value to agricultural producers (e.g., direct farmers) and food processing and distribution companies. MEC supports agri-food companies promoting the reduction of product losses and food waste and enhancing, from a commercial point of view, agri-food products with a strong local / regional connotation through product management and control systems that allow an improvement of the chemical, physical, organoleptic, and nutritional qualities of the products at the time of consumption.

On the other side, *MEC* provides value to a set of actors involved in various capacities with the use and consumption of agri-food products. Consumers (e.g., individual consumers, purchasing groups and restaurant / catering services) can be provided with high-quality local products characterized by a direct connection with producers, territory, and cultural values; not-for-profit associations can be easily receiving upcoming food for distribution to disadvantaged social groups; energy companies can access to food loss and waste to produce energy.

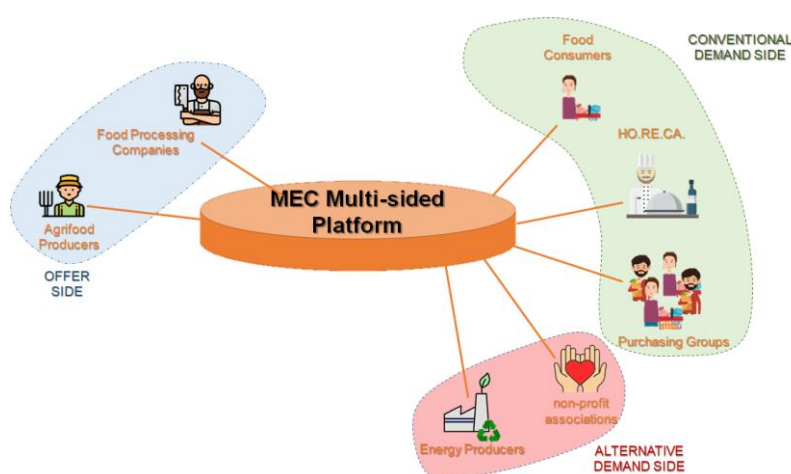


Figure 1 – Sides involved within the MEC Network.

A description of actors involved in MEC Network is provided as follows.

**Agrifood Producers:** A set of small and medium enterprises, producing high quality agri-food goods and operating in the four main agricultural sectors (wine, olive, fruit and vegetable and dairy productions).

**Food Processing Companies:** A set of small and medium enterprises specialized in the transformation of raw agricultural products into food.

**Purchasing Groups:** A set of final consumers, grouped in a self-organised non-profit purchasing group, who want to purchase agrifood goods at reduced prices. Consumers decide to share their 'shopping lists' to create a unique cumulative order for a heterogeneous bundle of products to be submitted to the platform.

**HO.RE.CA Operators:** A set of companies, operating in the Hotel, Restaurant and Catering Industry, that prepares and serves food and drinks to customers.

**Food Consumers:** A set of final consumers interested in purchasing local food product directly from producers.

**Non-profit associations:** A set of associations interested in receiving upcoming or unsold food for distribution to disadvantaged social groups;

**Energy producers:** A set of companies that are interested in accessing to food loss and waste to produce energy. Biogas, energy of organic waste captured through anaerobic digestion, can be burned to produce electricity and heat (cogeneration).

To enjoy diffused and equal trust from both agrifood producers and consumers, a Trusted Third Party (TTP) has the tasks to guarantee authority and collaboration catalyst. A technical staff within the TTP was invested by the role of technology intermediary and knowledgemediary, while another staff of the TTP has been charged with operational management of transactions. According to its role of collaboration catalyst, the TTP designed and proposed an organizational model shaping a blended form of a Collecting Buying Group and Collective farmer shops. From an operational viewpoint, the TTP, as transaction intermediary, collects and structures producers' offer by means of an e-catalogue; collects cumulative purchase orders from the demand side and processes them in order to form single purchase orders for each agrifood producer. As knowledgemediary, the TTP provides a web platform, which is based on the web 2.0 paradigms, and where web tools are available for sharing information and knowledge among users. In particular, by means of web 2.0 (social networking, photo and video sharing, mashups, podcast, etc.) tools, the TTP supports the development of virtual communities among MEC members. As matter of fact, such tools allow the creation and exchange of 'user-generated content', i.e. the blending of various kinds of media content, publicly available, that are produced by end-users. They are important in supporting the democratisation of knowledge and information, and their usage transforms MEC members from content consumers to content producers. In particular, agrifood consumers assume an active role as they get more involved in the production processes, becoming real prosumers. The virtual communities so created are based on a blending of technology and social interaction, which enables the co-creation of value for all communities' members.

The spread of the internet and the growing accessibility to technological solutions have revolutionized the lifestyle and habits of the population, not only as users but also as consumers. Grocery retailers are also adapting to the new type of customer and their needs, revising their business models with a view to a new type of trade and competition. In recent years, several traditional operators



in this sector have decided to activate new distribution channels by exploiting the potential of electronic commerce. In addition to this, several new players have entered this sector, basing their business exclusively on digital channels. In general e-grocery platforms can play a dual role. First, they can offer a new direct sales channel for individual retailers, allowing them to reach individual consumers, purchasing groups, but also business customers such as operators in the catering and restaurant sector. As previously stated, the internet has favored the entry into the market of operators who do not base their business on the direct sale of products, but act as intermediaries, facilitating the meeting between supply and demand, thus offering a two-category value proposition of actors:

- Agricultural producers and processing companies who manage to have a direct commercial channel with consumers. These operators have the advantage of not being forced to resort exclusively to large-scale retail trade and not investing money to create their own e-commerce platform.
- Consumers who have access to a large basket of products from different producers.

The MEC platform combines the above-mentioned conventional value proposition with a new value proposition that could refer to a new category of actors, interested in an alternative use of food, such as charitable / non-profit associations or companies capable of transforming food waste into energy.

The "conventional" flow therefore provides that the products coming from farms or from processing companies are collected at the logistics platform that will take care of breaking down the deliveries from the companies and reassembling them according to consumer orders.



Figure 2 – Conventional products flows within the MEC Network

In addition to this, other flows are enabled that we can call "alternative". For example, in order to reduce food waste, unsold or close to expiry products could be published on the platform and sold at a heavily discounted price, donated to non-profit organizations or sold to companies in the sector interested in alternative uses of food products. Likewise, expired food or production waste could be of interest to energy producers who could use these waste for energy purposes.

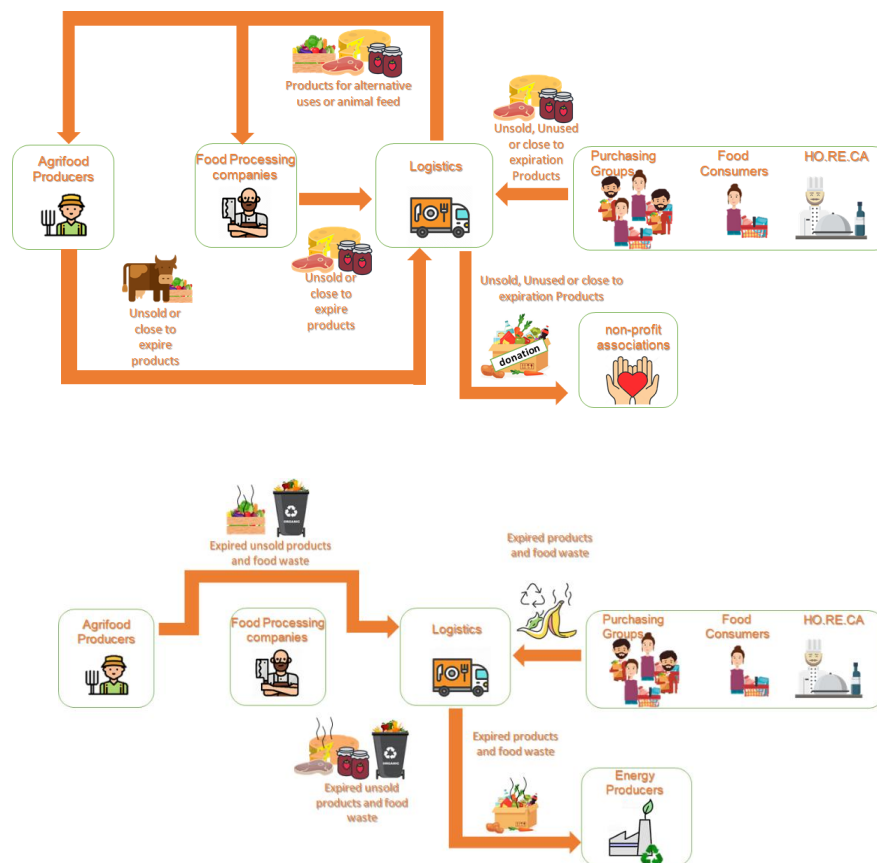


Figure 3 – Alternative products flows within the MEC Network

#### 4 Conclusions

The high dynamism and uncertainty of the reference context, force food supply chain operators to develop new skills, new methods, new structured approaches to face the challenges of the global market. We found in the literature a

significant amount of studies dealing with basic aspects of Sustainable food supply chain management. The attention of literature has so far concentrated mainly on the evaluation benefits of sustainability oriented strategies and advantages for involved parties, with a particular focus on how sustainability strategies have a positive impact on food quality, transparency and consumers' trust. However, less attention has been paid towards implications and issues of collaboration between different business organizations in sustainable food supply chains. Results of our systematic literature review led to the identification of four main topics dealing with collaboration in sustainable food supply chains.

. Sustainable change begins with recognition and modification of core values, assumptions and ideologies shared by members within organisations. Because of the complexities of the culture of change, many past projects of collecting farmers and consumers around agribusiness initiatives failed. In this paper, we presented some findings from the project MEC. In the case study, an instantiation of collaborative networks in agri-food supply chains within the Metropolitan City area of Reggio Calabria (Italy) has been proposed. Critical issues and lessons learned in the development of the project can be summarised as follows: the MEC Network plays a fundamental role as institutional framework, at all levels, for the development of the regional agrifood community. The establishment of a collaborative network where producers participated with public institutions and consumers, has been an important step in guaranteeing development and strengthening of the socioeconomic environment. This situation may clearly produce a catalysing effect for further organisations of producers (and/or consumers), encouraging the search for alternative markets for their products; since the early steps of the network establishment, commitment from local, public and private authorities is necessary.

In conceiving the MEC initiative, we first surveyed social and cultural specifics of small-scale producers, particularly their economic rationales (based on traditions and customs), which do not always coincide with the rationales of the greater organisations or institutions with which they usually interact. Participation of research and university centres is an enabling factor for the success of MEC establishment. The presence of a TTP contributes in providing an institutional framework guaranteeing neutrality and independence of interests; besides, this allowed intensive methodological thinking at the different stages of the process of building an agrifood learning community. Individualism of agrifood producers, lack of trust and spirit of coordination among stakeholders (consumers vs.

producers, producers vs. local authorities, producers vs. producers, etc.) and absence of a strategic vision (business vision of small producers is short-term, unlike the longterm view of agro industries) may hinder the establishment of a collaborative based initiative in the agri-food sector.

## Funding

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## **Customer Satisfaction and Added Value Creation Damaged by Knowledge Barriers**

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### **Abstract**

Information and knowledge management is key to create added value for organizations no matter what field organization is acting. Covid -19 has shown the importance of accurate and right information to be available for those who need information to be able to act. Respectively we have seen the challenges and problems when information has not received on time, information is insufficient or not received at all.

For organizations and their many stakeholders, customers included, uncertain times are the ultimate test for processes. This can be seen strongly in information and knowledge management practices. If organization has strong organizational culture where communication and knowledge management have strong position it can assume that ability and willingness to use alternative methods for communication when those are needed are in good level. This ensures also that ability to create added value for stakeholders and customers are not in danger and agility to react changes occurring in operating environment is existing. Barriers in communication have many different levels in organization. Individuals have different ways to communicate and receive information and these individual differences are creating needs to better and diverse communication within organization to create better possibilities to be successful also in organizational level. Today as covid-19 has changed dramatically ways to communicate and manage knowledge technological barriers and ability to use new technology has been the most important challenge organizations have been faced today. To be able to continue their businesses and survive new technology must be adopt and take in use even in individual level might be some challenges to learn and adopt new ways of doing things. This study focuses on added value and how communication as well as knowledge management. Case study is presented through industrial organization and their customer satisfaction survey to see how knowledge barriers are affecting on customer satisfaction and organization's ability to create added value through minimizing knowledge barriers. Through theoretical review of knowledge barriers, case study organization's customer satisfaction survey and survey creation process are shortly presented. Results of the customer satisfaction survey are introduced and results are reflected against theory related to different knowledge and information barriers. This evaluation is to be done to present the challenges what organizations are facing in individual, organizational and especially in technological level and how these all levels are connected when communication tools and methods must be

changed quickly and knowledge management is suddenly most important mode of management.

**Keywords** – knowledge barriers, added value, customer

**Paper Type** - Practical Paper

## 1 Introduction

Covid-19 forced us, organizations and individuals to take digitalization and tools modern technology is able to provide in use as quickly as possible to ensure that our daily operations can be secured in situation where processes are partly or fully remotely operated. Barriers were suddenly existing, disturbing organization's performance at all levels. These barriers needed to be recognized and solved, processes re-structured accordingly to keep daily operations running, customers served internally and externally. Added value by minimizing barriers internally to ensure operational performance at all levels in organization gives possibility to influence in customer satisfaction.

## 2 Added value and Customer satisfaction

Companies are having a great success do not just satisfy their customers, they strive "superb" and delight them. To have and maintain superior customer value means creating continuously experiences that exceed customer expectations. This value is the strategic driver and element that utilize to recognize and differentiate themselves from the pack in the mind of customer. Value is defined by our customers all the time and enables, if organization's value is outstanding, turn buyers into lifetime customers. (Johnson & Weinstein 2004:3)

So Companies have to create value for their customers and face the possible problems related to success and also failure of it, like deterring market share, declining customer loyalty, decreasing profits and chaos which may be caused by these matters. Anyway customer value is a key element for organizations to give direction to unite different business functions with strategies and common goals, recognize the importance of the focus on customer's expectations and needs; implement and develop information, personnel, business and quality systems to ensure and deliver required customer value. Approach build by customer value perspective can be shown as a pyramid with strategies and goals at the top and



quality, personnel, information and business systems at the bottom. Figure 1. Duchessi 2002: 1-3)

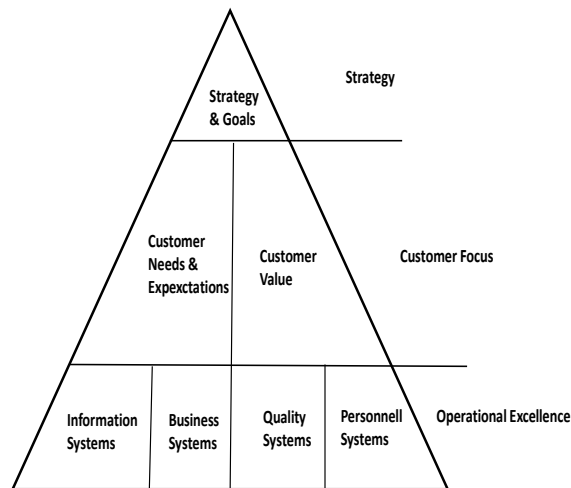


Figure 1. Customer Value Pyramid. ( Duchessi 2002: 1)

## 2.1 Definition of customer value

When defining customer value, customer value can be defined so that it represents the trade off between sacrifices and benefits from provider's relationship and product resources which customers think and believe to be facilitating their goals. At the same time we have to remember that quite often customer value is changing because customers are changing their own expectations. This aspect is a critical challenge for the providers because failing to meet customer expectations may lead to dissatisfaction and terminate the customer relationship. (Blocker et al 2011: 217-218)

Value as a term is used in many different contexts. For value definition customer perspective seems still be valid. Delivering and creating superior customer value to customers with high-value can be seen as increasing value of organization. There is a monetary worth in high-value customers as in individual customers to the organization which can be quantified, whereas organization's value quantifies the worth to its stakeholders. Still, customer value takes the perspective of the organization's customers. As a definition of customer value

and concept many different perspectives and meanings can be found and some of them are summarized in table 1. (Spiteri, Dion 2004:676-678)

Table 1: Definitions of Customer Value. ( Spiteri, Dion 2004:678)

<b>Researchers</b>	<b>Benefits</b>	<b>Sacrifices or costs</b>
Gale, 1994	Perceived quality	Relative prices
Butz & Goodstein, 1996	Emotional bond between producer and customer	Relative prices
Burns, 1993	Product value;posession value, value- in-use, overall value	Exchanged for product or price
Anderson, Jain&Chintagunta, 1993	Worth of set of economic, service, technical and social benefits	Exchanged for product or price
Sheth, Newman & Gross, 1991	5 categories of value; emotional, functional, social, epistemic and conditional value	Relative for sacrifices
Monroe, 1991	Quality and benefits	Relative for sacrifices
Zeithaml, 1988	Utility of what is received	What is given
Bagozzi, 1974	Maximise rewards	Minimize costs

### 3 Barriers in organization

Organizations are facing several challenges in their daily work in every organizational level. Challenges can be faced in individual as well as group or department levels while reaching the targets settled by management and owners.

Definition for knowledge has been often stated as a "justified personal belief." There are many classifications which specify various different kinds of knowledge. The most relevant and important distinction is between "tacit" and "explicit" knowledge. Knowledge is often tacit in nature and it has developed during long period of time. Some of it has merged in business activities processes and relationships that have been created over time when series of continuous improvements have implemented. Explicit knowledge is available for example in the form of sentences, words and documents words, different types of organized data, like computer programs. (King 2009: 6-8)

Creating knowledge is rather depending on tapping the tacit and quite often highly subjective insights, hunches and intuitions of individual employees and making these insights available for use and test for the organization. Personal commitment is playing a key role in terms of the employees' sense of identity

with the organization and its mission. Embodying tacit knowledge in actual technologies and products to reach actual personal commitment will require foremen and managers who are as comfortable with symbols and images as they are with numbers measuring productivity or market shares. (Nonaka 2007:7)

Knowledge management has become more important field of study as the technology has become important part of our daily life. We receive huge amounts of information through modern technology like internet, television and through different types of mobile applications. At the same time speed of information has increased and world has become smaller in that perspective. We get information quicker and at the same time we are asked to respond and act quicker to impulses we receive. This is happening at individual and organizational level. This phenomenon can be seen as a one side of globalization and networking with global business and economy. Knowledge management is partly and traditionally hardware and technology based research area. More and more it can be seen that research has more focus to human side of knowledge management. One of the reasons for turning focus for the human side of knowledge management might be that we have all needed information available, but the challenge is now that how we really can get best of it for individual and organizational use.

### ***3.1 Knowledge management within organization***

Knowledge management improves processes in organization, like collaborative decision making, innovation, collective and individual learning. These organizational processes create as process outcome better products, services and relationships and decisions as well as organizational behaviors and these issues and process outcomes lead to improved organizational performance as in Figure 1 presents. (King 2009: 6-8)



Figure 1. Knowledge process (King 2009: 6)

In knowledge processes in organizations we refine, storage, share, transfer, create, acquire and re-use information. Through efficient and good planning of knowledge management processes we increase and improve processes of innovation, individual and collaborative learning as well as decision making processes within organization. Through these actions and processes we improve our organizational performance by organizational behavior on the level of decisions, services, processes, relationships. Vital issue for achieving best possible result for improved organizational performance is to find causes for disturbance factors in knowledge management processes, organizational processes and also to find new ways and methods to improve ways we handle these processes within organization.

When bringing knowledge to product and service perspective in organization environment, it can be said that new products and efficiencies are difficult to sustain. By using knowledge we can provide a sustainable advantage. Competitors can always in period of time match the quality and price of a market leader's current service or product. When that happens, the knowledge intensive, rich, knowledge-managing company will have moved on to a new level of creativity, efficiency and quality. The knowledge advantage is sustainable because when efficiently used knowledge increasing returns and continuing advantages. Knowledge increases when used as ideas will breed new ideas knowledge which is shared stays with the giver and at the same time enriches the receiver. The potential key information for new ideas will be found from the stock of knowledge. And this stock is in any organization practically limitless if the people

in the organization are given opportunities to talk, think and to learn with one another. (Davenport 2014: 13)

Organization's performance is quite much depending on how managers are able to get activation done with individuals and teams turning knowledge into value-creating activities. Activities can take place through five different phases: 1) Initial sharing of experience, knowledge and practices among team members, 2) The effective creation of concepts for new products and services based on shared knowledge 3) the justification of these concepts are rooted in organization's strategy, focus interviews and market studies 4) Building a prototype of service offering and leveraging of concepts, prototypes and offering throughout the organization. (Von Krogh 1998: 133-134)

In the study of knowledge management in public organization Syed-Ikhsan and Rowland (2004:109), emphasized that to have good and successful strategy in knowledge management, organizations should always see it as total. All organization elements should be considered and analyzed when knowledge management is implemented. As technology play important role in sharing and developing knowledge, attention should also be paid to organizational context and culture in which people are encouraged to share knowledge. Technology may not stimulate the flow of knowledge and this is why organizational structure, people and technology should be considered together.

There seems not been any systematic knowledge management policy on strategic level in small and medium sized organizations. There are no goals included in the organizations strategy, or development, sharing or evaluation of the knowledge. On structural and cultural perspective there was hardly any systematic knowledge management policy on tactical level found in medium and small -sized companies. This brings out that there is no explicit policy on a tactical level in order to make the structure facilitating to development, locking of knowledge and acquisition of knowledge to make the culture motivating with a regard to utilizing and sharing and knowledge. Related to knowledge management policy on an operational level it appears that in small and medium-sized companies have different types of instruments used to evaluate knowledge and to determine the knowledge gap, to acquire knowledge, to develop knowledge and to share knowledge. These instruments are often not seen as an instrument for knowledge management within the companies but also, this does not necessarily mean that there is no knowledge management. (Uit Beijerse 2000: 15-18)

## **4 Knowledge sharing barriers**

There are many examples existing where knowledge sharing practices have not reach their goals- to manage organizations skills and assets. This occurs mainly because of potential knowledge sharing barriers. It has been agreed and acknowledged the biggest challenges within organization sharing practices is to maximize and protect the value which is derived from tacit knowledge. This tacit knowledge is held by organization's external stakeholders, customers and employees. (Riege 2005:3)

### **4.1 Definition of Barriers**

#### **4.1.1 Organizational Barriers**

When taking a perspective of organizational level, barriers are quite often tend to be linked for example lack of infrastructure and resources, the economic viability, the accessibility of informal and formal meeting spaces and physical environment. (Riege 2005: 23)

To have success in sharing knowledge within organization there must be a right organizational conditions and environment. There are many ways to share organizational, social or individual knowledge effectively. Barriers on organizational level can be outlined as:

- a) Size of the sites or business units are unmanageable to enhance contact and facilitate easiness in sharing knowledge and often they are therefore not small enough.
- b) Hierarchical structure in organization slows or inhibits most of the sharing practices.
- c) Layout of the working areas and physical work environment restrict effective sharing practices
- d) Knowledge flows and communication are restricted into specific directions.
- e) High external competitiveness within sites or functions and between subsidiaries.
- f) Deficiency of organization resources that can provide adequate sharing opportunities
- g) Lack of appropriate infrastructure which supports sharing practices.

- h) Lack of transparent recognition and rewards that would motivate people to share knowledge.
- i) Shortage of informal and formal spaces to generate, reflect and share new knowledge
- j) Lack of managerial direction and leadership how to communicate clearly the benefits and values of knowledge sharing practices.
- k) Sharing initiatives of knowledge management and integration of knowledge management strategy into organization's strategic approach and goals is unclear or missing. (Riege 2005: 25-26)

#### *4.1.2 Individual sharing barriers*

At employee or individual level barriers of sharing knowledge are often factors like lack of trust and time, differences in national culture, lack of social networks and communication skills as well as overemphasis of position status. Barriers at individual level can be listed as:

- a) Difference in ethnic background or national culture and beliefs as well as values associated with it.
- b) Lack of trust in credibility and accuracy of knowledge due to source
- c) Lack of trust in people because there may be occurring misuse of knowledge or taking unjust credit for it
- d) Taking ownership of intellectual property because of fear of not receiving accreditation and recognition from colleagues and managers
- e) Difference in levels of education
- f) Differences on genders
- g) Age differences.
- h) Insufficient evaluation, feedback, capture, communication and tolerance of the past mistakes that would enhance organizational and individual learning effects
- i) Dominance in sharing explicit over tacit knowledge such as experience and know-how that requires observation, hands- on learning, dialogue and interactive problem solving
- j) Low realization and awareness of the benefit and value of possessed knowledge to others
- k) Apprehension of fear that sharing may jeopardize or reduce people's job security

- l) General lack of time to identify colleagues in need of specific knowledge and general lack of time.(Riege 2005:23)

When going further and deeper for individual perspective individual sharing barriers can be described as uncertainty, loss of power, motivation and revelation. Uncertainty can be seen especially as a feeling among the less experienced and younger people, because they are not able to judge if their working results represent knowledge which is valuable. Their knowledge cannot be estimated if it is too well known or general or if the knowledge is too specific for special situation and therefore useless for colleagues in other cases. The positioning on the scale of specific to general is not trivial at all and thus it creates uncertainty. (Disterer, G 2001: 2)

Loss of power is quite common feature of individual level as knowledge can be used to enforce spheres of influence and to take action, to pass knowledge to colleagues may grant some of these potentials. The ones who do not own this knowledge are deprived to influence respectively. This applies to knowledge about procedures, competitors, suppliers' methods, formulas as well as customers from business perspective. By this perspective someone who will pass the knowledge to colleague will lose the exclusiveness of her or his influence and this might have suggested some respect and job security. "Knowledge is power" where experts with rare knowledge have monopolies of knowledge and reputation causes knowledge hoarding instead of knowledge transfer. In situations where job security is low power of knowledge becomes vital for the individual and knowledge can be seen as an insurance against losing job. (Disterer G 2001: 2)

Motivation can be also one reason for barrier at individual level as transferring knowledge can be seen as additional work. This is due the extra time needed for communication and documentation etc. Employees may not expect reciprocal benefits from transferring their knowledge because they do not experience it or they not believe these benefits. Even if people do expect some kind of reward for their contributions the question "what's in it for me "is not clear always to employees which are suffering from the lack of motivation. The need for self-motivated creativity is existing in order to foster knowledge sharing. Quite often the benefits of the contribution to a knowledge database is received by a different stakeholder at a later point of time, the benefits are quite often earned by colleagues of the provider, not provider itself. Knowledge sharing can be



beneficial only if everybody provides his knowledge unselfishly. (Disterer G 2001: 2)

A Revelation can be felt when putting results of the work or passing knowledge to colleagues, because it proclaims that this knowledge has certain rareness and value. Embarrassment may happen if this assessment is not shared by other users of the database and quite often some hasty colleagues will hurriedly suggest their necessary improvements just to emphasize their own expertise. (Disterer G 2001:2)

#### *4.1.3 Technology barriers*

At Technology level barriers are occurring with difficulties in integrating, building, and modifying technology-based systems. Barriers also correlate with factors like unrealistic expectations of ERP/IT-systems, unwillingness to use applications because of mismatch with need requirements. (After all there can be found various reasons why people hoar their knowledge and the contexts are often multi-dimensional). (Riege 2005: 23)

Knowledge sharing is also a technology issue and challenge. There is a little doubt that technology can be a facilitator to support and encourage knowledge sharing and its processes by making sharing more effective and easier. At the end, the key issue is to implement and choose technology which is most suitable and provides a close fit between organizations and people. Potential barriers for sharing can be.

- a) Lack of communication and demonstration of all possible advantages of new systems compared to existing one.
- b) Reluctance to use IT-systems due to lack of experience and familiarity with them
- c) Lack of training when employee is to be trained to be familiar with new IT-system
- d) Mismatch between integrated IT systems and processes restricts sharing practices and individual's deed requirements.
- e) Unrealistic expectations of employees on what technology cannot and can do
- f) Lack of integration of IT processes and systems impedes on the way people do things

- g) Lack of technical assistant and support as well as maintenance of integrated IT systems communication flows and obstructs work routines. (Riege 2005: 28-29)

## **5 Case study**

Creating added value for their internal processed as well as their customers. Case study is presented through industrial organization and their customer satisfaction survey to see how knowledge barriers are affecting on customer satisfaction and organization's ability to create added value through minimizing knowledge barriers. Through theoretical review of knowledge barriers, case study organization's customer satisfaction survey and survey creation process are shortly presented. Results of the customer satisfaction survey are to be introduced and these results are reflected against theory related to different knowledge and information barriers. Through this reflection weaknesses are revealed in customer added value creation and proposals for improvements are presented. Additionally, changes in organization's operating environment caused by covid-19 is evaluated through business perspective as well as through knowledge and communication perspective in general level. This evaluation is to be done to present the challenges what organizations are facing in individual, organizational and specially, in technological level and how these all levels are connected.

Customer were selected from 3 different segments so that all customer segments were covered. Totally 38 customers were requested to participate in the survey. Question patterns were discussed and prepared in a sales meeting January 2019 to have insights from customer interface and additional information from customers. At the first phase customers were approached via email; to give a gentle overview from the purpose, timing and information about the survey and how it will be done as a process. Survey itself was done by telephone interview during January 2019.

Analysis of empirical data revealed that there were clearly four themes which were continuously appearing when development needs were asked: Deliveries to be more accurate in time, in full and reliability and all functions, proactivity, more focus on innovations and product development and improving customer service.

For product development more activity and proposals were needed to create more added value to customer's product development function which would support customer's needs at their own development needs received from end customer. Reaction and response times related to information needed was experienced slow and more standardized and systematic methods in processes at customer interface was needed.

It was clearly stated that needs for better understanding of customer's needs through product development and new product innovations are expected.

*" One development need is to participate customer's R&D process. To offer new product innovations to customer"*

When experiences related to deliveries and quality were asked, deliveries were experienced to have big variations and some of the customers were very disappointed because of long delivery times or being uncertain that deliveries are delivered as promised. These failures in delivery quality have had serious influences on customer's own performance.

*" There are differences in quality of deliveries. One is having deliveries on time and in full, but another one is having big problems"*

*" In our weekly meetings you are always mentioned because of some problem."*

*" Act Systematically: Every order must have order confirmation and deliveries should be done accordingly. Deliveries should arrive as promised – too much post-deliveries"*

Role conflicts within organization clearly has reflections to relationship and how customer is served and informed.

*" Lead-times are okay. Customer service should be fixed first, meaning that there should be person who is in charge. Of course when you are familiar and know persons it helps, but sales assistant is missing. They have customer service manager, but person who is between production and customer is missing"*

When it was separately asked from customer that what are the main development areas where Company should focus more in future answers were divided as follows; Product Development 53% environmentally friendly solutions 50%, and lead-time 50%

After services was indicated to be something to be improved and harmonized as one site is acting differently than other. This is indication gaps in information and communication between sites.

*" Same things what we do with other sites; follow up on claims and other projects- what is the status and what will be done next etc."*

This has clearly indication that barriers have major effect on customer satisfaction and therefore minimizing barriers and focus improvements internally have direct influence how organization can improve their own performance on the markets.

Table 2. Summary how barriers at individual, organizational and technical level are influencing customer's experience.

<b>INDIVIDUAL LEVEL BARRIERS</b>	<b>CUSTOMER PERSPECTIVE</b>
Poorer understanding of customer requirements in production than earlier, as contact level is missing.	Information missing related to deliveries, not known who is in charge
<i>Difference in levels of education, causing e.g. shortages in language skills.</i>	Information missing related to deliveries, not known who is in charge.
<i>Insufficient learning loop and tolerance of past mistakes</i>	Lack of Research and development.
<i>Lack of trust (towards other units)</i>	Lack of Research and development, long lead-time..
<i>General lack of time</i>	delays, long lead-time

<b>ORGANIZATIONAL LEVEL BARRIERS</b>	<b>CUSTOMER PERSPECTIVE</b>
Communications break-down between sales, operative and development functions.	Lack of Research and development
Knowledge sharing problems between the unit and the corporation level	Information missing related to deliveries, not known who is in charge
Unclear roles and job descriptions	<i>not known who is in charge</i>
<i>High competitiveness between other subsidiaries</i>	<i>different methods within claim handling and follow up</i>
<i>Deficiency of resources</i>	delays, long lead-times

<b>TECHNOLOGICAL LEVEL BARRIERS</b>	<b>CUSTOMER PERSPECTIVE</b>
Data and information are incoherent and splattered into different information systems	delays, long lead-times
Information systems are not used comprehensively	delays, long lead-times
<i>Unrealistic expectations of employees about what technology can do or can't do</i>	delays, long lead-times
<i>Lack of integration of IT processes and systems</i>	delays, long lead-times
<i>Lack of technical support</i>	delays, long lead-times

## 6 Conclusions

Barriers occur in organizations and to improve processes and efficiency those existing barriers must be identified and recognized by all organization levels. By identifying organization can evaluate what is the influence of each barrier. By involving customer satisfaction to organizational barriers importance of minimising barriers and their effect on organizational success in markets is way to raise importance of barrier-studies in organizations. Case study clearly indicated how much specially, lead-times were effected by technology barriers by technological level barriers. As the short lead-time is one of the biggest advantages for organization to compete in the markets and acquire new customers, it is a must that organizations are doing all possible actions to be as flexible and as fast as possible to serve their customers in globally markets. Individual and organizational level barriers were clearly effecting to customer's perspective on organization's capability to do research and development. If organization wants to be competitive now and in future it is similarly important to be able to provide new products and services and in that way show customers that organization is worth to have long term business relationship as added value can be created through new ideas and development projects. Winning organizations should continuously identify and monitor their processes and minimize barriers at all levels. Through these actions organizations have clearly positive effect on their customers through better service. This achieved better service level will be seen as improved customer satisfaction and better business results.

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## Knowledge Sharing among Sales Channel Collaborations Considering Times of Crisis

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### Abstract

**Purpose** — The purpose of this study was to examine how knowledge management should be implemented in medium-sized manufacturing companies in order to ensure adequate B2B communication and knowledge sharing of explicit knowledge with distributors in the sales channel in times of impeded and limited access due to COVID-19 pandemic. Manufacturers traditionally manage their sales channel partnerships inefficiently, and especially SMEs do not often make use of consequent knowledge sharing. This leads to the fact that converting leads into sales becomes an on-going challenge and calls for new ways of inter-organizational knowledge sharing of explicit knowledge internationally.

**Methodology and approach** — To explore the complexity of business partner knowledge sharing in the B2B sector, a qualitative approach has been applied. Building on the purpose of the research, a single case study research as the research strategy provided in-depth information on the manufacturer-distributor knowledge sharing in times of crises. The contemporary phenomenon of SMEs within the real-life context of B2B communications primary data was collected in form of a self-administered questionnaire from international business partners in the sales channel of an industrial manufacturer of machine building industry in Germany.

**Findings** — The rising importance of knowledge being the fourth production factor generating values require companies to constantly transfer and share knowledge – not only inter-, but also intra-organizationally, especially when it comes to sales channel collaborations. The findings of this research highlight that the use and positioning of knowledge sharing among business partners in the sales channel is crucial and enable collaborations to improve B2B working flows cross-organizationally. Explicit knowledge such as specific product-related information material, prices or logistical information should be trained on the product, catalogues or via internet-mediated means and should furthermore be stored in a commonly used knowledge management tool. Tacit knowledge

should be transferred in a pre-agreed language, predominantly through joined customer visits and training on the product.

**Practical implications** — This research does not only enhance practical implementations in the case organisation but also can be conferred upon those organisations that rely on a manufacturer-distributor relationship in their sales channels. It provides insights regarding a proposed knowledge management in SMEs and it links the theoretical understanding of knowledge sharing with real-life practices in manufacturer-distributor relationship-related processes. Thus, this research generates new knowledge by combining knowledge management theory with practice to develop a framework that provides insights on observing, improving and preventing knowledge-based bottlenecks.

**Keywords** – Knowledge sharing, Knowledge sharing among collaborations, Manufacturer-distributor knowledge transfer, Small and medium-sized enterprises

**Paper type** – Academic Research Paper

## 1 Introduction

Nowadays, the fourth factor – knowledge – can be identified when looking at wealth-generating variables in organisations. In knowledge-based economies, firms that participate in the creation and utilisation of knowledge are able to gain a sustainable advantage from their business strategy (Ibrahim and Heng, 2013). In contrast, medium-sized companies do not often make use of knowledge sharing in order to become more competitive (Massaro et al., 2016; Wong and Aspinwall, 2005). In particular, manufacturing companies of this size traditionally manage their sales channel partnerships inefficiently via phone-calls, E-mails, presentations, face-to-face meetings and etc. While all these implying work-intensive communication and knowledge sharing processes lead to the fact that converting leads into sales becomes a difficult task, sales channels have received rising attention as a determination of business performance (Sharma and Mehotra, 2007; Jiang, Henneberg and Naudé, 2011; Parvinen and Pöyry, 2016).

The problem becomes more complicated, when external distributors of the sales channel are not on the same level of explicit knowledge because the sharing process lacks a concept of informing all international distributors from every location at once. Medium-sized manufacturing companies are at risk to lose potential and existing customers. There is a need to answer the question of how knowledge management can be implemented in order to ensure adequate B2B communication and sharing of explicit knowledge among channel collaborations.



This study investigates into a medium-sized engineer supplier for the machine building industry based in Germany.

## **2 Literature Review**

### ***2.1 Knowledge management capability in sales channel collaborations***

A company's knowledge management capability refers to the amount to which the company creates, shares and applies "*knowledge resources across functional boundaries*" (Liao, Chuang and To, 2011, p. 729). These KM activities enable the company to use new information, assimilate it and utilise it in order to create new knowledge (Wong and Wong, 2011). They "*co-exist, co-vary, and overlap with each other,*" (Liao, Chuang and To, 2011, p. 729).

