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Grand challenges: emerging trajectories in supply chain management

SPECIAL ISSUE
in collaboration with ADACI

Guest Editors
Francesco Rizzi, Marina Gigliotti, Paola Signori

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Original Research Papers

Useful information for readers e authors

Aphorisms

1. *All things are difficult before they are easy.*
   (John Norley)

2. *You can be anything you want to be, just turn yourself into anything you think that you could ever be.*
   (Freddie Mercury)

3. *The problem with the world is that the intelligent people are full of doubts, while the stupid ones are full of confidence.*
   (Charles Bukowski)

4. *Life isn't about finding yourself. Life is about creating yourself.*
   (George Bernard Shaw)

5. *All the years are stupid. It is once they have passed that they become interesting.*
   (Cesare Pavese)

About ADACI

For more than fifty years, ADACI has impacted the procurement and supply management profession through an active networking, conferences and events, development and research, dissemination of best practices, best in class education, and qualification. It continuously evolves to empower the next generation of supply chain professionals and support individuals' careers.

Its Mission

To advance the practice of procurement, supply management and logistics to drive value and competitive advantage, and contribute to a prosperous, sustainable world.

ADACI is:
- *the professional body for the Procurement and Supply Chain Management profession,*
- *the Italian association of buyers, category managers, supply chain managers, and logisticians of all industries and sectors,*
- *a recognized, not-for-profit professional body authorized to release qualification awards,*
- *a network of professionals, academics and industry experts who analyze and exchange information on macroeconomic topics, innovation, and themes relevant to the Procurement and Supply Chain Management,*
- *a learning community of all industries and sectors that seek to create value, and enhance its environmental, social and governance (ESG) measures to better serve companies, consumers and communities.*

Specific Objectives:

- *facilitate the development and distribution of knowledge to elevate and advance the procurement profession, thus favorably impacting the standard of living;*
- *further the principles and practices of procurement, strategic sourcing, supply chain management, and logistics ensuring the highest standard of business ethics;*
- *support the professional growth of its members;*
- *promote surveys, studies, researches and benchmarking activities,*
- *foster the relationships with the academic world to address and support its studies and researches on themes of interest to the industry;*
- *foster the knowledge of procurement, supply chain management, and logistics in school, industry and public undertakings,*
- *arrange events and forums for professional interaction on procurement and supply chain management.*

Membership: *over 1,300 members distributed in six multi-regional sections: Centro, Sud e Isole, Emilia Romagna e Marche, Lombardia e Liguria, Piemonte e Valle d'Aosta, Toscana ed Umbria,Tre Venezie.*

Leadership & Governance

ADACI is governed by a dedicated group of supply management practitioners and staff who support ISM's mission of helping industry professionals generate positive outcomes in their careers and for the organizations for which they work.

Conferences and Events

ADACI conferences and events are designed to be experiences. They are immersive and engaging, where you leave with learning new perspectives and best practices, gain new personal and professional connections and get a bit of inspiration to take back into the office.

Attendees have found ADACI conferences and events to be a starting point and a stimulus for their continuous learning and professional development. The best known are:

Negotiorum Fucina	*The annual Summit of the Association Two days of presentations and discussions in plenary and round table sessions*
CPO Lounge Community	*The annual summit of CPOs*
ADACI Opportunity	*Where sellers meet buyers with the support of an ICT platform*
ADACI Magister	*Academics present study, researches and business models to buyers practitioners*
ADACI Smart	*The academic world presents the researches done in the previous year*
Fucinandum Innovation	*Half-day regional meetings for the presentation of innovations, new materials, technologies and advanced solutions*
ADACI PA	*Event devoted to the Public Procurement topics*
ADACI Workshop	*Regional workshop on the price and market trends of raw materials*
University Campus	*education and training activities for students close to graduation.*

The 2023 IFPSM World Summit will be held in Florence (Italy)

Qualification awards

For more than fifty year, ADACI mission has been focused on the advancement of the procurement and supply management profession. ADACI connects, supports and advances the profession through best in class education, qualification, leadership development and research.

Your membership in ADACI will provide a powerful path to stay connected, engaged, and up-to-date with everything happening in procurement and supply chain management. ADACI has been authorised by the Italian Ministry of Economic Development to release qualification awards and specifically:

Basic qualification (L1) — *for buyers and other roles of the supply chain function such as: materials planning, warehouse management and transport. It corresponds to the second level of the European Qualification Framework.*

Intermediate qualification (L2) — *for senior buyers or middle managers operating in the materials planning, procurement governance & control, warehouse management and inbound and outbound logistics. It corresponds to the fourth level of the European Qualification Framework.*

Advanced qualification (L3) — *for procurement managers, category managers or managers of the other departments of the Procurement & Supply Chain function.*

Relationships with other organisations

ADACI collaborates with 30 Italian universities and many other organisations.

ADACI Formanagement Srl is a wholly owned company of ADACI established to manage education and training courses and consulting activities.

Created from in-depth analysis of supply management functions, its top level supply management training experience addresses the realities of supply management, as well as workplace complexities including globalization, use of technology, and expanded competencies that supply chain and procurement professionals employ to drive value in their organizations. ADACI Formanagement emphasises the major competencies of supply management including:

- *Sourcing*
- *Category Management*
- *Negotiation*
- *Legal and Contractual*
- *Supplier Relationship Management*
- *Cost and Price Management*
- *Financial Analysis*
- *Supply Chain Strategy*

- *Sales and Operations Planning*
- *Quality Management*
- *Logistics and Material Management*
- *Project Management*
- *Leadership and Business Acumen*
- *Systems Capability and Technology*
- *Risk and Compliance*
- *Corporate Social Responsibility*

The Head Office of Adaci and Adaci Formanagement Srl is located in Via Imperia 2 Milan, where six permanent employees manage the activities of both organisations.

ADACI is also one of founders og The International Federation of Purchasing and Supply Management (IFPSM) is the union of 44 National and Regional Purchasing Associations worldwide. Within this circle, about 250,000 Purchasing and Supply Management Professionals can be reached.

IFPSM's operations covers purchasing, materials management, logistics, supply chain management and strategic sourcing.

The Federation is dedicated to the service of our member associations and is ready and willing to work in partnership with other organizations that share our objectives and core values. In addition to the strong regional structure, IFPSM also delivers global events where members can engage and derive business and personal benefits, as annual World Summit conference.

Introduction

Fabrizio Santini

In the last almost two years, the global economic situation has been literally upset by the pandemic created by Covid-19, highlighting the importance of the purchasing process and the procurement function, which were the crucial points to enable a structured business continuity plan.

The Procurement managers have increasingly felt the need to confront each other to find new methods to deal with new and unexpected market situations. For this reason, ADACI has organized continuous opportunities for discussion, often carried out in webinar mode, such as the CPO Lounge Community and the Negotiorum Fucina. In addition, the search for different, new and innovative solutions has led to the search for collaboration with university professors who are engaged in scientific research in various fields and, thus, analyse corporate paradigms of strategic behaviour in the management of supply chains from different perspectives.

The Magister conference organized in collaboration and during the SIMA conference on 7/9/20 was indeed a meeting point between university culture and business managers in the framework of the ADACI SMART project.

For more than 30 years, researchers, managers and consultants have discussed and pleaded the need for a transition from the traditional vision of the purchasing function - considered a pure cost centre with mainly administrative responsibilities - towards a strategic approach to supply chain management, a real opportunity for the redefinition of entire intra-company relationships (e.g. between the company and its suppliers).

However, most businesses still underestimate and do not optimize this feature to the best of their ability.

Nonetheless, the debate between industry and academia has so far developed on often parallel tracks, only occasionally offering opportunities for exchange, debate and critical confrontation.

In a rapidly evolving context in which early adopter companies apply and pass on winning models to other organizations, the question remains why so many organizations have not been able to evolve their strategies in this framework. Albeit in light of the rapid changes in the competitive context there is increasing attention to the practices applied by companies considered "best-in-class", an element that would suggest widespread confidence in the possibility of replicating winning models in different application contexts, the question remains why many organizations have not been able to evolve their skills and competency management strategies in this area and why relations between companies and universities do not always have achieved the desired results.

The procurement process, if interpreted no longer only as a control valve for the optimal flow of goods and services but also as an opportunity

for integration between the various functions of the company, for the distribution of organizational value and the development of collaborations with suppliers, can therefore truly guide the identification of a strategic direction for the company and support the most appropriate business decisions.

"The ADACI SMART project aims to become a useful cultural reference for those researchers, managers and consultants who want to rigorously investigate the new evolutionary perspectives for the world of purchases. Therefore, the recipients are scholars, academic and non-academic, of business management, organizational sciences, management engineering, economics, and, more generally".

In times of scarce resources, efficiency is a crucial matter. This concerns material flows in production processes and time, money, creativity, and other intangible resources that might lead to progress in the relationship between academia and industry.

The search for such efficiency has been the guiding force behind the organization of the ADACI's (Associazione Italiana Acquisti e Supply Management) SMART (Supply Management Academic Research Table) conference, held in Livorno on 8th November 2019 and in Pisa on 7th September 2020. These conferences introduced a new format of collaboration between practitioners and scholars aimed at enhancing synergies between supply chain managers, who can provide access to relevant research environments and the benefits of privileged access to scientific stimuli, and researchers, who can apply scientific methods to solve urgent problems and are constantly challenged to advance their research and teaching performance.

Such collaboration contributes to exploring the practical and theoretical aspects of supply chain management from an inter-and trans-disciplinary perspective.

ADACI can and must be the organization that stimulates and supports this organic project.

The format consists of a two-year cycle with periodical meetings among practitioners supervised by a Scientific Committee that stimulate collaboration between companies and academia and prepare the grounds for a bottom-up definition of the key topics to be discussed during the final conference. The SMART conference follows a call for papers and a peer-review process where contributions are selected based on their scientific and practical relevance, which is a prerequisite for enabling synergies among the conference attendees. The best contributions are then divided into thematic panels where both practitioners and researchers act as discussants to ensure the necessary interaction and stimuli for improvement within a lively and dynamic environment.

What is the future of the ADACI Smart project? Only grow more.

ADACI will organize new cultural and professional events at an international level, including new call for papers, to involve European universities and beyond. The World Summit of the IFPSM (International Federation Purchasing Supply Management) will be held in Florence on

22nd/23rd September 2023. Grounding on the experience developed in the framework of the SIMA Conference, this will be just the first opportunity to organize further discussion sessions between researchers and practitioners in the ADACI Magister to explore new professional challenges and frontiers.

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Contemporary challenges in supply chain management: introducing the ADACI SMART dialogue among Italian scholars and practitioners

Francesco Rizzi - Marina Gigliotti - Paola Signori

The ADACI SMART project consists of biennial cycles of activities aimed at stimulating the dialogue among Italian scholars and practitioners on the contemporary challenges in supply chain management (SCM). Within the last two years, physical meetings and webinars aimed to reduce the distance between the scientific debate and industrial needs. The final goal was to stimulate the design of SCM studies where ADACI's associates act as stakeholders or, sometimes, even participants.

This Special Issue collects eight papers presented in the ADACI SMART Conference held in September 2020 in collaboration with SIMA - Italian Society of Management. These papers originate from various interactions with companies and lay solid foundations for potential follow-ups and further collaborations between the Academia and industry.

Despite focusing on a variety of facets of the evolution of SCM, these studies reflect the increasing concern towards operating SCM in connection with the broader contextual business environment.

Global value chains and socio-ecological crises exert increasing pressures on procurement professionals and introduce new risks of supply chain disruptions. Furthermore, as Wieland (2021) highlighted, supply chains can become vulnerable and harmful systems when not appropriately operated.

The selected papers have the merit of drawing the attention of scholars and managers to the need to integrate methodologically sound analyses into decision-making processes in response to the complex challenges mentioned above. In so doing, they have a shared ambition to prove that scientific theories and research methods can usefully add value to the empirical experiences that supply chain managers develop in their daily practice.