When focusing on an entrepreneurial environment, the differentiation between tacit and explicit knowledge is as essential as distinguishing between individual and organisational knowledge. Making tacit knowledge explicit carries the risk of losing sustainable competitive advantage. The more tangible the knowledge, the greater the risk of other firms to imitate this knowledge (Lubit, 2001). Nonaka and Toyama (2003) state that the only way to acquire tacit knowledge is to share experience by spending time together (Holste and Fields, 2010). In the opposite to tacit knowledge, explicit knowledge can be transmitted by using interaction between physical objects (Collins, 2010). It can be codified and/or verbalized (Takeuchi, 2013; Grover and Davenport, 2017) and expressed by data, numbers, formulas, pictures, manuals, and patents (Takeuchi, 2013). The specific characteristics of both, tacit and explicit knowledge have not really changed over the years apart from the fact that knowledge nowadays can be exchanged via digital solutions. Successful intra- and inter-organisational knowledge management is dependent on the willingness to share explicit and tacit knowledge in order to benefit the business partners. Therefore, a company is advised to keep a spirit of community among all employees and collaborative partners to encourage them to keep the knowledge growing (Al-Busaidi and Olfman, 2017).

Looking at supply chain knowledge management capability, the company's ability to learn from its partners is affected by the ability to transfer it internally among organisational members as knowledge (Spekman, Spear and Kamauff,

2002) in an organizational routine that generates memory from external collaboration partners.

## **2.2 Knowledge sharing methods**

Knowledge sharing is “the exchange of knowledge between and among individuals, and within and among teams, organisational units, and organisations” (Paulin and Suneson, 2012, p. 83).

Even if there is willingness to practice knowledge sharing it remains difficult to transfer knowledge adequately. While it may be simple to codify explicit knowledge, tacit knowledge requires intense interaction and can only be shared in small group settings (Dyer and Nobeoka, 2000). The phenomenon of failing to contribute is called free-riding problem – for individuals it is rational to use knowledge systems without adding to them because it would not carry any benefits (McCarthy and Riegelsberger, 2004). Different methods supporting tacit and explicit knowledge sharing are e.g. community of practice, storytelling, training, mentoring (Bryant, 2005; Bryant and Terborg, 2018; Dyer and Hatch, 2006) and knowledge sharing networks technologies. In the following, methods that are applicable for the manufacturer-distributor relationship are explained:

- Organisational **storytelling** contains information about past management actions, employee interaction or organizational events that are communicated informally. According to Ferneley and Sobreperez (2009) such stories can be fictional, factional, anecdotal or scripted. Storytelling includes several tools, each suitable for various business purposes (Denning, 2006). If the objective is to share knowledge, the story has to focus on mistakes made and shows in detail how these mistakes were corrected or solutions worked.
- **Training** is a company’s planned exertion to help its employees in the learning process of work-related competencies (Fong et al., 2011). As a medium motivating knowledge sharing it gives employees the chance to gather and share new knowledge. The evidence found in the link between team-based training activities and the level of commitment to learning supports the importance of training encouraging the creation of teams that are committed to learning (Jerez Gómez, Céspedes Lorente and Valle Cabrera, 2004).

- The most common **knowledge sharing network technologies** for explicit knowledge and information sharing include phone, video and audio conferencing, chat, e-mail, instant messaging, webinars, etc. By these ways, knowledge and information can flow digitally within seconds. When product-related information has to be shared, the concept of collaborative writing systems can be applied (Ruggles, 1997; Nabelsi, Gagnon and Brochot, 2017). Word processors provide support by allowing users to track changes and make annotations when collaborating on a document. Another technology could be wikis in order to share knowledge among members of a broader community by openly editing content that facilitate collaboration (Nabelsi, Gagnon and Brochot (2017). In order to share knowledge, a groupware or collaboration tools enable the knowledge flow and knowledge-sharing activities among different parties.

### **2.3 Knowledge sharing in sales channel collaborations**

According to Frohlich and Westbrook (2001, cited in Redaelli, Paiva and Teixeira (2015)) performance monitoring is the manufacturer's constant overseeing of their distributors' actions. Performance monitoring is the step right before cooperation, which helps to build trust and improve performance (Alsharo, Gregg and Ramirez, 2017; Redaelli, Paiva and Teixeira, 2015) and it is also consistent with tacit and explicit knowledge sharing among collaborations.

One way of doing this is to base the manufacturer-distributor relationship on regular visits of distributors' staff to the manufacturer's units and vice versa for knowledge-sharing activities. Another way is the direct transfer of the manufacturer's personnel to the suppliers/distributors. Siguaw, Baker and Simpson (2003) state that maintaining a good relationship with the distributor, increases their commitment and trust and therefore their willingness to share knowledge. Hence, Modi and Mabert (2007) suggest that direct involvement is a key strategy to make knowledge sharing possible because the manufacturer's staff can teach the distributor's staff and this allows the transfer of good practices (Dyer and Hatch, 2006).

Explicit knowledge acquisition can be related to the activities developed by the manufacturer in order to "*formally transfer information and knowledge to the distributor*" (Redaelli, Paiva and Teixeira, 2015, p. 426). Activities such as trainings on the product, technical courses, sales promotion campaigns etc. are supportive

mechanisms to transfer explicit knowledge to explicit (Nonaka, von Krogh, and Voelpel, 2006; von Krogh, Nonaka and Rechsteiner, 2012). Guenzi and Storbacka (2015) state that by monitoring the distributor's performance, the manufacturer has the possibility to identify failures and provide accurate knowledge. Nowadays, it is required that supply chains act flexibly in order to be able to remain competitive in increasingly multifaceted business environment (Blome, Schoenherr and Rexhausen, 2013). According to Parvinen and Pöyry (2018), the relationship of the manufacturer and the distributor consists of two parties, each wanting to get the most out of this relationship. Vázquez, Iglesias and Álvarez-González (2005) add that this relationship is based upon the will to maintain successful collaborative relationships. It is said that B2B partnerships base upon diverse factors (Jiang, Henneberg and Naudé, 2011) such as trust (Maheshwari, Kumar and Kumar, 2006; Vázquez, Iglesias and Álvarez-González, 2017), equitable interdependence, flexibility and information flow (Parvinen and Pöyry, 2018). Redaelli, Paiva and Teixeira (2015) resume these aspects by stating that the sharing of knowledge between the manufacturer and the distributor is the key for strong cooperation, trust, effectiveness and longer-lasting supplier-reseller partnerships.

The knowledge flow between supplier and distributor is of notable importance and might be one factor for achieving a sustainable balance and a successful relationship between the two parties (Parvinen and Pöyry, 2018). Knowledge transfer must occur within the manufacturer's plant (intra-firm knowledge sharing) and then spread to the distributor as interfirm knowledge sharing (Dyer and Hatch, 2006). Once the knowledge has spread to the distributor, Yilmaz, Sezen and Tumer Kabadayi (2004) agree that this kind of communication has become a key factor for quality business relationships. Further, Kotabe, Martin and Domoto (2003) confirm that the transfer of knowledge can be associated with an improving supplier performance and results in longer lasting relationships. Developing knowledge and sharing it between separate organizations has a positive effect on the development of mutual advantage (Durst and Edvardsson, 2012). A manufacturer that shares its knowledge adequately is likely to establish a long-lasting relationship between both parties and eases the development of innovations linked to distribution (Vázquez-Casielles, Iglesias and Varela-Neira, 2013).

Although literature demonstrates an agreed importance of collaborative relationships between manufacturer and distributors (Kianto et al. 2018; Parvinen

and Pöyry, 2018; Vázquez, Iglesias and Álvarez-González, 2013) as well as the importance of interfirm knowledge management, integrating it into the domain of B2B management has received less attention (Jayaram and Pathak, 2013). In addition, research is missing that combines the collaborative relationships between manufacturer and distributors with knowledge sharing concepts of small and medium-sized organisations.

## 2.4 Research question and objectives

The research assumed that small and medium-sized businesses do not manage knowledge efficiently and due to this, collaborating with the distributors does not work at its best. Therefore, the case study research aimed at investigating which means of knowledge sharing on what information bases are recommended to mitigate the potential risks of losing customers in the sales channel. Therefore, the overarching research question for this qualitative explanatory research was:

*How should knowledge management be implemented in medium-sized manufacturing companies in order to ensure adequate B2B communication among channel collaborations?*

The conceptual framework of this research illustrates those conditions of the distributor and the manufacturer that had to be figured out by answering relevant questions before elaborating on the need of knowledge sharing and the integration between channel members (figure 1).

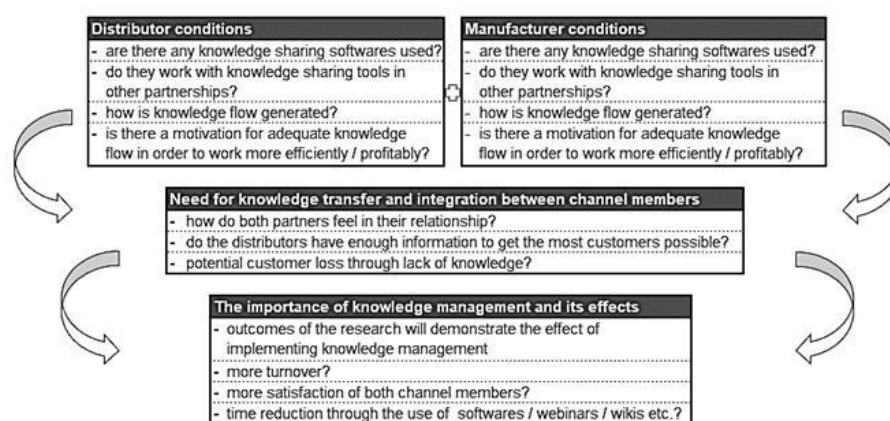


Figure 1: Conceptual research framework

### **3 Research Method**

#### ***3.1 Single case study qualitative research***

Processing data of a single case and studying the existing problem in order to explain the relationship between knowledge sharing and the potential loss of customers, while results are not pre-given, lead to an explanatory and inductive research approach in a case study research design (Yin, 2018). This was also reinforced by the wish to bring light to the complex problem of conceptualising and harmonising the knowledge sharing process between a medium-sized manufacturer and the external distributors of the sales channel. The suitable approach was the qualitative research methodology since the research aimed at analysing the complex phenomenon of business partner communication in the B2B business. As recommended by Yin (2018), small samples were used in a single case study research that was concerned with extending existing theory, since little research has been undertaken regarding knowledge sharing among B2B partners in sales channel of SMEs.

This single case study research focussed on two embedded units of analysis which were the distributors' employees who were involved by filling in questionnaires and the senior sales managers of the case organisation who reviewed the outcomes of the inquiry during interviews in order to interpret the research outcomes. The case organisation was a medium-sized mechanical engineer supplier for cables, connectors and cable assemblies for more than 15 years, a business that is exclusively dependent on customer's needs. Recently, the firm released a completely new product line of luminaires that required to establish a new way of distributing the new product line on the European and North American market through a network of distributors in Europe and in Canada. The headquarter is located in Germany employing roughly 150 people in both commercial and technical areas. Facilities for the series production of cable assemblies are located in Germany and Eastern Europe. The company's customers are predominantly working in the area of machine and plant engineering.

#### ***3.2 Sampling and data collection***

The sampling methods were narrowed down to purposive homogeneous sampling. Bryman (2016) add that the use of the purposive sampling strategy is

most applicable when there is a wish to select cases that are particularly informative. The focus on one specific sub-group, in this case the sales representatives of the distributors' firms, enabled the researchers to study this group in-depth. Participants were selected by finding contact person in a mailing list of the 20 distributors who were working as commercial and technical experts in the branch of industrial luminaires.

The tool used for creating and distributing the questionnaire was Google Forms. It was most suitable to use a self-administered mail questionnaire with open and pre-configured questions, aiming at qualitative data collection. The use of questionnaires was also simplifying the access to the distributors during the external circumstances of the pandemic Covid-19 combining pre-configured and open questions in a faster way than by interviews (Maylor, Blackmon and Huemann, 2017).

In addition, as already mentioned, 2 expert interviews were conducted with the senior sales manager and the international sales manager of the case organisation. Nevertheless, the findings are based on the online inquiry. Ethical issues were paid attention to by informing participants about their rights in advance. The data collection took place from March – April 2020. The questionnaire was answered by 12 out of 20 participants (60% response rate). 5 of them were technicians (product managers) and 7 of them were commercials (sales managers).

## **4 Findings and Discussion**

### ***4.1 Knowledge sharing in the sales channel***

Firstly, distributors' overall satisfaction with the collaboration with the case organisation has been examined. The calculated average of 0.325 demonstrates that the distributors are slightly satisfied, however when splitting the commercials and the technicians into two separate groups, the commercials are less satisfied (0.14) than the technicians (0.20). In order to be able to differentiate the knowledge sharing with the distributors, nine factors were evaluated: availability of contact persons for product-related support, reliability of statements given, language (mother-tongue, English), personal perception of manufacturer, onboarding programs, trainings on the product, transparency of processes, and provision of case studies.

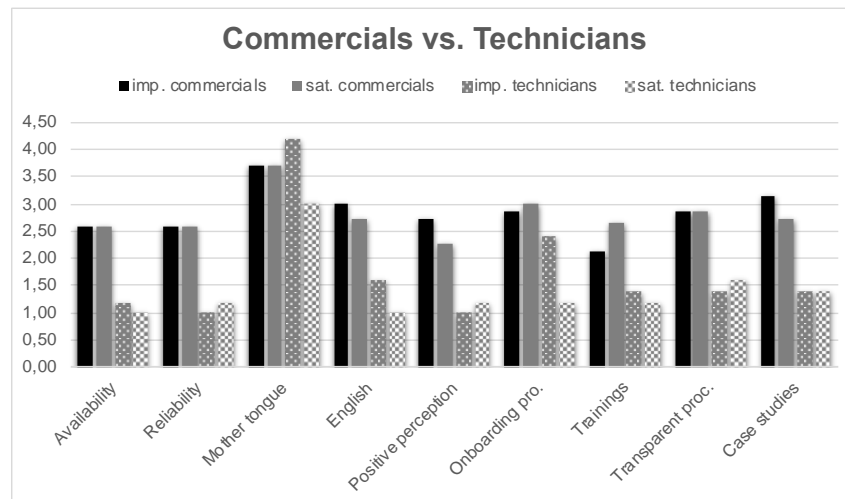


Figure 2: Importance vs satisfaction of knowledge transfer factors

Splitting up the participants into the two departmental groups, differences were visible (figure 2). While the commercials rated the average importance with Ø2.80 (slightly important), the technicians evaluated it with Ø1.70 (moderately important). In relation to this, the commercials were less satisfied (Ø2.8) than the technicians (Ø1.40). Especially noticeable were the specific differences e.g. when it comes to English as the spoken language, the trainings on the product and the provision of case studies. According to Paulin and Suneson (2012), knowledge sharing is knowledge exchange between and among individuals. Therefore, the language manufacturer and distributor talk in to one another plays an important role. The findings show that speaking the mother tongue of each distributor is rather unimportant (Ø3.92), which makes English the more important basis for a mutual language (Ø2.42). Case studies could be seen as a form of business narrative and therefore be related to storytelling, since stories turn information into meaningful units and expound tacit knowledge (Leblanc, Leblanc and Hogg (2006), Whyte and Classen, 2012).

Apart from the fact that explicit knowledge also has to be provided, the current academic debate does not explicitly mention which kind of knowledge should be provided in a manufacturer-distributor relationship. However, the authors assumed that the following four aspects would be helpful for a working relationship: specific product-related information material (data sheet, drawing, manual CAD, etc.), prices (list prices, graduated prices, discounts, etc.), logistics (availability of articles, delivery dates, etc.) and general technological information



material (working principles/glossary). The overall satisfaction concerning the four explicit knowledge categories was evaluated as following (figure 3).

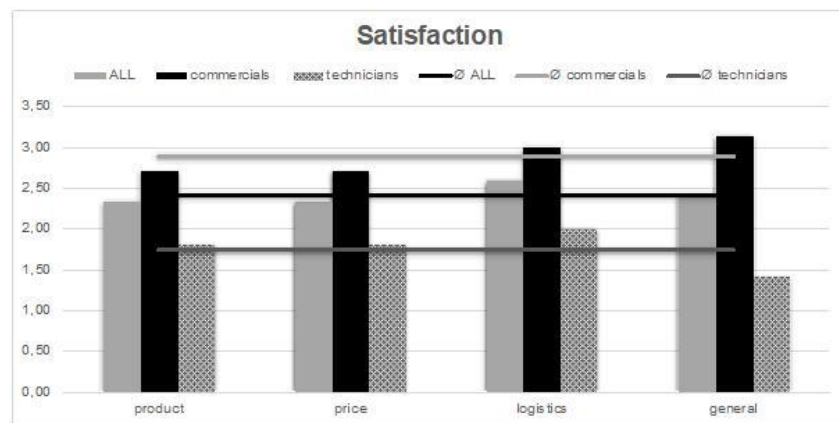


Figure 3: Explicit knowledge categories

Giving each participant the possibility to choose as many options as they like the following ranking has emerged: 1. specific product-related information material and prices (both at 100%), 2. logistics (75%), and 3. general technological information (50%).

#### 4.2 Knowledge sharing in manufacturer-distributor relationships

This section aimed at finding out where the knowledge shared is rooted in and how satisfying each means was. Company-related knowledge of relevance for the distributors was provided through the following media: Advertising campaigns, online catalogue, printed catalogue, homepage, emails, phone, social media, joined customer visits and trainings on the product. These media are predominantly enabling to transfer explicit knowledge, that can be easily codified and/ or verbalised (Nonaka and Toyama, 2003; Holste and Fields, 2010).

In general, these media were seen as moderately important (Ø2.40) and also moderately satisfying (Ø2.20). The most important knowledge bases, herein, were the trainings on the product and congruently the satisfaction rate was also the best. Nonaka and Toyama, (2003, p. 4) explains this as the means of "shared direct experience". Albeit, joined customer visits and trainings on the product perfectly allow for transferring tacit knowledge its universal application possibilities are limited in times of pandemics when personal contacts are prohibited. Video-

conferencing tools and virtual trainings, however, could substitute the personal contact during live trainings. Nevertheless, both knowledge media represent parts of the knowledge creation process based on Nonaka and Toyama's SECI-model (Kahrens and Früauff, 2018) whenever tacit knowledge is amplified by sharing it with the distributors.

When considering the commercials' group, they define trainings on the product, joined customer visits and information via telephone as the three most important factors. This correlates also with their satisfaction ranking. The overall ranking by the technicians is better because the most important information bases for them are firstly the homepage, followed by the catalogue and thirdly the trainings on the product.

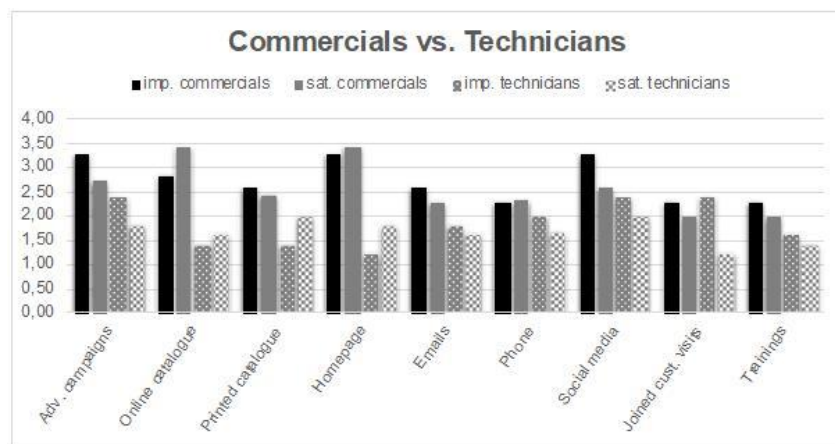


Figure 4: Importance vs satisfaction of knowledge bases

Information technology is only a tool (Wong and Aspinwall, 2005), but it works also as a facilitator for knowledge management (Wong, 2005) and generates several sub-tools, such as wikis and clouds that ease knowledge sharing. The participants were asked which knowledge sharing tools they already use e.g. in other (inter-)national collaborations. While none of the participants worked with platforms and shared workspaces, they predominantly used clouds (83.33%), succeeded by mailing lists (58.33%), instant messaging services and video calling applications (50.00%). Nabelsi, Gagnon and Brochot (2017) reveal that the use of wikis facilitates collaboration. This study further demonstrates that wikis are not as common among channel collaborations as the use of e.g. clouds. While commercials already use clouds for (inter-)national collaborations, followed by

video calling applications, mailing lists and instant messaging services, technicians, instead, used mailing lists and instant messaging services besides cloud services (figure 5). In order to communicate, most participants tend to use instant messenger services (Ø83.33%), 70% of those using WhatsApp, which could again underline Dyer and Nobeoka's (2000) statement of speed and ease with which knowledge sharing network members can communicate and share their knowledge. This may furthermore lead to the fact that in times of crisis, staying in contact via instant messenger services is helpful in keeping the closeness between manufacturer and distributor.

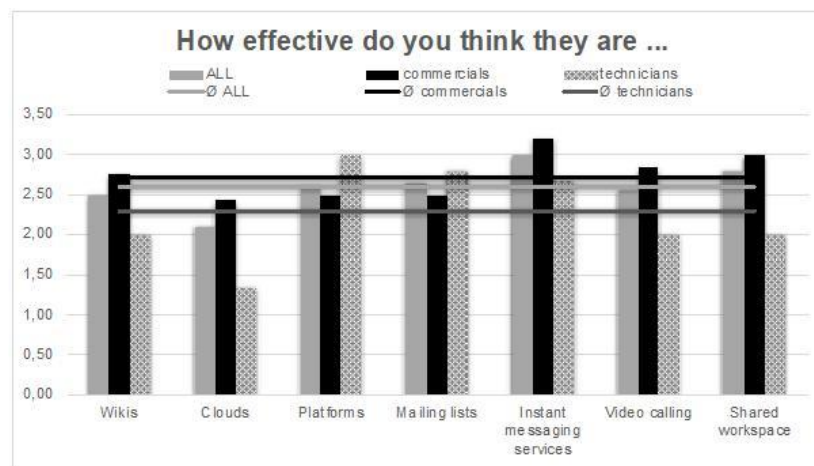


Figure 5: Perceived effectiveness of knowledge sharing network technology

To evaluate whether knowledge sharing can improve B2B communication and therefore potentially increase sales, it was necessary to find out whether due to a lack of knowledge customers could be lost. All participants agreed on factors such as lack of availability of the contact person or reliability of the statements. This was followed by the personal perception of the manufacturing firm. The least probable aspect to lose a potential customer, was seen in the fact that organisation's contact person does not communicate in the distributor's mother tongue.

According to Holste and Fields (2010), Levy (2011) and Paulin and Suneson (2012) and the findings, the following downwards spiral could emerge: The lack of product trainings would imply the lack of knowledge sharing. This affects trust that must arise when collaborating and hinders the knowledge sharing process. Overall, the technicians saw more potential in losing customers due to the lack of

knowledge. This underlined that one of the participants has already lost potential customers due to fact that personnel was not available for questions, statements given were not reliable, and there were insufficient trainings on the products. As a result, the probability of occurrence to lose a potential customer due to the lack of knowledge is given.

## **5 Conclusion**

This research project explained how knowledge sharing should be implemented in medium-sized manufacturing companies to ensure adequate B2B communication among channel collaborations. Taking the findings, the overall collaboration with the case organisation was perceived as slightly satisfying, but the reason for this did not deal with knowledge sharing or anything that has to do with knowledge in a broader sense.

Knowledge sharing through case studies, transparent processes or the language were important factors, that at the same time were satisfying for the distributors. Explicit knowledge that should be transferred was specific product-related information material, and the prices of the products. Logistical aspects, such as delivery or production times were still (but less) important and general technological information material were not required.

Furthermore, the knowledge bases provided, showed that the one that is most important for the distributors, was the most satisfying at the same time (trainings on the product). Strikingly, the printed catalogue is more important and more satisfying than the online version of it. Summing up, the two ways of transferring tacit knowledge, i.e. joined customer visits and product trainings are useful methods to share knowledge among manufacturer and distributor.

Nearly all of the above-mentioned aspects were far better rated by the technicians than by the commercials. While it was slightly probable to the commercials to lose a customer due to the lack of knowledge, it was moderately probable to the technicians. The highest probability of losing a potential customer was seen in the lack of reliability and the unavailability of the contact person. This could have been put into a more complete picture on the knowledge types and knowledge sharing activities. Thus, this research touched upon several aspects that might have the potential of future research. An interesting topic would be to analyse the cultural aspects that influence international B2B in sales

channel collaborations. Further, it would be interesting to repeat the study after being in a pandemic for more than one year.

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## **Excubation Platforms: Enabler of Digital Entrepreneurship Support?**

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### **Abstract**

Research on entrepreneurial ecosystems has gained significant interest throughout the academic community in recent years. In this context, the role of digital transformation and particularly digital platforms for improving the communication and collaboration of various actors in such ecosystems is increasingly being discussed. In this paper, we conceptualize how excubation platforms (XPs) can support the interaction among the actors in entrepreneurial ecosystems contributing to 1) an improved matchmaking between entrepreneurs and entrepreneurship supporters, 2) a better coordination of the multitude of support programs available, 3) novel approaches for quality control enabled by one digital solution used by all actors and 4) a more structured exchange of competence and experience between the individual entrepreneurs. We illustrate these potentials by the case of the Norwegian entrepreneurial ecosystem, where a pilot for an XP is currently being developed.

**Keywords** – Entrepreneurial Ecosystem, Excubator, Incubator, Business Model, Entrepreneurship Support

**Paper type** – Academic Research Paper

## 1 Introduction

Digital Platforms (DPs) and Multi-Sided Platforms (MSPs) gained significant research interest in recent years (e.g. Abdelkafi et al., 2019; Hagiwara & Wright, 2015; Täuscher & Laudien, 2018). In the context of open innovation and entrepreneurship, they are evaluated as drivers of value creation or as specific components of business models (BMs) (e.g. Helfat & Raubitschek, 2018; Nambisan et al., 2018; Nambisan et al., 2019). Besides the increasing importance of such platforms in general, they received an additional boost during the COVID-19 pandemic (JHCRC, 2021; Zhu et al., 2020) due to the need to switch towards digital and online formats (see, for example, Dwivedi et al., 2020; Kuckertz et al., 2020).

However, while these potentials of DPs and MSPs as part of the outcome of entrepreneurial activities are increasingly being discussed (e.g. Cenamor et al., 2019; de Oliveira & Cortimiglia, 2017; Srinivasan & Venkatraman, 2018), we argue that their role as connectors between entrepreneurs and their supporters (coaches, incubators, etc.) in the entrepreneurial ecosystem has received insufficient attention so far. This is in line with Elia et al. (2020) arguing that more research is needed on the digital organization of entrepreneurial ecosystems' design and implementation. Especially in times of the current COVID-19 pandemic, where many entrepreneurship support programs based on physically coming together in incubator spaces are deprived of their working basis, the relevance of digital solutions is increasing (e.g. EBN, 2020; Giones et al., 2020; Lose, 2020). In this context, we are currently experiencing a shift from primarily physical incubators with accompanying digital programs to a holistic accompaniment of entrepreneurs that often runs digitally only and supports the entire entrepreneurial lifecycle. Such programs are often referred to as *excubators* (Carman, 2013; Deeb, 2014), an approach that has been in practice for about a decade but seems to not playing a role in the academic debate yet (see Scopus, 2021).

Consequently, this paper aims to provide a first conceptualization of excubation platforms (XPs) as a new infrastructure enabling entrepreneurial ecosystems, thereby exploring the question how an XPs can create value for the actors within these ecosystems. Therefore, we develop a model depicting the key components and actors of an XP based on the DP, MSP and entrepreneurial ecosystem literatures. We then illustrate how an XP could look like in practice by discussing its current and future role in the Norwegian entrepreneurship ecosystem. We thus contribute to the ongoing academic debate on entrepreneurial ecosystems by providing a conceptualization of how the XP as a novel digital platform solution can organize the support of entrepreneurs in a better and more comprehensive manner.

## **2 Background**

### **2.1 About Platforms**

When discussing platforms in the context of business or entrepreneurship, we typically refer to digital platforms (DPs) and Multi-Sided Platforms (MSPs). DPs can broadly be defined as “technical elements (of software and hardware) and associated organizational processes and standards”, while MSPs add the notion of “mediating different groups of users, such as buyers and sellers” (de Reuver et al., 2018, p. 127). Investigating what DPs and MSPs do, Parker et al. (2016) describe that they enable the interaction among third-party producers of complementary goods and services, thereby seeking to create value for all participants. The participants can be distinguished in several kinds of actors – typically platform owners and platform providers, complementors and consumers – together forming the platform ecosystem (Abdelkafi et al., 2019; de Reuver et al., 2018; Van Alstyne et al., 2016).

Van Alstyne et al. (2016) illustrate this using the example of the Android platform: Google (today Alphabet) is the owner of the platform, mobile devices running the Android system are the platform provider, third party app developers are the complementors, creating complementary, digital products for this platform and the users of the mobile devices are the consumers not only using the devices themselves, but also the apps offered via the platform. This underlines that these platforms create value for the involved actors, by enabling goods to be exchanged and by creating matches among different users.

In the entrepreneurial context, we see that DPs and MSPs are frequently discussed as an outcome. For instance, platforms are described as parts of new ventures' business models (de Oliveira & Cortimiglia, 2017; Hagiwara & Wright, 2015), as local enablers of entrepreneurial activity (Freire-Gibb & Lorentzen, 2011) or entrepreneurship itself is described as a platform for contributing to the solution of societal challenges (Markman et al., 2016). More generally, the role of digital transformation is discussed in the context of entrepreneurial ecosystems (Elia et al., 2020; Sussan & Acs, 2017), an aspect that is further elaborated in the following section of this paper.

However, despite the multitude of governmental programs using significant resources on the support of entrepreneurial activity (Dahle et al., 2020), few studies seem to investigate the use of platforms to organize such support. Here, the *excubator* could deliver a foundation for a particular kind of platforms addressing this challenge. Carman (2013) distinguishes *excubators* from accelerators and incubators stating that while these would "typically last for just three months of the year, the *excubator* is designed to support startups from the very beginning with ideation to the very end of what hopes to be a successful exit".

## **2.2 Entrepreneurial Ecosystems**

Entrepreneurial ecosystems gained substantial popularity during the last years. After its introduction by Isenberg (2010) and Feld (2012), the concept was widely adopted outside of academia, leading to "a situation where research is led by policy rather than policy being guided by rigorous academic research (Stam & Bosma, 2015; Stam & Spigel, 2018)" (Wurth et al., 2021, p. 1). This development is summarized in a recent, comprehensive literature study and research agenda by Wurth et al. (2021). They highlight that the concept of entrepreneurial ecosystems has the potential to synthesize a variety of research streams in the field and that future ecosystem research should specifically discuss how it could be an enabler of entrepreneurship.

The purpose of entrepreneurial ecosystems is to provide a fruitful environment to support the growth of start-ups (Spigel & Harrison, 2018). The key actors within the ecosystem include individual entrepreneurs as well as entrepreneurship supporters providing resources including trainings, networks, talented workers and financing. Further actors include academic institutions, financial institutions, existing firms and the government (Brown & Mason, 2017; Spigel & Harrison,

2018). According to Spigel and Harrison (2018), successful entrepreneurial ecosystems are characterized by engaged entrepreneurs who benefit from the resources in the ecosystem and who use opportunities to interact with other actors in the ecosystems. Hence, a well-functioning interplay of entrepreneurship supporters and entrepreneurs is crucial for the entrepreneurial ecosystem's success. In the last two decades, various highly specialized entrepreneurship supporter types have emerged to address the diversity of entrepreneurial needs, e.g., along the entrepreneurial life cycle, pre-seed, seed and growth phases (investors, incubators, accelerators).

Yet, due to the specialization of entrepreneurship supporters, there is a challenge for them to find the right entrepreneurs for the programs they offer. Additionally, entrepreneurs can struggle to find the right support program for their needs at a certain development stage of their initiatives. This indicates a need for better coordination of how actors within the entrepreneurial ecosystem communicate and find each other to cooperate. Digital entrepreneurial ecosystems can enable a more efficient connection of actors and activities within the ecosystem (Elia et al., 2020). This is linked to the idea of XPs, which represent a specific digital organization of an entrepreneurial ecosystem and thus can be a significant driver of entrepreneurship support. For instance, an XP could improve the interactions among the actors in an entrepreneurial ecosystem by providing an overarching platform to connect a variety of different support offerings, making it easier for entrepreneurs to find the right helpers for the stage they are in and making it easier for the entrepreneurship supporters to find the right entrepreneurs who would benefit most from the support they offer. The following section expands on these thoughts by providing a comprehensive conceptualization of XPs and their role within the entrepreneurial ecosystem.

### **3 Conceptualization of an Excubation Platform**

We define an XP as a digital and multi-sided platform that can be used by entrepreneurship supporters for offering comprehensive support programs to entrepreneurs throughout the whole lifecycle of entrepreneurial initiatives. To conceptualize the role of XPs within the entrepreneurial ecosystem, we use the concept of *entrepreneurial activity systems* (Amit & Zott, 2015; Zott & Amit, 2010). It describes the activity of entrepreneurs from a systems perspective distinguishing three main system elements: The *governance*, describing the actor

who carries out the activity, the *content*, describing what the activities involve and the *structure*, describing how one activity is interrelated with one or several others.

Regarding the *governance*, we can identify the essential roles of platform actors highlighted in section 2.1 for XPs in the entrepreneurial ecosystem. The institution governing the respective XP (e.g. a regional government) is the *platform owner*. Its task is to strategically plan how, where and for what purpose the XP is offered. The *platform provider* would typically be a consortium of technology providers selected to develop the XP. Their responsibility is the technical and methodical development and provision of the XP as well as the operational support of all processes that are handled via the platform. Entrepreneurship supporters (e.g. incubators, accelerators, etc.) are the *complementors* of the XP, offering concrete programs that help entrepreneurs in developing their initiatives, founding their businesses etc. Finally, the entrepreneurs are the *consumers*, participating in programs selected via the platform.

Regarding the *content* and *structure*, we can identify several activities for each actor in the system that are interrelated when going through an XP. This is set out in Figure 1.

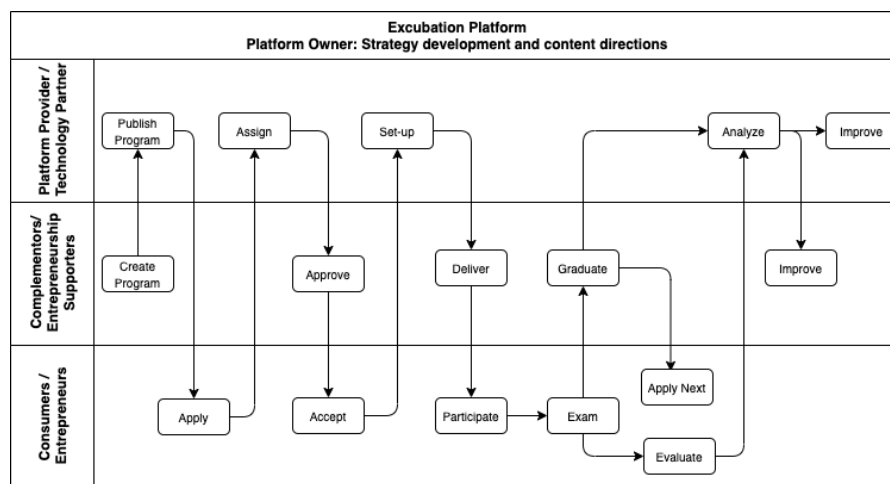


Figure 1: EPs in the Entrepreneurial Ecosystem

Here, all *complementors* design their support program before the *platform provider* (on behalf of the *platform owner*) quality assure and then publish the

program. The *consumers* then apply to a subset of the programs available on the platform before the *platform provider* assign the *consumer* to the most relevant program. The *complementors* and the *consumers* accept the match before the program is set up and delivered. Finally, the *consumers* finish the program with an exam, which is evaluated by the *complementors*. If the *consumers* graduate from one program, they can apply for the next level of programs. The evaluation of the program, together with the activities performed, is analyzed by the *platform provider* as a starting point for improvements to be made jointly with the *complementors*.

## **4 Illustrating the Excubation Platform – The case of Norway**

### **4.1 State of Play – Norway’s Entrepreneurial Ecosystem today**

National, regional, and local levels of the Norwegian government spend millions of Norwegian Kroner annually on a multitude of different government support programs for entrepreneurs (e.g. MTIF, 2016). In addition to this, commercial actors like consultancy firms, banks, investors, and co-working spaces provide entrepreneurial support, and academic institutions have their own offerings in the form of special courses, technology transfer offices and makerspaces. Together, all these programs provide funding, financial grants, incubation, mentoring, education and networking for entrepreneurs in all stages of their development.

Examples of complementors providing such programs would be *Innovation Norway*<sup>1</sup>, that provide funding for high-growth entrepreneurs, SIVA (Norwegian Association for Industrial Growth) that manages more than 150 incubators of various kind across Norway, The Norwegian Culture Council providing entrepreneurship support for Arts Entrepreneurs, 356 municipalities responsible for the initial support of start-ups and 10 regions coordinating the entrepreneurship support in their areas.

As highlighted in Section 2.2, entrepreneurial ecosystems can be defined as “a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory” (Stam & Spigel, 2018, p. 407). Consequently, we argue that the sum of all these support organizations and

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<sup>1</sup> The national innovation support organisation of Norway

the entrepreneurs using them jointly constitute the Norwegian Entrepreneurial Ecosystem (NEE).

#### **4.2 Observed Challenges regarding the Norwegian Entrepreneurial Ecosystem**

The NEE undeniably provides significant value to entrepreneurs, making Norway an attractive location for entrepreneurial venturing. Still, there is clear room for improvement, causing *Innovation Norway* to take the initiative for a further coordination of the different actors in the Ecosystem in 2021 (Innovation Norway, 2021). We identify four specific and practical areas of potential improvements for the NEE in the future:

- (1) It could be easier for the individual entrepreneurs to find the program most suited for them, depending on their vertical industry, life phase and special need – while the programs struggle to recruit the right entrepreneurs for their individual programs.
- (2) The programs could be better coordinated. This means that they would benefit from having better communication between each of them, and also that the business development methodology the different programs used could be more similar. This would enable a smoother transition of entrepreneurs between the programs, and a better division of tasks between different programs.
- (3) There is a need for a better effect measurement and quality control for the programs, enabling the allocation of resources to the programs benefiting entrepreneurs the most.
- (4) There could be a more structured exchange of competence and experience between the individual entrepreneurs, creating better entrepreneurial networks.

#### **4.3 Piloting the Excubation Platform Concept**

We argue that the XP conceptualized in section 3 of this paper constitutes a suitable tool to implement these improvements. The new role of *Innovation Norway* as a coordinator within the NEE suggests that they could act as the potential *platform owner*, developing a strategy for enabling entrepreneurship in Norway by means of an XP connecting the multitude of individual support



offerings (then *complementors*) in the ecosystem. A chosen consortium of technology providers could develop the platform, supporting *Innovation Norway* in the process. Finally, the Norwegian entrepreneurs would take the role of the platform's *customers* receiving a better-coordinated and more comprehensive support on their way through the individual phases of the entrepreneurial process.

In the context of its role as a coordinator in the NEE, *Innovation Norway* funded an initial pilot program to develop a platform supporting Norwegian entrepreneurs, taking the anticipated role of the *platform owner*. Therefore, a coordination of the programs from five different *complementors* is currently being set up. The platform provider for this particular pilot is *Entrepreneurdy AS*, a Norwegian methods and tech provider within the entrepreneurship space. In addition to the *complementors* offerings, the *platform provider* is setting up a residual program to create an offering for entrepreneurs not fitting into the other programs. Table 1 provides an overview of the support programs in this pilot.

Table 1: Entrepreneurship Support Programs in the Incubation Pilot

Complementor	Program	Description
Norwegian Culture Council	Ovasjon	30-week virtual program for Arts Entrepreneurs.
Norwegian Unemployment Agency	NAV	36-week virtual program that allows unemployed people to develop an entrepreneurial initiative while keeping their benefits.
The region of Møre & Romsdal	Hoppid	4-week hybrid program for startups, combining grants, mentoring and training
The region of Vestland	Driftig	4-week hybrid program for startups
The region of Nordland	Nordland	8-week hybrid program for startups
EIKA Bank Group	Lokal	12-week hybrid program for growth phase companies
Innovation Norway	Program # 13	Virtual incubation program utilizing only MOOC-based learning.

The services provided within this platform pilot include the 1) program marketing and recruitment for all six programs as well as an automatic assignment to one of the six platforms based on geography, life phase, vertical industry, and entitlement to support, 2) the application and an automated approval for the assigned program, 3) the program design and implementation

utilizing an Entrepreneurship Management System (EMS), 4) the program evaluation and analysis based on both the input in the EMS and the direct feedback from the consumers and the complementors and 5) in-cohort communication as well as in-program and in-ecosystem communication, enabling the consumers and the complementors to interact with each other and share experiences and knowledge.

#### 4.4 Indications for Value Creation from a Pre-Study

We are accompanying the design of the XP for the pilot program initiated by *Innovation Norway*, supporting this process from an academic perspective. In the current phase, we are aiming to identify suitable indicators for the entrepreneurs' level of engagement in the course of the support programs, to reason whether the XP can add value by addressing the challenges described in Section 4.2. Therefore, we measure the number of interactions for three programs that will be part of the complementors in the XP but have previously cooperated individually with a digital platform provider. Thus, there is data on entrepreneurs' engagement before the introduction of the XP. These three programs are *Ovasjon* (run by the Norwegian Culture Council), *Hoppid* (run by the region of Møre and Romsdal) and *Driftig* (run by the Region of Vestland). The number of cases, i.e. entrepreneurial initiatives supported and captured via the digital platform, is 317 from *Ovasjon*, 405 from *Hoppid*, and 92 from *Driftig*, adding up to 814 cases. The measured, average number of interactions per case is set out in Table 2.

Table 2: Entrepreneurs Interactions before the Pilot Platform

	<b>Ovasjon</b>	<b>Hoppid</b>	<b>Driftig</b>
Purpose	14	9	9
Resources	16	9	10
Business Idea	30	17	17
Business Model	41	18	19
Objectives	20	11	14
Tasks	20	12	13

As soon as the pilot program of *Innovation Norway* described in Section 4.3 has been running for a sufficient time, we plan to measure this number of interactions again. The hypothesis is that the increased quality control within the programs, the improved consumer-program match and the increased interaction among the

platform participants will drive up the average number of interactions within each of the three programs. This empirical study on the XP concept will be a part of our future research on the subject.

## 5 Conclusions and Future Research

This paper conceptualizes how excubation platforms (XPs) can support the interaction among the actors in entrepreneurial ecosystems contributing to 1) an improved matchmaking between entrepreneurs and entrepreneurship supporters, 2) a better coordination of the multitude of support programs available, 3) novel approaches for quality control enabled by one digital solution used by all actors and 4) a more structured exchange of competence and experience between the individual entrepreneurs.

On this basis, we derive three propositions: We propose that entrepreneurs as *consumers* of an XP will display a continuum of ability and willingness to engage with their ecosystem, which will affect their ability to benefit from the resources it provides. Moreover, we propose that entrepreneurship supporters contributing to an XP will be enabled to develop novel services, advance servitization and co-create with other *complementors* to develop new solutions. Finally, we propose that governmental bodies acting as *platform owners* of an XP will benefit from the opportunity to store data on the supported cases for quality control and continuous improvement and that they are enabled to create scalable systems with an improved coordination of the support process.

We contribute to the academic debate by framing the role of Digital Platforms (DPs) and Multi-Sided Platforms (MSPs) beyond the outcome of entrepreneurial activities as part of entrepreneurship support within the entrepreneurial ecosystem. We therefore transfer the excubation approach widely used in entrepreneurship practice to an academic foundation in a platform context by defining the XP concept. We discuss and illustrate the potential effects and procedures of implementation for such XPs in the context of the Norwegian entrepreneurial ecosystem, thereby providing a basis for further investigation of holistic and digital entrepreneurship support approaches.

For entrepreneurship practice, we highlight opportunities for entrepreneurship support beyond physical meetings and map their potentials and challenges. We show how entrepreneurial supporters can enhance the engagement of their customers (the entrepreneurs) using digital platforms and comprehensive

accompaniment throughout the entire entrepreneurial lifecycle by means of the XP concept.

As this paper is conceptual in nature, setting out the fundamental structures and potentials of XPs, future research should explore further use cases and seek empirical evidence for the potentials of value creation through these kinds of platforms in the entrepreneurial ecosystem. As set out in section 4.3, our own research will involve the empirical investigation of a respective initiative in Norway that is currently in an early stage of development.

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## The Role of Knowledge Complexity for Absorptive Capacity: Evidence from ICT Firms

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### Abstract

**Purpose** – This paper explores the moderation effect of knowledge complexity and social integration mechanisms on the relationships between the absorptive capacity (ACAP) components in southern Brazilian firms.

**Design/methodology/approach** –Our sample includes 174 ICT firms from ten clusters of technology-based firms located in Southern Brazil. Hypotheses were tested using structural equation modelling (PLS-SEM) supported by the software ADANCO 2.0.1.

**Originality/value** –We found that knowledge complexity matters for absorptive capacity. Depending on knowledge complexity, social integration mechanisms may be both: a blessing and a curse for absorptive capacity. Specifically, we found that in the paths from acquisition to assimilation, and from acquisition to transformation, high levels of social integration mechanisms help acquire complex knowledge, but they may constraint the absorption of simple knowledge. Our findings contribute to the KBV of the firm by improving our understanding of the role of knowledge complexity as an antecedent of absorptive capacity' components.

**Practical implications** – By identifying the role of knowledge complexity on the efficiency of both social integration mechanisms and ACAP, this study brings valuable information to

managers of both Brazilian firms and foreign organisations willing to establish their operations in Brazil, for the efficient allocation of firm resources for improving the firm innovative performance.

**Keywords** – Knowledge Complexity, Absorptive Capacity, Social Integration Mechanisms, Brazil, ICT.

**Paper type** – Academic Research Paper

## 1 Introduction

For the knowledge-based view (KBV), firm competitiveness is a function of how firms integrate the specialised knowledge that workers possess into the final products (Grant, 1996). In the current scenario, much valuable knowledge to innovate may be located outside the physical boundaries of the firm (Asimakopoulous, Revilla & Slavova, 2020). For this reason, knowledge absorptive capacity – the ability to acquire, to assimilate, to transform and to apply external knowledge to create value – emerged as a critical organisational competence (Cohen & Levinthal, 1990; Zahra & George, 2002). The antecedents of knowledge absorptive capacity have been analysed by several studies from different research streams (Apriliyanti & Alon, 2017). One of the factors proposed as fundamental for the development of absorptive capacity is the social integration mechanisms (e.g. Zahra & George, 2002; Enkel, Groemminger, Heil, 2017; Von Briel, Schneider & Lowry, 2019), the routines and processes that stimulate social integration between group members (Von Briel, Schneider & Lowry, 2019). Nevertheless, both conceptual and empirical views on the relationship between social integration mechanisms and absorptive capacity are divergent. Some authors posit that social integration mechanisms affect only the transition from knowledge assimilation to transformation, and that this influence is always positive (Zahra & George, 2002), while other authors argue that social integration mechanisms affect all relationships between the components of absorptive capacity and this influence may be either positive or negative, depending on contextual factors (Todorova & Durisin, 2007). From the empirical side, the findings are contradictory as well. The moderation effects of social integration mechanisms on the transition from what Zahra & George (2002) called the potential absorptive capacity (acquisition and assimilation) to realised absorptive capacity (transformation and exploitation) have been found as positive (Leal-



Rodriguez, Roldán, Ariza-Montes & Leal-Millán, 2014), negative (Armstrong & Lengnick-Hall, 2013) or not significant at all (Gluch, Gustafsson & Thuvander, 2009). These differences may be explained by the complexity of the knowledge which is being acquired, assimilated, transformed and applied. Managing knowledge may be easier or harder, depending on the nature of the knowledge involved, which may be more or less complex (Kim & Anand, 2018).

Knowledge complexity has been theorised as an antecedent of absorptive capacity (Vega-Jurado, Gutiérrez-Gracia, & Fernández-De-Lucio, 2008), or as a moderator of the effect of social integration mechanisms on absorptive capacity (Todorova & Durisin, 2007). Drawing on the 'weak ties' theory (Hansen, 1999), Todorova & Durisin (2007) stated that the complexity of knowledge will affect the efficiency of social integration mechanisms for enhancing absorptive capacity components, and ultimately, innovation performance. For Todorova & Durisin (2007), when knowledge complexity is high, strong social integration mechanisms are more efficient for enhancing absorptive capacity. On the other hand, when the knowledge is simple, weak social integration mechanisms are better to absorb this knowledge. Despite this, the effects of knowledge complexity, and its joint effects together with social integration mechanisms, on absorptive capacity have not been properly explored. Wang and Han (2011) analysed absorptive capacity as a moderator between properties of knowledge —tacitness, ambiguity, and complexity— and innovation performance. Other studies explored knowledge complexity and absorptive capacity as antecedents of uniformity (Minguella-Rata, Rodríguez-Benavides & López-Sánchez, 2012). Thus, to the best of our knowledge the joint effect of knowledge complexity and social integration mechanisms—two antecedents of absorptive capacity — remains unexplored. In this context, some questions emerge: How may the complexity of knowledge affect absorptive capacity' components? How may the complexity of knowledge affect the intensity and efficiency of other absorptive capacity antecedents, such as social integration mechanisms? What is the joint effect of knowledge complexity and social integration mechanisms on absorptive capacity' components? In line with studies of Dittlo (2004) and Winkelbach and Walter (2015), for addressing these research questions, the present authors chose firms from a knowledge-intensive sector such as ICT, because this sector has firms that are used to managing knowledge with a broader range of complexity.

## **2 Social integration Mechanisms and Absorptive Capacity**

The term “social integration mechanisms” have been used to describe a variety of such initiatives that contribute to building connectedness, socialisation and shared meanings among employees of an organisation, and thus influence various knowledge processes (Zahra & George, 2002; Armstrong & Lengenick-Hall, 2013). For instance, these mechanisms contribute to building channels for both distributing information and gathering interpretations across the organisation, and by doing so, they improve knowledge-processing capabilities (Armstrong & Lengenick-Hall, 2013). Social integration mechanisms overcome the challenges related to the information exchange within an organisation (Zahra and George, 2002), and they aim to facilitate the externalisation of tacit knowledge (Nonaka, 1994). They promote the efficient circulation of information flows within the firm (Fosfuri & Tribó, 2008), and they make interunit knowledge transfer more intensive by building up interpersonal networks (Peltokorpi, 2017).

Previous research broadly agrees that social integration mechanisms are important for absorptive capacity (Zahra & George, 2002; Todorova & Durisin, 2007; Spithoven et al., 2010). Some scholars have theorised that these mechanisms may affect the relationships between the different components of absorptive capacity, but they disagree on whether this moderating effect is positive or negative, and whether it holds for all relationships between absorptive capacity components, or just for some of them. For instance, scholars like Zahra & George (2002) or Easterby-Smith, Graça, Antonacopoulou & Ferdinand (2008), posit that social integration mechanisms moderates the transition from assimilation to transformation, and that this moderation effect is always positive. On the other hand, Todorova & Durisin (2007) state that social integration mechanisms moderates all the relationships between the different components of absorptive capacity, and that these moderations may be positive or negative depending on specific circumstances.

From the empirical side, the results are still very limited and inconclusive. Most studies have focused on analysing the moderation effect of social integration mechanisms on what Zahra & George (2002) called the transition from potential to realized absorptive capacity (assimilation to transformation), but with different results: while Leal-Rodriguez, Roldán, Ariza-Montes & Leal-Millán (2014) found that social integration mechanisms moderate positively the transition from potential to realised absorptive capacity, Armstrong & Lengenick-Hall (2013) found

this moderation to be negative, and Gluch et al. (2009) found no significant effects at all. Following Todorova & Durisin (2007) we posit that these contradictory results regarding the role of social integration mechanisms for absorptive capacity may be explained by including knowledge complexity in our equation. Besides, in line with several scholars (Todorova & Durisin, 2007; Patterson & Ambrosini, 2015; Björkman et al., 2007) we posit that social integration mechanisms may moderate all relationships between the components of absorptive capacity, and not just some of them.

### **3 The role of knowledge complexity for Absorptive Capacity**

Complex knowledge is a source of competitive advantage because it is difficult to imitate, and its management inside the organisation is challenging (Kim & Anand, 2018; Vuori et al., 2019). Li, Shi, Li & Wang (2015) stated that complex knowledge uses to be tacit, highly specialised and is difficult to formalize. In this line, Hansen (1999) posited that complex knowledge is usually uncoded, and it possesses a high number of elements and interdependencies among these elements (Simon, 1962). These attributes of knowledge complexity are related to the individual specialised knowledge used for performing a specific task, and ultimately, it differs from what Louadi (2008) called 'knowledge heterogeneity', a term related to the extent to which the old and new knowledge existing in the individuals and organisational units is different.

Since absorptive capacity promotes organisational innovations (Cohen & Levinthal, 1990; Zahra & George, 2002), and knowledge complexity has been linked to radical innovations (Pérez-Luño, Medina, Lavado, & Rodríguez, 2011), it is important to understand the relationship between knowledge complexity and absorptive capacity. We posit that knowledge complexity may affect the effect of social integration mechanisms on the different components of absorptive capacity in several ways. First, tasks that need a higher level of cognitive processing tend to need greater time for recovering from interruptions (Golden & Gajendran, 2019), and social interactions may be a source of interruptions for people performing individual tasks. Besides, knowledge complexity may affect some KM processes. For instance, some scholars stated that complex knowledge is more difficult to codify, and ultimately, to share (Hansen, 1999; Li et al., 2015). Thus, other studies have proposed that when the knowledge is more complex, information flows and information processing may become more biased (Kim &

Anand, 2018) and this may cause difficulties for efficient knowledge sharing (Heiman & Nickerson, 2004; Li et al., 2015). When the knowledge is complex, the efficiency of knowledge application depends on the level of cross-functional integration (Pérez-Luño, Bojica, & Golapakrishnan, 2019), which may be provided by social integration mechanisms. Knowledge complexity may also affect the reuse of knowledge, by hampering the needed level of interaction between the author and the user for developing a shared perspective (Boh, 2008).

Based on Hansen (1999), Todorova & Durisin (2007) proposed that knowledge complexity may affect the efficiency of social integration mechanisms for enhancing absorptive capacity components, and ultimately, firm outcomes. Hansen (1999) posit that when knowledge is simple, weak ties tend to be more efficient for enhancing information flows during search processes, by minimising the existence of redundant knowledge, and ultimately, by reducing search costs. Social integration mechanisms make the ties among employees stronger. Thus, Todorova & Durisin (2007) stated that when the knowledge is simple, weak social integration mechanisms are better to absorb this knowledge. On the Other hand, when knowledge complexity is high, strong social integration mechanisms are more efficient for enhancing absorptive capacity. Then, Todorova & Durisin (2007) stated that the moderation effect of social integration mechanisms on the relationships between the different components of absorptive capacity may be positive or negative depending on knowledge complexity. This proposition of Todorova and Durisin (2007) has not properly discussed yet. Thus, to the best of our knowledge the joint effect of knowledge complexity and social integration mechanisms—two antecedents of absorptive capacity — remains unexplored. Based on the propositions of Todorova & Durisin (2007), we posit that the more complex is the knowledge the firm is acquiring, the higher level of social integration mechanisms is required for enhancing the transition from acquisition to assimilation of knowledge. On the other hand, when the knowledge is simple, weak ties are better for the efficiency of the transition from acquisition to assimilation. In other words:

*H1. The moderation effect of social integration mechanisms (SIM) and knowledge complexity (KC), on the relationship between acquisition and assimilation of knowledge, is positive.*

Similarly, we developed these hypotheses for analysing how social integration mechanisms and knowledge complexity moderate the other paths inside absorptive capacity:

*H2. The moderation effect of social integration mechanisms (SIM) and knowledge complexity (KC), on the relationship between acquisition and transformation of knowledge, is positive.*

*H3. The moderation effect of social integration mechanisms (SIM) and knowledge complexity (KC), on the relationship between assimilation and exploitation of knowledge, is positive.*

*H4. The moderation effect of social integration mechanisms (SIM) and knowledge complexity (KC), on the relationship between transformation and exploitation of knowledge, is positive.*

## **4 Methodology**

### **4.1 Sample**

To address these research questions, this study used a sample that comprises 174 technology-based firms located in the three states of Southern Brazil: Paraná, Santa Catarina and Rio Grande do Sul. The three states hold innovation ecosystems that are leaders in Brazil, and together, these states possess and together they have 46 technological parks and 73 incubators (Conceição Neto et al., 2018; INNOVA.RS, 2019; ACATE, 2020). After sending invitations to these groups, ten technological clusters from the three states participated in our study. They are the Santa Catarina Technology Association, Deatec Chapecó, Polo Inovale, Tecnoparque – Hotmilk of the Catholic University of Paraná, Itaupú Technology Park, Maringá Technology Incubator, Pato Branco Technological Park, Biopark of Toledo, Tecnovates, Feevale TechPark and Technological Park of the Catholic University of Rio Grande do Sul. A total of 708 firms belong to these clusters. Data was collected between December 2019 and February 2020, by mailing the companies' CEOs. As a result of collection efforts, we collected 174 usable responses, representing a response rate of 24.6%, which is superior to other studies in the Brazilian context (i.e. Dávila, Andreeva, Varvakis, 2019).

### **4.2 Measures**

We use an online survey that integrates scales of absorptive capacity, knowledge complexity and social innovation mechanisms. For measuring the four components of absorptive capacity –acquisition, assimilation, transformation and

exploitation–, we used the scale developed by Flatten, Engelen, Zahra & Brettel (2011), composed of 15 items and that was built considering different research streams and models for ACAP (Todorova & Durisin, 2007; Zahra & George, 2002). We measured Social integration mechanisms by using a scale developed by Distel (2019). The scale for measuring Knowledge complexity was based on Li et al. (2015).

The wording and structure of all scales were validated in a pre-test for assuring that they are adequate and easy to understand by Brazilian managers. All scales used in this study are presented in Table 1. All items used in the survey have a five-point Likert scale with values ranging from 1- strongly disagree to 5 - strongly agree.

### **4.3 Analysis**

For analysing the moderation effects of knowledge complexity and social integration mechanisms on each path of absorptive capacity, we used partial least squares structural equation modelling (PLS-SEM), supported by ADANCO software version 2.1.1. We chose PLS-SEM because it is best suited to relatively small datasets and it does not rely on the assumption of normality (Henseler et al., 2016). For modelling the moderation effects, we used the two-stage approach proposed by Henseler (2017). In the first stage, we estimated the model without the interaction, and we created an interaction term by extracting the construct scores. In the second stage, we estimated a new model that includes the interaction. We decided to test four models instead of just one model with the moderation effects of both knowledge complexity and social integration mechanisms on the four components of absorptive capacity, to avoid multicollinearity created by the use of the same component to test moderation effects along the 'absorptive capacity circuit'. For analysing the results, we followed the best practices suggested by Ringle, Sarstedt, and Straub (2012).

## **5 Results**

Before analysing the measurement model and structural model, we applied some remedies for avoiding common method bias.

We used some procedural remedies suggested by Podsakoff et al. (2012). The online survey was managed and performed by the associations to which firms belong. By doing this, we provided to respondents the same data collection

standards they use to deal with (e.g. ethics, privacy, communication style and channel), and we increased the probability of honest answers. We chose respondents that were familiar with innovation and business management issues. On the statistical side, we compared the answers of early and late respondents for testing nonresponse bias, by using discriminant analysis (Armstrong & Overton, 1977) and no significant differences were found. Besides, we tested a model that included additional unmeasured latent factors to represent CMB, and as suggested by Liang, Saraf, Hu, & Xue (2007), we confirmed that the loadings on the unmeasured latent factor were lower than the loadings on the construct factors. In addition, we checked that variance inflation factors (VIF) for each construct factor in each latent variable were lower than 3.3 (Kock, 2015). These procedural and statistical procedures taken together decreased the risk of CMB being a serious concern in this research.

### 5.1 Measurement model.

We confirmed good reliability in latent constructs by calculating scores (above 0.65) as recommended by Nunnally & Bernstein (1994) for Cronbach's Alpha, composite reliability, and rho A tests. The AVE scores above 0.5 for all latent variables as suggested by Fornell & Larcker (1981), and the loadings of all indicators above 0.6 (Hair, Black, Babin, Anderson, & Tatham, 2006) evidenced an adequate convergent validity (see table 1).

Table 1. Scale items, scale reliability and validity

Indicators		Factor loadings	Dijkstra-Henseler's rho ( $\rho_A$ )	Jöreskog's rho ( $\rho_C$ )	Cronbach's alpha ( $\alpha$ )	AVE
<b>Acquisition</b>			0.782	0.854	0.771	0.596
AQ1	Our company seeks information through joint projects with companies and research institutions beyond your industry.	0.684				
AQ2	The search for relevant information concerning our industry is an everyday business in our company.	0.756				

AQ3	Our management motivates the employees to use information sources within our industry.	0.868				
AQ4	Our management expects that the employees deal with information beyond our industry.	0.769				
<b>Assimilation</b>			0.822	0.880	0.817	0.647
AS1	In our company ideas and concepts are communicated cross-departmental.	0.847				
AS2	Our management emphasizes cross-departmental support to solve problems.	0.829				
AS3	In our company there is a quick information flow, e.g., if a business unit obtains important information it communicates this information promptly to all other business units or departments.	0.809				
AS4	Our management demands periodical cross-departmental meetings to interchange new developments, problems, and achievements	0.728				
<b>Transformation</b>			0.904	0.933	0.904	0.777
TR1	Our employees have the ability to structure and use collected knowledge.	0.866				
TR2	Our employees are used to absorb new knowledge as well as to prepare it for further purposes and to make it available.	0.890				
TR3	Our employees successfully link existing knowledge with new insights.	0.884				
TR4	Our employees are able to apply new knowledge in their practical work.	0.886				
<b>Exploitation</b>			0.825	0.894	0.822	0.739
EX1	Our management supports the development of prototypes.	0.845				
EX2	Our company regularly reconsiders technologies and adapts them accordant to new knowledge.	0.898				



EX3	Our company has the ability to work more effective by adopting new technologies.	0.833				
<b>Social Integration Mechanisms</b>			0.868	0.899	0.859	0.643
SIM1	The activities of the different departments are tightly coordinated.	0.801				
SIM2	The activities of the production and marketing/sales units are tightly coordinated.	0.864				
SIM3	The activities of the R&D and marketing/sales units are tightly coordinated.	0.866				
SIM4	The activities of the R&D and production units are tightly coordinated.	0.796				
SIM5	Our firm maintains open communication channels in its operations.	0.665				
<b>Knowledge Complexity (KC)</b>			0.740	0.842	0.715	0.643
KC1	The company uses knowledge that is normally difficult to understand	0.833				
KC2	The knowledge used by the company is not obvious and often includes technical words.	0.885				
KC3	The knowledge used by the company has few examples of practical application.	0.671				

As suggested by Fornell & Larcker (1981), we assessed Discriminant validity by checking that the square root of AVE in each latent construct is higher than the correlation between the construct and the other ones (see table 2). Descriptive statistics show that firms in the sample tend to use medium levels of social integration mechanisms (mean of 3.54) and these firms use to deal with simple and complex knowledge (mean of 3.32). Besides, assimilation and exploitation are the most representative components of ACAP most frequently performed by the firms in our sample (means of 4.24 and 4.22).

Table 2. Descriptive statistics, correlations and Fornell-Larcker criterion

Construct		Mean	StD	AC	AS	TR	EX	SIM	KC
AC	Acquisition	4.08	0.67	0.60					
AS	Assimilation	4.24	0.63	0.30	0.65				
TR	Transformation	4.08	0.72	0.24	0.35	0.78			
EX	Exploitation	4.22	0.72	0.26	0.29	0.37	0.74		
SIM	Social Int. Mechanisms	3.54	0.78	0.12	0.17	0.17	0.11	0.64	
KC	Knowledge complexity	3.32	0.94	0.01	0.01	0.01	0.02	0.00	0.64
Squared correlations; AVE in the diagonal.									

### 5.2 Structural model.

To analyse the moderation effects of both knowledge complexity and social integration mechanisms acting together on each path between components of absorptive capacity, we tested four models. For each model, following the suggestions of Henseler et al. (2016), a bootstrapping procedure was performed (with 4999 bootstrap samples) to obtain and present confidence intervals about each construct and path in the model. Table 3 summarizes the results of the four models tested.

Table 3. Results of the path analysis

Paths	Coefficients $\beta$ (p-values in brackets)				
	Model 0 (no mod)	Model 1	Model 2	Model 3	Model 4
Acquisition → Assimilation	0.57 (0.00)	0.46 (0.00)	0.57 (0.00)	0.57 (0.00)	0.57 (0.00)
Acquisition → Transformation	0.50 (0.00)	0.50 (0.00)	0.35 (0.00)	0.50 (0.00)	0.50 (0.00)
Assimilation → Exploitation	0.29 (0.00)	0.29 (0.00)	0.29 (0.00)	0.27 (0.00)	0.28 (0.00)
Transformation → Exploitation	0.44 (0.00)	0.44 (0.00)	0.44 (0.00)	0.44 (0.00)	0.41 (0.00)
Acquisition x Social Integration Mechanisms (SIM) x Knowledge Complexity (KC) → Assimilation		0.18 (0.00)			
Acquisition x SIM x KC → Transformation			0.25 (0.00)		
Assimilation x SIM x KC →				0.05	

Exploitation				(0.53)	
Transformation x SIM x KC → Exploitation					0.07 (0.40)
<b>SRMR</b>	0.07	0.07	0.07	0.07	0.07
<b>Adjusted R-squared</b>					
Assimilation	0.32	0.33	0.32	0.32	0.32
Transformation	0.24	0.24	0.28	0.24	0.24
Exploitation	0.42	0.42	0.42	0.42	0.42

\*  $p$ -values are reported in brackets after  $\beta$  coefficients.

The results indicate that the paths from acquisition to assimilation, from acquisition to transformation, from assimilation to exploitation, and from transformation to exploitation were positive and significant, as Todorova and Durisin (2007) predicted. All models showed an estimated SRMR value of 0.07, which is acceptable according to Henseler et al. (2016). The adjusted- $R^2$  values for assimilation, transformation and exploitation vary between 0.24 and 0.42. This explanatory power is in line with previous studies that explore absorptive capacity, where explained variance varies from 0.18 to 0.81 (Saraf, Liang, Xue & Hu, 2013; Ali & Park, 2016; Aliasghar, Rose, & Chetty, 2019).

Model 0 is a baseline model that excludes any moderations. Model 1 aimed to test the joint moderation effect of knowledge complexity and social integration mechanisms on the relationship between acquisition and assimilation components, which was positive and significant ( $\beta = 0.18$ ,  $p = 0.00$ ). Then, hypothesis 1 was confirmed. Model 2 confirmed hypothesis 2, as it tested the joint moderation effect of knowledge complexity and social integration mechanisms on the relationship between acquisition and transformation. This moderation effect is positive and significant ( $\beta = 0.25$ ,  $p = 0.00$ ). Hypothesis 3, regarding the joint moderation effect of knowledge complexity and social integration mechanisms on the relationship between assimilation and exploitation components, tested in model 3, was not confirmed ( $\beta = 0.05$ ,  $p = 0.53$ ). Finally, model 4 tested the moderation effect of social integration mechanisms on the relationship between transformation and exploitation components (hypothesis 4), and this effect was not confirmed ( $\beta = 0.07$ ,  $p = 0.40$ ).

## 6 Conclusion

We found that knowledge complexity matters for absorptive capacity and depending on that complexity, social integration mechanisms may be both: a blessing and a curse for absorptive capacity. Specifically, we found that in the paths from acquisition to assimilation, and from acquisition to transformation, high levels of social integration mechanisms help acquire complex knowledge, but they may constraint the absorption of simple knowledge. Taking together, our findings help to explain why some firms are more efficient at leveraging innovation than others with the same levels of absorptive capacity, and the same use of social interaction mechanisms.

This study contributed to the KBV of the firm by improving our understanding of the role of knowledge complexity as an antecedent of the efficiency of absorptive capacity' components. Besides, our findings contributed to organisational learning literature by providing a better understanding of how we can improve both absorptive capacity' components and outcomes, taking into consideration the knowledge complexity that firms use to deal with.

On the practical side, we demonstrated that maximum levels of social integrations mechanisms are not always beneficial for organisations. Since simple and complex knowledge requires different levels of social integration mechanisms for being transformed into organisational innovations, we posit that managers in ICT firms should evaluate to deploy different organisational units for absorbing simple (for exploitation projects) and complex knowledge (for exploration of new opportunities).

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## Healthcare System in the Digital Era: the Telemedicine Contribution to Overcoming the Social Boundaries in an Uncertain Time

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### Abstract

The health system's role for the welfare of the community and the growth and development of nations is widely known, and Business Economics scholars have paid great attention to the study of the sector. This paper focuses on a particular aspect of health care and aims to analyse the intellectual capital (IC) in the healthcare system regarding telemedicine's contribution at Covid-19.

The healthcare sector is "knowledge-intensive". For this reason, the study of IC becomes central in Business Economics studies that are increasingly oriented towards enhancing the intangible resources used and created by organisations. Recent scholars have investigated the development of knowledge-based activities as a significant factor in adopting innovation in healthcare organisations and institutions. However, scholars have paid little attention to the contribution of telemedicine to the generation of IC.

This paper aims to bridge the gap focusing on a particular aspect of health care and analyse the IC in the healthcare system regarding telemedicine's contribution at Covid-19.

Notably, we focus on how digital transformation and the knowledge management system used by telemedicine could contribute to the intellectual capital in the healthcare sector. To comply with the paper aim, we use a qualitative research method based on a case study particularly suitable for IC in health care studies. More precisely, we analyse a non-profit organisation that for over 15 years has offered a free multi-specialist teleconsultation service to answer medical questions from the most disadvantaged places in the world.

The findings show that telemedicine can develop and share knowledge in disadvantaged areas of the world . The IC makes the new business model capable of contributing to the improvement of the health conditions of the entire population, including the most fragile. Thus this research provides an original contribution to the literature on IC at the time of Covid-19.

**Keywords** – Intellectual Capital, Telemedicine, Knowledge Management, Covid-19, Non-Profit Organisation

**Paper type** – Academic Research Paper

## 1 Introduction

The health system's role for the welfare of the community and the growth and development of nations is widely known (EC, 2009), and Business Economics scholars have paid great attention to the study of the sector. The healthcare sector is knowledge-intensive, and this creates value and growth for organisations.

In the past two decades, extensive literature has turned the interest to exploring intellectual capital in the healthcare industry (Habersam and Piber, 2003; Zigan et al., 2008; Evans et al., 2015; Cavicchi, 2017). Recent scholars have investigated the development of knowledge-based activities as a significant factor in adopting innovation in healthcare organisations and institutions (Huang et al., 2021). Knowledge-based capital (KBC) comprises a variety of non-tangible assets. These assets are "the largest form of business investments and a key contributor to growth in advanced economies" (OECD, 2013:24) because they create future benefits for businesses. Still, these assets often cannot be accounted for because not referable to substantiated rights or expenses.

Even as the elements of a knowledge-based capital might take many forms and significance (Borchet al., 1999; Hitt et al., 2000), are fundamentally distinct in how they accumulate and distribute knowledge—namely, through individuals (human capital), relational ties (relational capital), and organisational systems (structural capital).

Following the OECD definition (OECD, 2013), KBC could be classified into three distinct groups: (1) computerised information (e.g. software and databases); (2) innovative property (e.g. patents, copyrights, design, trademarks, research & development); and (3) economic competencies (brand equity, human capital such as worker training and management consulting) or networks and people and

institutions and organisational know-how that increases enterprises' efficiency (OECD, 2013; Corrado et al., 2005; Paoloni et al., 2020).

IC becomes a crucial tool, especially in the health care sector, which has "knowledge intensive" features, especially telemedicine.

Telemedicine is a care pattern for patients that uses technology for both healthcare communication and delivery. This care application has been around for decades, and it has had an extensive development because it is easy to use for the patient, like a call to own physician for advice and treatment.

Due to recent advancing technology (e.g. streaming, video and text messages), telemedicine has quickly and widely extended its scope and capabilities. These effects have expanded during the Covid-19 era because of the need to maintain social distance (Colbert et al., 2020). However, scholars have paid little attention to the contribution of telemedicine to the generation of IC (Kraus et al., 2021).

This paper aims to bridge the gap focusing on a particular aspect of health care and seeks to analyse the intellectual capital (IC) in the healthcare system with specific regard to telemedicine's contribution at the time of Covid-19 by answering the following research question:

*How digital transformation and the knowledge management system used by telemedicine contribute to the intellectual capital in the healthcare sector?*

To comply with the paper aim, we use a qualitative research method based on a case study (Yin, 2014) particularly suitable for studies on IC in health care (Paoloni et al., 2020). More precisely, we will analyse a non-profit organisation that for over 15 years has offered a free multi-specialist teleconsultation service to answer medical questions from the most disadvantaged places in the world.

The findings show that telemedicine can develop and share knowledge in disadvantaged areas of the world. The IC makes the new business model capable of contributing to the improvement of the health conditions of the entire population, including the most fragile. Thus this research provides an original contribution to the literature on IC at the time of Covid-19.

The remainder of the paper is organised as follows: Section 2 examines the relevant literature on the IC, focusing on its application to the telemedicine sector. Section 3 outlines the research methodology. Section 4 presents the findings and discussion from the pilot case study. Lastly, section 5 presents the conclusions of the paper and future research directions.

## 2 Literature review and theoretical framework

The healthcare sector is "knowledge-intensive". Thus, the study of IC becomes central in Business Economics studies that are increasingly oriented towards enhancing the intangible resources used and created by organisations. Recent works have highlighted the growing interest in IC in the health sector (Paoloni et al., 2020). Some authors investigate knowledge generation and sharing as a fundamental intangible resource in creating a competitive advantage (Baum et al., 2000; Dyer and Nobeoka, 2000) by reducing costs (Cegarra-Navarro and Cepeda Carrion, 2013).

Kamaluddin and Rahman (2009) focused on IC's components (relational capital (RC), organisational capital (OC), and human capital (HC)) as value creators (Cavicchi, 2017).

HC concerns the organisation's human aspect and is represented by blending human skills, qualifications, and expertise (Bontis, 1998; Bontis et al., 1999). In this vein, HC refers to the value of the knowledge and talent that is embodied in people who form the organisation, expressing intangible resources as know-how, capacities, knowledge, skill, competence, attitude, intellectual agility, creativity (Edvinsson and Malone, 1997; Kaplan and Norton, 1996; Marr and Schiuma, 2001; Hamzah et al., 2018).

Youndt et al. (2004) define OC as the knowledge, skills, experience and information institutionalised, codified, and used by patents, systems, databases, routines and processes and includes other not evaluable intangible assets (Edvinsson and Malone, 1997).

RC refers to the internal and external relationships of the organisations (Paoloni, 2021).

All three components of the IC take on interesting connotations in telemedicine.

In the current context, still strongly pervaded by the emergency generated by the pandemic, an essential role in the provision of health services can be played by telemedicine (Leite et al., 2021; Bahl et al., 2020; Haleem and Javaid, 2020). The term "telemedicine" identifies a sector of the communication technologies sector (Information and Communication Systems, ICT) applied in the context of carrying out health care activities. The term is used to describe the computer and telecommunication systems that allow people to work together in time and space

and refer generically to the use of information technology in medicine (Craig, 1999; Rajani and Perry, 1999, EC, 2009).

Alonso et al. (2019) show that telemedicine and e-health allow offering predictive, personalised, preventive and participatory medical services. Thus, telehealth provides various benefits for patients with different illnesses and is vital for improving medical services. Bartel et al. (2014) underline that telemedicine is supported by greater patient participation in diagnosis and medical procedures. In this vein, the inquiries on the value creation process need to concentrate on the capabilities of general practitioners or the performance of digital devices (Huang et al., 2021). Simultaneously, these investigations should extend attention to what is happening to the knowledge sharing process (Mura et al., 2012; Radaelli et al., 2014), including the active role of a patient, who seems to be more integrated into intellectual capital exploitation (Piri and Asefzadeh, 2006).

Telemedicine resumes three knowledge-based activities in the healthcare ecosystem. Human capital develops capabilities for each health stakeholder. Relational capital promotes innovation and improves the effectiveness of the medical service. Structural capital is formed by a digital servitisation strategy (Huang et al., 2021).