In detail, the papers in this Special Issue deal with relevant topics related to modern SCM that refer to three main thematic areas: technology and Industry 4.0; risk management; sustainability. These areas reflect, respectively, the drivers, the processes and the goals of the recent evolution of SCM and, thus, provide a pretty comprehensive view on contemporary transformations in a business function that, differently from how it appears today, only a few years ago, was mainly referred to as an organisational structure suffused of primarily administrative and non-strategic responsibilities.

The first three papers in the Special Issue investigate the dynamics involved in the digital transformation of supply chains (SCs). To this end, they seize the opportunity to observe the adoption of Industry 4.0

technologies in Italian companies. As a result, these papers help better understand the enabling conditions and the paths that determine the possibility for the procurement function to "collect, analyse, and process data within the organisation and its internal and external environment and to become a strategic interface to support organisational efficiency, effectiveness, and profitability" (Bienhaus and Haddud, 2018).

In the paper "SMEs @ Industry 4.0: A comparison between the top and average performers", Marco Bettiol, Mauro Capestro, Eleonora Di Maria (University of Padova) and Stefano Micelli (Ca' Foscari University) analyse whether economic and financial firm's performance influence the adoption of Industry 4.0 technologies. The paper contributes to the literature on barriers and drivers of Industry 4.0 implementation on SMEs (Horváth and Szabó, 2019), showing the results of quantitative research comparing the top and average performers in adopting Industry 4.0 technologies. The paper concludes that top and average performers present similarities in technology selection, implementation barriers, and motivations. Moreover, adopters show higher technological maturity than non-adopters, which is thus a key discriminant for adopting Industry 4.0 technologies.

Niccolò Fiorini (University of Siena), in his paper "New value creation opportunities for Start-ups with I4.0: resources and capitalisation capabilities and effects on the Value Chain", provides some first insights on the opportunity of value creation generated by Industry 4.0 (Xu *et al.*, 2018) for start-ups. The results of the qualitative research allow identifying three value creation opportunities granted by Industry 4.0, based on the prevalence of internal or external resource/capabilities or their combination. Moreover, the paper highlights how these start-ups adopt new business models coherent with the adopted Industry 4.0 technology. To this end, the authors discuss the company's role in the supply chain, the value created, and the source resources and competencies.

Silvia Bruzzi (University of Genoa), Nicola Balbi (ADACI Lombardy-Liguria), Leonardo Barcellini (Ernst&Young), and Vincenzo Genco (ADACI Lombardy-Liguria) are the authors of the paper "Toward the Strengthening of Enabling Technologies in Italy: Results of the Second Survey on Procurement 4.0". This study shows the results of the second survey conducted on Procurement 4.0 concerning the adoption level of enabling technologies, the main characteristics of adopters, the procurement function's engagement, and the skills involved (Bals *et al.*, 2019). The results confirm that, from a system perspective, enabling technologies passed their infancy stage and started their introduction phase, with greater involvement of the procurement function. Furthermore, the authors highlight the need for more robust training on soft and digital skills.

The second thematic addressed by two papers in this Special Issue is risk management. Nowadays, all business functions acknowledge the importance of managing risks in the pursuit of business continuity and sustained business performance. Given that a risk-oriented mindset has generated and well-elaborated specialised tools, SC managers are increasingly involved in trans-functional teams to provide intelligence on the dynamics at the interface with suppliers (Heckmann *et al.*, 2015).

This group of papers discusses the changes in the procurement function in Italian firms that occurred to improve organisational risk management capabilities.

Marco Perona (University of Brescia) authored the paper titled "Supply Risk Management: a perspective on the Italian manufacturing sector", providing preliminary results on supply disruptions and their causes in the Italian context. This study fills a research gap related to the likelihood of sudden and unforeseen interruption of supplies (Revilla and Saenz, 2017), providing an empirical observation of their nature and frequency. Furthermore, the findings outline that suppliers' financial default is the most frequent cause and that firm size and industrial sector influence occurrence likelihood and breakdown origin.

Elisa Martinelli (University of Modena and Reggio Emilia), Federica Dallanoce (ADACI) and Giampiero Carozza (Gruppo Amadori) in their paper "Business resilience and risk management during the Covid-19 pandemic: the Amadori case-study" explore business resilience during the Covid-19 pandemic from a risk management standpoint, contributing to the combination of these two research topics (Berkes, 2007). Through a case study approach, the paper provides a specific focus on the procurement area and outlines how redundancy and rapidity are vital features to increase business resilience during the lockdown phase, while robustness, rapidity and resourcefulness are crucial in the post-lockdown phase.

The last three papers deal with sustainability issues in SCM. Sustainability is a major driver for reconfiguring organisational dynamic capabilities (Buzzao and Rizzi, 2021) and developing proactive and reactive SCM practices (Kähkönen *et al.*, 2018). The papers in this sub-group offer empirical insights into the SCM practices that Italian organisations adopt to pursue business model innovation and high-performance reconfigurations of intra- end inter-organisational dynamics.

Sara Scipioni and Federico Niccolini (University of Pisa) are the authors of the paper titled "How to Close the Loop: Organizational Learning Processes and Contextual Factors for Small and Medium Enterprises' Circular Business Models Introduction". The paper discusses the factor enabling the implementation of circular business models (Bocken *et al.*, 2014) in SMEs, highlighting the specific role of organisational learning. Furthermore, the study provides a model that explains the interrelations between contextual factors and intra- and inter-organisational learning processes in enabling circular business models.

Kunle Francis Oguntegbe, Nadia Di Paola and Roberto Vona (University of Naples "Federico II") authored the paper "Blockchain technology, social capital and sustainable supply chain management". It investigates the role of blockchain technology in implementing a sustainable SC (Jabbour *et al.*, 2020). By combining the social capital theory and the resource-based view, the study identifies the key sustainability objectives that organisations pursue by adopting blockchain technology. Moreover, the paper provides some propositions on the interconnections among digital supply chain systems and the social capital's relational, cognitive and structural components in pursuing a sustainable SC.