The characteristics of telemedicine make it an exciting sector for studies on IC under different profiles: i) knowledge management (human capital), ii) dissemination of knowledge through the use of innovative digital and communication technologies (organisational capital), iii) cooperative work as a network of medical expertise (relational capital). Added to these aspects is iv) the social value (social impact) created by telemedicine to reach populations in disadvantaged areas of the territory where there would be little or no possibility of treatment (territorial intangible).

Regarding the latter aspect, the OECD (1991) defines the impact as the set of positive and negative, intentional or unintentional variations produced directly or indirectly by a development intervention. Different tools and measures of the social performance of non-profit organisations have been introduced since the late 1990s to provide a more holistic and sophisticated assessment of the results achieved in terms of impact and change (Arvidson 2009; Gibbon and Dey, 2011). Some scholars have adopted a qualitative (Kaplan and Norton, 1992; Paton, 2003) and universalist perspective. The most debated questions have always concerned which instruments were best suited to measuring (Marr and Schiuma, 2003), given the impossibility of using the known Tayloristic (individualistic) tools for non-

profit organisations that rarely offered comparable measurements (Nicholls, 2009).

This study will lay the foundations for analysing all the aforementioned profiles to bring out the telemedicine business model's fundamental contribution to efficient and effective healthcare management.

### **3 Research methodology**

To achieve the research goal, we choose to use a qualitative research method based on a case study (Yin, 2014), particularly suitable for studies on IC in health care (Paoloni et al., 2020). More precisely, we will analyse a non-profit organisation that for over 15 years has offered a free multi-specialist teleconsultation service to answer medical questions from the most disadvantaged places in the world.

Our analyses are mainly based on interviews with the organisation's director and project managers and secondary sources (websites, specialist literature, newspapers, financial statements, databases).

For the analysis of relational capital, we apply the C.A.O.S. model (Paoloni, 2011; 2021), which is widely used in the national and international literature to comply various purposes linked to RC studies (Paoloni and Dumay, 2015; Paoloni et al., 2018; Dal Mas and Paoloni, 2019; Paoloni et al., 2020; Cosentino et al., 2021).

C.A.O.S. model is part of the Strategic Management studies. Notably, it fits the reflections on the sources of competitive advantage as a development of the Knowledge-based View (Nonaka and Takeuchi 1995; Hung *et al.*, 2014) that led to the Relational-based View (RBV) (Dyer and Singh, 1998; Lavie, 2006; Chung et al., 2019). RBV introduces the possession and dissemination of knowledge as well as the economic and social relationships between company and environment as value drivers, extending the boundaries of study on competitive advantage (Li et al., 2021).

This model analyses how the types and intensity of the relationships woven by small and medium-sized enterprises can be framed during a given phase of their life cycle through a relational matrix. In this study, we propose an original application of the model to non-profit organisations in which the contribution of relational capital is particularly significant (Kong and Farrell, 2010; Eng et al., 2020).

## 4 Results and Discussion

### 4.1. Knowledge management (Human Capital)

The activities are carried out by a group of computer technicians and volunteer doctors who offer their professionalism free of charge to colleagues located above all and in developing countries, particularly in sub-Saharan Africa. During the health emergency, various activities were carried out on the Italian territory too. As the director said:

*'We offer teleconsultations in various specialist branches such as cardiology, neurology, infectious diseases, neurology, haematology, radiology, internal medicine, paediatrics. To date, we have delivered 15,924 number of consultations'*

The contribution of the HC is evident since it is only services rendered by highly specialised personnel. Furthermore, in the case analysed, since the activities were provided free of charge, it was possible to detect a solid intangible contribution (Quarter et al., 2003; Mook et al., 2009; Cosentino, 2020). The volunteers make their time and energy available - all of a high professional level, in the case examined - to favour the achievement of social objectives.

*'Multidisciplinary medical teleconsultation service uses a pool of Italian and European specialists who provide their consultancy free of charge. Retired doctors are a great wealth'* (director)

The services rendered can be valued according to the replacement cost criterion for each function (UN, 2002) which provides for the determination of an adequate shadow wage, capable of expressing the remuneration corresponding to the service rendered by the voluntary worker. In principle, it would be appropriate to consider a salary equal to the average or median wage if there are significant deviations between the minimum and the maximum. The market recognises workers employed in the same activities in which the volunteers were engaged. This remuneration should then be corrected to consider the difference in productivity and skills, which may exist between paid and voluntary workers (Cnel and Istat, 2011).

The value attributable to voluntary work constitutes "notional income" that cannot be accounted for according to the techniques of accounting practice. This income allows covering 'ideally' the so-called figurative costs or the costs that the organisation would have incurred in the absence of the services provided free of charge by the volunteers. (Cosentino, 2020).

#### **4.2. Innovative digital and communication technologies (Organisational Capital)**

The instrumentation of each remote health centre is modular and can include sophisticated and innovative health equipment (e.g. electrocardiograph, oximeter, HD webcam, ophthalmoscope, X-ray scanner).

The organisation uses ad hoc software whose IT assistance and development can never connect the specialists. An Italian software house guarantees the assistance.

*'We operate through a web-based platform created by our partner, which has able to work even offline. This software capability is a relevant item for health centres with poor internet access'* (Director).

Each teleconsultation is "sorted" automatically to the doctors available based on different points: i) language, ii) urgency, iii) specialised branch required. The corresponding doctors are felt via SMS, e-mail or other alerting procedures, and they can consult the answer from software or online through any device, even smartphone.

The mechanism is simple. As described by the director:

*'The facility in Africa sends the clinical question through a dedicated platform to which instrumental tests such as an electrocardiogram, an electroencephalogram, other tests performed locally can be attached. According to the speciality, the volunteer doctors participating in the project respond by giving diagnostic suggestions, therapeutic indications, and other documents explaining how to treat the highlighted pathology'.*

To support the process, two remote units (Service Centre and Health Help Desk) supervise and, if necessary, intervene to ensure each teleconsultation's success and correct timing. The technical help desk assists each operator with any technical problems.

The association has created a technological platform that connects about 200 Italian and European specialists with hospitals and health centres in various developing countries.

In 2020, the non-profit organisation reached 12,000 teleconsultations, coming from thirty-nine centres in Africa, Peru and Brazil.



### 4.3. Network of medical expertise (Relational Capital)

For this part of the research, the analyses were conducted in the conceptual framework of the C.A.O.S. (Paoloni, 2011; 2021), which is part of the line of studies on relational capital (Dyer and Sigh, 1998; Lavie, 2006; Sulistyo, 2016; Fernandez-Olmos et al., 2020).

The model summarises some qualitative variables concerning four different elements (Table 1). We adapted the original model, considering its implementation to a non-profit organisation rather than a small/medium enterprise to which the model has been applied so far.

C.A.O.S. is an acronym and summarises the qualitative variables observed with respect to personal Characteristics (C) of the entrepreneur (founders in this study), territorial Ambience (A)<sup>1</sup> where the organisation investigated works, Organizational and managerial aspects (O). Lastly, a specific phase in the corporate life cycle investigated by the researcher (S). In the authentic model, the letter "S" corresponds to "start-up." In this research, we intend it as "sustainability", namely the organisation's capacity to survive in the dynamic context.

Table 1 - Description of the factors of the C.A.O.S. (Paoloni, 2011; 2021)

Acronym	Variables	Description
C	Personal element	→ Characteristics of the founders
A	Macro element	→ territorial operative Ambience (environment)
O	Micro element	→ Organisational aspects and management style
S	Time element	→ Sustainability (cycle life in which the organisation is analysed)

#### 4.3.1. Characteristics (C)

Ten years ago, the organisation was founded by a group of IT technicians and volunteer doctors to offer their professionalism free of charge and answer medical questions from the most disadvantaged places globally.

The association was born as a spin-off of the "Dream" project of the Community of Sant'Egidio to fight AIDS in Africa. Later, the telemedicine service was also installed in other health centres in developing countries. To date, the association can count on a network of about 200 specialists from different

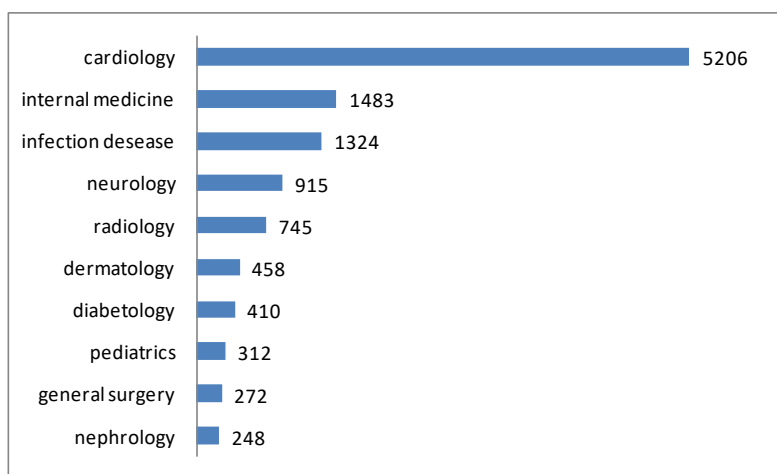
<sup>1</sup> The letter "A" of the acronym derives from the Italian "ambiente", which translated becomes "environment". In the research, we keep the authentic letter to stay faithful to the original model.

European structures connected, through an ad hoc technological platform, with hospitals and health centres in developing countries.

#### 4.3.2. Environment (A)

The activities turn to different categories of stakeholders. Firstly, to health cooperation programs located in disadvantaged places that desire to enrich their work with a specialist teleconsultation. Secondly, to specialist doctors who aim to become part of the network by making their experience available and actively contributing, free of charge, to health cooperation projects. Thirdly, to governmental and non-governmental rural hospitals, in countries or countries areas in particular poverty. Finally, to the biomedical device industry in the hope of introducing new devices to make peripheral workstations more economical, complete and competitive.

The survey on the ten most requested types of consultations shows a prevalence of teleconsultations in cardiology, followed by internal medicine (Figure 1).



*Figure 1 – First ten clinical categories required (all countries)*

*Source: Our elaboration on Association's data*

In Italy, the most numerous teleconsultations are internal medicine, followed by ambulatory and infection disease ones (Figure 2).

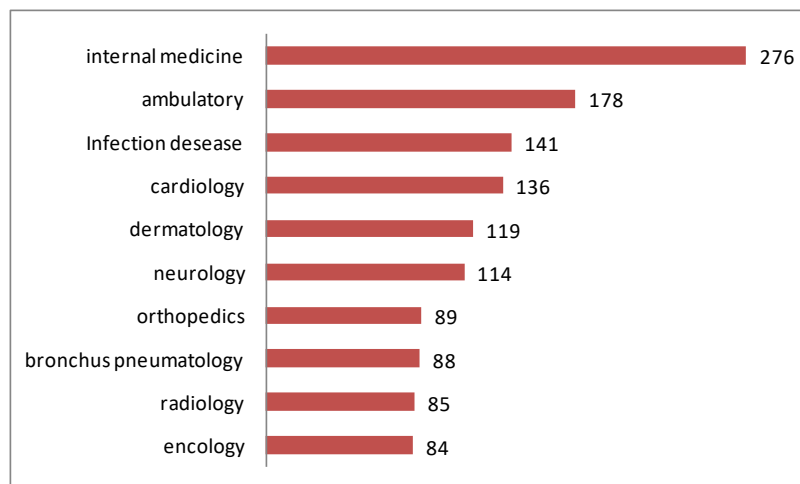


Figure 2 – First ten clinical categories required (Italy)  
Source: Our elaboration on Association's data

#### 4.3.3. Organisation (O)

The organisational structure is very complex.

Figure 3 summarises the organisation chart. Relationships are not hierarchical but collaborative.

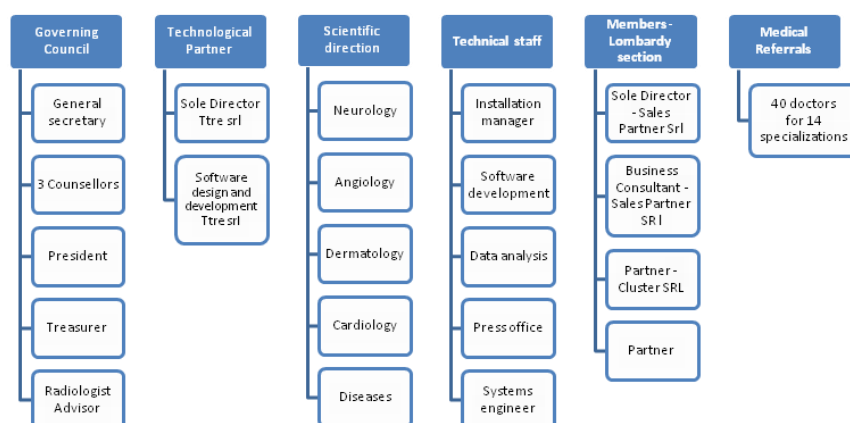


Figure 3 – Organisation chart  
Source – Our elaboration on Association's data

#### 4.3.4. Sustainability (S)

Since the beginning of the pandemic, the association with a traditional partner has activated a new telephone line for the most vulnerable people in Rome. In addition to providing social help, it also offered the possibility of a multi-specialist teleconsultation. These services are helpful for the people who, due to the Covid-19 emergency, struggle to turn to the traditional health system.

New telemedicine service is waiting to be launched in Southern Italy, in the Calabria region, to support fragile people in a depressed peninsula area.

We have analysed the association's activities in the last three years to highlight what effects the pandemic has produced on the volume of activities and the recipients of production.

In 2020, total activities decreased by 6.4% compared to the previous year, while for the current year, the consultations provided are just under half of those in 2019 (data referring to half year).

Focusing attention on Italy, where the association, doctors and partners are based, we notice that the contraction of activities abroad corresponded to a more than proportional increase in Italy, with a growth of 600% and 102 consultations in 2019 and 739 in 2020.

This is a consequence of pandemic. In the last year, in fact, many activities have been suspended, particularly training for doctors in disadvantaged areas of the planet. However, activities in Italy have increased due to the growing demand from patients who have had difficulty accessing traditional facilities, overcrowded by the pandemic.

The situation appears re-established in the current year, and the activities toward Italy are less than half of those carried out in 2019 (42).

Figure 4 shows the general data relating to the activities carried out in Italy (Rome), the Mediterranean, Africa, Peru, Brazil compared with those carried out in Italy. The data referring to 2021 are updated as of 30 June 2021.

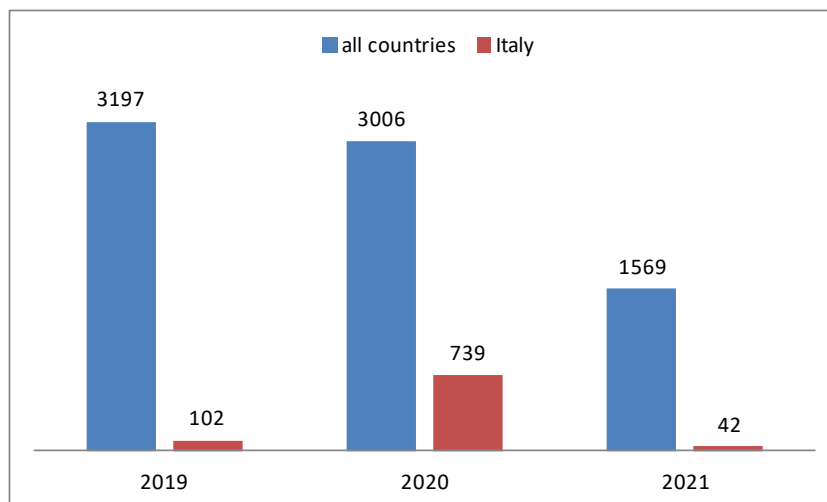


Figure 4 - Number of teleconsultations  
Source: Our elaboration on Association's data

#### 4.4. Social and economic impact

Table 2 summarises some results relating to the economic and social impact generated by the activities.

The analysis does not consider complex methodologies usually used for impact measurements such as SROI (SROI Network, 2012), SEIE (Zamagni et al., 2015) or others (Grieco et al., 2015) that require ad hoc in-depth analysis.

To offer a first representation of the impact, we used some data from the interviews with the association's director and the website.

Table 2 - The impact generated by the activities

Social Impact	Economic Impact
23 medical specialties	150,000 Euros/year the platform cost
15,924 total teleconsultations since 2001	12,000 Euros the equipment cost for the implementation of a telemedicine centre
200 European volunteer specialists involved	
39 centres located in Italy (Rome), Mediterranean, Africa, Peru, Brazil	

## 5 Conclusions

This research has shown how telemedicine represents a successful new business model even in times of crisis.

The organisational model makes it possible to i) offer cutting-edge specialist assistance, ii) contain costs (Cegarra-Navarro and Cepeda Carrion, 2013), iii) reach disadvantaged areas of the planet easily, iv) strengthen the skills and autonomy of the most backward countries through a knowledge-sharing process (Mura et al. 2012; Radaelli et al., 2014), v) pushing the structures operating there to interact with those of the advanced countries (Corrado et al., 2005; Paoloni et al., 2020).

A well-structured organisation, such as the case study analysed, require: a) highly specialised and motivated human capital (Bontis, 1998; Bontis et al., 1999), b) orienting towards technological innovation (Youndt et al., 2004), c) strength by a vast network of formal and informal relationships both with other non-profit organisations and with institutions (Paoloni, 2011; 2021). Finally, it can generate value for the social stakeholder (Cavicchi, 2017).

The aforementioned characteristics formed the IC (Kamaluddin and Rahman, 2009; OECD, 2013; Huang et al., 2021) and make the new business model capable of contributing to the improvement of the health conditions of the entire population, including the most fragile (Huang et al., 2021). Thus, it becomes a new way of doing high-impact and low-cost cooperation. Thus, in the current context, still strongly pervaded by the emergency generated by the pandemic, an essential role in the provision of health services can be played by telemedicine (Leite et al., 2021; Bahl et al., 2020; Haleem and Javaid, 2020).

### **5.1. Originality, Value and Future step**

This research contributes to studies on IC in health care by focusing on the contribution of telemedicine to the creation of IC.

Notably, the present work underlines the telemedicine capacity to develop and share knowledge in disadvantaged areas of the world (Mura et al., 2012; Radaelli et al., 2014). Furthermore, in the current context, still strongly permeated by the health emergency generated by the pandemic, the importance of those forms of assistance and diagnosis is growing. On the one hand, in a crucial moment for humanity, they favour adequate health services. On the other hand, they allow professionals located in different territorial contexts to arrive at a more precise diagnosis and ensure a proper level of performance in areas not easily reachable.

Telemedicine is part of this, and its application has made it possible to manage complex processes at the time of Covid-19, overcoming all the constraints imposed by the restrictions on the movement of individuals and by the rules on social distancing put in place by governments to contain the spread of the virus.

Although the conclusions we have reached align with the prevailing literature, they require future investigations that include analysing other organisations, public and private, profit and non-profit, to compare results and impacts.

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## Industrial Symbiosis: Business Models Compared

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### Abstract

The main purpose of this work is to systematically reconstruct the context of industrial symbiosis initiatives with relation to the networks of actors, the roles they play, the factors that determined the initiative, the obstacles that hinder (or have hindered) their implementation, the expected and/or achieved benefits, and the development prospects through the presentation of an original database of 18 case studies.

**Keywords** – industrial symbiosis, sustainability, business models

**Paper type** – Academic Research Paper

### 1 Introduction

In the operational context, the term "industrial symbiosis" appears in the nineties and goes back to Christensen (1992), manager of the eco-industrial park of Kalundborg in Denmark who defines industrial symbiosis as "a cooperation between different industries by which the presence of each ... increases the

viability of the other(s), and by which the demands [of] society for resource savings and environmental protection are considered."; quickly, the concept spreads in the scientific literature with the seminal studies of Frosch e Gallopoulos (1989), Ehrenfeld e Gertler (1997), Lowe (1997) e Schwarz e Steininger (1997).

The concept of industrial symbiosis, based on the opportunities to use the flows of resources of any kind within networks of industrial actors, is therefore related to the problems posed by the exhaustion of resources, the management of waste and by-products and the pollution; as such, the principles of symbiosis play an important role in the transition towards sustainability, here assumed - in line with the widespread scientific perspective and the general perception of the concept (Barile and Saviano, 2018; Saviano et al., 2017) - such as the ability, in economic activities, to balance social, economic and environmental objectives at different levels: micro-level within individual companies; macro-level related to the business networks involved in the symbiotic initiative; meso level as the network of formal or informal contracts between the companies involved, within the market, between civil and social institutions; at the meta-level, considering the society or the territory as a complex interactive and holistic living system (Barile et al., 2016; Simone et al., 2018). The application of the principles of industrial symbiosis is therefore aimed at configuring industrial eco-systems intended as a community or network of companies and other organizations in a region who choose to interact by exchanging and making use of byproducts and/or energy in a way that reduces resource inputs, increases energy efficiency, and reduces the volume of waste products Lowe (1997).

Closely linked to the concept of industrial symbiosis are, but not limited to, its concretizations in industrial agglomerations (industrial parks) in which companies seek (and carry out) exchanges of residues of any kind, thus configuring eco-industrial parks to which literature and operational practice devote increasing attention (Caroli et al., 2015).

## **2 Literature review and paper positioning**

The laying of the discussion along with a series of dimensions - not always coinciding - is not new, it is found, among others, in Benedetti et al. (2017), in various contributions from the University of Linköping and Massard et al. (2014). However, contributions aimed at specifying these dimensions in the various types of initiatives are not found in the literature and/or in the main databases

available: apart from the uniqueness of the single eco-industrial park, each of them can be considered as part of a homogeneous category, using one or more of the taxonomies designed to classify drivers, barriers, expected or achieved benefits, to outline development prospects, etc. The issue of identifying similarities and differences in industrial symbiosis initiatives, in particular in their concretization in eco-industrial parks has produced in the literature a series of finalized classification proposals, through the definition of homogeneous classes of characteristics and of problems, to the identification of the methodologies (from the scientific point of view) and of the operational approaches (from the practical point of view) most suitable for interpreting their characteristics and functioning. One of the first taxonomies is due to Lowe (1997), who classifies eco-industrial parks into two types: co-located eco-industrial parks and virtual eco-industrial parks: the former are systems in which companies are located in the same site or the same region; virtual ones do not require the co-location of companies in the same region but are still based on the exchanges of by-products and waste between companies. In co-located parks, the proximity of companies simplifies exchanges and obtaining benefits, especially through the reduction of logistics, transport and storage costs; virtual ones produce, according to the author, significant environmental benefits precisely because the exchanges of waste, materials and energy, taking place in a wider territorial context, having a greater impact on the socio-economic-environmental milieu of the region. Subsequently, Chertow (2000) distinguishes five types of industrial symbiosis by proposing a taxonomy to which the literature still refers widely: through waste exchanges; within a company; between production units co-located in a defined eco-industrial park; between non co-located companies; between companies organized "virtually" in a wider region. Another classification is due to Boons et al. (2015) along with the three different characteristics of the process, residues, and place: the process-oriented industrial symbiosis refers to a network of companies that collaborate concerning a specific industrial process; residue-oriented symbiosis refers to a cooperative network around a flow of residues; place-oriented symbiosis refers to a cooperative network linked to a specific geographic location. In the Authors' work, the basis for subsequent classification proposals based on the characteristics of the network can be found, namely the size, heterogeneity and intensity of the links between the participating actors. Domenech et al. (2019) focus their attention on the aspects related to the birth of the symbiotic initiatives distinguishing: self-organized symbiotic activity,

which emerges as a result of direct interactions between industrial players; networks that are formed with the support of an intermediary who coordinates the activities of the participating companies; planned networks, which result from a plan or program of the central or local Authorities, generally for a specific industrial area, therefore of a top-down nature, aimed at configuring coordinated economic activity systems in terms of infrastructures, services and flows of any type between the actors. Zhang et al. (2016), noting that the various classifications existing in the literature were of the qualitative type, propose, based on a network analysis conducted on 8 case studies, classification of quantitative nature into three distinct types: with a modest degree of completeness, in which the links are few in number and there are nodes (participating companies) outside the network; a high degree of completeness in the form of "tenant" mutualism - in which there are few "dominant" firms and the other actors are in a situation of dependence from them; high degree of completeness in the form of "equality-oriented" mutualism, in which the participating companies are roughly equal in importance or there are many with dominant roles so that the relatively high number of leading companies leads to the development of relationships and roles of more homogeneous responsibilities. From the point of view of operational practice, the dimensions of the classification contained, albeit implicitly, in Massard et al. (2014) and the papers of the MAESTRI project: Massard et al. (2014) classify, in fact, the 302 industrial parks they surveyed in industrial, combined (industrial and residential), and strictly urban, referring to the term urban symbiosis as the possibility of using urban by-products (in particular waste) as alternatives in industrial processes: similar to industrial symbiosis, urban symbiosis is therefore based on synergistic opportunities between businesses and local communities. As part of the MAESTRI project "Energy and resource management systems for better efficiency in the process industries" of the Center for Industrial Sustainability of the University of Cambridge in the context of Horizon 2020 of the European Union, a classification based on the state of progress of the initiatives are introduced, as implemented, underdevelopment, planned, at the feasibility recognition stage. Following the dimension of the typology of the main actors involved (whether only firms participate in the initiative or if urban settlements are involved as well), it is possible to distinguish industrial, combined or exclusively urban parks. Concerning the level of completeness of the symbiotic initiatives, parks can instead be distinguished in parks that have already been fully exploited (implemented) or are only partially exploited (planned) or both. This

approach, in the case of firms involved in the initiative, provides a possible measure of their propensity to innovation and of their sensitivity to two of the cornerstones of sustainability (social and environmental sustainability) which are to be placed side by side with the third, consisting of the economic goals. Finally, concerning the characteristics of the decision-maker, it is possible to distinguish whether a park is centralized in a single large dominant subject (generally one of the companies that play a central role in the network), polarized between a few important companies, or even widespread in a sort of equal responsibility or management of the network. This work deals with this latter aspect through a network analysis of a sample of eco-industrial parks, which characteristics have been deduced on a quantitative basis constituted by the density of the network and the degree of centrality of the actors, taking into account the nature of the park (whether industrial, urban, or combined) and the role of either provider or user of the exchanged flows of the main actors.

### **3 Materials and methods**

The scientific literature, in particular the contributions pertaining, mainly, to the field of industrial ecology, is rich in case studies of existing eco-industrial parks, on the innovative initiatives taking place within them, on the planning after the identification of symbiotic opportunities between companies located more or less close to each other. Most of the existing databases and summary documents aimed at scientific speculation on the subject are based on case studies found in the literature, of which bibliographic references are promptly provided. This work also makes use of secondary sources consisting of the data and information contained in the main databases available, in the scientific literature based on the study of single or multiple cases integrated with what can be found on the parks' websites, press news, multimedia material of scientific and informative nature available on the main social networks. The case studies were selected drawing on the following sources:

- The database developed during the activities within the MAESTRI project "Energy and resource management systems for better efficiency in the process industries" carried out by the Center for Industrial Sustainability, University of Cambridge. The database, containing 46 case studies, consists of a narrative section organized along the dimensions "main challenge (triggering)", "main barriers",



"approach", "discovery process", "prerequisites (precondition)" and a section in which symbiotic enterprises and the type of resources exchanged are qualified (Benedetti et al., 2017).

- "The project of the Industrial and Urban Symbiosis Research Group of the Environmental Management and Technology Division at Linköping University" containing various case studies not all previously covered in the literature. The cases are organized according to "key players," "main resources exchanged", "enabling factors", "economic and environmental benefits", "key drivers and barriers", "possible future synergies".
- The database narratively exposed by Massard et al. (2014) in which, 168 eco-industrial parks where significant incentives for innovation can be found are examined. The cases are treated along the dimensions of "genesis", "objectives", "success factors", "development prospects".

The criteria for selecting the cases examined was essentially the evaluation of the abundance, relevance and accuracy of the available data. The selected cases included the eco-industrial park of Kalundborg in Denmark which, being one of the best known and most important examples of the application of the principles of industrial symbiosis, is the subject of continuous interest by scholars (Doménech & Davies, 2011; Ehrenfeld & Gertler, 1997; Jacobsen, 2006) and managers to appropriate the good practices therein. A sample of 18 case studies was obtained, preliminarily classified according to the level of completeness and type (Table 1):

Table 1: Selected case studies

<b>Identifier</b>	<b>Country</b>	<b>Completeness level</b>	<b>Type (according to Massard 2014)</b>
The eco-industrial park of Kalundborg, Denmark	Denmark	Implemented	combined
Symbiosis in the industrial park of Ulsan, South Korea	South Korea	Implemented	combined
Symbiotic exchanges in the Landskrona area, Sweden	Sweden	Partially Implemented	combined
Industrial symbiosis in the area of the municipality of Norrköping and the island of Händelö, Sweden	Sweden	Implemented	combined
The urban and industrial district of Liuzhou, China	China	Partially Implemented	combined

The industrial and urban symbiosis in the Kawasaki area, Japan	Japan	Implemented	combined
The production settlements of the Kymijoki River area in Kuusankoski (now Kouvola), Finland	Finland	Implemented	industrial
Production settlements in the Humber region, United Kingdom	United Kingdom	Partially Implemented	industrial
The Guitang Group in Guanxi Province, China	China	Implemented	industrial
Nanning Sugar Co. Ltd, China	China	Implemented	industrial
Industrial symbiosis and waste recovery in the Mysore area, India	India	Implemented	industrial
The chemical site of Bussi sul Tirino, Italy	Italy	Partially Implemented	industrial
Plastic Alfa, Caltagirone, Sicily, Italy	Italy	Implemented	industrial
"Green" project, Emilia Romagna, Italy	Italy	Planned	industrial
The British Sugar case in the UK	United Kingdom	Implemented	industrial
The productive settlements of Taranto, Italy	Italy	Partially Implemented	industrial*
Industrial settlements in the Chamusca area, Portugal	Portugal	Planned	industrial**
The aluminium industrial district in Gladstone, Australia	Australia	Partially Implemented	industrial***

\* urban participation planned for the reception of steam

\*\* urban participation planned for the delivery of waste

\*\*\* urban participation planned for the supply of lubricating oils

## 4 Discussion

### ***The production settlements of the Kymijoki River area in Kuusankoski (now Kouvola), Finland***

Founded in 1872 in Finland, the UPM Kymi paper mill has gone through alternating periods of high and low production and given the need to adapt to changing market conditions it has always adopted symbiotic approaches, such as Industrial Symbiosis. Symbiotic relationships in the district began more than a century ago when the paper mill started the production of chemical pulp to meet the growing demand for the product from the Russian market. On that occasion, a new chemical plant was installed that supplied chemicals for the production of paper and received waste energy from the mill. The main prerequisite for the

creation of symbiotic exchanges was the production of pulp and paper which led companies to adopt a 'symbiotic way of operating' in Finland and Sweden. Since the founding of the paper mill, waste has been used for the production of paper as rags, instead of wood, were often used as raw materials.

### ***Production settlements in the Humber region, United Kingdom***

The Humber region is one of the largest port complexes in the UK. The industrialization of the region began in the 1960s and the dominant industries are chemicals, oil and gas, food processing, furniture, iron, steel and other metals. The Humber Region Industrial Symbiosis Program started in 2000 and was the first regional program for IS in the United Kingdom. The Program was launched following an initiative by a large global oil and gas company that aimed to create a cogeneration plant in the region, involving neighbouring industrial companies from the planning stage.

In addition, the companies involved had to pay a certain percentage of the profits obtained from this cooperation for the creation of a coordinating body. The development of the project was initially hampered by the reluctance of local companies due to the lack of competence in this type of agreement and the limited participation of these companies as many of them were competing in the same market segment. Since 2003, HISP has been integrated into the NISP and encompasses the entire Yorkshire and Humber region. It currently works with hundreds of companies that use public funding.

### ***The Guitang Group in Guanxi Province, China***

The Guitang Group, located in the Guangxi Zhuang Autonomous Region, was founded by the state in 1956. The group that runs one of China's largest sugar refineries has exploited its by-products through internal symbiosis. The main objective that guided the implementation of the Industrial Symbiosis in the Guitang group district was to maintain its competitiveness despite the high prices of sugar cane imposed by the local government by using the by-products and reducing disposal costs to have more economic benefits and reduce pollution. In regards to the technological barrier, the company has implemented collaborative projects with local universities and its own Technology Center. The Guitang group has devised various processes for using its by-products as inputs.

### ***Nanning Sugar Co. Ltd, China***

In recent decades the company has directed its development strategy towards the realization and permanent integration of Industrial Symbiosis and has managed to create a large district led by a single industrial sector aimed at the production of sugar and at the same time diversified between producers of alcohol and fertilizers, agro-industries, cement factories, pulp and paper, wood and chemical companies. The pressing need to survive a competitive market was the main challenge that led to the implementation of the Industrial Symbiosis in the case of Nanning Sugar Co. Decided to implement diversification by reusing part of its waste materials they began to incorporate the Industrial Symbiosis in its development strategy by reorganizing the entire company structure. The main factors that allowed the implementation of the Industrial Symbiosis were the industrial policies that started to push towards sustainable development and the absence of problems associated with the negotiation between the affiliated companies since the company founded the majority of them.

### ***Industrial symbiosis and waste recovery in the Mysore area, India***

In Southern India, the cities of Nanjangud and Mysore are home to a large group of industrial companies and multinational companies that make up the Nanjangud Industrial Area, of which the main representatives are food and beverage producers, agri-food industries, chemical companies and producers of pulp and paper, concrete and wood-based products. To implement industrial symbiotic exchanges, a process based on interactions and negotiations between the participating companies has been initiated which has given rise to a completely self-organized symbiotic industrial system. In India, no regulation binds the management of waste, in particular dry non-hazardous waste, so companies autonomously organize exchanges of internal waste and, more rarely, with external companies.

### ***The chemical site of Bussi sul Tirino, Italy***

In this district, Industrial Symbiosis has never been implemented, only a first attempt to identify symbiotic opportunities and their feasibility is reported. The reason that led the local government in 2008 to finance this exploratory research project, managed by the University of Chieti «G. D'Annunzio », was the need to

revitalize the industrial area from an economic and social point of view. The main prerequisites for the launch of the Industrial Symbiosis implementation project were determined by the fact that in the region several plants are operating in complementary industries with good logistical connections and the companies of the chemical site of Bussi already shared some facilities and services.

In addition, companies in the sector were involved in the project. The commitment of local companies has also been strengthened by a regional regulation that defines the discipline of Ecologically Equipped Estates. The strong opposition of the local community deriving from a lack of knowledge on the theme of Industrial Symbiosis, strong resistance to change and previous bad management of hazardous waste in the chemical site of Bussi was immediately the main obstacle to the project.

#### ***Plastic Alfa, Caltagirone, Sicily, Italy***

As part of the "BIO4BIO" project, several new symbiotic exchanges in the Sicily region were identified and evaluated and various companies producing fruit juices, feed, biofuels, plastic products and agricultural industries that had an interest in industrial symbiosis were involved; they wanted to enter new markets and increase their competitiveness while preserving the surrounding environment. The main obstacle that the companies faced to exploit the waste from local agro-industries and create new symbiotic exchanges was the high effort required in terms of time and resources to develop, test and expand the new technologies needed for waste treatment.

#### ***"Green" project, Emilia Romagna, Italy***

Numerous companies took part in the project such as food industries, agricultural industries, fuel or electricity producers, producers of plastic products, chemical companies. Here, ENEA has, first of all, illustrated the scope and purpose of the project, as well as the data collection tool and in a second phase sent to all the participants in the focus group structured spreadsheets for the start of the data collection. Subsequently, the ENEA researchers conducted a matchmaking activity aimed at identifying potential exchanges.

### ***The British Sugar case in the UK***

British Sugar, one of the largest sugar producers in the UK, was acquired by AB Sugar in 1991. Continued benchmarking with other sugar producers around the world has also made it possible to find new symbiotic opportunities. The process of implementing symbiotic exchanges has been almost entirely led by British Sugar over the years as its management was very focused on business growth and development.

### ***The productive settlements of Taranto, Italy***

In Southern Italy, in Taranto, there is an industrial district centred on the Ilva steel mills which include oil refineries, power plants and construction and cement companies, but also small agricultural industries and a large brewery. The district was born in the 1960s following the national strategy for the industrial development of the South. Since the founding of the district, industrial symbiosis experiments have been launched by the Ilva plant and the cement factory to reduce costs and increase competitiveness. Starting from the recognition of the high risk of environmental crisis, various stakeholders have made efforts to support companies in preventing pollution and its consequences. The study was commissioned to the University of Bari and was an attempt to highlight the potential of Industrial Symbiosis for solving environmental problems. The process began with the collection of data regarding the environmental performance of the companies involved. Finally, the results were presented to the companies and a series of interviews made it possible to assess their willingness to collaborate on broader and easier Industrial Symbiosis projects.

### ***Industrial settlements in the Chamusca area, Portugal***

The Relvão Eco-Industrial Park in Portugal is a project launched in 2006 thanks to various stakeholders, including the Portuguese government, the municipal government of Chamusca, the Technical University of Lisbon, together with industrial companies and entrepreneurs. Currently, the Industrial Park includes pulp and paper companies, chemical companies, waste treatment plants and agricultural industries. When the Relvão EIP project started, the Chamusca region had already started a plan for the treatment and disposal of hazardous waste and some companies in the centre had already established some spontaneous

synergies. However, the project envisaged a remarkable sustainable development of the region and triggered all efforts for the implementation of Industrial Symbiosis. In just four years, more than twenty companies have joined the network for the waste management and recovery industry. The objectives of the Relvão EIP are to develop knowledge of the characteristics and quantities of waste materials among the companies in the region and thus to identify potential IS to be implemented.

### ***The aluminium industrial district in Gladstone, Australia***

Gladstone, Queensland, is a large geographic area and is one of the major mineral industrial clusters in Australia. The companies in the district have decided to implement spontaneous symbiotic exchanges to pursue economic, as well as environmental and social benefits. However, after the Center for Sustainable Resource Processing, a national initiative created with the participation of associations of mineral processing companies, research centres and the national government, began to explore new possibilities for achieving greater resource efficiency, new exchanges have been identified and implemented in the area. The CSRП initially carried out a detailed analysis of the flows of waste materials, energy and water and used the data obtained for the construction of a database, thus facilitating the identification and mapping of by-products. This has allowed not only the achievement of a spontaneity of the implementations of Industrial Symbiosis coordinated by the CSRП but also a greater awareness of industrial development and the issues related to the efficiency of the Gladstone area.