In their paper "Greening SCM through SC integration: an exploratory investigation among Italian supply chain managers", Francesco Rizzi (University of Perugia), Eleonora Annunziata (Sant'Anna School of Advanced Studies), and Marina Gigliotti (University of Perugia) discuss the link between SC integration and the implementation of green SCM practices (Vachon and Klassen, 2006). The paper contributes to the academic debate by providing detailed empirical evidence of the differences among the paths that link internal and external integration with the implementation of specific GSCM practices. Moreover, the authors suggest further disentangling this link by investigating the organisational culture's role rather than company size.

Overall, we see this collection of papers as a stimulus for further studies in collaboration between the Academia and ADACI's associates, not as an endpoint. SCM in Italy is at a critical crossroads, and creating synergies among a great variety of competencies and experiences to build knowledge in the field is more necessary than ever. The ADACI SMART project continues on solid groundings and the ambition to generate value for researchers and practitioners in SCM.

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Selected papers

SMEs @ Industry 4.0: a comparison between top and average performers

Marco Bettiol - Mauro Capestro - Eleonora Di Maria
Stefano Micelli

Abstract

*Purpose of the pape*r: *This study explores the adoption of Industry 4.0 technologies by small- and medium-sized enterprises (SMEs), evaluating if firm's economic and financial performances play a strategic role in the implementation paths.*

Methodology: *Through a quantitative survey that collected 366 questionnaires, the study used a multivariate analysis to assess the similarities and differences between two different groups of Italian manufacturing SMEs with respect to the adoption of Industry 4.0.*

Findings: *Despite some similarities in terms of adoption (technologies most adopted, most important motivations, and barriers of adoption), top performers show a higher adoption rate of robotics and big data/analytics, consistently with their orientation towards international competitiveness and the competitive strategies characterizing small firms (customization and flexibility).*

Research limits: Despite the explorative purpose of the study, it is worth mentioning that it considers a small sample of manufacturing SMEs operating in different sectors. Future studies could investigate these comparisons, focusing on a larger sample or on fewer sectors.

Practical implications: Although the financial resources support and affect the implementation of Industry 4.0, especially in terms of intensity of investment, the digital transformation of SMEs is based on the firm's innovation resources and capabilities that are the result of the firm's overall strategy.

Originality of the paper: *The research is one of the first studies that explores the effects of economic and financial performance on the implementation paths of Industry 4.0, with a focus on SMEs and with the aim to advance literature about the Industry 4.0 trajectories.*

Key words: Industry 4.0; digital transformation; digital strategy; economic-financial performance; SMEs; comparative multivariate analysis

1. Introduction

In recent years, the industrial landscape has begun undergoing a deep technological transformation concerning the full digitalization of business processes (Frank *et al.*, 2019a). The peculiar feature of this fourth industrial revolution, known also as Industry 4.0, is its higher degree of complexity compared to the previous technological waves. It encompasses the integration of different digital technologies into a knowledge-

based production system (Kagermann, 2015) and products (Porter and Heppelmann, 2014, 2015) in order to face the growing complexity of markets and competition. The Industry 4.0 paradigm embraces several enabling technologies. Focusing on the production, operation, and services related to the manufacturing industries, scholars have outlined different enabling technologies as follows: big data and analytics, cloud-computing, Internet of Things (IoT), cybersecurity, simulation, value-chain integration systems, additive manufacturing, augmented reality (AR), and artificial intelligence (AI) (Dalmarco *et al.*, 2019; Lee *et al.*, 2018).

Some of these technologies affect the manufacturing processes and outputs, from the optimization of the overall production process (through an effective use of inputs, less waste, lower production time, higher control, and support over operation phases) to the improvement of prototyping, new product development, and customization processes (Fettermann *et al.*, 2018). Production optimization is related to adopting technologies such as robotics (autonomous and collaborative robots), simulation, and AR (Lu, 2017). The improvements of product development and customization are related to the adoption of additive manufacturing technologies, such as 3D printing, which allows firms to enhance the customers' active role in producing (design and production) personalized products (Rayna and Striukova, 2016). Other technologies, such as AI, big data, and IoT, are mainly used for marketing through an effective customer targeting and offering; they are used on the relationships along the value chain as well as on the strategic approach to markets and supply chain activities (Schrauf and Berttram, 2016; Büchi *et al.*, 2020).

The firm's information technology (IT) maturity, referring to the IT infrastructure and digital skills is considered essential for the implementation of Industry 4.0 (Mittal *et al.*, 2018). However, recent research shows that the main hurdle that firms need to overcome, in approaching Industry 4.0, is the financial constraints (Arnold and Voigt, 2019; Piccarozzi *et al.*, 2018). In particular, this issue is particularly relevant for SMEs, where the amount of financial resources available could represent either the main risks of Industry 4.0 failure (Moeuf *et al.*, 2018) or the driver for a positive adoption (Tortorella and Fettermann, 2018). In this regard, several government initiatives were implemented in Europe to financially support firms in the adoption of new technologies (Sony and Naik, 2019). Among those initiatives, the Italian Government launched the Industry 4.0 National Plan in 2016 to foster the implementation of Industry 4.0 within the manufacturing industries (Agostini and Filippini, 2019) and to give financial support to the manufacturing firms for adopting Industry 4.0 technologies (Bettiol *et al.*, 2020, Lucchese *et al.*, 2016).

The literature on Industry 4.0 focused on the barriers, drivers, and benefits of firms adopting it (Dalenogare *et al.*, 2018). Despite this growing attention, little is known about the role of economic and financial performances on the patterns of adoption and the use of Industry 4.0 technologies in the realm of SMEs. In other words, the literature did not investigate if and how the economic and financial issues influence the probability and intensity of adopting those technologies. In this regard, the study aims at filling this gap by exploring the adoption of Industry

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4.0 technologies between the SMEs with higher economic and financial performances (top performers) and the SMEs with average performances (average performers). In so doing, the study assessed-through an online survey that collected 366 questionnaires (166 top and 200 average performers) - the type of technologies adopted by the two different groups of SMEs, the role of firm strategy (motivations and barriers of adoption), firm resources (IT and skills), and of the public financial support, in order to verify differences and similarities between top and average performers that adopted Industry 4.0 technologies.

Following existing literature on the analysis of the technology adoption paths between different groups of firms (Oettmeier and Hofmann, 2017), we adopted a multivariate analysis of variance (chi-square and t-test) method based on data collected through a survey on Italian manufacturing SMEs. The study mainly works to advance literature on the digital transformation of SMEs by showing how economic and financial performances strategically affect the implementation of Industry 4.0 in terms of both drivers and barriers of adoption. In so doing, the study stresses the higher relevance for top performers respect to the average performers of both robotics and big data with the aim to improve efficiency and develop new products to compete in the new international scenario. Moreover, the top performers have invested in the adoption of a higher number of different technologies (sum of the Industry 4.0 technologies adopted), reaching a high level of digital transformation (Mittal *et al.*, 2018). In this case, the higher levels of economic and financial performances may be directly linked to the investment in more different technologies. Another contribution addresses the role of public funds in supporting the diffusion of Industry 4.0 in Italy. Paradoxically, access to the national funds for the adoption of Industry 4.0 technologies has been particularly important for top performers rather than average performers, showing that there is not a direct relationship between the lack of financial resources and the access to public resources.

2. Theoretical background

2.1 Industry 4.0 enabling technologies

The digital transformation of manufacturing industries through Industry 4.0 is driven by the adoption of a large set of technologies (Lu, 2017)-even if scholars and practitioners focused only on those considered the pillars of the Industry 4.0 technological revolution (Agostini and Filippini 2019; Moeuf *et al.* 2019)-that allow firms to improve in different domains, from product development and design to operation and logistic activities, as well as marketing activities (Dalenogare *et al.*, 2018).

Considering Industry 4.0 as a new manufacturing approach that relies on technologies able to gather and analyse data in real time, in order to control and customize the production processes, we have limited the scope of our review to empirical studies concerning the adoption of the following enabling technologies (Agostini and Filippini 2019; Büchi *et al.* 2020; da Silva *et al.* 2019; Mitra *et al.* 2018; Mouef *et al.* 2020; 2018):
- *Advanced and innovative robotics* concern interconnected and modular

production systems (i.e., automatic machinery, autonomous and advanced robotics, collaborative robots, etc.) that use robots and machineries connected with other information technologies, such as sensors, artificial intelligence, machine-learning, IoT, cloud computing, big data, and/or 3D printing. Such types of technologies are used principally in the production processes for their effects on productivity and employment (Daim *et al.*, 2018).

- *Additive manufacturing* refers to the use of 3D printing technology that bases on the additive production which creates products by building up layers of plastic, metal or other material, directly from digital design files. 3D printing enables firms to improve the design, prototyping, and production of complex products as well as the customization of products (Candi and Beltagui, 2019).

- *Systems integration* considers the integration offered in two directions: internal and/or external. The former (horizontal integration) regards the integration of information systems within the internal business areas (Veile *et al.*, 2020). The latter (vertical integration) concerns the integration of information systems between the firm from one side and its suppliers and customers from the other side. Vertical integration systems allow manufacturing improvements as they could reduce production costs and improve productivity and product quality due to more effectiveness of incoming and outgoing supply chain activities (Fiorini *et al.*, 2019).

- *Big data and analytics* are technologies, tools, and techniques used to gather, archive, and analyse huge amounts of data coming from smart products, smart manufacturing systems, and people interconnected and integrated within the firm's environment as well as the environment around it. Such technologies could enable the firm to improve the production processes and product quality and customization due to the possibility of using the knowledge emerged from the analysis of data and affecting the decision-making process, thereby making it more effective (Raguseo, 2018).

- *Cloud computing* technologies are adopted to manage the storage and processing of large amounts of data with high performance in terms of speed, flexibility, and efficiency. Most of the time it is combined with other technologies, such as Enterprise Resource Planning (ERP) and/or big data, allowing the real-time sharing of information across business areas and external networks and ensuring data for different purposes in the production of other business domains (Gupta *et al.*, 2019).

- *Artificial intelligence (*AI) addresses technological solutions developed to act alone without human intervention to solve problems that would typically require it. It is "a system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Haenlein and Kaplan, 2019, p. 5). Artificial intelligence affects the firm's decision-making process with positive effects on several applications, from production processes (Lee *et al.*, 2018) supporting productivity and quality, to marketing improving customer services and customization (Davenport *et al.*, 2020).

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- *Cybersecurity* technologies include technological measures developed to ensure the security of information and data flows moving in the online environment over interconnected corporate systems. The increasing use of inter-connected technologies makes the smart manufacturing systems vulnerable to cyber risks (Tuptuk, 2018).
- *Augmented reality* (AR) is a series of technologies and devices used to simulate an environment containing real and virtual objects with the aim to improve production processes by enhancing design, prototyping, and product development; reducing set-up costs; processing time-receiving information in real-time, and providing virtual training. In this way, the human performances increase through the ability to reproduce and reuse digital information and knowledge to support the operation activities (Uva *et al.*, 2018). In particular, AR is considered a key technology for the development of smart manufacturing systems as it makes possible the shift from mass production to mass customization (Uva *et al.*, 2018).
- *Internet of Things* (IoT) refers to technologies, devices, and sensors that favour the integration among people, products, and machines. Internet of Things creates a new world in which objects can automatically communicate in real-time, providing valuable feedbacks and information that improve services for the benefit of mankind (Sestino *et al.*, 2020).

Industry 4.0 is characterized by the integration and interoperability of enabling technologies that allow the digitalization of business processes within and beyond the boundaries of the organization (Lu, 2017). However, Industry 4.0 technologies affect the business processes in a different way, allowing firms to implement them in different business functions for different purposes linked to the benefits they expect (Dalenogare *et al.*, 2018). Despite the key role of strategic expectations about the benefits of the use of Industry 4.0 technologies, the implementation depends on other factors that act as constraints of adoption, such as financial resources (Mittal *et al.*, 2018).