### ***The eco-industrial park of Kalundborg, Denmark***

The Kalundborg Industrial District Symbiosis Network is one of the best-known examples of a long-term collaboration between different industrial sectors resulting in mutual economic and environmental benefits. The symbiosis network of the Kalundborg industrial district in Denmark was born thanks to a series of interactions between local companies and was the strategy followed by the participating companies to ensure the survival and expansion of local businesses. The basis for the development of Industrial Symbiosis in the Kalundborg area was mutual trust between companies, open communication between employees, the relative geographical isolation of the companies, the pre-existence of common

infrastructures and the awareness of the consequent economic and environmental benefits, deriving from the synergies of the network. The Kalundborg Symbiosis Institute created in 1996 now comprises nine public and private companies in the Kalundborg area, including the world's largest industrial producers such as the insulin-producing 'Novo Nordisk' and the enzyme-producing 'Novozymes'.

### ***Symbiosis in the industrial park of Ulsan, South Korea***

Ulsan Industrial Park in South Korea is one of six parks involved in the project run by the Korea National Cleaner Production Center affiliated with the Korean Institute of Industrial Technology in collaboration with the Korean Ministry of Commerce, Industry and Energy since 2006. The project involves the Korea Industrial Complex Corporation, the Ulsan eco-industrial park centre in charge of promoting industrial symbiosis, the Ulsan city government and various research and development centres. Strengths for the development of Industrial Symbiosis are the support of the government in the promotion and coordination of the project, the positive attitude of the participating companies that contributed to the coordination of the industrial complex and the financial gain.

### ***Symbiotic exchanges in the Landskrona area, Sweden***

The Landskrona Industrial Symbiosis Project, launched in 2003 in the industrial city of Landskrona in southwestern Sweden, involved 21 companies of different sizes and from different industrial sectors and the Technical and Environmental Departments and the Trade and Industry Office of the Municipality by Landskrona. The project promoters aimed to establish and implement long-term symbiotic relationships between the companies involved through exchanges of materials, adequate human resources and knowledge to cut costs and increase competitiveness by improving image and impact. environmental.

### ***Industrial symbiosis in the area of the municipality of Norrköping and the island of Händelö, Sweden***

The 'twin cities' of Norrköping and Linköping and the entire Östergötland region in Sweden, in collaboration with the University of Linköping, promote the development of clean technologies and establish more collaborative networks



between businesses to implement industrial ecology schemes. In the municipality of Norrköping and Linköping, collaboration networks were created between different actors and organizations which led to the establishment of a well-established and well-developed industrial symbiosis. The main companies in the network come from the forestry industry, agro-industry and the electricity/gas generation sector. To guarantee a continuous supply of electricity and heat at competitive prices to companies, a thermal and power plant has been created on the island of Händelö, opposite the city of Norrköping, which has led, over the years, to the creation on the island of an industrial symbiotic district focused on the production of energy and fuels. Later, the process also included exchanges of waste raw materials for the production of new usable products. To date, the entire Östergötland region promotes the development of clean technologies and establishes collaborative networks between companies to implement industrial ecology schemes.

#### ***The urban and industrial district of Liuzhou, China***

In the Guangxi province of southern China lies Liuzhou, an industrial city home to a large industrial district, consisting mainly of heavy industries such as steel, automotive, cement, chemicals and power generation companies. In recent years, the national and local government has also involved companies and researchers to identify new potential exchanges to be implemented in the district. Since 2001, the Chinese government has launched several initiatives to encourage the implementation of the circular economy in cities. To overcome constraints, the construction of efficient energy structures has been proposed that channel funds and savings towards the construction of transport structures and the development of new technologies as well as awareness-raising activities, such as periodic newsletters and workshops. Material flow analysis was used to identify potential new trades and their profitability. Finally, new scenarios were described based on new potential symbiotic exchanges and their feasibility and profitability were assessed.

#### ***The industrial and urban symbiosis in the Kawasaki area, Japan***

The city of Kawasaki, located between Tokyo and Yokohama, is one of the most productive industrial areas in Japan, hosting 74 industrial plants that come mainly

from the steel, cement, chemical and paper sectors. The Kawasaki Eco-Town project, launched in 1997, promotes the effective use of commercial and industrial waste generated in the city and its recycling into raw materials that can be used by industries located in the city. Eco-Town's objectives were aimed at creating a resource recycling company and revitalizing the coastal area by reducing the impact of industrial activities on the environment. To overcome this barrier, the Japanese government has financed the creation of several waste recycling plants in the region, to allow the reuse of municipal and industrial waste in the area. The main factors that have enabled Eco-Town's success have been the political support and incentives provided by the national government and the presence of relatively large iron, steel and cement industries which have proved to be suitable consumers for a wide range of flows of different waste.

## 5 Conclusions

Concerning the systematic study of symbiotic initiatives, in particular of existing or developing eco-industrial parks, the need to define homogeneous categories was highlighted, to build theoretical reference frameworks adapted to each category that allows the governing bodies (Golinelli, 2000; Barile, 2009) to select the strategies more suitable for maintaining the conditions of equilibrium in compliance with the principles of autopoiesis and homeostasis to guarantee the survival of the systems (Barile et al., 2013). In this context, it was concluded that the traditional dimensions along which the classifications existing in the literature have been proposed must be accompanied by quantitative aspects of the density and centrality of the graphs that these parks represent.

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## The Sustainability and Flexibility of Work in Times of Emergency: the Case of PA

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### Abstract

The pandemic from Covid 19 brought changes in the PA and the actuality of the topic of smart working (SW) in PA has exploded since March 2020. In a very short time the use of digital has increased more than it has been attempted in many years.

The PA has reacted swiftly to ensure the provision of services to citizens and to respond to the needs generated by the pandemic, understanding the importance and the need for a profound renewal based on cultural change, digital transformation and the enhancement of women and men.

Of course we can not consider the SW an innovation or a new mode of work as the Law n. 191 of 1998 has been in force for more than 20 years.

The paper wants to reflect on the decisive role of human action within organizations and tries to answer research questions trying to understand the reasons that motivate employees of the PA to want to continue working in SW even after the pandemic and if this can be considered a new way of working.

All this is part of the introduction of an innovative mode of work organization, based on the use of flexibility, on the assessment by objectives, on the recognition of the needs of employees, all in the light of the need to reconcile work and personal time. Text of the abstract

**Keywords** – Smart Working, Sustainability, Knowledge Management, PA, Covid 19

**Paper type** – Practical Paper

## **1 Introduction**

The pandemic from Covid 19 brought radical changes in people's lives by restoring to the institutions that centrality that, not always, over the years had translated into innovation.

The actuality of the topic of smart working (SW) in PA has exploded since March 2020 with the emergency related to the Covid-19 pandemic.

Organizations during the health emergency experienced an artificial way of working.

In the short span of time of two to three months, the virus has managed to push digital adoption more than it has been attempted in many years.

For this reason, the PA is more than ever at the center of the digital change process that gives it the role of leader becoming the pillar on which to build the solidity of the country.

All this was seen at the time of the emergency when the PA reacted quickly, sometimes even without adequate preparation, in order to ensure the provision of services to citizens and respond to the needs generated by the pandemic.

The pandemic was an element of acceleration of the processes of technological and organizational transformation on which it had long been reflected.

The PA has been able to really understand the importance and the necessity of a deep renewal based on the digital transformation and on the valorization of women and men.

The PA has been promoter of the development and diffusion of the ICT for the application of a system of SW accompanied from a cultural change that has carried a great number of dependent to manifest the will to continue the activity in SW after the overcoming health emergency.

Of course we can not consider the SW an innovation or a new mode of work as the Law n. 191 of 1998 has been in force for more than 20 years.

This law provided for the possibility for Pas to use forms of distance work. For this reason it is possible to install the computer equipment and the necessary telephone and telematic connections and allow employees to work in a place other than the workplace, for the same remuneration.

The Ministry of Labour and Social Policy defines SW or Agile Work as a mode of execution of the employment relationship characterized by the absence of time or space constraints and a phased organization, cycles and objectives, established by mutual agreement between employee and employer.

With the Directive n. 3 of 2017 on agile work officially begins the season of "agile work" in the PA providing for the introduction of new and more agile measures to reconcile work and life times of its employees.

The stated aims refer to the introduction of the most innovative ways of work organization, based on the use of flexibility, on the assessment by objectives, on the recognition of the needs of employees, all in the light of the need to reconcile work and life.

At the base of the SW there is a cultural, organizational and process revolution passing to a culture oriented to the results to an evaluation linked to the actual performances.

The SW becomes a new management philosophy based on the return of flexibility and autonomy to people in the choice of spaces, times and tools to be used in the face of greater responsibility for the results to be achieved.

The context in which SW has developed and the new managerial trends have made it possible to interpret the theme of agile work from a perspective of complexity that takes into account the multiple dimensions at stake and the different cultural references with the aim of clarifying the basic aspects of this new organisational approach.

From the various studies it emerges that the implementation of the SW in PA undoubtedly leads to advantages for both the workers and the organization.

Since February 2020, due to the spread of the health emergency for COVID, a series of measures have been enacted to simplify access to the SW and disseminate the maximum use in PA.

The paper, aware of the decisive role of human action within organizations, starting from the latest results published by the National Observatory of Agile Work in PA established by the Decree of 4 November 2020, would like to answer the following research questions:

- What are the reasons why PA employees want to continue working in SW even after the pandemic?
- Can we consider SW a new way of working?

This theme is particularly relevant as the concepts of flexibility, autonomy, empowerment and results orientation summarize the philosophy behind the SW and can be productive of benefits not only within companies, but also in the public administration.

The increase in the quantity and quality of time due to the lack of home-work travel allows people in condition to experience new daily forms of resynchronization of work commitments with family and personal needs.

## **2 Literature review and Methodology**

In literature we find many definitions of SW each of which highlights different characteristics, peculiar to this new work culture.

Autonomy and collaboration in a working context are key themes of the SW and to be reached must be used in the correct way ICT and appropriate physical spaces.

The term SW describes a new, more open working environment that breaks the physical barriers of the office as we know it and this allows a workplace that allows you to maximize the leverage of dynamic creativity of employees and their emotional relationship to work (Osservatorio 2014).

In the literature, we find many definitions of SW each of which highlights different characteristics, peculiar to this new culture of work.

However, it is possible to grasp the similarities and cornerstones on which this new managerial thinking is based: collaboration, flexibility of working conditions, reconfiguration of spaces and innovation; without neglecting the cultural characteristics of the organization, the degree of autonomy in the choices and empowerment of the staff (Verbeke, Schulz, Greidanus, and Hambley, 2008; Nidumolu, Prahalad, and Rangaswami, 2009).

The evolution of organizational models and human capital management systems are strategic levers to focus on.

In this context, the growing attention to SW is inserted: an innovative approach to work organization that integrates and overcomes the concepts of telework and mobile work, questioning the traditional constraints (physical space, working hours and tools).

The Observatory on SW of the Politecnico di Milano in fact states that "SW implies the development of a new culture of work that does not involve carrying out activities in a traditional way with the addition of new technologies and with the support of redesigned offices.

It's about new ways of working using new tools, new processes, and new approaches to management and teamwork".

And we can still say that the transition to SW is much more than a project of technological innovation; because it involves questioning stereotypes relating to places, times and work tools.

SW sets itself up as a new organizational paradigm in which technologies play a key role in discovering, sharing, co-creating and distributing knowledge.

Technology allows remote working blurring geographical, cultural and functional boundaries in a complex and dynamic environment (Padroni, 2010).

ICT solutions make it easier for workers to share files, information, data and ideas (Chudoba et al., 2005). In this way, all employees can interact in real time flexibly and effectively in a SW environment.

Another important element is innovations in HR practices and in the organisational model.

One of the essential drivers to build and develop a SW model is represented by ICT (Mann, 2012), also essential to enable new ways of working, but that must be supported by a strong cultural change that must lead people to be active protagonists of this change, where ICT is the tool and not the end.

It is peaceful to assert that more and more often the SW is considered a instrument of business increase and this takes the start from the theory of the Resource-based view (RBV) that evidences the business resources like means in order to maintain and to increase the competitive advantage.

In the light of RBV resources are a set of tangible and intangible factors with which the organization interacts directly or indirectly in its processes.

For the RBV, intangible resources and human resources are the most critical and therefore the most difficult to imitate.

According to the RBV the competitive advantage is not consequence of investments aimed to discourage the competitors but from a greater efficiency and the possession of rare resources, a set of competences and activities to added value that resizes the role of the "organizational structure" on performance.

The SW can be a valuable tool available to the PA to increase the effectiveness and efficiency of employees even in particular situations such as the one we are experiencing.

The field survey, also taking into account institutional policy, responds mainly to the purpose of monitoring the propensity of the PA to implement innovative models of work organization oriented to technology, with sustainability objectives.



In particular, the paper, through the reading of the results of some qualitative research, carried out at national level will focus on the identification of the strengths and weaknesses found by employees in the implementation of the SW.

### **3 Results and Practical Implications**

The paper responds to research questions by investigating the perception that PA employees have of SW to understand whether it can be considered an alternative way of working or just a way to manage the emergency related to COVID because in some research (La PA oltre il Covid e Strategie individuali e organizzative in risposta all'emergenza) carried out by FPA in 2020 has shown that employees are in favour of continuing to work in SW even after the pandemic phase has been overcome.

The Research involved some Italian Public with the aim of bringing out the critical issues from employees in the implementation of the SW and the related actions to be taken for its correct implementation taking into account that the evolution of organizational models and management systems of human capital represent strategic levers.

This new way of working has suddenly involved a large number of workers, regardless of the characteristics of the work carried out and regardless of the companies in which they operate.

Among the peculiarities of SW we can highlight the strengths and weaknesses both for the company that adopts it, but also and above all, for the worker himself.

The strengths of the protagonists of the SW show greater flexibility for working hours, allowing to work in the home environment, increasing the time to spend with the cohabiting and the opportunity to carry out work activities at the same time as domestic and family care activities.

Another strong point highlighted is the time savings used in travel, critical element for those who face daily traffic; Workers say that they concentrate more in the home environment and that they also incur lower costs when it comes to moving or eating out of the home.

It is common ground that many workers restrict travel and this also has an impact on the environment.

Table 1 summarises the main strengths of the SW emerging from the research.

Table 1

<b>Strengths of the SW</b>
The flexibility of working time
The possibility of working from the home
The opportunity to carry out at the same time work activities and domestic and family care
Saving time on travel
The increased concentration capacity allowed by the domestic environment
Lower costs due to travel, meals away from home
The opportunity to spend time with cohabiting relatives while working

Turning to the points of weakness we highlight the reduction of sociality and relationship with their colleagues in the office.

Obviously, by working at a distance, they are unable to engage in direct dialogue with the other team members or with those responsible, and this could become a problem.

Other respondents argue that with SW, if on the one hand it brings workers at ease to work in the home, on the other, many have the feeling of being confined within the domestic environment with an impact on the psychological state.

In fact, having the feeling of never disconnecting could lead these individuals to psychologically distance themselves from their own work, due to the feeling of never quitting and never ending.

Other disadvantages are the loss of the division of the day into time for work and time for leisure; and the fragmentation of work and domestic and family care activities.

In addition to these disadvantages, a number of technological difficulties may also arise.

Table 2 shows the main weaknesses of the research findings.

Table 2.

<b>Weaknesses of the SW</b>
The loss of sociality with office colleagues
The feeling of being confined to the domestic environment
The loss of the subdivision of the day in time worked and free time
Fragmentation of work and domestic and family care
The slowdown of work activities without deadline

The difficulty of performing complex operations with one or more remote working groups
The complexities of distance dialogue with colleagues and managers
The difficulty to act in a remote technical environment, without any assistance support in presence

The widespread and sudden introduction of SW required organizational interventions.

The introduction of SW may be accompanied by the definition of more specialised organisational roles and units in which objectives are identified with more specific and measurable results; or a redesign that aims to make more autonomous and less interconnected between them, the different organisational units and the different roles that take place within the enterprise.

In many cases, these companies, in order to ensure and ensure that the SW is adopted and used effectively, have chosen to go and redefine in detail the coordination and planning mechanisms regarding the timing and mode of use; in addition, they have intervened on the methods used for the management of human resources, so as to enhance the work and the results obtained by smartworkers.

From the research of FPA "Strategie individuali e organizzative in risposta all'emergenza" carried out in 2020 involved 5,225 people of which 4,200 civil servants of which 92.3% are resorted to SW.

73.5% of these from home throughout working hours, 18.8% with some re-enters in the office or work suspensions with vacation days, recoveries or leave.

Those excluded from the SW were just 4.7% (2% for personal choice, 1.2% because in essential sectors or services, another 1.2% because he works in institutions that have not activated).

88% of the employees judged the experience of success and 61.1% believed that this new culture, based on flexibility and cooperation within institutions, between institutions and in relations with citizens and businesses, will prevail even after the end of the emergency phase.

93.6% would like to continue working in smart working even after the health emergency.

The research "La PA oltre il Covid" through a survey conducted in collaboration with the Istituto Piepoli in 2020 on a sample of 1000 people representative of the

Italian population and a second survey of over 2000 people who make up the Panelpa of the FPA community, compares the views of users and public employees on the role of the PA in the emergency and in the recovery sees the SW theme present in both investigations.

In the first second the majority of Italians, (53%), the SW is an opportunity for a more efficient and modern administration, a share well above 29% that considers it a risk for absenteeism and opportunistic behavior (13% considers it irrelevant).

In the second the SW was positive, but civil servants do not yet see a new orientation to results.

For 42.8% the practice of evaluation has not changed, for 44.6% there are still changes in this sense but signs of improvement, only 12.6% see a real change.

With distance work there is a greater need for a constant and effective sharing of objectives and strategies, but for the majority the internal communication is not improved but there are signs of change (40.6%) or there is no improvement and seems insufficient (36.1%).

If in June 2020, over 60% of respondents said that the SW would bring a positive change in the PA, now thinks it will take more time as there are still several technological and cultural limits that have limited the spread of SW in the PA.

Among them the lack of digitalisation, the perception that many activities in public bodies were not compatible with remote work, the complex bureaucratic procedures and the lack of awareness of the benefits obtainable (already listed above).

In trying to define and interpret the implications of SW it is good to analyze both the employee and the company actors.

From the point of view of the employee there is a decrease in stress, a better balance between private life and work, and a higher consideration of self and their daily work, managing the work at bestlife balance, making the most of the time available, reducing travel costs.

For the employer the greatest benefits arise from a greater attractiveness of their organization in the world of work and a greater efficiency linked to a decrease in costs.

Among the main strengths it is possible to summarize:

- rationalisation in the use of resources and increased productivity.

- promotion of the use of the most innovative digital technologies and use of smart working as a lever for digital transformation and the development of digital knowledge;
- the reduction of gender differences through a diversity management policy;
- the reduction of forms of “physiological absenteeism”.

In order to justify the affirmative answer to the question of search and to bring out the motivations of the dependent of the PA we refer to the Institute of Research on the Population and the Social Policies that has elaborated and described the results of the survey “Smart Working e questioni di genere negli enti di ricerca”.

The survey was carried out through an online questionnaire given to the workers of the main Italian research institutions, from April 2020 until June 2020; The questionnaire was completed by 2,721 employees of different Italian research institutions, including researchers, technologists, technical staff and administrative staff.

Among the respondents to the SW questionnaire, 45.20% are men while 54.80% are women and most workers have carried out SW activities throughout the period of the health emergency, and a small percentage, alternated SW to work at its place of work.

From the various answers it has emerged that in greater percentage the women regarding the men, have preferred to dedicate their free time to the home reorganization, to the experimentation in the kitchen, to the sport practiced to house etc.

Men, on the other hand, in higher percentages than women, preferred to read, participate in in-depth online courses, read, watch movies and TV series and the online shop.

More or less in the same percentages, both men and women have devoted themselves equally to the care of physical well-being and rest.

Table 3 lists the main activities of employees working in SW.

Table 3.

<b>Complementary activities carried out</b>
Follow in-depth online courses
Reading, music and cinema

Perform large house cleaning and tidy papers and documents
Experiment in the kitchen
Caring for personal well-being, both physical and spiritual
Assisting relatives and friends in need
Shop online
Reserve a higher dose of rest
Home sports

For these reasons most workers would be willing to continue working in SW even after the health emergency, because they feel that it can give much more benefits than disadvantages.

A small minority, on the other hand, want to go back to work at their workplace and sit at their desk, because there, they are more efficient than at home.

No one can give a precise answer to this question, but certainly a large number of workers, having been forced to use this method of work, have greatly revalued it and indeed, have also begun to appreciate it and to prefer it compared to classical work.

Other workers, however, perhaps those in a higher age group, will continue to prefer work in the office for personal comfort, because they do not know how to use a computer or because they do not feel safe to work with it.

Despite this, however, we can say that the COVID-19 emergency has allowed workers to discover a whole new world and a way to work, where there are no more schedules, and continuous supervision, a more "free" job; and surely this new way of working has won over many workers, especially the younger ones.

In conclusion, we can say that the SW, in this time of pandemic, cannot be considered a simple and immediate solution to the problems that have arisen before us since March 2020.

On the one hand, the SW makes it possible not to create gatherings in workplaces and to limit movements, on the other hand, workers find themselves catapulted into a whole new way of working where they no longer have certain limits of space and time.

For some all this is very favorable and can be much more productive, for other workers instead, the opposite case occurs and it is for this that investments are necessary on the organizational structure that is necessary to adopt.

For these reasons the SW can be considered a lever of change for the PA and its workers because it allows to go beyond compliance, favors collaboration, planning, management of results.

The SW thus becomes a new mode of work that goes beyond the emergency situation related to the pandemic and in this way it is interpreted the willingness of employees to continue to work in SW.

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## Scientific Collaboration Networks in Fiocruz

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### Abstract

This paper presents the profile of the professionals at the Oswaldo Cruz Foundation who work in scientific research, with the aim of understanding within a perspective of decolonization and understanding the central actors of collaborative research networks. The methodology used was through reinforce the theoretical framework and data extraction in platforms that compile data from researchers and technologists who conducted research at Fiocruz are working in Science and Technology. In the conclusion, this initial project allowed an approximation of understanding about the profile of Fiocruz research professionals and analyze data to mapping of both scientific collaborative networks, their central nodes, and links.

**Keywords** – Researches, Scientific collaboration networks, Knowledge Management.

**Paper type** – Practical Paper

### 1 Introduction

The 21st century is characterized, among many aspects, by the configuration of the network society, a global interdependence, which was facilitated by the development of information and communication technologies. This environment has allowed not only the creation of new forms of relationship between organizations, people and the world, but also the development and availability of new innovative products and services.



Given this scenario, the enormous, complex challenges of networking in the health sector, especially those of public health in the country's health research institutions such as the Oswaldo Cruz Foundation (Fiocruz), assume a strategic role in the establishment of more projects, integrators and collaborative arrangements, which allow monitoring and generating more efficient and coordinated actions.

It is widely known that research groups that work in an integrated and coordinated manner produce more effective results, achieve goals quickly and have greater visibility. In fact, the greater the size and diversity of teams, the greater these effects. Therefore, it is extremely important for an institution with dozens of units within a diverse administrative structure like Fiocruz to map out and characterize the profile of collaborative networks and the professionals that make them up, as well as obtain data to analyze what critical knowledge is being acquired, retained, shared and disseminated in order to facilitate the entire process of development and monitoring of research projects whose effective results are for society.

Fiocruz is one of the few institutions that brings together the main elements of the innovation chain (generation, conversion, and dissemination of ideas) from the laboratory bench to advanced, biomedical, and social research activities. In a way, everyone has some level of collaborative environment. However, there is a weakness that needs to be improved and solidified through the integration of institutional strategies in research, development, and innovation that promote an agenda of priorities enabling a generation of new technologies that address public health problems and, consequently, the country's economic development. Given this scenario, the first stage of this innovation project sought answers to the following guiding questions: What is the profile of researchers and technologists who conducted research at Fiocruz? How are Fiocruz's scientific collaboration networks composed?

This project aims to investigate Fiocruz's scientific collaboration networks, the profile of its actors, and its main areas. As an innovative management product, this project is intended to create, from this data, a virtual platform of the mapped networks. This allows for a better visualization of the Fiocruz community and provides a translation to society of the institution's scientific production, bringing more transparency to the work of its scientific collaboration networks. The main focus is to strengthen the group's competitive intelligence, and thus accelerate

the dissemination of results obtained in health research and increase the visibility of the group and the institution.

## **2 Scientific Collaborative Networks**

Information and knowledge management plays an important role among collaborative research networks; it can support Fiocruz's innovation policy and assist in the management of the Institution's research projects. Fiocruz already has some expressive collaborative environments, such as Virtual Campus, Observatory of Science, Technology and Innovation in Health, ARCA - Institutional Repository and Data Repository, Agora Platform, among others, but the Institution still does not know how its groups collaborate internally and externally. Thus, the online platform for viewing networks can help manage the Institution's policies and research, in addition to understanding the organizational knowledge and intelligence generated by these collaborative practices, in favor of more effective results in scientific activity.

According to Castells (1999), we are in a network society and, for Benkler (2006), we live in the networked information economy. This may mean that it is not just an economy based on information, knowledge and culture, but above all, it is a network of decentralized information and communication links.

To meet current demands, it is necessary to develop skills and competences that allow the conscious, creative, and beneficial use of information, data, and knowledge. In this sense, Vitorino and Piantola (2009) state that to be competent in information, it is necessary to know how to recognize when information is needed, and to locate, evaluate and, effectively use the information. Furthermore, it is essential for scientific development that information and knowledge are shared, communicated, and debated.

Some authors help with the theoretical support of the research, as their studies address such points of view about interactions in research and collaborative networks, among them: Katz (1997), Carr (2010), Lastres & Ferraz (1999), Barnes (1954), Kudashin (2004), Portugal (2011), Fialho (2018, 2020) and Barabási (2016). All of these authors direct us to critical thinking about the analysis of social networks. Finally, Latour (2017) supports us on the "actor-network" relationship.

For Portugal (2007), in the social sciences, network analysis has always been an interdisciplinary field par excellence. In the view of Guimarães (2014), there is a

space for fluxes and that trust relationships are maintained indirectly, in general, mediated by communication devices through which trust is built.

Finally, Wellman and Berkowitz (1991) are useful to complement some analyses. According to them, social structures act as networks--as sets of "nodes" and ties that represent the interconnections, the flow of relations, the transfers, and structural relations between the "nodes." Kudashin (2004) perceives the social network as a set of relationships that can be mapped.

### **3 Coloniality of Power**

The research project intends to investigate the profile of researchers who work in networks--and thus provoke a reflection on the importance of diversity in research groups--and assess the gender and race quantitative of researchers and technologists who work at the forefront of Science.

According to Leone (2017), the insertion of women in economic activity in Brazil began to intensify in the 1970s, in a period of economic expansion, at the height of an urbanization and industrialization process that configured a favorable period for the incorporation of new workers into the labor market.

Despite the evolution of female work over the years, and the changes in values related to the role of women in Brazilian society, it is essential to understand whether these changes happen in the environment of collaborative scientific networks, especially those sexual in nature as it is what defines the place of men and women in this context.

Considering the transformations of work went from a logic of reproduction and repetition to a logic of knowledge and innovation--especially with regard to collaborative scientific networks--the most important thing in a process of cooperative creation is the knowledge generated by these groups: immaterial work.

According to Foucault, the subject is born from the relationship of other subjects constituted by social practices of power and control. It is in this relationship of power and control, for the maintenance of capitalism, that the Eurocentric culture strengthens the erasure of other cultures, the kidnapping of ancestors, and the construction of inequalities in the dimensions of power, knowledge, and being.

Racism is a power system that is born from the racialized production of the other for the permanence of concentrated wealth. According to Fanon (2009),

colonial relations were naturalized and do not end with the end of colonialism. In this relationship, eugenics establishes relations of power and a state of domination as for someone to live it is necessary for someone else to die.

From the privilege of establishing states of domination, people are placed on the sidelines or excluded from hierarchical structures and, therefore, are not subject to the same rules and the same opportunities. Thus, in these static and hierarchical structures, we can observe these power relations and the hardships of racism that affect these relations.

#### **4 Metodology**

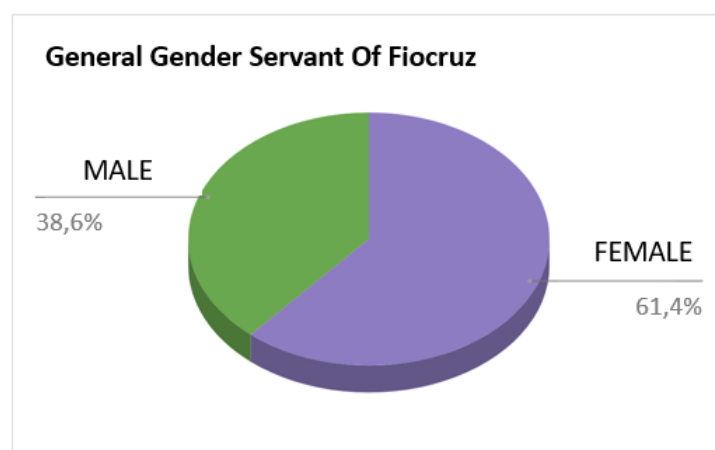
To achieve the proposed objectives, it was essential to analyze and identify the profile of actors (researchers and technologists) who work in scientific research at Fiocruz. This research was quantitative and qualitative, with data collection techniques such as data extraction in the General Administration System to identify researchers and technologists and their respective race/ethnicity and gender. After the first collection, data were extracted from the Lattes Platform of professionals in relation to their training (postgraduate).

In the next stage of the project, the academic production of professionals and their scientific collaboration--that is, the dynamics of collaborative work between scientists--will be extracted from the Lattes Platform, through a system called ScriptLattes. The selection of scientific and academic production will be from 2000 to 2020; and we will analyze how this academic production is related and whether the identified research networks help the institution to be strategic. The case study methodology helped to draw an overview of the researchers' profile so that we can later use the social network analysis methodology to facilitate the understanding of the relationships and links of the areas involved in the process.

#### **5 Results**

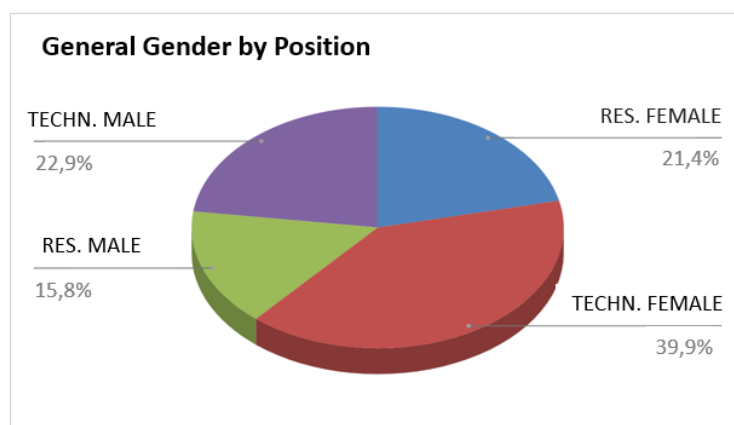
For the authors Li, Liao and Yen (2013), one way of accumulating cognitive capital is through the diversity of the collaboration team, because while there is interaction between professionals, the chance of applying new knowledge increases. It can also lead to the deepening and sharing of knowledge, and possibly an expansion of the network. It is in this sense that the first analyses were interested in understanding the profile of professionals who work in research at the institution, taking 2020 as the base year and understanding this diversity.

According to the graphs below, it can be seen that the Institution's scientific profile, regardless of position, is mostly female. Graph 1 shows that in a population of 2,428 researchers and technologists, in relation to gender, it is 61.4% female and 38.6% male.



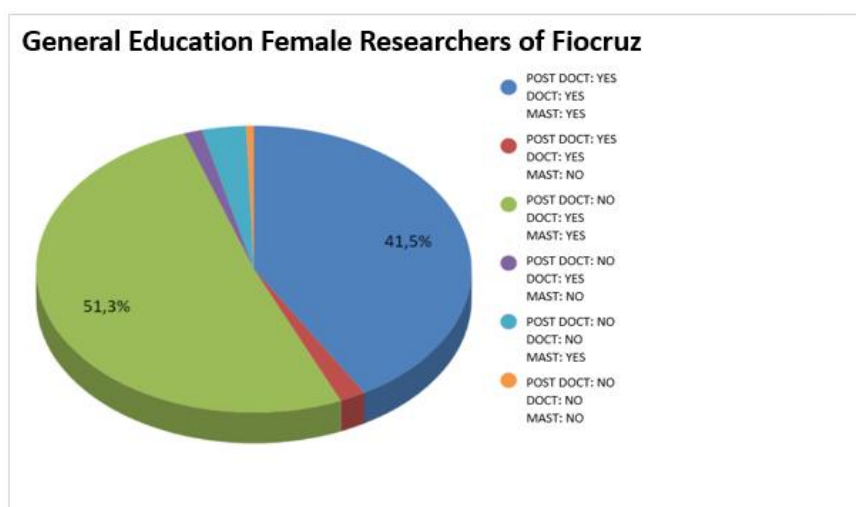
Graph 1: Gender x Servants, Fiocruz 2020.  
Source: Prepared by the authors (2021)

Graph 2 shows that the position of technologists and the female gender has the highest number of professionals, and this predominance of gender is also present in the position of researcher.

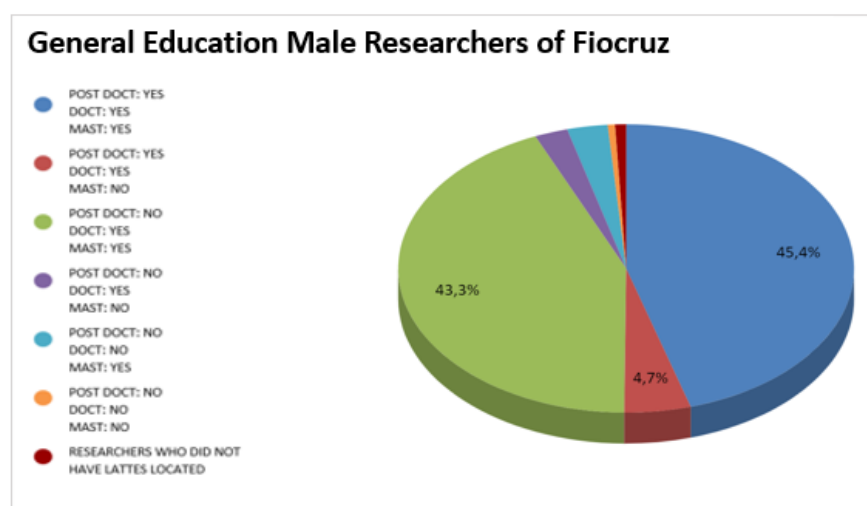


Graph 2: Gender x Position. Fiocruz, 2020.  
Source: Prepared by the authors (2021)

The data extracted from the Lattes Database, created by the National Council for Research and Technological Development (CNPq) and compulsory for all researchers in the country, is self-declaratory and dynamic. It can be concluded in Graphs 3 and 4 that the professional research staff regardless of gender is highly qualified, and that most of them have doctorates and post-doc.

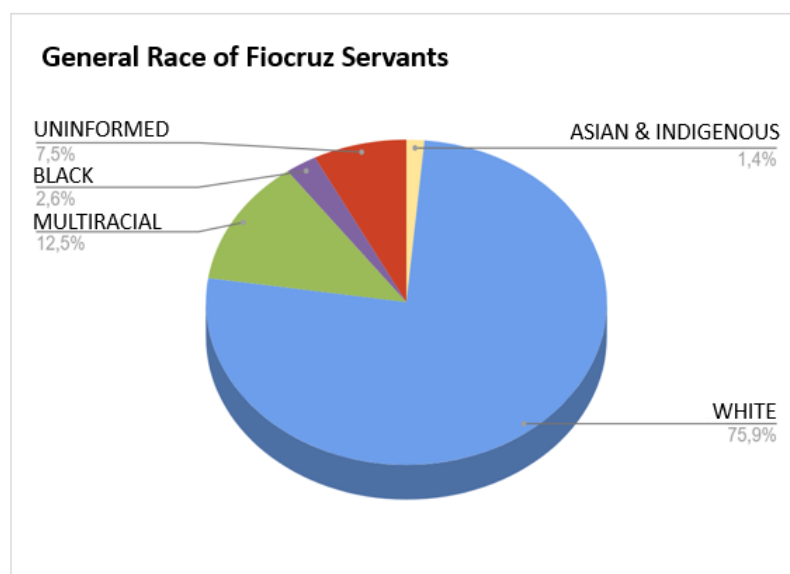


Graph 3 : Graduate x Female Researchers. Fiocruz, 2020  
Source: Prepared by the authors (2021)



Graph 4: Graduate x Male Researchers. Fiocruz, 2020.  
Source: Prepared by the authors (2021)

We found that even the Institution that positions itself in the struggle for a fairer and more equitable society, that is committed to the diversity of the Brazilian people and their demands, and that carries out actions aimed at that their workers can face all forms of discrimination and exclusion, as the group of Black researchers and technologists is 2.6% compared to the white race, which is 75.9%.



Graph 5: General Race x Servants. Fiocruz, 2020  
Source: Elaborated by the authors (2021)

## 6 Conclusions

This initial project allowed an approximation of understanding about the profile of Fiocruz research professionals, who are responsible for the production of knowledge that makes up the essence of the mission of the Institution. The next phases of the project intend to be more analytical than descriptive, as they will have other data sources and will require the contextualization of the acquired information and will present a mapping of both researchers and scientific collaborative networks, their central nodes, and links.

Gender and ethnic-racial diversity may favor increased productivity and even reflect the transparency of deliveries to the Brazilian people, in addition to meeting their multiple demands and democratically proposing the generation of

new science, technology and innovation public policies based on different perspectives that will consequently promote the growth and development of this society.

In this case, we conclude that the profile of researchers who work in scientific research in health is mostly female and white, which reinforces the advancement of women's insertion in the labor market but demonstrates that the coloniality of power and racism prevail.