2.2 Drivers and barriers of Industry 4.0 implementation

Initially, the digitalization strategy based on Industry 4.0 aimed at automating and optimizing the manufacturing processes with the main purpose of increasing productivity and efficiency (Sanders *et al.* 2016). In this first step, firms aimed principally to automate the production processes through the adoption of advanced and innovative robots (Mittal *et al.*, 2018). In a second step, other types of strategic purposes arose, mainly linked to market benefits (Chiarini *et al.*, 2020). Within this new technological revolution, production and market goals play a joined role as they could enable firms to implement a mass customization and personalization strategy (Wang *et al.*, 2017). This is very important for SMEs' growth because it puts together the marketing-benefits of a single (customized) batch with the cost-benefits of mass production (Fogliatto *et al.*, 2012). The linkage between technologies and new managerial opportunities relates to the effects that the different technologies may have on the different

business processes (Liao *et al.*, 2017). Recently, scholars have identified several impacts of this, including the increase of productivity, production efficiency, flexibility, and environmental sustainability from the side of manufacturing domains (de Sousa *et al.*, 2018; Fettermann *et al.*, 2018; Tortorella and Fettermann, 2018). They also recognize the rising of product quality and customization, the reduction of time-to-market response, the new role of consumers and suppliers interactions along the value chain (Bogers *et al.*, 2016; Leeflang *et al.*, 2014), the impact on the business model (Wei *et al.*, 2017), and the increase of servitization (Bortoluzzi *et al.*, 2019). The benefits expected from the use of the new technologies become strategic drivers of adoption (Agrawal *et al.*, 2018).

The adoption of new technologies also depends on some challenges that firms have to face. This is particularly true in the realm of SMEs that have specific features that may undermine the adoption of the concept of technologies (Moeuf *et al.*, 2020). As already shown for the adoption of previous technologies (Haug *et al.*, 2011), SMEs may find it difficult to adopt Industry 4.0 technologies in relation to specific constraints. Recent research highlights some internal and external constraints/barriers for SMEs (Horváth and Szabó, 2019; Masood and Sonntag, 2020; Mittal *et al.*, 2018) that may be summarized as follows:

- lack of financial resources;
- lack of adequate technological assets;
- lack of adequate internal and/or external information systems;
- lack of adequate skills/expertise;
- reluctance towards opportunities, most of the time linked to the long implementation time.

Among the different barriers, researchers have broadly investigated the lack of financial resources (Kiel *et al.*, 2017; Mittal *et al.*, 2018; Müller *et al.*, 2018) in relation to the comparison between SMEs and large firms (Horváth and Szabó, 2019). Such works have suggested that the lack of financial resources is a significant obstacle to implementing Industry 4.0. To overcome this obstacle, several national governments of advanced economies, such as the Italian government, introduced public financial initiatives to support SMEs in the implementation of Industry 4.0 (Capestro and Kinkel, 2020). Those initiatives aim to reduce barriers, to foster digital transformation, and to increase the number of firms that could benefit from new technologies. The public financial support is an exogenous event that could reduce the risk of the SMEs in investing in such technologies and, in doing so, could enlarge the number of firms that use Industry 4.0 technologies to improve their competitiveness. However, the firm's availability of financial resources, as literature points out (Frank *et al.*, 2019a), could be relevant for adopted Industry 4.0 technologies affecting the intensity (number of technologies) and the breadth (variety of technologies) of Industry 4.0 investment (Agostini and Nosella, 2019, Büchi *et al.*, 2020). Hence, our main research question is as follows: *Do SMEs with different levels of economic and financial performances follow different Industry 4.0 implementation paths?*

In addition, SMEs with different financial resources could be driven by different strategic motivations in adopting this paradigm. In

particular, they may be driven by different expected benefits that the new technologies will allow them to achieve (Dalenogare *et al.*, 2018). Beyond financial resources, several scholars hypothesized the relevance of specific characteristics of the firm, i.e., Strategy, Research and Development (R&D), and Marketing, in the adoption of technologies (Laforet, 2009), as well as of Industry 4.0 (Dalenogare *et al.*, 2018; Müller *et al.*, 2018). In this vein, it is not the dimension (small or large) of the firm that is relevant but its strategic drivers. Despite this growing interest, there is a lack of empirical evidence on the relevance of firms' strategic drivers. Therefore, the study tries to answer a second research question: *Are there any differences about the strategic drivers of adoption between the SMEs with different economic and financial performances?* In so doing, the paper also aimed at assessing the role of internal skills and if there is a direct relationship between the lack of financial resources and the access to the public financial funds.

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3. Methodology

To assess if economic and financial performances may play a role in differentiating the implementation of Industry 4.0 by SMEs, we have taken into consideration two different groups of SMEs with different levels of economic and financial performances. Specifically, the two groups include one group of SMEs with economic and financial performance indicators above the average values of the population (named top performers), and to another group of SMEs with economic and financial performance indicators equal to the average values of the population (named average performers). The two groups of SMEs (top and average performers) and the related performance indicators used to identify them are based on an Italian bank report[1] (respectively for the top performers → Average Turnover 2016-2018: €7.1 million; Average Turnover growth 2016-2018: +15.8%; Average ROE: 2016-2018 = 20.1%; for the average performers → Average Turnover growth 2016-2018: €4.6 million; Average Turnover growth 2016-2018: +4.3%; Average ROE: 2016-2018 = 8.0%). Both groups include SMEs operating in the main manufacturing "Made in Italy" sectors-mechanics, fashion, food, home system, and furniture-as well as in other relevant industries, such as in addition to automotive, chemical, and pharmaceuticals; logistic and transport, and building-related productions and technology. The choice that the different economic and financial indicators use to identify the two SME groups is based on opportunistic methodology. The choice about the use of multi-industry samples is based on recent literature on the topic (Cimini *et al.*, 2021; Pirola *et al.*, 2019). Both choices are suitable for exploratory purposes.