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# Rediscovering Urban Intelligence within Sustainable Cities

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## Abstract

Cities are rediscovering the importance of becoming as intelligent communities and facing the challenge of advancing as smart, inclusive and sustainable cities in order to promote urban communities as engines of social and economic growth and societal development. Intelligent cities drive the urban community towards sustainability for ensuring social and inclusive growth. The future of sustainable urban development relies on intelligent cities which are able to promote future urban development and support social and economic growth of urban areas, developing urban intelligence to solve problems and drive towards the urban community towards urban sustainability. Intelligent cities identify possible itineraries of urban development in terms of social and economic growth within urban environments. Cities construct a pathway to develop urban intelligence as a source for sustainable urban future, promoting a smart vision to urban development as a key driver for enhancing the urban community and driving collaboration and cooperation among the urban private and public actors as a framework for innovation, knowledge and value creation processes.

**Keywords** – Intelligent and sustainable cities, smart city and community, collaboration.

**Paper type** – Academic Research Paper

## 1 Introduction

Today, cities are rediscovering the importance of intelligent communities as engines of smart, inclusive and sustainable growth and cities in order to promote urban communities as drivers of social and economic growth and societal development. Intelligent cities drive the urban community towards sustainability. Urban sustainability is becoming both a source and goal leading to cities working to promote sustainable urban development relying on urban intelligence. Cities contribute to sustaining value creation processes, becoming sustainable and intelligent communities that develop smart-driven and collaborative processes in

order to develop knowledge, support learning and innovation using the potential of information technology to support change in a significant way. Developing cities as sustainable communities helps cities to actively play a key role in promoting urban value creation and contribute to achieving urban sustainability too (Haapio, 2012). Cities identify a path for sustainability that helps improve and extend the wealth of community promoting social and technological change (Williams, 2010). Cities construct a truly smart and sustainable city moving from techno-centricity to post-anthropocentric approach (Yigitcanlar *et al.*, 2019). Cities become intelligent urban communities that develop a smart approach as cultural vision to urban development, strengthen the community to develop the potential of information technology in order to drive an intelligent urban growth and mobilise the organisation sustaining the cooperation among the helices of urban landscape (Lombardi *et al.*, 2011). Information technology helps cities to adopt a smart mind set constructing a dialogue with civil society in order to drive urban innovation and advance to build a sustainable city (European Economic and Social Committee, 2015). Smart cities should use technology to develop democratic and participatory governance capacities as necessary means for creating public and sustainable value (Deakin 2014). Cities adopt a smart city vision to support sustainable urban growth (Deakin *et al.*, 2012). Cities need to be intelligent communities in order to continue to live (Schnore, 1971) and become spaces for social and inclusive innovation (Newman and Jennings, 2008).

The pathway leading to urban sustainability relies on cities rediscovering urban intelligence as a key source that enables the city to develop as an organisation which contributes to value creation and wealth within urban spaces and environments. Cities are building a city as sustainable organisation, meeting the needs of communities without compromising the wealth of future generations. The future of sustainable development relies on intelligent cities of the future which are able to promote urban development and support social and economic growth of urban areas, developing urban intelligence to solve problems and drive towards the urban community towards urban sustainability. Intelligent cities identify possible itineraries of future urban development in terms of social and economic growth within urban environments, being able to see which intelligence are involved in the process of urban development (Santangelo, 2016). Intelligent cities use the potential of information technology to make the city more innovative, smart and efficient and have to develop technology to stress the need

for integration among innovation actors, connected communities, digital application that support the urban intelligence (Kominos, 2011).

While there are studies that focus on the role of the intelligent city, there are few studies that investigate which are the drivers that lead the city to becoming an intelligent city. Cities need to adapt to social and economic change, driving innovation, by becoming more smart and sustainable cities than the past cities. The aim of this study is to elucidate how cities develop sources to build urban intelligence. Smart city vision, smart-enabled community development, collaboration enable the intelligent city.

Smart and sustainable communities construct a vision of the urban future, identifying dialogue, partnership and collaboration as a way to take social and economic advantages and advance the city to become a sustainable urban community (Eger, 1997). Smart city and smart community become an urban vision and means that enable urban communities to develop urban intelligence and promote smartness in services management, urban mentality and governance as sources to build the city of the future as an entity that continuously develops innovation for change. This study analyses how cities construct urban intelligence for sustainability, and become intelligent and sustainable cities. The study is theoretical and relies on a literature review and analysis related to the concepts of sustainable and intelligent city, smart city and community as drivers of development and enablers of collaboration and cooperation. The selected contributions are interpreted in a narrative synthesis in order to elucidate new perspectives and advance theoretical frameworks on emerging issues (Denyer and Tranfield, 2006; Dixon-Woods, Agarwall, Young, Jones and Sutton, 2004).

The paper is articulated in the following way. After introduction and methodological section, in the second and third paragraphs, the role and meaning of intelligent cities and communities, and sustainable cities is elucidated. In the fifth paragraph, building urban intelligence relies on promoting a smart vision to urban development, rediscovering the community and enabling collaborative processes for knowledge, innovation and learning. Finally, discussion and conclusions are outset.

## **2 Becoming intelligent cities and communities**

Intelligence refers to the ability to learn and apply knowledge in new situations. As organizations, cities have to develop intelligence as the ability to drive change,

facing the uncertainty emerging from external pressures and environment (Brătianu, Vasilache and Janu, 2006). Intelligent cities contribute to facing and solving problems, and identifying solutions to urban development, focusing on collaborative innovation. (Komninos, 2009). According to Briggs (2005) a sustainable city is a dynamic and intelligent system which is able to adapt to change to proceed towards long-term health and success, and the «city intelligence is the capability of this network of organizational systems to function effectively, and successfully, over a period of time» (p. 39). According to Komninos (2006) intelligent cities are territories where high capacity for learning and innovation emerge in relation both to creativity of population and institution of knowledge creation, and digital infrastructure. Cities employ technology becoming spaces that construct strategic collective intelligence which is cooperative (Komninos, 2006). Hollands (2008) elucidates that the intelligent city brings together information technology and people to enhance innovation, learning, knowledge and problem solving. «Digital collaborative spaces and intelligent cities sustain a particular form of collective intelligence, in which information collection, assessment and dissemination rely on the combined action of a group of people, a community, or a network of companies and organisations» (Komninos, 2009, pp. 348-349). According to Santinha and de Castro (2010) the intelligent city provides high-quality economic services and supports the development of an organizational and technologically innovative environment capable of promoting competitiveness among firms and creativity. As intelligent communities, cities develop new collaborative opportunity for economic growth and social welfare. Urban spaces open up to possibilities of public collaborative and multi-actor innovation by involving civil society and citizens (Sørensen and Törfing, 2018). The intelligence of a city refers to collaboration and involvement of citizens, companies and public authorities as an organizational framework that enables urban innovation (Komninos, 2015). The role of both *smart* and *intelligent* cities is to integrate the physical, institutional and digital dimensions of urban spaces. Even if the concepts of *smart* and *intelligent* cities tend to be overlapping, the *smart* city stresses the importance of technologies and interactive media that support knowledge diffusion and interaction, *intelligent* cities focus on collective and collaborative intelligence, leading to innovation systems and web based collaborative spaces (Stratigeia, 2012). Intelligent cities adopt a smart approach to urban development but also integrate digital city dimension into the social space of the city and enable digital

spaces to enhance collaboration, social networking and collective intelligence in order to make the city as innovative and inclusive community (Kominos and Tsarchopoulos, 2013). Intelligent cities as communities contribute to both ensuring better quality of life of people within urban spaces and enabling value creation processes in long term horizon. Cities emerge as platforms that promote co-production of social value, capabilities and innovation, building a strategic urban intelligence (Ravetz and Miles, 2015).

### **3 Towards sustainable cities**

Cities contribute to creating social organisms and communities, promoting social interaction, creative processes, by improving the wealth of people in urban spaces (Camagni, 1996). Cities provide services and become social incubators for social change and innovation (Evans, 2005). Cities of tomorrow should be sustainable cities which are able to design an urban and sustainable development within global and competitive economies and open societies. A sustainable city should be able to reform the way in which the city tends to interact with global economy and environment (Haughton, 1997). Sustainable cities build an inclusive and learning urban prosperous future (Osborne, Kearns and Yang, 2013). Cities of tomorrow can assume a holistic model of sustainable urban development, promoting place- and people-based approaches, shaping governance and cooperation infrastructures and ensuring spatial development and efficient use of resources (European Union, 2011). Sustainable cities employ human, social, organizational and technological capability to drive change (Williams, 2010), promoting evolving partnerships among heterogeneous actors (Bayulken and Huisingh, 2015), transforming knowledge resources and reinforcing knowledge assets and intellectual infrastructures (Knight, 1995). As organizations, cities should encourage the use of knowledge in order to achieve social, economic and environmental issues, and advance towards sustainability (Leon, 2013). Following a knowledge-based view, cities are shaping the city as a sustainable entity which is able to establish key priorities, long-term urban planning, by integrating knowledge management processes (Chang *et al.*, 2018).

Building sustainable urban development relies on improving the quality of life for people in a city, preserving ecological, cultural, social and economic elements without a burden can occur on the future generations. Sustainable cities contribute to promoting sustainable urban development improving and

extending the wealth of people within a community (Trindade *et al.*, 2017). Sustainable cities develop the city as a community encouraging cooperation and collaboration between city government, people, business, research and education centers by promoting social and economic innovation, providing services, creating knowledge for continuous learning in order to ensure high quality of life. As urban communities designing long-terms policies for change and continuous innovation, sustainable cities should promote trust-based relationships by sustaining citizen participation in policy choices. Cities have to adopt a model of sustainable city development. In particular, «cities need to adopt an integrated approach to planning and development, integrating the social, economic, environmental and territorial dimensions of urban development» (European Union, 2011, p. 60). Intelligently-sustainable cities are responsible to ensure sustainable urban metabolism, by developing sustainable environment, economy and society (Gargiulo Morelli *et al.*, 2013). Sustainable cities should continuously develop the city as a future-oriented and innovation-driven smart community. In particular, sustainable cities adopt a demand-driven approach meeting the needs of people living in urban environments and promoting a smart city vision that enhances the importance of information technology as a source to support urban future, knowledge and innovation (Angelidou, 2015).

#### **4 Building urban intelligence within a city willing to be a sustainable city: smart city, community and collaboration**

Cities have to invest in smart city vision, community and collaborative processes in order to become a sustainable city. Cities investing in technology aim to become smart. According to Giffinger *et al.* (2007) smart cities employ strategically information technology to drive innovation and support service management in order to improve the quality of life within urban communities. Technology is opening up cities driving innovation in services, business, economy and governance, becoming smart cities in order to support social and economic growth and enhance the quality of life within urban communities (Nam and Pardo, 2011a; Shapiro, 2006). Smart cities contribute to shaping a sustainable city, by integrating technological, organizational and social infrastructures and capabilities, promoting sustainable economic growth and participatory governance (Albino, Berardi and Dangelico, 2015; Caragliu, Del Bo and Nijkamp, 2011). In particular, advanced ICT offer a potential for planning the city building

capabilities for shaping urban sustainability. The adoption of information technology is leading to cities becoming smart and sustainable communities (Bibri and Krogstie, 2017). Smart city vision and applications contribute to sustainable urban development and driving place-based collective intelligence (Angelidou *et al.*, 2017). Adopting a smart city perspective drives open innovation, leading to smarter, inclusive and sustainable cities (Paskaleva, 2011). Smart city visions contribute to improving urban sustainability, tracking a pathway for sustainable future (Ahvenniemi, Huovila, Pinto-Seppä and Airksinen, 2017).

According to Kourtit and Nijkamp (2012) smart cities concern human, technological and social capital as drivers of sustainable urban growth, and help to improve the urban performance of a city. Information technology enables cities to identify a smart vision to building satisfying conditions for urban development, promoting smartness as a source for sustainable urban spaces and growth. Smart and sustainable cities use information and communication technology, identifying new ways to address urban development, preserving capabilities and meeting the needs of future generations (Höjer and Wangel, 2015). A city should be sustainable to be a smart city too. According to Bifulco, Tregua, Amitrano and D'Auria (2016) the role of information technology in smart city framework is to promote sustainable urban development of cities. ICTs contribute to sustaining smart strategy, improving services and quality of life towards sustainability (Bifulco, Tregua, Amitrano and D'Auria, 2016).

Cities of the future will build a smart community in the knowledge-based economies, playing a central role for improving urban competitiveness and development (Begg, 1999, Eger, 2009). Promoting community, technology and policy as drivers of urban sustainable development help cities to adopt a smart strategy (Yigitcanlar *et al.*, 2019). Cities develop smartness by enhancing the collaboration as a source that enables urban development and innovation (Meijer and Bolívar, 2016). Cities becoming smart communities and sustainable cities tend to ensure efficient service delivery and infrastructures improving quality of life and well-being of its citizens, ensuring economic growth and employment opportunities (Dhingra and Chattopadhyay, 2016).

Information technology helps to support the sustainability of cities by making more smart the urban community (Walters, 2011). Promoting smartness helps cities to become smart communities able to drive urban change (Deakin, 2011). As communities using the potential of information technology, cities develop technologies as a means that empowers citizens as co-designers and co-



producers of public services, sustaining innovation, citizen-centricity, knowledge and sustainability (Granier and Kudo, 2016).

Intelligent cities use the potential of information technology to make the city as a smart city and community, rediscovering the opportunities for innovation development, social and participatory growth of the urban community as decision-maker of the urban future, by using information technology to make real smart city as a city which enhances democratic practice, enabling citizens to decide what kind of city want to live in (Hollands, 2008).

Sustaining smart city and community development helps to empower individuals and groups to use skills and information for change within communities (Stratigeia, 2012). According to Komninos and Tsarchopoulos (2013) the advent of digital and smart cities helps cities to produce collective and collaborative intelligence. «The digital life of cities starts at the hyperspace, but it soon becomes part of the social life and the physical environment of cities, empowering people and advancing citizen's capabilities by collaborative, collective, and embedded intelligence» (p. 151). Cities adopt a smart approach becoming platforms for engendering innovation by investing in human capital and involving people to interact and cooperate to build collaborative processes between people, business and government within community as means that leads to urban public value and innovation (Hollands, 2008; Paskaleva, 2011). Cities are drivers of economic growth and main actors of open innovation, encouraging multi-level and sector interactions between private and public organizations involved in the co-creation, co-design and co-implementation of integrated and innovative solutions (European Commission, 2017). Cities are becoming smart cities by involving universities, industry, government and civil society as one of the main key actors in order to promote the development and performance of cities (Lombardi *et al.*, 2011).

Technology helps to drive urban innovation in management, governance, and policy (Nam and Pardo, 2011b) leading cities to improving urban quality of life as a means for sustainable development (Bătăgan, 2011) by making urban communities, cities and human settlements as inclusive, safe, resilient and sustainable as requested by the goals 11.b3 of *UN 2030 Agenda for sustainable development*. Building a smart community means to develop and implement cooperation and collaborative processes as a way to drive urban sustainable development (Eger, 2005). The smart community develop collaboration, cooperation and partnership among voluntary, education, private and public

organizations, and citizens within urban space (Lindskog, 2004). As smart communities, cities proactively are using information technology to promote sustainable wellbeing for people (Lara *et al.*, 2016). Cities adopt a human-centred vision to smart city development in order to develop collaborative processes that drive urban innovation processes (Andreani *et al.*, 2019).

## **5 Discussion and conclusions**

Cities drive urban, social and economic development, selecting a pathway for urban sustainability, by identifying the sources for urban intelligence. As sustainable ecosystems and engines of economic growth, cities of tomorrow should select a strategic agenda by involving different stakeholders who will be working together in designing and implementing collaborative and cooperative smart and human-oriented processes that enable the opportunity for breeding new urban knowledge and innovation. Smart city vision, smart community and collaboration are at the heart of the city becoming an intelligent city which develops in order to promote a sustainable urban future and contribute to wealth of urban communities. Information technology is emerging as a source that supports cities to drive social and economic growth and innovation, and evolve as a community becoming smart rediscovering the cooperation among urban stakeholders and collaborative processes as engines of development. As following a smart approach to urban development, cities tend to design a pathway for sustainability and learn how to build the organisational processes and patterns that drive cities to act and evolve as smart communities which design and implement collaborative processes within urban spaces.

Cities should become intelligent communities that adopt a smart urban view as strategic and cultural vision for growth, promoting collaborative and collective intelligence by using the potential of information technology, leading to cooperative patterns that involve local government, business, research centres and citizenry that learn how to breed social and economic urban innovation, contribute to new value and knowledge. Cities design a pathway to urban sustainability, rediscovering the importance of the urban community as engine of social, inclusive and economic growth, strengthening the collaborative processes as drivers and key sources that shape the city's intelligence as a means that opens to future and sustainable urban development.

The future of cities should be sustainable. Cities are rediscovering the importance of developing urban intelligence and defining intelligent solutions to facing and solving urban problems that influence social and economic development of urban environments and communities. Cities of the future should face and win the challenge of sustainability as source for creating public value and benefit the economic and urban development. Cities should learn how to become intelligent urban communities that evolve using the potential of information technology and digital, interactive applications in order to drive urban growth and promote value creation and enable the city as an intelligent actor which supports a continuous orientation towards urban sustainability and innovation. Intelligent cities become drivers and engines of sustainable urban development and contribute to shaping the city as a sustainable community. As intelligent urban communities, cities should develop a smart-enabled vision a cultural and strategic approach to urban design mobilizing the organisational pattern for cities as engines of innovation and knowledge, following technological evolution that leads to considering cities not only as services providers but enablers of innovation, learning and knowledge. Future research perspectives imply to investigate how European cities are tracking a pathway to urban development becoming intelligent cities, by employing technological and social capabilities to promote smartness and community as drivers of urban sustainability.

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## Knowledge Management in the Early Stage of Collaborative Product Design by the Entrepreneurial Team

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### Abstract

In dynamic business environments with uncertainty and risks entrepreneurs make efforts to customize new products to latent user needs. In a product development process, user/customer integration (an approach of giving users an active role in an innovative product design) relates to challenging processes of collaboration and knowledge sharing with and within an entrepreneurial team. The paper research is focused on a model that comprise knowledge conversion and knowledge sharing barriers in an entrepreneurial team working in collaboration with innovative and "ordinary" users at early stage of product design. The key barriers to knowledge sharing in collaborative entrepreneurial team were formulated and assessed based on qualitative research (observation, questionnaire, and in-depth interviews). At the early stage of product design, in the model of knowledge conversion in collaborative entrepreneurial teams, the role of exploratory prototyping is identified.

**Keywords** – Knowledge sharing, Collaborative product design, innovative user, Fuzzy front end, Entrepreneurial team

**Paper type** – Academic Research Paper



## 1 Introduction

Today knowledge (individual and collective, internal, and external, explicit, and tacit) has become one of strategic assets of an organization. The experienced knowledge management (KM) has potential to produce sustainable competitive advantage (Bollinger & Smith, 2001; Murray & Peyrefitte, 2007; Constantinescu, 2008; Liyange et al., 2009, Lee, 2016; Ferreira, 2020; Marchegiani, 2021). There is growing flow of research devoted to KM not only in large but also in small organization and entrepreneurial entities (Hutchinson and Quintas, 2008; Presutti et al., 2011; Gaimon and Bailey, 2013; Alvarez et al., 2016; Bandera, 2017). KM practices in small and large organisations differ significantly (Hutchinson and Quintas, 2008; Zieba et al., 2016). In this regard, it takes the sense to extend research and study if and how small and micro companies, including entrepreneurial teams, manage their knowledge. KM in entrepreneurship is based on research of endogenous growth (Romer 1994), knowledge spillover (Cuervo et al. 2007; Audretsch and Keilbach, 2007; Acs et al. 2013; Caizza et al. 2020), strategic entrepreneurship (Agarwal et al. 2010; Audretsch et al. 2015; Ghio et al. 2015; Tavassoli, et al. 2017) and open innovation (van deVrande et al, 2009; West et al. 2014; West and Bogers 2014). Adoption of digital technologies and knowledge spillovers changed the entrepreneurial environment (Li et al. 2016; Hoffman and Yeh 2018; Kuratko et al. 2020). The modern social and network infrastructure creates new opportunities for nascent entrepreneurs, and a great interest in how nascent entrepreneurs can access and share knowledge via collaboration and co-creation with external partners (customers, users, suppliers, etc.) with the aim to new/innovative product design (Ahumada-Tello et al., 2017; Welter et al. 2019, Belitski et al.2021).

Entrepreneurial teams that challenge invention of innovative products come through stages with various priority goals on a way to sustainable business development. The first stage of product design is full of uncertainties and poorly formalized. This is pre-development (early) stage, so-called fuzzy front-end (FFE), where a concept of product and its feature set are determined and validated (Kim and Wilemon, 2002; Koen et al., 2014; Pereira et al., 2017). Entrepreneurial teams act at this FFE stage as creative design teams having in mind some extra-long-term goals/objectives related to business-model (scalability features of start-up operations) that are built around innovative product later. The teams face two critical questions at the FFE. How to evade useless efforts by creating an

innovative product/service that does not have value for customers. And how to verify success of an innovative product/service that will meet customers' expectations before running out of resources that entrepreneurs currently have. Users/ customers with their own innovative initiatives can demonstrate new opportunities for entrepreneurial team to make valuable market offerings (Witell et al. 2011) by participating in product/service/business model development with specific degree of participation in design process, i.e. "design for", "design with" and "design by" (Kaulio, 1998).

The necessity of external collaboration, to get competitive advantage, is challenging for entrepreneurial teams as external stakeholders are not the ones that get through HR requirements to comply with levels of professional education, experience, and soft skills match. In this sphere formulation of issues/problems and search of solutions lies in cross-section of the three domains: collaborative management, knowledge management, and entrepreneurial management.

In the knowledge management domain, we focus in this research on knowledge sharing (Yeşil and Hırlak, 2016; Kucharska and Kowalczyk, 2016; Zammit et al., 2016; Mathrani and Edwards, 2020) through which knowledge, skills, and expertise are exchanged among entrepreneurial team members and external stakeholders.

The collaborative management domain in this research is associated with choose of the methods and management of user/customer integration in IPD, whereby entrepreneurial team members attain tacit knowledge from use/customer and internalize that knowledge into IPD (Lilien, et al., 2002; Füller and Matzler, 2007; Bartl, et al., 2012; Bretschneider and Zogaj, 2016).

The entrepreneurial management domain is an "approach to management" which is characterized by "the pursuit of opportunity without regard to resources currently controlled" (Stevenson, 1983, Stevenson and Jarillo, 1990). Entrepreneurship as opportunity-based management behavior most fit in design of innovation solution. In this research entrepreneurial teams use Lean Startup techniques, iterate "hypothesis – build – measure – learn – new hypothesis" in feedback loop and improve PD to be competitive in shorter product life cycles (Blank, 2013). Authors of this paper define an entrepreneurial team as a cross-function collaborative team that attain knowledge, generate, and test hypotheses in an uncertain environment in collaboration with customers/users, iterate and learn with the aim to create valuable product/service and effective business

model. This definition refers to foundations of entrepreneurial management practices.

The goal of this research is to study the model of knowledge conversion and knowledge sharing barriers in entrepreneurial team working in collaboration with innovative and “ordinary” users at early stage (FFE) of product design (Co-PD). The research questions are formulated as follows: what are main barriers to knowledge sharing in collaborative entrepreneurial teams in FFE of Co-PD process? How exploratory prototyping influences knowledge sharing in FFE of Co-PD process?

The paper is structured in the following way. Section 2 presents theoretical background on collaboration, user/customer integration and knowledge sharing. Section 3 describes the process of collaborative product design by entrepreneurial team. Section 4 defines the research design, describes how the study was planned and executed. Section 5 presents SEI model of knowledge conversion and barriers to knowledge sharing in collaborative entrepreneurial team. The results are summarized in the Conclusion.

## **2 Theoretical background: collaboration and knowledge sharing**

### ***2.1 Collaboration and user/customer integration in Co-PD***

Collaboration is investigated from various direction, in particular, as a process for cross-organizational linkage (Emden et al., 2006), cross-enterprise processes (Deck and Strom, 2002; Bodas Freitas and Fontana, 2018; Sinkovics et al., 2018), as well as customer co-creation of innovation in corporations and SME's (Vrandea et al., 2009; Frow et al., 2015; Kleber, 2019). Collaboration can provide benefits of speed and resources savings in the IPD processes, through the effective and efficient sharing and combination of knowledge (Mathrani et al., 2011; Mathrani and Edwards, 2020). However, when communication between stakeholders of PD processes breaks down, the collaboration could act as a backward step. Geographical proximity plays an essential role in knowledge sharing into early stage of PD (Davids and Frenken, 2017).

Users/customers knowledge is impossible to replace in PD process (Sawhney et al., 2003; Su, et al., 2006). The model of user/customer integration in PD significantly depends on many factors such as stage of PD, degree of future product innovativeness, industry, type of market and users/customers, etc. (Enkel

et al., 2005; Lau et al., 2010; Sandmeier et al., 2010; Bretschneider and Zogaj, 2016). Thus, being integrated into the PD process, user/customer bring not only information regarding their needs/wants but also provide various solutions concerning different activities within the PD.

In this research entrepreneurial teams used Lead Users model (Lilien, et al., 2002; von Hippel, 2002) for integration of innovative users ('leading-edge user') (von Hippel and Katz, 2002) in Co-PD and were enriched with knowledge from "ordinary" users (market majority) by focus groups and user testing exploratory prototypes. The ability of innovative users to be effective in FFE of PD is explained by combination of superior knowledge of the user domain (so-called, use-experience) and sufficient technological knowledge.

## **2.2 User/customer knowledge sharing and barriers**

Dissemination of knowledge, understanding of a subject gained through study and experience, is an essential entity of modern competitive environment with rapid change of customer requirements and shortening product life cycles (Wang & Noe, 2010).

Knowledge is an irreplaceable resource for PD process and is crucial for creation innovative product. "It includes experience, values, insights and contextual information and helps in evaluation and incorporation of new experiences and creation of new knowledge" (Barney, 2001; Indira et al., 2012). User/customer knowledge includes both explicit and tacit one. Explicit knowledge is type of knowledge that the individual holds consciously in mental focus, that can be easily explained and can be communicated to others, which means it can be symbolic and documented, eg., user manual of for employee or user (Nonaka and von Krogh, 2009; Agan et al., 2018).

Tacit knowledge represents internalized knowledge, engrained with actions and experience, while including cognitive and technical elements, e.g., mental models, skills, ingenuity (Nonaka and Takeuchi, 1995; Agan et al., 2018). User/customer tacit knowledge is difficult to articulate and communicate, other than by direct interaction, telling metaphors and storytelling (Leonard and Sensiper, 1998; Hernandez-Serrano, et al., 2002).

SECI (Socialization—Externalization—Combination—Internalization) model of knowledge conversion illustrates how two types of knowledge are converted to one another (1-from tacit to tacit, 2- from tacit to explicit, 3- from explicit to

explicit, 4- from explicit to tacit) and create new knowledge model (Nonaka and Takeuchi, 1995; Nonaka et al., 2000).

In response to expanding importance and demand of knowledge sharing both in society and in business environment, the study of knowledge sharing barriers at different organizations took place (Barson et al., 2009; Kaps, 2011; Lilleore and Hansen, 2011; Santos et al. 2012; Athar and Evans, 2015; Zammit, 2015; Riege, 2005; Yeşil and Hırlak, 2016 Akgün et al., 2017).

Innovation activities stimulate research of tacit knowledge sharing barriers (Haldin-Herrgard, 2000; Cumberland and Githens, 2012; Park, 2012; Bretschneider and Zogaj, 2016; Kucharska and Kowalczyk 2016; Mathrani and Edwards, 2020). The process of user/customer tacit knowledge sharing is not well understood, but can provide ideas for breakthrough innovations (Mascitelli, 2000). Considering this, the authors of the paper showed interest and focused the research on study of knowledge conversion in collaborative entrepreneurial team and barriers to knowledge sharing in FFE of Co-PD process.

### **3 Early Stage of Collaborative Product Design by Entrepreneurial Team**

The result of the 2019/20, nine entrepreneurial teams of four-six members were plunged into collaborative product design (Co-PD) projects with user/customers at innovation lab organized in design thinking style with flexible creative spaces and prototyping equipment (3D printers, CNC milling and laser machines, scanners, etc.) during 2-2.5 months. The teams managed Co-PD projects through all stages of the creative problem identification and problem-solving design process within FFE: identification of customer/market/technology opportunities, development product ideas to meet customer demand and product concepts (Kim and Wilemon, 2002; Koen *et al.*, 2014) (see Fig.1). The teams developed and validated product concepts, i.e. minimum viable products (MVPs) (Blank, 2013) in the field of packaging of various categories of goods and business models. Design thinking and TRIZ approach were used throughout the Co-PD process.

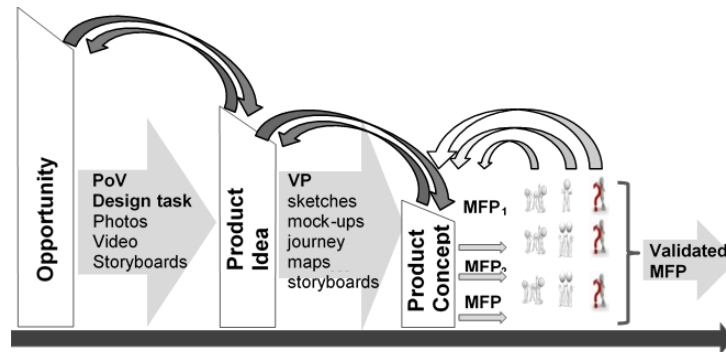


Fig. 1. Early stage (fuzzy front-end, FFE) of product design.

Collaboration and knowledge sharing were organized by integration of users/customers in Co-PD process. The models for integration depend on types of users. Entrepreneurial teams used Empathic Design and the Lead User method (<http://www.leaduser.com/>) for integration with innovative user within the early stage (FFE) of Co-PD. Empathic Design method supposes that users are observed while using prototypes in natural environment (Evans et al., 2002). Lead User method is based on participation in Co-PD of innovative ('leading-edge') users (individuals or companies) that are experiencing "pain"/needs that are ahead of existing targeted market. Often, they develop solution to satisfy their own leading-edge needs ("magic pill" to relieve their own "pain") that after adaption can be attractive commercially (von Hippel and Katz, 2002; Lüthje and Herstatt, 2004; Ebel, 2013).

The "ordinary" users (market majority, use solutions existing on the market) is integrated in Co-PD process by Focus Groups, Concept Testing and Empathic Design methods (Bretschneider, 2016).

In some Co-PD projects, the end users of the future product are individuals (B2C) and the customers are organizations/companies (B2B). In this case, the leaders of the entrepreneurial teams established communications with key decision-makers in the organization, potential customer of the future product. Key success factors of knowledge/information sharing are soft skills in communication and negotiation, and the method of Dialogue (Zhang et al., 2012).

The nine collaborative entrepreneurial teams worked independently from each other and iterated "hypothesis – build – measure – learn – new hypothesis" feedback loop in 3 phases of FFEol domain based on knowledge sharing and experimentation with users/customers (see Fig.1). On the first phase (Ph.1)

"Opportunity" entrepreneurial teams were involved in the design research (user in-context interview and observation). Interviews and observations were conducted in the everyday user context which gave deep and reach view of the details of use-cases, "pains", insights, and user behaviours. In parallel teams study the trends in the certain areas and searching lead users and experts. Entrepreneurial teams used design tools (knowledge wall, persona profile, empathy, and trend mapping). Set of photos, videos, interviews, storyboards are working material for further discussion in a team with identified lead users and experts. The project team interviews lead users to gain deeper insight into emerging needs. Point of view (design task) is formulated at the end of this FFE phase. On the next phase (Ph.2) "Product Idea", entrepreneurial teams organised series of workshops with lead users to share knowledge/experience and finding solution for market. At this phase, the first exploratory prototypes appear in a form of sketch and mock-ups of the future product to start visual communication for representation specific and details within and outside the collaborative teams. Value propositions of a future solution are created and validated with users. In the third phase (Ph.3) called "Product concept" the teams prototyped and tested several minimum product feature sets (MPF). MPF is a "product" which has just enough features to gather validated learning about the product and its continued development (Blank, 2013). Validated MFP goes to the next stages of product development process.

## **4 Research design and process**

### **4.1 Qualitative research**

Due to the exploratory nature of the research, a qualitative type of study was chosen. This approach suits the goal of this research and let us to study the model of knowledge conversion and knowledge sharing barriers in entrepreneurial teams working in collaboration with lead and ordinary users at early stage (FFE) of product design (Co-PD). The authors used qualitative approach of the study with the focus on both individual (member of entrepreneurial team) and team, by observations in a natural environment and in-depth interviews with identification of insights of the respondents. We conducted a case study using the flexibility of this research format, because it did not require a strict pre-planned structure (Yin, 2013). This gave us to use three various data

collection tools (semi-structured interviews, questionnaire, and observation) when needed. We conducted research in a real time when Co-PD process and team activities were in progress.

#### ***4.2 Research process and data collection***

Authors started this research by reviewing the relevant literature around five main areas: knowledge management, innovative product design, collaboration, user/customer integration in product design and entrepreneurial management. Through this study, authors discovered Co-PD process, types of users involved in Co-PD, key joint activities of entrepreneurial team members and user/customers in the different stages of the innovation process. The research questions were formulated based on some gap in theories. Through this research we are going to discover specific feature of model of knowledge conversion and knowledge sharing barriers in entrepreneurial team working in collaboration with lead and ordinary users at early stage (FFE) of product design (Co-PD). For that we conducted a case study within nine entrepreneurial teams working in collaboration with lead and ordinary users at early stage (FFE) of product design (Co-PD).

The process of data collection started with observation of stakeholders and team work to better understand the situation with Co-PD in real time. Given the walking distance, the researchers regularly attended seminars organized by entrepreneurial teams and innovative users, as well as work areas where a concept of new product was created. We used the "shadow" method and observed the details of interactions between members of entrepreneurial teams and innovation users and ordinary users. The accumulated insights made it possible to prepare the survey and interviews with the members of the project teams more effectively. That provided us with an opportunity to better understand the context in which the innovative solution has been developed.

The next step after the start of the observation, which was continued by the researchers throughout the entire process, was the questioning of the members of the entrepreneurial teams (49 people) at the start of the project work to get an idea of their background. The response rate was 95,9%. The next questionnaire was repeated towards the end of the project activity. The response rate was 91,8%.



Previously we created an interview guide including questions concerning the focus areas. In advance, we arranged date/time and familiarized the respondents with the structure of the interview. From experience, it is important that the interview is conducted "not on the run", and the respondent allocates enough time for this activity. The interviews continued at around 1.5 hour each, based on a specific agenda upon the main fields of research. In case of exceeding the time, we arranged an addition meeting. Often, several follow-up questions were sent to responder through e-mails and that allowed to complete incomplete answers of the questionnaire. The interviews were recorded and transcribed afterwards. The aim of the interviews and questionnaire was to identify of the aspects that are covered behind the facts.

## **5 Research results and discussion**

### **5.1 Entrepreneurial team**

There are numerous differing definitions of the term "entrepreneurial team" in existing literature and one of the commonly used is formulated as follows: *"An entrepreneurial team consists of two or more persons who have an interest, both financial and otherwise, in and commitment to a venture's future and success; whose work is interdependent in the pursuit of common goals and venture success; who are accountable to the entrepreneurial team and for the venture; who are considered to be at the executive level with executive responsibility in the early phases of the venture, including founding and prestart up; and who are seen as a social entity by themselves and by others."* (Schjoedt and Kraus, 2009).

In this research we study nine entrepreneurial teams which iterate through "hypothesis – build – measure – learn – new hypothesis" feedback loop in FFE of Co-PD process in order to create a value proposition, user acceptable product concept and business model concept during 2-2.5 months. To have the access to user/customer knowledge, entrepreneurial teams organised collaboration with innovative and "ordinary" users by different models of their integration in FFE of Co-PD.

The integration model depends on the role of a particular category of users in the FFE of Co-PD process because users play different roles in Co-PD. "Ordinary" users are the providers of information about the "pain"/problems/needs of users/customers of the existing market, as well as provide valuable feedback on

user testing of created product concept. Innovative users are co-creators of the new commercial product concept and participate more-less in all phases of FFE of Co-PD (see. Fig.1) with the entrepreneurial team.

Model of knowledge conversion in collaborative entrepreneurial team and knowledge sharing barriers are discussed next section.

### **5.2 SEI model of knowledge conversion in collaborative entrepreneurial team**

The results of our observation in the real context of teamwork, questioning (45 respondents) and interviews (22 respondents), were the raw material for analysis how knowledge was converted within collaborative entrepreneurial teams using knowledge conversion model (Nonaka and Takeuchi, 1995; Nonaka et al., 2000).

#### *5.2.1 Socialization - conversion of tacit-to-tacit knowledge*

Socialization is based on the informal interactions and hands-on experiences obtained inside the team and through collaboration with "ordinary" and innovative users. The common language should be arisen and taken by all collaborative team members for effective transfer and shared tacit knowledge. This is one of the key issues identified in the study. Often innovative users have a different background, level and scope of knowledge and competencies, as well as cultural characteristics. At the very beginning of the joint project activity with selected innovative users, the entrepreneurial teams arranged a series of prof workshops (1-2 times a week) and informal events on weekends ("Friday night") outside the office. This allows not only to come to a common language of communication, but also to quickly establish personal communication, which is very important for the transfer and sharing tacit knowledge.

#### *5.2.2 Externalization -conversion of tacit to explicit knowledge*

Regular prof meetings (on/offline) and workshops (1-2 times a week) one of the tools to convert the accumulated tacit knowledge into explicit. But the research revealed inconsistency between spending resources on preparation of high-quality documentation of the event materials in small team with the frequency of their use by team members. The team members did not spend time reading post-meeting documents. One of the solutions, tested by collaborative teams, of effective knowledge conversion (tacit to explicit) was regular representations in different forms (sketches, storyboards, mockups, exploratory

prototypes, etc.) of the current project results in combination with storytelling and scenario of use (use cases). This format of knowledge converting (so called, intangible to tangible) was developed teams in the practical teams work and shown effectiveness (value/price) for product concept development. Such format of knowledge sharing was also very much accepted by innovative users, since the visualization of solutions was a very understandable form for them to give clearer feedback, comments on changes in the concept design.

#### *5.2.3 Combination - conversion of explicit-to-explicit knowledge*

Research revealed that limited resources (time, people, money) that are under the control of the small entrepreneurial teams do not allow them to accumulate explicit knowledge systematically, documented it and create a new set of systematic explicit knowledge. Unwillingness of team members to develop and save documentation of meetings and workshops in a proper way leads to limitations in new explicit knowledge accumulation and add risk for further success in product development. In this case the mode "Combination" of knowledge conversion model in small entrepreneurial teams is almost "empty" and can be eliminated for such cases.

#### *5.2.4 Internalization - conversion of explicit to tacit knowledge*

Research shown that internalization in entrepreneurial team working in collaboration with innovative takes place mainly through learning by doing. Collaborative team members and integrated users communicate each other and, in many cases, orally learn about the implicit (or explicit) knowledge and further directly assimilate it through learning by doing.

Fig.2 shows the SEI (socialization, externalization and internalization) model of knowledge conversion in an entrepreneurial team working in collaboration with innovative and ordinary users at early stage (FFE) of Co-PD.

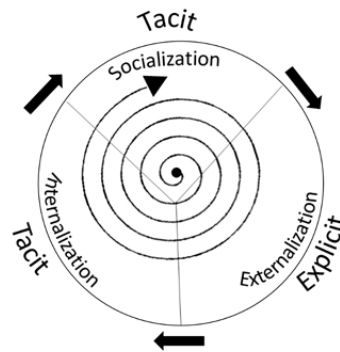


Fig. 2. SEI (socialization, externalization and internalization) model of knowledge conversion model.

### 5.3 Barriers to knowledge sharing in collaborative entrepreneurial team

The results of our questioning (45 respondents) and interviews (22 respondents) were the raw material for analysis barriers to knowledge sharing in entrepreneurial team working in collaboration with innovative and ordinary users at early stage (FFE) of Co-PD. Based on the analysis of the materials of the questionnaire and interviews, as well as the literature review, the key barriers to knowledge sharing in collaborative entrepreneurial team were formulated, see Tables 1,2. Authors asked the team members (45 respondents) to rate the significance of the barriers and the frequency of their occurrence during activities in the FFE of Co-PD process. The assessment was carried out using the 4-point Likert scale (from "not a barrier" to "extreme barrier" and from "never" to "very time"). Tables 1,2 show the number of respondents who chose this or that significance of barriers in knowledge share and frequency of their occurrence in FEE of Co-PD.

Table 1. Knowledge sharing barriers in collaborative entrepreneurial team: significance

Nº	Barrier	Extreme barrier	Moderate barrier	Somewhat of a barrier	Not a barrier
<b>Individual level</b>					
1	lack of time to share knowledge	16	15	10	4
2	insufficient time of interaction between knowledge sources and	17	14	9	5

	recipients				
3	dominance in sharing explicit over tacit knowledge	13	11	12	9
4	insufficient tolerance of past mistakes	26	11	9	2
5	insufficient communication	31	10	4	0
6	poor verbal/written communication skills	37	5	2	1
7	poor interpersonal skills	32	8	3	2
8	insufficient evaluation and feedback	33	10	1	1
9	differences in experience levels	19	17	6	3
10	lack of trust in people because they misuse knowledge and misguide	39	3	3	0
11	lack of trust in the credibility/accuracy of knowledge due to the source	21	18	5	1
12	lack of clarity (ownership of rights) with intellectual property rights	15	17	10	3
13	national culture differences, values and beliefs associated with it	18	16	8	3
14	lack of clarity awareness of the value and benefit of possessed knowledge	30	12	2	1
15	time constrains in research/ problem solving /project	20	15	6	4
16	distance between actors	19	17	5	4
	<b>Team level</b>				
1	lack of managerial direction in terms of clearly communicating the benefits and values of knowledge sharing practices	17	19	5	4
2	lack of formal (including physical) spaces to share, reflect and generate (new) knowledge	27	11	4	3
3	lack of informal spaces to share, reflect and generate (new) knowledge	31	10	2	2
4	lack of clear rewards/recognition to motivate people to share their knowledge	10	11	19	5

5	existing organization culture does not support sharing practices	20	14	5	6
6	deficiency of resources to provide sharing knowledge	29	13	2	1

Source: author's elaboration based on own research and adaptation (Riege, 2005).

The study showed that large number of respondents defined the barriers associated with trust, communication, language, time, awareness, and distance as "Extreme barrier" to sharing of tacit knowledge (Haldin-Herrgard, 2000; Cumberland and Githens, 2012) (see Table 1). Tacit knowledge is sharing from person to person and having trust within this connection reduces risk and uncertainty. Cultural relations between individuals allows to build trust and indicates ability of tacit knowledge sharing. Tacit knowledge is most effectively shared through face-to-face interaction. Our empirical research supports notion that distance is a relevant barrier to the transfer of tacit knowledge. According to this research, more than half of the respondents meet such category of barriers in collaborative product design (see Table 2).

Table 2. Knowledge sharing barriers in collaborative entrepreneurial team: frequency of occurrence

Nº	Barrier	Every time	Often	Rarely	Never
<b>Individual level</b>					
1	lack of time to share knowledge	10	15	15	5
2	insufficient time of interaction between knowledge sources and recipients	16	20	5	4
3	dominance in sharing explicit over tacit knowledge	17	15	21	3
4	insufficient tolerance of past mistakes	15	20	9	1
5	insufficient communication	20	17	6	2
6	poor verbal/written communication skills	15	19	10	1
7	poor interpersonal skills	14	18	9	4
8	insufficient evaluation and feedback	13	22	7	3
9	differences in experience levels	15	20	8	2
10	lack of trust in people because	7	9	19	10

	they misuse knowledge and misguide				
11	lack of trust in the credibility/accuracy of knowledge due to the source	11	19	14	1
12	lack of clarity (ownership of rights) with intellectual property rights	9	20	14	2
13	national culture differences, values and beliefs associated with it	7	15	20	3
14	lack of clarity awareness of the value and benefit of possessed knowledge	16	17	11	1
15	time constrains in research/ problem solving /project	21	17	5	2
16	distance between actors	15	16	10	4
	<b>Team level</b>				
1	lack of managerial direction in terms of clearly communicating the benefits and values of knowledge sharing practices	33	10	1	1
2	lack of formal (including physical) spaces to share, reflect and generate (new) knowledge	5	4	1	35
3	lack of informal spaces to share, reflect and generate (new) knowledge	15	10	14	6
4	lack of clear rewards/recognition to motivate people to share their knowledge	32	8	3	2
5	existing organization culture does not support sharing practices	9	5	12	19
6	deficiency of resources to provide sharing knowledge	25	11	4	5

Source: author's elaboration based on own research and adaptation (Riege, 2005).

## 6 Conclusions

We found that knowledge conversion in entrepreneurial team working in collaboration with innovative and ordinary users at early stage (FFE) of product design can be described by 3-mode SEI (socialization, externalization, and internalization) model. SEI can be considered as a special case of the general SECI model of knowledge conversion (Nonaka et al., 2000). Elimination of "Combination" mode relates to the lack of converted "explicit to explicit" content

of knowledge due to limit of resources (people, time, money) of small collaborative entrepreneurial teams. We revealed that exploratory prototyping and systematic representation were the main tool that provides conversion of tacit to explicit knowledge in "Externalization" mode for collaborative entrepreneurial teams in a situation of limited documentation.

The key barriers to knowledge sharing in collaborative entrepreneurial team were formulated and assessed based on the analysis of the materials of the questionnaire and interviews, as well as the literature review. The study showed that large number of respondents defined the barriers associated with trust, communication, language, time, awareness and distance as "Extreme barrier" to sharing of tacit knowledge.

The limitations of this study are related to its qualitative nature and limited sample size. At the next step, we will include a quantitative part of the research considering the accumulated data. The further direction of the research will be associated with development of new models of knowledge sharing in an interdisciplinary entrepreneurial teams that creates an innovative product in collaboration with various categories of stakeholders.

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## The Venture Capital Deal Sourcing Process in Uncertain Time

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### Abstract

The paper aims to propose a theoretical framework that brings together all the determinants behind VC investment decisions in startups, assessing the relevance of determinants in uncertain times. Specifically, we explore whether these determinants are subject to change during periods of high uncertainty, such as that generated by the covid-19 pandemic. We conducted a literature review drawing a taxonomy of VC determinants. In the literature review, we have recognized 4 determinants: localness, networking, startup industry and entrepreneurial team. Later this we have developed semi-structured interviews to test the relevance of identified determinants. Interviews are directed to 5 VC experts. Results show a relevant emphasis for the entrepreneurial team and networking determinants, while a moderate relevance for the localness and industry.

**Keywords** – Venture capital, determinant, investment decision, uncertainty

**Paper type** – Academic Research Paper

## **1 Introduction**

In accordance with Mason (2020), the economic crisis created by the COVID-19 pandemic will cause a contraction in the supply of venture capital since investors will focus on supporting their existing investee companies and much less on new investments. This suggests that venture capitalists (VC) could change or revise the startup deal-sourcing process, introducing new determinants or giving the existing ones a different priority. The paper aims to investigate which determinants behind investment decisions are relevant for VCs in uncertain times.

A wide literature faces the issue of venture capitalists' (VC) ' investment determinants, however, to the best of our knowledge nobody has explored VC investment decision criteria during or after a crisis. The goal of our study is to generate a theoretical framework that brings together all the determinants behind VC investment decisions in startups, assessing the relevance of determinants in uncertain times. Specifically, we asked whether these determinants are subject to change during periods of high uncertainty, such as that generated by the covid-19 pandemic.

To answer our research question, we conducted a literature review drawing a taxonomy of VC determinants. In the literature review, we have recognized 4 determinants: localness, networking, startup industry and entrepreneurial team. Later this we have developed semi-structured interviews to test the relevance of identified determinants. Interviews are directed to 5 VC experts. Results show a relevant emphasis for the entrepreneurial team and networking determinants, while a moderate relevance for the localness and industry.

## **2 Theoretical background**

Venture Capital has been defined as one of the key figures in generating growth and innovation. Since World War II, the trend has taken hold in the United States, resulting in the entrenched growth of an outsized innovative entrepreneurial fabric. The role and functions played by venture capitalists in the development of entrepreneurship have been widely documented. Realities such as those in Silicon Valley (Ferrary and Granovetter, 2009), Route 128, etc., have been carefully studied and unpacked to understand the dynamics of such disruptive innovation, highlighting the added value brought by the VC. The literature showed that the main motivations behind investment decisions could be incorporated into four macro-categories that we defined as (1) Localness, (2)



Networking, (3) Startup Industry and (4) Entrepreneurial Team. Each of them will be examined in detail in the following paragraphs.

## **2.1 Localness**

Proximity between individuals increases the probability of establishing relationships of friendship and marriage (Bossard, 1932). Similarly, it has been postulated that as distance increases, in terms of spatial proximity, the likelihood of meeting and, therefore, establishing a social relationship decreases (Lazarsfeld and Merton, 1954; Blau, 1977; Blau and Schwartz, 1984).

Processes related to social networks can be borrowed to describe the structures of economic exchange relationships in physical and social space (Granovetter, 1985; Burt, 1992). Information about potential investment opportunities is closely linked to geographic and industrial spaces (Gupta&Sapienza, 1992; Norton&Tenenbaum, 1993; Langeland, 2007; Sorenson&Stuart, 2001). According to Sorenson and Stuart (2001) it is precisely the highly circumscribed flow of information to such "natural boundaries" that contributes to VCs' geographic and industrial investment location choices. This evidence can be linked to pre and post-investment activities: location, in fact, facilitates the discovery and evaluation of opportunities, as well as the possibility for VCs to join boards of directors (Lerner, 1995). Spatial proximity allows VCs also to monitor the companies they have invested in, provide additional services, and train the management team (Chen et al. 2010). Geographic proximity reduces the time costs of monitoring, considering that VCs spend half of their time monitoring and consulting (Sahlman, 1989; Gorman and Sahlman, 1989).

Cumming and Dai (2010) report that some VCs make their investment decisions based on the "20-minute rule", i.e. if a startup company seeking venture capital is not within a 20-minute drive of the VCs' offices, it will not be funded.

Studying venture capital clusters in three metropolitan areas (San Francisco, Boston, and New York) Chen et al. (2010) find the reasons behind agglomerations in three main factors: first-order agglomeration externalities (among venture capital firms), second-order agglomeration externalities (among the types of firms in which venture capital firms invest), and the historical artefact of the location of early venture capital firms in these cities.

Moreover, there are other relevant aspects related to "Localness", as we meant it. These are all those variables linked to a given Country's political, economic,

social, and cultural characteristics. Many scholars focused on macroeconomic aspects defined as sources of a country's attractiveness. These relate to: economic activity, capital market depth, taxation, investor protection and corporate governance, human and social environment and entrepreneurial culture (Groh et al., 2010).

VC firms also depend on the presence of a number of institutions to operate. VCs invest in countries characterized by technological, legal, financial, and political institutions that create innovative opportunities, protect investors' rights, facilitate exit, and ensure regulatory stability, respectively (Guler & Guillén, 2010; Powell, Koput, Bowie, & Smith-Doerr, 2002; Nahata, 2014).

Li and Zahara (2012) also argue that a nation's formal institutions influence the level of its VC activity; the more developed these institutions are, the more likely they are to reduce transaction problems and encourage VC funding. Where formal and informal institutions are weaker, as in the case of emerging countries (Jeng and Wells, 2000; Groh, & Wallmeroth, 2016), different levels of VC presence and investment will be inferred. There are other elements that influence investment decisions, such as the effect of M&A investment volume, the legal rights index, corruption, and innovation (Groh & Wallmeroth, 2016).

Another key aspect is the cultural difference; high differences in ethnicities (Bengtsson and Hsu, 2015), languages, values, and beliefs tend to decrease the likelihood of investment in a given country (Li et al. 2014; Buchner, et al., 2018; Nahata et al., 2014).

Cultural distance often increases agency problems and can negatively affect levels of trust, reputation, financial contracts, and business performance (Li et al., 2014 ; Nahata et al., 2014 ).

Other studies, however, emphasize that cultural differences can add value as it has been shown that VCs are likely to engage in a more intensive screening of potential investments for selection when investing in culturally distant nations, particularly in emerging economies, and that careful deal selection contributes significantly to VC success. In addition, the impact of local investor participation, which serves to mitigate problems arising from institutional and cultural disparities between countries, has been investigated by scholars. While the presence of local investors in VC consortia has a positive impact on firm success in developed countries, it does not affect firm success in emerging economies (Nahata et al., 2014).

## **2.2 Networking**

VCs develop strong ties with other VC firms, and within the industries they repeatedly invest (Sorenson & Stuart, 2001). The importance of networks to entrepreneurial success is widely documented. Scholars investigate the strength of established social relationships as a key to investment success with respect to VCs.

Venture capitalists develop strong ties with other venture capital firms and within the industries in which they repeatedly invest. Interpersonal relationships serve as the primary pathway that structures the transmission of information; the composition of social and professional relationship networks determines which actors learn of promising investment opportunities (Sorenson & Stuart, 2001). In addition, the direct and indirect network ties of financial intermediaries mitigate the effects of distance and local investment preference (Jääskeläinen, & Maula, 2014). Moreover, the centrality of the VCs' position within the network is also essential. Positional characteristics influence the likelihood of venture capitalists to invest not only locally but also outside their local industry and geographic boundaries. Central VC firms can leverage relationships to identify and evaluate distant investment opportunities.

Proximity within networks facilitates cross-border transactions, suggesting that distance from the network is a relevant dimension of distance in addition to its geographic and cultural dimensions.

Indirect ties mitigate the problem related to opportunity identification, which is important for IPOs. On the other hand, direct ties appear to serve as a conduit for information transfer, reducing the problems of assessing the quality of entrepreneurs and consequently facilitating IPO exits to markets to which the firm is connected.

Investors, who can connect to non-local markets despite distance, have less social distance from these markets and consequently can obtain better information from them. In addition to mitigating the local bias based on geographic distance, network ties also mitigate the bias based on cultural distance (Guiso et al., 2009). Again, it emerges from the literature that in cross-border investments, entrepreneurial firms supported by international and local VC unions are more successful than those supported by either one or the other. This suggests that an investment criterion could be based on the complementarity of local and international VCs (Chemmanur, Hull & Krishnan, 2016).

The relevance of interpersonal relationships is further highlighted by the need to establish trust mechanisms within networks (Bottazzi et al., 2016).

### **2.3. Entrepreneurial Team**

Before deciding to invest in a new venture, VCs thoroughly examine the personality and experience of the entrepreneur to ensure that the entrepreneur has the characteristics and qualities required to thrive in the competitive business world (Dhochak & Sharma, 2016).

In a study of a sample of Indian VCs, what emerged was that Indian venture capitalists focus on the personality of the entrepreneur as it reflects their commitment to the project; they also evaluate the entrepreneurs' leadership skills and track record (Dhochak & Sharma, 2016).

In addition to the entrepreneur's leadership skills and personality, an interesting analysis conducted by Warnick et al (2018) , highlights the importance of entrepreneurs' passion, in terms of product passion and entrepreneurial passion. The likelihood that an investment by VCs will be made increases due to passion for the product rather than entrepreneurial passion. Another important factor is the role played by openness to feedback in elevating the attractiveness of perceived passion for the product and entrepreneurial passion in the eyes of investors. The latter element mitigates investors' concerns that unbridled passion will result in entrepreneurial ego, rigidity, or resistance from the investor, the market, and other key stakeholders (Warnick et al, 2018).

### **2.4. Startup Industry**

VCs tend to specialize in specific industries, thus developing expertise in a particular field that allows them to generate more value for the startups and for the VCs themselves (Zhong et al., 2018).

Firms' market sectors are important factors when evaluating investment deals (Tyebjee and Bruno, 1984). Indeed, "industry" spaces represent the natural boundaries where a large information flow about potential investment opportunities develops.

Some VC firms, in fact, specialize in making investments within a particular industry, while others diversify their investments across industries, adopting a

more generalist approach. In general, the performance of specialized VCs appears to be better (Gompers et al., 2009; Hochberg et al., 2015).

In addition, specialization in a particular industry grows experience in parallel, which causes a VC specializing in a specific industry to extend the network of personal contacts among entrepreneurs and other investors in that sector. With a large number of contacts, VCs can identify new investment opportunities (Sorenson & Stuart, 2001). In addition, the more experience the VC has within the target industry, the more industry-specific experience and industry-specific social capital the VC can provide.

### **3 Methodology**

#### **3.1 Method**

We apply the expert interview methodology. The interview is an attempt to obtain systematic and complete information by an expert who possesses certain valid pieces of knowledge and information that is not available to the researcher (Bogner and Menz, 2009). More precisely we conduct a systematizing expert interview to have access to exclusive knowledge possessed by experts (Gläser and Laudel, 2004; Bogner and Menz, 2009) concerning investment determinants and their degree of importance in uncertain times. Interviews are conducted at the level of investment executives upwards, including assistant directors and directors of VC funds. We select 5 VC experts from qualified VC companies with national experience. We in fact started to explore the phenomenon in the Italian scenario. Interviews are semi-structured, and questions are constructed on the basis of available literature, which focuses on the following determinants: localness, networking, entrepreneurial team and startups industry.

##### *3.1.1 Sample of experts*

Table 1 shows a systematic overview of experts. Each of them has a broader national experience. Their company provenance is variegated.

Expert 1 is the CEO and founder of Vertis SGR spa, a dynamic and independent (private) asset management company. His company operates through six closed-end investment funds, reserved for qualified investors, taking on investments in research projects, spin-offs, startups and SMEs and is the reference for investments in innovative Made in Italy. The firm deals with private equity and

venture capital. Venture capital invests with the "Vertis Venture", "Vertis Venture 2 Scaleup", "Vertis Venture 3 Technology Transfer" and "Vertis Venture 4 Scaleup Lazio" funds.

Expert 2 is a strategic and financial advisor for startup, private and public funds. He has a long standing experience in Italian VC funds, particularly seed capital funds. He has been following the Southern ecosystem of startups for years and collaborates with universities, research centers, trade associations, regional finance companies, accelerators and incubators in the main central and southern regions.

Expert 3 is an investment analyst in CDP Venture Capital SGR. The company aims to expand direct and indirect investments, overseeing existing funds while encouraging the emergence of new funds to support the Italian ecosystem startups. More specifically the interview analyst deals with bringing together companies, investors and startups for exchange of high tech ideas and pursue new opportunities.

Expert 4 is a procurement and innovation manager for an Italian Corporate Venture Capital fund. The manager is an expert in seed startup and later stage venture capital. The fund invests in the most promising digital startups with a strong fit with the business strategy.

Expert 5 is an investor manager at LUISS Alumni 4 Growth, the Investment Club of Luiss graduates managed in advisory mode on individual potential club deals, by a company wholly owned by the Luiss Guido Carli University. The Club promotes four to six annual micro-seed investments in Luiss-related startups. Investments prevalently concern Italian startups, however the founder team could be composed by foreign students

Table 1. Sample of expert

Expert ID	Expert position	Company	Interview duration
1	Founder and CEO	Vertis SGR spa	45 minutes
2	Strategic and Financial Advisor	Various banks and incubators	90 minutes
3	Investment analyst	CDP Venture Capital SGR	60 minutes

4	Procurement and Innovation manager	Corporate Venture Capital	30 minutes
5	Investor Manager	LUISS ALumni 4 Growth	30 minutes

## 4 Results and Discussion

Results of expert interviews are illustrated in table 2. The table reports key quotations grouped in four determinants (localness, networking, industry sector and entrepreneurial team), as well as quotes on Covid pandemic issues.

Table 2. Quotations

Expert ID	Determinant	Quotations
1	Localness	<i>"[...]the geography impacts on competencies"</i> <i>"There is a Nord-Sud gap. [...] the Sud gap enables a discount rate for investor"</i>
	Networking	<i>"[...]be part of a network, particularly be part of an accelerator, or in order to facilitate the VC approach to the startup"</i>
	Industry sector	<i>"Distinctive technology rather than the sectors is a key determinant"</i>
	Entrepreneurial team	<i>"The founder competencies and experience is a leading determinant"</i> <i>"[...]having had experience in successful consultant companies such as McKinsey means be prepared to face constantly challenge"</i> <i>"Being a serial entrepreneur is a positive signal"</i>
	Others	<i>"Covid has stressed the relevance of the entrepreneurial team. The particularly mature team have been more agile to face the crisis"</i> <i>"[...] Covid has downsized the startup evaluation"</i>
2	Localness	<i>"The localness is relevant, however the entrepreneurial team prevails [...]"</i> <i>"The legal framework is key aspect...it is a crucial aspect of the Italian context where investment are slow and complex"</i> <i>"The localness impacts on the education and on professional experience [...], in the Southern Italy there isn't top business schools, or top consulting companies, or big companies"</i> <i>"Localness is relevant for the seed capital investment"</i> <i>"National sub-culture impact on the deal process [...]"</i>

	Networking	<i>"the network is crucial to build a trust relationship" "[...]having a business angeli is a pre-condition to access at a first round of investment"</i>
	Industry sector	<i>"The industry sector is relevant for specialized funds, otherwise there are other core elements: the products/services, the traction, the market and the competitive advantages"</i>
	Entrepreneurial team	<i>"People lead the investment choice [...]" "Team competencies and experience are relevant, however soft skill such as speaking in a concise and persuasive way is really important", "The entrepreneurial team should know the right manner to interface with VCs" "Education background and professional experience make the difference"</i>
	Others	<i>"Covid has addressed new investment in covid related firms to re-launch promising businesses[...]"</i>
<b>3</b>	Localness	<i>"We believe in people before their idea[...]" "[...]few startups propose really an innovative idea, thus people make the difference" "The localness impact on the funds reasoning process, but not particularly in the VC deal processing, first of all if the fund is an institutional fund" "The localness could be a relevant determinant for private investors, not institutional" "The fiscal framework is a limit for the italian startup and VC scenario"</i>
	Networking	<i>"Being part of an incubator is relevant [...]particularly for deep tech startups" "After the team, we look at the startup network [...]" "There is another determinant from our point of view: the fundraising. Before investing, for us is relevant that other people believe in the team and in the idea"</i>
	Industry sector	<i>"The industry is relevant for private investors, institutional investor tend to trigger horizontal process in the startup ecosystem"</i>
	Entrepreneurial team	<i>"Education background and professional experience is not so relevant" "We observe the team credibility and their soft skill"</i>
	Others	<i>"Covid has accelerate the decline of sick startups...however it has encouraged some funders and some investors in starting a new path for the growth"</i>



4	Localness	<p><i>"Proximity is essential... it is necessary to easily organize meetings and strengthen relationships and trust"</i></p> <p><i>"The context in which the startup is located is certainly relevant to its success. A successful startup is unlikely to be placed in an unfavorable context."</i></p>
	Networking	<i>"The networking is not a priority...for us is more important the market, not the network"</i>
	Industry sector	<i>"A great idea can be independent by the sector [...]"</i>
	Entrepreneurial team	<i>"People are fundamental, indeed the team is fundamental. If the idea is proposed by an individual it will never be selected. "</i>
	Others	<i>"Covid has not influenced particularly trends or industry, but it has stressed the relevance of the proximity to the firms"</i>
5	Localness	<p><i>""Geographic proximity to target companies influence our investment decision"</i></p> <p><i>"Being proxime to other VC funds is important"</i></p> <p><i>"The economic and financial market are relevant for investment outside our target market (Italy)"</i></p> <p><i>"The legal system influence investment decisions, particularly the fiscal system is very important"</i></p> <p><i>"The level of innovativeness of the region in which startup is located influence affect our decision"</i></p>
	Networking	<p><i>"Founder personal relationship affect our investment decision"</i></p> <p><i>"From our point of view is very important that the investor and the entrepreneur attended the same educational institutions, or the same professional and trade association"</i></p>
	Industry sector	<i>"The industry proximity between investor interest and startup is relevant in the deal process"</i>
	Entrepreneurial team	<i>"The passion of the entrepreneur is moderately relevant, while the leadership and management skills are really important"</i>
	Others	<p><i>"The political stability is relevant for investment during the Covid period"</i></p> <p><i>"The Covis pandemic brought out new trend, i.e sustainability"</i></p> <p><i>"Entrepreneurial team influence investment decisions by a VC fund particularly during the Covid pandemic"</i></p>

Expert interviews confirm the relevance of some of the determinants identified. Particularly the entrepreneurial team and the networking are considered relevant respect to industry sector and localness. Experts in fact appear to agree on the relevance of the entrepreneurial team. Differently from Warnick et al (2018), rather than passion for the idea, investors consider really relevant the personality of the entrepreneur, leadership skills, the track record (Dhochak & Sharma, 2016) and the educational and professional background. However a difference concerning the team background may happen depending on the nature of the fund, private or public.

Networking is a further key determinant. Similarly to Chemmanur, Hull and Krishnan (2016) an investment criterion could be based on the complementarity with other startups' investors such as business angel, incubators, seed capital funds. More than networking some interviews suggest to use as a determinant the fundraising, thus the network of investors. In addition the need to establish trust mechanisms within networks (Bottazzi et al., 2016) is confirmed.

The localness and the industry sectors are considered less relevant than others. Differently from Gupta and Sapienza (1992) or Sorenson and Stuart (2001) the localness is seen as a moderator of the entrepreneurial background. Experts agree in considering localness as a driver for founders competencies, but less as a driver of the investment choice. However, the regional location of the startup could affect the fiscal system, thus may encourage or discourage mainly private investors in their decision.

The industry sector turns out to be the least relevant. Some experts assume the industry is a key determinant for specialised funds or private funds, not for institutional funds. Instead industry experts suggest other determinants such as the competitive advantage and the value proposition.

Concerning the relevance of certain determinants in uncertain times, experts agree that the Covid pandemic has even more increased the importance of the team. Particularly their ability to react and organize the startup with an agile approach.

## **5 Conclusions**

Our paper contributes two folds: i) it enriches the strand of literature investigating the VC role in ecosystems by providing an original perspective about the VC decision making process in uncertain times; ii) propose a taxonomy

of VC determinants. Furthermore, the study may reveal implications for entrepreneurs that intend to receive a VC investment.

Several limitations affect the paper and concern mainly the tiny sample dimension and the national experience of experts. However, in the near future we will enlarge the sample involving international experts and revise some dimensions adding a determinant for the startups' value proposition.

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## **Creative Industries as Key Partners for Blue and Green Growth in the Baltic Sea Region: A Modern Guide Towards Sustainable Regional (Cross)Innovation in SMEs**

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### **Abstract**

Since the last three decades Creative industries (CIs) have seen a sharp rise in their development. They became a central element of modern economy. Nowadays, discourses on CIs are mainly led by their distinctive contribution to different spheres of social and

economic activity: economic growth, new jobs, social cohesion, innovation and competitiveness of companies. Paradoxically, despite compelling calls for the promotion of CIs, their integration success remains rather elusive. In fact, on the one hand knowledge transfer from CIs to other industry sectors is underused, potential unexploited and synergies between CIs and other sectors arriving at innovation limited. In addition, low cross-sectoral collaboration and engagement of CIs in co-creation activities are linked with lack of awareness from both sectors, differences in communication and working methods. On the other hand, traditional industry sectors, such as maritime or production industry record low innovativeness, suffer from pressure resulting from environmental impact and necessity to provide sustainable solutions. In the face of the European Green Deal objectives to be reached by 2050 and contribution to the Agenda 2030 of the United Nations, sustainable innovation and development become the epicentre of the European future related discourses. In this light, the paper addresses research-to-practice problem pointing to the missing theoretical and practical foundation for cross-sectoral collaboration partnerships and tangible results thereof within the regional geographical nexus in which creative economy and CIs are getting an increasing importance. In particular, using real-life innovation prototyping projects as implemented in the South Baltic Sea Region (SBSR) in the frame of the cross-border project "CTCC – Creative Traditional Companies Cooperation" (July 2017–June 2021) that is part-financed by the European Regional Development Funds (ERDF), 32 traditional industry Small and Medium-Sized Enterprises (SMEs) from blue (ports, shipping, shipbuilding and tourism) and green (nutrition, renewable energy, recycling) economy sectors engaged both in formal and informal collaboration modes with CIs. The present research delivers particularly managerial contributions by showcasing how enterprise managers and innovation developers can engage into cross-sectoral innovation development through real-life prototyping along with CIs, what tools and processes help them to chop their way through the undergrowth in the frame of innovation development project as well as how tangible results can be achieved and ramped up. From the theoretical perspective, the research gap on cross-sectoral collaboration with CIs and co-creation for innovation is decreased as well as the focus on CIs as innovation brokers and intermediaries on a firm-level strengthened.

**Keywords** – Creative Industries, cross-innovation, traditional SMEs innovation, regional development, co-creation (*max 5 words*)

**Paper type** – Academic Research Paper and Practical Paper

## 1 Introduction

By no doubt creativity is key source of competitiveness, innovation and growth. Recent developments and discourses touched upon sustainable development, inclusion, resilience and recovery brought creativity and thus Creative Industries back on stage. For this reason, the United Nations Conference on Trade and Development (UNCTAD) has dedicated 2021 as the International Year of the

Creative Economy for Sustainable Development, with high potentials of Cultural and Creative Industries (CCIs) contribution to the achievement of the Sustainable Development Goals (SDGs) of the United Nations (UN). Similarly, new institutional arrangements were introduced to support better proaction and reaction to faced complex societal, environmental and global problems, such as the New European Bauhaus Initiative launched in 2021. With fancy words as co-creation and co-design, new European ways are searched for to fix and reinforce sustainable development and find new avenues for Europe's competitiveness and way out of the lockdown.

Bearing this in mind it becomes clear that new tangible and hands-on instruments and solutions are needed to reignite and inspire key economy drivers – Small and Medium Sized Enterprises (SMEs) in Europe. This seems, however, to be a Sisyphean task on the European level. A more dramatic picture arises comparing the calls for CCIs (re)ignition on the longitudinal axis: EU underpins growing role of CCIs for innovation, sustainability and inclusion from 2010 onwards, in particular with the release of the Green Paper "Unlocking the Potential of Cultural and Creative Industries" (EC, 2010). In the Council Conclusions as of 2015 on CCIs cross-over effects aiming at innovation, economic sustainability and social inclusion it is stressed that "(...) there is a lack of awareness of the potential of combining arts, culture and creativity with technology, science and business, as well as insufficient exchange of good practices. In particular, the *catalytic effect* of culture and the arts on innovation in all sectors is still underestimated and thereby underused; (...) sectors and policies are still often organised in silos, thus limiting the scope for synergies and the emergence of innovative solutions (...)." (2015 / C 172/04, p. 13). The policy supports that there is a growing need to establish brokering and collaboration networks between CCIs and other sectors to drive innovation, parse market potentials and perceive creativity as an asset in the entire ecosystem (EC, 2018, p. 1; EC, 2019, p. 25).

Acknowledging this potential, CCIs shall play more crucial role in the future. This is already articulated by different institutions on the European level, national, transnational, cross-border, regional and local. To start with, the new EU Communication on "A New Industrial Strategy for Europe" (2020) addresses the challenges and points out that the way things are designed should be revolutionised, apply circular economy principles, and co-create via Public-Private Partnerships to help industry to develop technologies to meet their goals. In



addition, with the European Innovation Council that has started in 2021, a new place-based innovation and innovation should be encouraged. This would allow regions to develop and test new solutions with SMEs and consumers, drawing on their local characteristics, strengths and specialisms (EC, COM (2020) 102 final, p. 10). Similarly, the call for sustainable products' design was reinforced with "A new Circular Economy Action Plan for A Cleaner and More Competitive Europe" that amplifies the need for addressing aspects of products' sustainability and sufficient design in terms of circularity already at the design and value chain management stages (EC, COM (2020) 98 final, p. 3).

Against this background, the present research postulates itself somewhere on the crossroads of traditional innovation development and a growing interest on CCIs catalyst and brokerage effects in the regional nexus – would they act as drivers, connectors or integrators for the purpose of sustainable innovation development and search of problem / idea solutions of economic agents (Colombo et al., 2015; Gassmann et al., 2011; Bonetto et al., 2014; Halevy et al., 2019; Obstfeld, 2017; Sdrali, 2020). In contrast to a series of research papers, this research focuses on revealing potential of Creative Industries (CIs) only, meaning that only design, architecture, advertising and software and games are under scrutiny as key CIs sectors according to the taxonomy of the EU, leaving sectors of culture, such as museums, film, etc. outside the research nexus. More specifically, the researchers address the research gap following Bakhshi & McVittie (2009) and raises the research question (RQ) on how CIs can practically engage into innovation with traditional businesses (blue and green regional SMEs) and develop tangible innovation solutions' prototypes via co-creation and cross-collaboration?

In order to answer this question, the research utilises the action research and uses 33 innovation prototype journeys involving both CIs and traditional blue (marine resource-based) and green (ecology and circular economy driven) SMEs from the Interreg South Baltic Sea Region (SBSR). During a 17-month prototyping phase, 33 innovation prototypes were developed in the field of product, service, business modelling and marketing. All of them make a sound contribution towards improving regional performance of involved SMEs from Germany, Lithuania, Poland and Sweden. Against this, this pioneering project serves as a result-rich pilot establishing a bridge between CIs and traditional industry sectors in Europe and paves the way for hands-on actions leading to sustainable innovation development and regional growth. Therefore, this study contributes to

policy-driven managerial discourses supporting practical co-creation and cross-sectoral collaboration for innovation via formal and informal cross-sectoral collaboration modes as well as reduces the research gap on CIs potential for regional economy on macro (regional) and micro (firm level).

Following this endeavour, the paper starts with comprehensive positioning of the research in the theoretical domain, continues with the overview of the methodological journey and presents the achieved results – how practically both sides – CIs and traditional industry SMEs can deliver innovation outputs. Next, research achievements are elaborated on in the topical context and future research trajectories delineated.

## **2 Laying the groundwork: A cross-perspective in the theoretical realm**

In the macroeconomic paradigm innovation is a key to economic growth and welfare. Looping innovation discourse, creativity acts as significant ingredient for innovation, as coined by Schumpeter. It is a process of “creative destruction” – new ways using existing means, materials and methods. Something new can be created not from regular basis, but rather from something that is new to the existing value system of static economy. New is a new kind. It is also using and / or employing something in a new manner, thus carrying out new combinations (Schumpeter, 1911, pp. 409-410). Innovation means creativity plus exploration (O’Sullivan and Dooley, 2009, p. 8). Creativity is essential part of innovation, thus implying growing needs to determine needs to determine methods, which could be used to generate more and better ideas, which then could be commercialised, thus turning into innovations (von Stamm, 2008, p. 2). To utilise creativity for innovations, there is a need to locate and utilise it within the process, i.e. ideation, development and commercialisation, innovation being an output thereof. The creative process goes further than the simple production of visual outputs, as design is inserted into many areas of management decision-making. Design is an internal management process that integrates market research, marketing strategy, branding, engineering, new product development, production planning, distribution and corporate communication policies (de Mozota, 2003, p. 18). Much more, design process can facilitate innovation potential of a conceptual solution with a set of elements, so-called innovation vectors and improve the decision-making process for a given design problem (de Bassi Padilha et al., 2017,

p. 59) and reveal avenues for companies to consider and integrate preferences of customers and experts for product innovation through prioritisation and evaluation of product design factors (Yu and Li, 2021, p. 13). Indeed, the recent literature confirms that innovation is an outcome of scientific activity and creativity, and that the combination thereof is a key to innovation (Cerisola, 2019; Chapain and Strykiewicz, 2017; Rodriguez-Pose and Lee, 2020, p. 1).

However, the relation between CIs and other industries should be perceived through the lens of knowledge spill-overs (Bakhshi and McVittie, 2009; Caves, 2000; Santoro et al., 2020). These, in turn, emerge as an outcome of formal and informal collaborative modes between CIs and other firms, networks (Ferraris et al., 2017), strategic alliances (Chesbrough, 2006; Zollo et al., 2002) or even user-communities (Prause and Thurner, 2014). Therefore, when exchanging and transferring knowledge, methods, tools and perception of the environment from the own perspective, CIs and other sectors engage into cross-sectoral collaboration and develop a cross-innovation process (Bresciani et al., 2017; Enkel and Gassmann, 2010). A cross-innovation has numerous advantages, starting with competitive advantage and improved business performance (Almeida and Kogut, 1999; Matejun, 2018; Powell et al., 1999), higher level of innovation (Bellantuono et al. 2013; Laursen and Salter, 2006; Santoro, 2017; Stuart 1998) and a sound contribution to environmentally friendly solutions (de Medeiros et al., 2014) and eco-design (van Hemel and Cramer, 2002).