After identifying the two groups of SMEs, a CAWI-based survey[2] was carried out between September 2019 and February 2020. The

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[1]   Banca IFIS, Market Watch PMI Fattore I, https://www.bancaifis.it/app/uploads/2020/06/MW-PMI-Fattore-I-febbraio-2020.pdf

[2]   A CAWI survey, acronym of Computer Assisted Web Interviewing, is a web-based data collection methodology based on a questionnaire provided with a link, in a panel, or a website, to the respondents that autonomously answer the interview by computer, tablet, smartphone, or any other device.

questionnaire was sent to a stratified sample of 1,986 top-performing firms and to a stratified sample of 4,808 average-performing firms, randomly selected and resulting in a total of 366 questionnaires. Specifically, 166 questionnaires (representing about 8% of the sample considered with a response rate of 8.4%) refer to SMEs with higher financial performances and 200 questionnaires (representing about 3% of the sample considered with a response rate of 4.2%) refer to SMEs with average performances. The sample stratification and the random selection of both samples (top and average performers) allowed all sectors to be investigated, enhancing the generalizability of the study as past research has shown (To and Ngai, 2006).

The questionnaire has several sections. First, it outlines the firm's competitive characteristics, such as industry, firm size, percentage of export and R&D expenditure on turnover, the type of market-Business-to-Business (B2B) or Business-to-Consumer (B2C)-the competitive factors (O'Regan *et al.*, 2006), and the Information and Communication Technologies (ICT) firms already use. Then, the survey focused on the assessment of the Industry 4.0 implementation, both in terms of technologies adopted as well as of strategic decisions that drive the adoption. In particular, the adoption of the technologies listed in the Industry 4.0 Italian National Plan (Agostini and Filippini, 2019) were assessed through a binary variable (yes or no) with a multiple-choice option. The investigated technologies are as follows: advanced and innovative robotics (robotics), 3D printing, value chain integration systems (integration systems), big data and analytics (big data), cloud computing (cloud), AI, cyber-security technologies, AR, and IoT.

As far as the assessment of strategic variables related to the digital transformation, the questionnaire assessed both the motivations and the barriers of adoption (Dalenogare *et al.*, 2018; Müller et al, 2018) as well as the link between Industry 4.0 and digital skills through a five-points Likert scale (completely disagree = 1; completely agree = 5) and, finally, the access to the government financial supports through a dichotomous variable (1 = yes; 0 = no). According to the exploratory purpose of the study, we performed a multivariate analysis of variance (chi-square and t-test) for the variables investigated, with the aim at comparing top and average performers. The core analysis has taken into consideration the adoption firms of top- and average-performing groups. For the sample descriptive statistics, the analysis was also performed to explore the differences between adopting and non-adopting firms within the two main groups (top and average performer) of SMEs.

4. Results

4.1 Descriptive results

The first step of analysis focused on the description of the sample and a preliminary evaluation of the two different groups of SMEs (top vs. average performers). Technology, mechanics, constructions, and food are the main

sectors composing both groups. The overall sample shows an adoption rate of 49.2% (186 firms adopted at least one of the Industry 4.0 technologies investigated), with significant differences between the two groups (see Table 1). In the top performer group, 60.8% (101 of 166) adopted at least one of the Industry 4.0 technologies investigated. Instead, for the average performer group, the adoption rate was 42.5% (85 of 200). In addition, Table 1 shows that top and average performers are mainly composed of B2B firms with a proprietary brand and the suppliers localized in the company's region and/or in Italy.

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Tab. 1: Descriptive statistics

Descriptive	Overall sample			Adopters			Top performers			Average performers		
	Adp vs No-adp		Sig.	Top vs Avg		Sig.	Adp vs No-adp		Sig.	Adp vs No-adp		Sig.
Industry 4.0 adoption	49.2%	50.8%		54.3%	45.7%	***	60.8%	39.2%	***	42.5%	57.5%	***
Employees (avg. 2018)												
Total	29.8	18.8	***	36.2	22.2	*	36.2	20.0	**	22.2	16.3	°
Graduate/ Technical	10.3	5.6	**	13.8	7.7	*	13.8	4.9	**	7.7	4.1	°
Export (% on turnover 2018)	33.6%	21.8%	***	35.0%	23.8%	*	35.0%	31.5%		23.8%	20.3%	
R&D (% of turnover 2018)	7.3%	5.4%		8.0%	7.9%		8.0%	6.1%		7.9%	3.6%	**
Market												
B2B	93.0%	83.3%	**	95.0%	90.6%		95.0%	87.7%	°	90.6%	80.9%	°
Buyer brand	32.7%	29.5%		30.2%	28.6%		30.2%	36.8%		28.6%	30.1%	
Owner brand	67.3%	70.5%		69.8%	71.4%		69.8%	63.2%		71.4%	69.9%	
B2C	7.0%	16.7%	**	5.0%	9.4%		5.0%	12.3%	°	9.4%	19.1%	°
Supplier's location												
Company's region	44.4%	52.8%	*	42.2%	47.1%		42.2%	50.5%		47.1%	54.0%	
Italy (other regions)	38.9%	34.6%		40.5%	37.0%		40.5%	33.8%		37.0%	35.2%	
Abroad	16.7%	12.6%	°	17.3%	15.9%		17.3%	15.7%		15.9%	10.8%	
N	166	200		101	85		101	65		85	115	

Notes: Adp = I4.0 adopters, No-adp = I4.0 non-adopters; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ° $p < 0.10$.

Source: Authors' elaboration

Top performers have more skilled resources and a higher international orientation compared to the average performers (Table 1). The same significant differences characterize the adopters respect the non-adopters, with the top performers showing higher values for employees and export rate. Instead, comparing adopters and non-adopters of both top and average performers determined that adopting firms have a significantly higher number of employees and of graduate and/or technical diplomas (total employees: 36.2 vs. 20.0, $p < 0.01$; graduate/technical employees: 13.8 vs. 4.9, $p < 0.01$ for the top performers; total employees: 22.2 vs. 16.3, $p <$

0.10; graduate/technical employees: 7.7 vs. 4.1, $p < 0.10$ for the average performers).