Indeed, making the case of cross-industry collaboration, which encapsulates cross-disciplinary co-work, co-creation and thus cross-sectoral collaboration is beneficial to all involved parties. It implies on the one hand and is governed by on the other hand by causality and interdependencies among nature, people and agents (companies). Likewise, these co-exist, co-create and co-evolve in the common setting geographical region, economic agglomeration and bounded micro-sphere – companies. Interdependency includes also aspects of physical and intangible assets (infrastructure), institutions, sources of knowledge, human capital interactions and spill-overs and network effects (Audretsch et al., 2016; Jackson et al., 2017). As a result, co-creation and cross-sectoral collaboration shall be reviewed from the perspective of entrepreneurial ecosystems, where people, materials, good and activities under different governance patterns reconcile (Colombo et al., 2019) and enable development and growth of dynamic, goal-driven communities, characterised by complexity, dynamism, adaption and emergence perspective (Gobble, 2014). Cross-sectoral collaboration enables

cross-innovation, since it is based on interplay of strong relations that presuppose collaboration, trust and co-creation of value and share of complementary technologies and competencies (Durst and Poutanen, 2013; Frow et al., 2015; Payne et al., 2008).

Bearing in mind the potential of CIs for regional SMEs, benefits for regional innovation and thus regional growth from cross-sectoral or cross-industry collaboration become huge. Integration of diverse perspectives might result in reciprocal benefits, strengthening inclusion, holistic perception of a problem or solution.

### **3 Methodology**

The research approach is of qualitative nature, dominated by a qualitative paradigm (Silverman, 2020). The research pinpoints the social construct's domain, as it deals with regional enterprises and innovation development. Taking the research gap under scrutiny, we might use the arguing of Creswell (2014), who contends that if a concept or phenomenon needs to be explored and comprehended, since only scant research on that has been done, then qualitative approach appears to be feasible. Additionally, qualitative research is especially useful when the researcher does not know the important variables to examine (p. 50).

Therefore, the impetus of inductive reasoning and thus aimed conceptualisation supports the use of the overall methodological approach (Gioia et al., 2013). An action research approach was employed throughout the entire research trajectory (Eden and Huxham, 2006; Foss and Moldenæs, 2007; Maestrini et al., 2016; Susman and Evered, 1978), as the research lasted for a longer period and the research results were recalled and reconciled in several progress phases. It is a suitable approach for the present research, since it is able to provide a way to act in a holistic and complex way. It supports a dualistic and dialectic view employed here and discussed above and opens up opportunities to bridge both science and practice. Furthermore, it enables to intertwine different research methodology categories (Zhang et al., 2015, p. 151). This is also the case in the present research. Action results is applicable, since the researchers of this paper were directly involved in the ongoing projects as innovation brokers – creative brokers – and undertook an observation and assessment of a real-time innovation prototyping within and with local and regional SMEs. Learning cycles in the frame

of the action research that were integrated in the upcoming research activities constituted also an important research component (Gustavsen, 2005, p. 281). The aggregated research trajectory can be summarised in the following way:

Table 1: Research Trajectory Overview

<b>Research scope</b>	<b>Interreg VA project CTCC – Creative Traditional Companies Cooperation</b>
Geographical coverage	South Baltic Sea Region – Danish, German, Lithuanian, Polish and Swedish coastal regions
Research scale	33 prototypes developed for 32 traditional SMEs
Research approach	Inductive
Research methods	Shadowing, co-creation, expert interviews
Research data	Qualitative
Research techniques	Data analysis, coding, decoding, explanation building
Research validation	external validity by innovation experts and policy makers in the frame of pitching ideas

Wrapping up the research journey we claim that we underpin the qualitative research methodology by integrating the so-called actor's approach (Arbnor and Bjerke, 2008). The research deals with reality and real challenges of SMEs addressed within the applied research project. The reality is socially constructed including and integrating stakeholders, participating and constructing sense-making and understanding (Lincoln et al., 2011).

The researchers disclosed their bias through the participation in the project as leading researchers and encountered this through involvement of experts in validation of the results as well as presentation of the intermediate results to direct target groups – regional SMEs.

## 4 Results

At the core of the CTCC project, there is cross-border and cross-sectoral collaboration across disciplines, industry sectors, institutions, performance areas, geographical regions and socio-economic contexts. Indeed, this bears higher success for the project, as cross-sectoral, interdisciplinary and cross-institutional cooperation might lead to higher innovation outputs, where all possible different perspectives are merged together to deliver the value to customers and users, thus meeting their expectations and avoiding any unpredicted effects or negative implications on environmental, technological, market and social levels. In

particular, the project delivers 33 tangible innovation solutions – innovation prototypes in product, service, marketing / branding and organisational level. This is achieved within the innovation development project – the so-called “Creative Auditing” that is done in the frame of minimum 17-month lasting project phase by interdisciplinary teams, where traditional sector SMEs cooperate and engage in innovation development together with start-ups, SMEs and freelances from the mentioned Creative Industries.



Figure 1: Creative Audit Tool for Cross-Sectoral Innovation in Traditional Industry SMEs  
(Source: Laima Gerlitz, 2020)

Creative Audit Tool (Figure 1) was applied during the innovation prototype development phase that took place more than 17 months out of 36-month project length. In synopsis, the project applied a holistic and multidisciplinary approach, where several key tools and methods from the innovation development, creativity and design management were applied. The Creative Audit Tool supports contribution towards development of specific mechanisms and tools that stand behind innovation processes (EC, 2010, p.17). Indeed, current research shows only a very limited record when it comes to practical tools for

SMEs, e.g. design audit tool by Moultrie et al. 2007. Yet, also existing, these tools mostly concern new product development, does not consider recent industry and transformation trends, i.e. digital transformation and Industry 4.0, as they were developed before industrial changes occurred. In addition, scrutinised approaches remain too theoretical and provide only auditing strategies without any specification of practical implications (Gabl et al., 2016), static tools without a process orientation that deliver status quo (Baumgarth et al., 2016) or are oriented towards organisational culture only, i.e. on branding and brand audits (Marrs et al., 2011; Wallström et al., 2008).

By contrast, at the core of the CTCC the delivered Creative Audit Tool there is a traditional SME that by bypassing specific steps and applying given appropriate methods is able to arrive and solid, tested and sustainable innovation output – would it be product, service, organisational improvement, e.g. change management or application of new organisational procedures and methods which optimise SME performance, or a business model aiming at improving SME's positioning, differentiation and diversification efforts through targeted marketing and branding activities. Significantly, it differs from other similar tools, as it underpins innovation character. Innovation is regarded as a key towards transformation. The tool is universal, it can be used for any kind of innovation development, a problem / challenge solving or company idea maturing. Creative brokers act within the innovation process as "owners" of the Creative Audit Tool, who are responsible for guidance, counselling between creative and traditional sectors, monitoring the progress in innovation, control and evaluation. Since innovation is a process that requires high complexity, the tool serves also as facilitator and bridge of diverse processes, actors and stakeholders meeting in innovation development. In particular, having an external source of innovation – Creative Broker – a new perspective outside of SME is integrated.

In the following, the research summarises how Creative Brokers support innovation development in selected SMEs from Germany, Lithuania and Poland, and thus contribute toward Blue and Green Growth in the region and in the EU (Table 2). The selected cases display balanced geographical coverage (Germany, Lithuania and Poland), followed by the principles of cross-sectoral balance and balance regarding innovation output (product, service, business model, organisational innovation). Finally, the balance was kept when revealing contribution for both – Blue and Green Growth in the innovation paradigm of the EU. The present paper showcases only results of nine selected SMEs based on the

fact that by the finalisation of this research, that was hampered by the COVID-19 pandemic outbreak, only these nine prototypes were fully fledged and the prototype development cycle closed. For the purpose of presentation, SMEs names were anonymised in order to safeguard confidentiality and data protection. This does not affect research results.

Table 2: Selected Cases of Creative Audit Tool Application & Collaboration with Creative Brokers for Blue Growth Innovation in Traditional SMEs (Source: CTCC project, 2020)

Organisational Level		Creative Audit Tool Application (process level)			
Traditional Sector SME	Traditional SME Expertise Field	Product Innovation	Service Innovation	Organisational Innovation	Marketing & Branding (Business Model) Innovation
<b>SME 1</b> <b>Neustrelitz,</b> <b>Germany</b>	Sustainable agriculture	Online platform			Digital business model (pricing & service components for digital marketing)
<b>SME 2</b> <b>Rostock,</b> <b>Germany</b>	Sustainable food		Online platform for customers pre-ordering products and picking them up in the physical store)		
<b>SME 3</b> <b>Rostock,</b> <b>Germany</b>	Small wind energy plants		Online information tool as part of overall strategy		Improved communication strategy
<b>SME 4</b> <b>Klaipeda,</b> <b>Lithuania</b>	Food industry, production			Development of identity & communication channels for a start-up	Presentation of SME for exhibitions
<b>SME 5</b> <b>Klaipeda,</b> <b>Lithuania</b>	Maritime transport & shipbuilding	Smart catamaran using solar	Sustainable ride sharing solution on the water		



Organisational Level		Creative Audit Tool Application (process level)			
Traditional Sector SME	Traditional SME Expertise Field	Product Innovation	Service Innovation	Organisational Innovation	Marketing & Branding (Business Model) Innovation
		power	(rental service)		
<b>SME 6</b> <b>Klaipeda,</b> <b>Lithuania</b>	Maritime transport & shipbuilding				Open innovation space for creative industries
<b>SME 7</b> <b>Elblag,</b> <b>Poland</b>	Heat pump manufacturer		Heat pump packaging	Development of corporate identity & communication channels	
<b>SM8</b> <b>Elblag,</b> <b>Poland</b>	Sport kayaks for kids	Three visually differing kayaks			Customisation of product
<b>SME 9</b> <b>Elblag,</b> <b>Poland</b>	Solar energy installations on roofs				Animated video showcasing product for potential customers

Taking a closer look on the selected nine SMEs that were engaged in cross-sectoral development, it can be concluded that most innovations occur in the organisation and service dimension. Though, some SMEs enter also into cross-sectoral innovation to develop novel products not existing on the market – either in the blue or green sector, e.g. SME 1 in Germany, SME 5 in Klaipeda or SME 8 in Poland. In all participating regions, concerned SMEs were engaged in product development, despite regional dimension, i.e. urban agglomeration (Rostock, Klaipeda) or remote regional surroundings (Elblag). The necessity to develop new products results from any missing alternatives, as SMEs producing them enter the new arena and act as first movers. In addition, SMEs developing products engaged into the project as a result of missing resources, either human or financial, or limited capacity and capabilities to apply creative tools. With the

CTCC project, manufacturing SMEs were mainly supported by providing them with creative human resources (e.g. designers), creative tools applications (visualisation, aesthetic appearance) and user-driven approaches (customer / user engagement, tracking of their buying behaviour, engagement).

With creativity potential utilised, traditional SMEs are able to better build up their competitive position with new products and strengthen it by accompanied service or business modelling orientation, thus paving the way for an expansion of their market positioning and reaching out new customer groups. Such companies use cooperation with Creative Industries to increase their productivity, resource efficiency, integrity of products with social, environmental and technological dimensions. Interestingly, by aiming at introducing innovations, such SMEs set out also at enhancing their business portfolio with new business models or branding activities in the experience field on the one hand, i.e. how SMEs can better deliver the offerings to customers and users and represent them via different channels, e.g. networks, exhibitions, etc. On the other hand, this group of SMEs concentrate on services that accompany their products, e.g. online digital tools to use, test the product, or functionality improvement, e.g. when changing the product packaging. As a result, manufacturing SMEs do not longer focus solely on product development itself, but treat innovation development as a bundle of outputs, residing in organisational (business performance, differentiation, positioning and branding) and market (customer / user engagement) fields, going beyond the operational internal business system.

When it comes to SMEs aiming at developing new business models or enhancing their marketing capacity and brand building, such SMEs tend mostly utilise creative potential in order to better understand and integrate their customers and users, e.g. SME 3 from Rostock, SME 6 from Klaipeda or SME 8 from Elblag. SMEs capitalise from creativity, since it enables "translation" of SMEs products and services into the language that is understandable for its customers and users (visual, interactive and user experience driven design utilisation). In this light, the current research confirms the available research outputs highlighting that so far maritime and green industry tend to engage into cooperation with Creative Industries for the purpose of design and capitalisation of marketing instruments for traditional SMEs (e.g. Innobarometer, 2016). In spite of the number of scrutinised SMEs in the following table, the current research is optimistic about the expanding boundaries of traditional business cooperation with Creative Industries, where design becomes an integral process of an SME, a

strategic resource that streamlines SME performance, the mushrooming thereof visible with SME 6 in Klaipeda that acknowledge the role of design and creativity for maritime industry and uses them as a driver for new spin-offs, industry settling and similar. In this, design is used not only for aesthetical appearance and visualisation, but for strategic management purposes. Overall, the development of new products is the most predominant innovation type, followed by service and business modelling innovation. This insight bears a huge potential for the regional economy growth, since SMEs are open to innovation. The majority of start-ups and small enterprises concentrate on product development or its improvement, whereas those who have products aim at better customer / user satisfaction, strengthening market positioning and value generation. Indeed, this is mainly achieved through product servitisation and opening up new horizons with tailored made business models. With this, Creative Industries are able to support traditional manufacturing SMEs in engaging new partnerships and providing with opportunities for collaboration (EC, 2018; EU, 2016).

## **5 Discussion and concluding remarks**

Indeed, as the current project results showcase, innovation development and capacity building in traditional sector SMEs deliver multiple effects and are in line with some relevant key trends on scientific and policy discourses. In particular, by enhancing product portfolio with business models SMEs increase their competitive edge and customer satisfaction. With that, SMEs are more flexible to move on the market and / or adapt to the changing market conditions – transformations, in particular, when digital services are at the core of SMEs' business portfolio. These potentials have been recently highlighted by the topical policy papers on CIs (European Commission, 2019, p. 49; European Commission, 2019, p. 7; COM(2018) 267; European Parliament, 2016). In this line, development of product-related services strengthens SMEs performance, in particular long-term profitability, brand development, their differentiation and positioning on the market. With their improved innovation capacity in the service product and portfolio, regional SMEs are capable also to improve their organisational culture, which is crucial in transformation, as the recent research shows (Bustinza et al., 2017; Gerlitz, 2017) as well as underpins marketing and brand building through customer loyalty to an organisation and its system of values. Indeed, the recent European reports on clusters and industrial change pinpoint CIs as being one of

the ten future emerging industries, which are better equipped to response to uncertainty, potential utilisation, employment growth (European Union, 2020). In addition, regional SMEs learn to engage in new business partnerships with Creative Industries and benefit from application of sector-wide tools and methods within the innovation development. Importantly, SMEs get access to knowledge and information, which is not residing in-house, which makes them stronger in their performance, as pinpointed in the study implemented by the KEA (European Commission, 2019, p. 49).

In sum, the CTCC platform and network has seen so far positive results from cross-sectoral collaboration and innovation development on a short-term, where innovation prototypes are developed with SMEs. It was clearly demonstrated that, although not simple, cross-sectoral collaboration leads to success – tangible solutions, improved capacity building, absorbed knowledge and toolkits from other industries leading towards new business portfolio diversifications, differentiation and better value proposition for customers and users, thus strengthening competitive edge of our regional SMEs on macro-regional, national and international arenas, supported by better visualisation and emotional presentation of their innovation products, services, business models or processes. In addition, the CTCC project supports internationalisation of SMEs as well as strengthening of cross-sectoral and cross-border relationships. As this project demonstrates, co-working for innovation purpose, exchanging of practices via trainings and study visits, changing the perspective and stepping out of own comfort zone, thus leaving geographical, cultural and social proximity, open up new horizons for both Creative Industries and traditional SMEs to cooperate, facilitate transition towards sustainability and market their products.

As a result, this underpins synergy effects for Blue and Green Growth. Significant contribution to sustainable Blue and Green Growth by regional SMEs that develop sustainable and user-driven products includes also recognition and manifestation of the given environmental, social and other concerns of society and searches for the ways to better respond to the given challenges Baltic Sea and its region is facing. With this, the project not only support recent policy trends on capitalisation of CIs potential, but also support research on Responsible Innovation, in which design and creativity play crucial role (Prause et al., 2018). The dovetailing of different sectors' experts, actors of different institutions and governance structures, like quintuple-helix approach stands for, within the innovation prototyping project facilitates market entry and capitalisation of the

developed innovation outputs, as they tend to comply with any environmental regulations and any policy expectations, fulfil the market needs through involvement of customers and users as well as deliver knowledge and skills demanded on the market through involvement of higher education and research institutions. Next to this, innovations delivered as a result of cross-sectoral collaboration integrates within the natural and social ecosystem by supporting preservation of natural resources, reusing existing resources and saving resources that are rare in the Baltic Sea Region.

Future research avenues will need to focus on more informal cross-sectoral collaboration modes and in particular examining social and cultural aspects that might either amplify or hamper cross-sectoral collaboration. In addition, more in-depth research is needed on the inception of cross-sectional collaboration for innovation and what principals, activities and methods could facilitate engagement of both sides. Likewise, succeeding research should increase scale of the present research by analysing and evaluating all 33 prototypes and their outputs.

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## **Knowledge Management and Relational Capital to Support Business Resilience. Evidence from the Italian Agro-Food Sector**

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### **Abstract**

The recent pandemic has changed the reference context of companies and imposed significant changes on them to react to the crisis and contain its effects.

The paper aims to investigate the managers' contribution to overcoming the crisis both in managing internal production processes and through the networks and relationships that they can activate or use. This research contributes to the literature highlight the contribution of relationships to companies' value and managers' role. The results show that managerial skills are drivers of critical success factors for the manager's professional qualities and the ability to manage and implement solid formal relationships in the reference territory and through networks.

**Keywords** – Knowledge Management, Wine Sector, Relational Capital, Manager, Covid-19

**Paper type** – Academic Research Paper

## 1 Introduction

The economic crises characterised the economic and social scenario of recent decades changed and made more complex how people, businesses and territories operate to survive, innovate, explore and organise (Rullani, 2011). The crises have forced companies to identify new paths for growth and development. Companies operate according to the logic of creating a competitive advantage, structuring a series of activities envisaged in the value chain. Still, the territory's functioning that surrounds them and acts according to different logics should not be overlooked. While the company is a production system, the territory must be interpreted as an exchange system in which individuals are at the same time economic operators, family members, institutional members, consumers. The result is a new company vision that includes relations with the external environment (Paoloni, 2021; Paoloni *et al.*, 2019; Tseng, 2014). Thus the company value should reflect the economic-financial performance and those feed the collective well-being (Paoloni *et al.*, 2018; Iaia *et al.*, 2019; Cosentino, 2020).

Intangible resources, such as trust, relational systems, reputation, legitimacy, consensus, combine to constitute the so-called territorial social capital (Manning, 2015; de Castro *et al.*, 2004) while skills (Pérez-Salazar *et al.*, 2019; Belso-Martinez and Diez-Vial, 2018), the attitudes and skills of human resources, the level of social cohesion, the quality of life, the vitality of economic and social exchanges are the basis of the harmonious development of the territory (Boedker *et al.*, 2005; St Pierre and Audet, 2011) and the performance of Italian companies. The territory is not the physical and geographical place where the company operates but represents a strategic resource. Thus, it becomes the space where intangible resources are developed. These resources are knowledge, creativity, culture, art, and a context characterised by its identity, its economic, social and environmental development is defined (Barzotto *et al.*, 2016). Finally, in the territory, relations between the various actors are born and developed, which can encourage a harmonious development process, including technological ones.

In this context, the health emergency, which humanity has faced since the early months of 2020, requires scholars to investigate its effects on companies (Mullins, 2020; Lucchese and Pianta, 2020). In this way, scholars can give visibility to the current conditions of the productive world and propose concrete suggestions that help businesses recover more quickly from the crisis.

In the changed environmental context, investigating managers' contribution to the productive world becomes central. This aspect is less investigated by recent literature. We aim to fill the gap paying particular attention to the role played by managers in the Covid-19 era. More precisely, we aim to *investigate the managers' contribution to overcoming the crisis both in managing internal production processes and through the networks and relationships that they can activate or use*.

The remainder of the paper is organised as follows: Section 2 examines the relevant literature on relational capital and knowledge management. Section 3 outlines the research methodology. Section 4 presents the findings and discussion from the pilot case study. Lastly, section 5 shows the conclusions of the paper and future research directions.

## **2 Relational capital and knowledge management**

Companies necessitate identifying new growth and development paths takes on specific implications during unforeseen shocks (He and Harris, 2020; Mora Cortez and Johnston, 2020), such as that caused by the Covid-19, which is plaguing the entire planet, as revealed by the leading economic indicators (Eurostat, 2021; Istat, 2021).

Scholars have underlined what happens when sudden situations occur, including those caused by catastrophic events, and investigated resilience as a survival factor in the face of threats from the external environment (Van Der Vegt *et al.*, 2015).

The so-called "organisational resilience" (OR) can be included in this stream of research, defined as the aptitude of an organisation to prevent actual occurrences and adapt to unexpected interruptions (proactive aspect). Organisational resilience also includes organisation promptness to adopt random measures reacting to aforementioned interruptions, guaranteeing business continuity (reactive factor) (Jia *et al.*, 2020). In the analysis of OR in states of emergency, Prasad *et al.* (2019) emphasised how relational capital shows its functionality as a value driver due to its capability of allowing organisations access to salient information and resources achieving proactive and reactive OR (Bode & Macdonald, 2016; Johnson *et al.*, 2013).

The attention paid to relational capital and the management's willingness to care about the relationships and implements contacts with stakeholders help

open communication and share information by building behavioural transparency more sought-after during disasters and natural calamities (Villena *et al.*, 2011; Lengnick-Hall *et al.*, 2011). Recent studies emphasised companies' collaborative strategies in the time of Covid-19 (Crick and Crick, 2020; Bapuji *et al.*, 2020) and hypothesised a difficulty in maintaining existing ones (Obal and Gao, 2020).

A crucial aspect to inquire about is relationships as development drivers (Palmatier, 2008) because they can become evaluative factors of resilience and business development in Covid-19 (Eggers, 2020).

In companies' growth processes and their resilience to economic crises, the relationships between organisations and the environment encourage the harmonious development of firms. By adopting this perspective, the economic development of businesses becomes an objective realisable if joined with the other purposes of the territory, such as quality of life, conservation of the landscape, enhancement of available resources and social growth (Cantino *et al.*, 2019; Cillo *et al.*, 2019).

Scholars have recognised the possession of unique and rare knowledge as the leading resource for creating business value (Belso-Martinez and Diez-Vial, 2018). The preservation of knowledge and its application grounded the basis of economic growth and well-being. The organisation's capability to innovate is closely related to its endowments of intellectual capital and its capacity to use knowledge resources (Guthrie *et al.*, 2001).

The development of this approach led to the relationship-based vision (Dyer and Singh 1998). The value created by companies derives from the keeping and dissemination of knowledge and the relationships that the company fosters, the so-called relational capital (Johansson, 2007). Thus, the knowledge incorporated in customers, suppliers and consumers, and the organisation's internal and external relationships (Boedker *et al.*, 2004) represent the relational capital (Johansson, 2007; de Castro *et al.*, 2004). Relational capital is also defined as part of a company's strategy to obtain competitive advantages (Subramaniam and Youndt, 2005; Paoloni, 2021), even in times of crisis (Crick and Crick, 2020; Bapuji *et al.*, 2020).

Scholars emphasised knowledge generation and sharing as a primary intangible resource in generating a competitive advantage (Baum *et al.*, 2001; Dyer and Nobeoka, 2000) by reducing costs (Cepeda-Carrion *et al.*, 2019).

Kamaluddin and Rahman (2009) focused on IC's constituents (relational capital (RC), organisational capital (OC), and human capital (HC)) as value creators (Cavicchi, 2017).

HC concerns the organisation's human aspect and is represented by blending human skills, qualifications, and expertise (Bontis, 1998; Bontis *et al.*, 1999). In this vein, HC refers to the value of the knowledge and talent that is encompassed in people who make up an organisation, conveying intangible resources as know-how, capacities, knowledge, skill, competence, attitude, intellectual agility, creativity (Edvinsson and Malone, 1997; Kaplan and Norton, 1996; Marr and Schiuma, 2001; Hamzah *et al.*, 2018).

Youndt *et al.* (2004) define OC as the knowledge, skills, experience and information institutionalised, codified, and used by patents, systems, databases, routines and processes and includes other not evaluable intangible assets (Edvinsson and Malone, 1997). Paoloni (2021) stressed the RC as formed by the internal and external relationships of the organisations.

Started from previous studies (Tell *et al.*, 2016), this study aims to deepen the research on the relational capital of companies operating in the agro-food sector (Fernandez-Olmos *et al.*, 2021; Paoloni *et al.*, 2020; Cosentino *et al.*, 2021).

The agro-food sector represents an integral part of the European and Italian economy in particular. Companies operate in a highly competitive market due to various factors such as increasing globalisation, the progressive reduction of entry barriers, the presence of large multinationals (Franceschelli *et al.*, 2018; Wilkinson, 2009). Faced with essential constraints, such as slowing demand and strengthening the food retail sector, agro-food companies have developed new sector strategies, especially in Western countries. They have expanded their markets towards emerging economies where the firms fight for leadership positions. All these strategies lead to a greater concentration of capital and highlight the main trends of the world food oligopoly (Tozanli, 1998 Gumbert & Fuchs, 2018; Caiazza *et al.*, 2014).

The changed context during Covid19 has prompted the authors to deepen the behaviour analysis of agro-food companies in response to the crisis. Notably, we observe what impact Covid19 has had on companies' strategies, activities, tools, and results in the agro-food sector, especially concerning resilience strategies. Particular attention was paid to the contribution that knowledge management and formal and informal relations, external and external to the company, gave

both during the critical phase of the lockdown and later, given the persistence of the pandemic and its impact on global economic systems.

### **3 Research methodology**

To comply with the paper aim, we used a qualitative research investigation methodology based on the analysis of the case study (Yin, 2014), particularly suitable for understanding complex phenomena according to a holistic approach (Flynn *et al.*, 1990).

The research was structured based on the following research protocol (Yin, 2014):

i) industry choice: started from recent studies (Paoloni *et al.*, 2020; Fernandez-Olmos *et al.*, 2021; Cosentino *et al.*, 2021), we compared the same context in two different phases: ante and post Covid-19. Notably, we selected an agro-food company operating in the wine sector.

ii) case study choice: we chose a case study that would allow for a broader framework of observation, albeit indirectly. Thus, we investigated a cooperative in the wine sector, active in the centre of Italy. The choice of an agricultural cooperative, whose members are the holders of the raw material (grapes), allows for a comprehensive view of the entire territory. Italian legislation requires members to cultivate land within 40 kilometres of the cooperative's headquarters. In this case, the exchanges of materials are considered contributions rather than trading.

To identify the connections between the relevant aspects, we selected three variables: a) company size, b) company longevity, c) territory (Stake and Schwandt, 2006):

a) company size: we analysed a medium/large cooperative, of which over 200 agricultural entrepreneurs are members;

b) company longevity: we observed a mature enterprise, which would allow us to reach conclusions of general validity;

c) territory: the research protocol provided for on-site visits. To avoid interruptions to the research protocol due to restrictions on free movement, we have chosen a company active in the Roman territory, easily accessible to researchers with national relevance, capable of offering an observation area extended to the Italian region.

iii) strong propensity of management to change.

Based on the points above, we investigated a cooperative in the wine sector, with a long tradition, firmly rooted in Italy's centre for over a century. Despite the territorial connotation, it is a company that operates throughout the national territory and abroad, to a minimal extent.

Data sources are summarised in Table 1.

Table 1: Data source

Database	Typology	Subjects	Interview code
Primary data	Interviews	<ul style="list-style-type: none"> <li>– Director of Quality Sistem</li> <li>– Cooperative President</li> <li>– Professional Accountant</li> </ul>	l <sub>1</sub> l <sub>2</sub> l <sub>3</sub>
Secondary data	Documents, site visits and virtual tours	<ul style="list-style-type: none"> <li>– Scientific literature</li> <li>– Social media</li> <li>– Specialised newspapers</li> <li>– Web sites</li> <li>– Accounting system</li> </ul>	

The interviews were carried out from April 2020 to June 2021 to capture the various phases faced by the company during the last year. The sessions lasted a total of 600 minutes and guaranteed the anonymity of the interviewees. The interviews were recorded and transcribed. The data were analysed using in-vivo coding in NVivo (Miles *et al.*, 2013), and each author performed reliability checks. The results achieved were discussed among the authors and with the interviewees (Yin, 2014).

## 4 Results and discussion

### 4.1 From birth to development

The company was founded in 1945 by farmers moved by the desire for aggregation. The winery was born on the rubble of a public enopoly, innovative and self-sufficient.

As Cooperative President told:

*"Since its inception, the cooperative has always followed the ambition of innovation. The lines, the packaging have observed over time following the taste and style."*



In 2005, the management team prompt to start a new production line. The oenologists and the chemical managers tested it for over a decade, and recently a new line of wine is launched on the market to conquer Ho.re.ca. Italian and beyond.

*"We intended to give a strong image, not only of innovation but also of quality. We had an image in our mind: that of 'millions of hands' that reach the shelves of large-scale distribution to take our quality wines." (I<sub>2</sub>).*

The skills of old and new managers and operators have been used in the continuous search for quality. The arrival in the company of a new manager, with high expertise in the oenological field, has determined a turning point in the production process and the corporate image.

*"Structured production processes, stringent internal quality controls, automation of the production chain have made it possible to obtain essential quality certifications." (I<sub>1</sub>)*

A continuous process of updating and modernisation was undertaken, which required a careful assessment of the available resources (the vineyards of our members) to be addressed with technical choices, first in the production (vines and types of farming) and then in the cellar, with differentiated collections (hand and mechanical).

*"Each process was subjected to a technical-economic evaluation and required shared choices with the cellar technicians and the producers in the countryside" (I<sub>1</sub>).*

#### **4.2 Knowledge management through technological innovation**

Love for tradition and link with the territory do not hinder the technological innovations into the company. Thus, in 2011, improve the quality of the product and efficiency of the production chain led realisation of essential investments aimed at the structural and technological modernisation of the main plant. To date, this plant has become a cutting-edge complex in the oenological sector, respectful of the environment and the safeguarding of the wine product.

The cooperative has made critical investments over the last decade and planned for the near future, thanks to the grants provided by Italian and European legislation to encourage the agro-food sector development. As underlined I<sub>1</sub>:

*"Investments are a fundamental strategic variable for us. We would not have given up on carrying out the planned technological innovations. Non-repayable*

*grants have given us some breathing room and have allowed us to improve the quality of planned investments."*

Table 2 - Investments and technological innovations introduced before Covid-19 (completed)

Year	Value	Typology	Public coverage
2011	3,000,000	Bottling machines and point of sale	RDP <sup>1</sup>
2011	150,000	Construction of a photovoltaic system and reclamation of the structure	INAIL <sup>2</sup>
2013	250,000	Furniture and Fencing Establishment	CMO <sup>3</sup>
2013-2014	300,000	Vitrification of cellar tanks, laser	CMO
2016	200.000	China / Canada / Switzerland	CMO Third countries <sup>4</sup>
2018	290.000	Laboratory and canteen	CMO

Table 3 - Investments in technological innovations introduced before Covid-19 (in progress)

Public coverage	Value	
	Requested	Obtained
RDP	783,117.65	313,247.06
RDP	794,437.56	317,775.02
CMO Third countries 2018 (Switzerland )	130,306.00	65,153.00
RDP	206,143.40	118,279.00

<sup>1</sup> Rural development programmes (RDPs) represent the primary operational tool for programming and financing interventions in the agricultural, forestry and rural sectors funding by European Union. The contribution of the European Union to the EU's rural development objectives.

<sup>2</sup> INAIL is an Italian public body that manages compulsory insurance against accidents at work and occupational diseases.

<sup>3</sup> Common market organisations (CMOs) provide a safety net to agricultural markets through the use of market-support tools, exceptional measures and aid schemes for specific sectors (in particular fruit and vegetables, and wine), to encourage producer cooperation through producer organisations and particular rules on competition and to lay down marketing standards for certain products.

<sup>4</sup> The CMOs for third countries are aimed at strengthening the internationalisation of companies.

### 4.3 The measures adopted during the pandemic

#### 4.3.1 Knowledge management and distribution channels

Various strategies have been adopted to respond promptly to the collapse in sales of the Ho.Re.Ca. channel (Hôtellerie, Restaurant and Café/Catering) or the purchases decrease of high-end wines from large-scale distribution. Firstly, the company had to reinvent the local visibility channel quickly but straightforwardly, which has always represented an important strategic development factor.

*"We had to face a challenging moment, and we got activated immediately." (I<sub>1</sub>)*

The closure of the store during the first lockdown forced the adoption of various commercial solutions. In particular: i) improved the online shop on the site (introduced before the pandemic); ii) entered a 'WhatsApp Business' number on the site for customer care, with the possibility of a direct order; iii) launched a Facebook Ads campaign with the objective of 'conversions' and 'call to action' (entitled " chat on WhatsApp ") in Italy with a focus on the region; iv) increased the number of couriers for deliveries throughout Italy.

#### 4.3.2 Relational capital and formal relationships

The health emergency has pushed the company to strengthen formal relations with institutions. To support measures provided by ordinary legislation, the Italian Government added others to support businesses during the pandemic. The health emergency and the lockdown made it necessary to resort to the subsidies provided by the Government to contain the effects of the pandemic on businesses. Table 4 summarises the measures used by the cooperative and the extent of acceptance to date.

Table 4 - Facilitation and support measures that the company resorted to during Covid-19

Facilitation and support measures provided by the Lazio Region			
Typology	Status of the request	Value	
		Requested	Obtained
CMO 2020	Admissible but not financeable due to lack of funds	273.932,00	//
Facilitation and support measures provided by the Italian Government			
Typology	Status of the request	Value	

		Requested	Obtained
Disinfection	Admissible	7,850.00	7,850.00
Smart Working 2020	Admissible	15,000.00	15,000.00
Mortgage moratorium	Admissible	600,000.00	600,000.00
Replacement and new liquidity	Under evaluation	2,000,000.00	

In this context, the formal relationship ability of the Director of Quality Systems (DRS) favoured the achievement of various results: i) obtaining loans and facilities; ii) adoption of advanced software for the management of production processes; iii) improvement of relationships with the PA and banks. The close relationships with external stakeholders made it possible to contain the crisis's effects. Some of these stakeholders are institutional (banks, Italian Government, Lazio Region).

*"The cooperative was able to access subsidised bank loans for over 3 billion Euros, provided for by the subsidy measures arranged by the Italian Government. It also obtained various non-repayable loans to encourage digitalisation and smart working" (I<sub>3</sub>).*

Different stakeholders are consortia and other wineries spread throughout the Italian territory. The partnerships with them have favoured innovative software to manage production processes and quality control.

*'Existing relationships were consolidated to obtain the necessary support for choosing the most appropriate and efficient software (...).I trusted large consortia in central Italy, who suggested advanced software to improve the product's internal control system' (I<sub>1</sub>).*

The interviews revealed a further role of DQS's skills and attitude in fostering the company's resilience under investigation.

*"Over the past year, the board of directors and I have let QM lead and strengthen relationships with banks and public administrations" (I<sub>2</sub>).*

At the same time, I<sub>1</sub> points out: *"I noticed an increase in trust in me, which has favoured both the relationships between the company and external stakeholders and my career within the company. I recently obtained the qualification of quality director, thanks to the results achieved in relationships with institutions and external lenders".*

## 5 Conclusions

During Covid19, all companies were severely hit by the freezing of activities and reduced consumption. The agro-food sector, particularly in the wine sector, struck this effect due to the closure of the Ho.Re.Ca channel, the sharp contraction in exports and the changed propensity to consume.

The analysis of the sector conducted through the case study allowed us to have an extended vision of the Roman territory, focusing on typical productions, viticulture, established and with a long tradition.

The results show that knowledge management through technological innovations is a critical success factor for companies (Belso-Martinez and Diez-Vial, 2018; Guthrie *et al.*, 2001; Baum *et al.*, 2001; Dyer and Nobeoka, 2000). Thus, the support measures must be strengthened to encourage the increase in investments in the entire sector.

The technological innovations introduced to improve the performances in terms of efficiency and productivity unfold their effects in multiple ways: i) improving the product quality, ii) enhancing the quality system (traceability of flows from the entry of the material before bottling, up to distribution), iii) reducing penalties as a result of non-compliance with health safety conditions, iv) facilitating consumer protection, thanks to a more effective control system.

In general, in the agro-food sector, wine in particular, the "quality control" area, plays a central role in the entire production process, especially in doc production, as in our case study (Youndt *et al.*, 2004; Cepeda-Carrion *et al.*, 2019).

The observation of reality in this last year has shown that the management of knowledge and technological and digital innovations produces at least two effects (Edvinsson and Malone, 1997; Kaplan and Norton, 1996; Marr and Schiuma, 2001; Hamzah *et al.*, 2018).

First of all, it makes production flexible and able to adapt to unexpected market changes. The dematerialisation of some company functions and implementing new business models (virtual trade versus traditional trade, for example) act as a driving force in periods of production shock. However, there remains the need for personal relationships based on trust and the urgency of human confrontation, which must be valued, even if they can occur in different ways than traditional ones.

The company's ability to innovate and to face the challenges of innovation in advance, concerning market demands or the changed environmental context, is confirmed as a critical factor for business success.

The aforementioned results contribute to the emerging literature on successful strategies used by companies to face the crisis, offering an original enrichment to the literature and practice on knowledge management and relational capital contribution to company resilience (Fernandez-Olmos *et al.*, 2021; Paoloni *et al.*, 2020; Cosentino *et al.*, 2021). Our research analysed a medium-sized company with extensive connections with other companies in the area, operating in the wine sector, which has been seriously affected by the pandemic crisis. Our findings offer general validity conclusions on the need for companies to develop authentic and virtual relationships with external stakeholders.

Less definitive are the conclusions on women managers' roles in guiding and promoting these processes (second research question). To obtain more general results, the future phases of the research foresee comparing the case study analysed with another case study, homogeneous by sector of activity, size and the territorial context characterised by male management.

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