The second preliminary step of analysis focused on the comparison of the competitive factors. For both groups, production flexibility is the most important competitive factor and price is less important (but with statistically significant differences between the two. Respectively, 22.5% vs. 12.5%, $p < 0.05$; values based on high/very-high answers of the five-point Likert scale). This is also true for the adopting firms of both groups of SMEs. Instead, considering the adopters group, the only significant differences between top and average performers refer to the higher importance of *product uniqueness* and *variety* for each (respectively, 63.4% vs. 52.9%, $p < 0.05$; 50.5% vs. 37.6%, $p < 0.10$). Within the non-adopters, no differences arise between top and average performers.

In order to frame the Industry 4.0 investment strategy of firms, an additional analysis refers to the assessment of ICT endowment (see Table 2) that can show a firm's technological trajectory (Bettiol *et al.*, 2019). There are interesting differences emerging among the groups. As one might expect, analyses confirm a difference between top and average performers with the former being more technologically advanced than the latter, especially in relation to the technologies' ability to manage business processes (such as ERP, 58.4% top vs. 45.5% average performers, $p < 0.01$) and customers (CRM, 52.5% top vs. 28.5% average performers, $p < 0.001$).

Tab. 2: ICT

ICT	Overall sample		Sig.	Adopters		Sig.	Top performers		Sig.	Average performers		Sig.
	Adp vs No-adp			Top vs Avg			Adp vs No-adp			Adp vs No-adp		
Website	93.0%	92.2%		94.1%	96.5%		94.1%	89.2%		96.5%	90.4%	
Social Network	57.2%	61.0%		69.3%	62.4%		69.3%	38.5%	***	62.4%	60.0%	
E-commerce	9.0%	6.5%	*	5.9%	12.9%	°	5.9%	13.8%	°	12.9%	19.1%	
Enterprise Resource Plan. (ERP)	58.4%	45.5%	**	67.3%	54.1%	°	67.3%	44.6%	**	54.1%	37.4%	*
Customer Relationship Man. (CRM)	52.5%	28.5%	***	64.4%	40.0%	**	64.4%	33.8%	***	40.0%	20.0%	**
Supply Chain Man. (SCM)	16.9%	9.0%	**	18.8%	12.9%		18.8%	13.8%		12.9%	6.1%	°
ICT intensity												
One ICT	12.7%	15.5%		4.9%	10.6%		4.9%	24.6%	***	10.6%	19.1%	°
Two ICT	27.7%	36.0%	°	23.8%	32.9%		23.8%	33.8%		32.9%	38.3%	
Three ICT	30.1%	32.5%		31.7%	33.9%		31.7%	27.7%		33.9%	30.6%	
Four+ ICT	29.5%	16.0%	**	39.6%	25.9%	*	39.6%	13.9%	***	25.9%	8.7%	**
N	166	200		101	85		101	65		85	115	

Notes: Adp = I4.0 adopters, No-adp = I4.0 non-adopters; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ° $p < 0.10$.

Source: Authors' elaboration

Top performers also show higher ICT intensity consistently with prior studies (Hendricks *et al.*, 2007). Focusing on adopting firms, the

comparison between top and average performers shows similar differences, and specifically the higher use of CRM (64.4% vs. 40.0%, $p < 0.01$) and the use of a highest number of ICT (four or more ICT: 39.6% vs. 25.9%, $p < 0.05$) of the top performers. Finally, the most interesting results concern the differences between adopters and non-adopters. Indeed, such differences are similar in both the top and average performers. The adopters of both groups have, in general, higher rates of adoption in relation to the different technologies (especially the more complex ones, i.e., ERP) and a higher ICT endowment compared to non-adopters.

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4.2 Industry 4.0 results

The core of our analysis is related to the implementation of Industry 4.0 comparing top and average performers. Firstly, as shown in Figure 1, the analysis aimed to evaluate the differences in the adoption rate of the single enabling technologies of the Italian Industry 4.0 National Plan as well as the intensity (number of different technologies adopted) of Industry 4.0. Cloud is the technology most adopted by both groups. Except for cloud and AR, top performers show higher adoption rates for all the technologies investigated, but the only significant differences refer to the robotics (35.6% top vs. 10.6% average performers, $p < 0.001$) and to big data and analytics (24.8% top vs. 10.6% average performers, $p < 0.01$). Consistent with the evidence on ICT endowment, top performers adopted a higher number of Industry 4.0 technologies (three or more technologies) with respect to the average performers.

Fig. 1: Industry 4.0 adoption
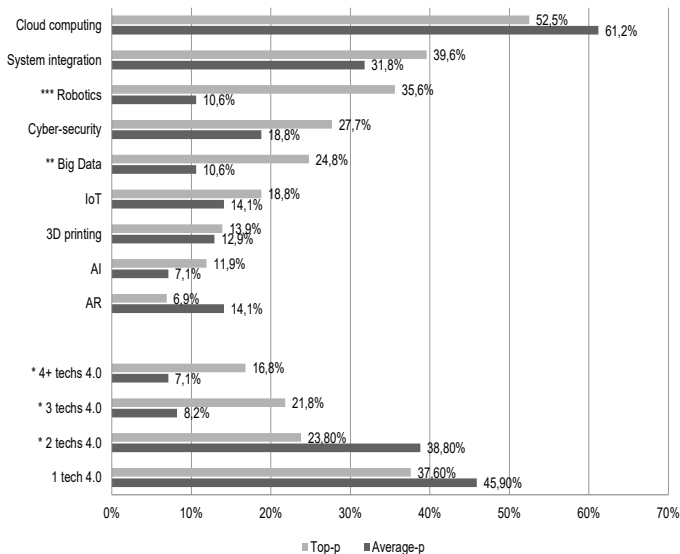
Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; top performers = 101, average performers = 85.

Source: Authors' elaboration

The Industry 4.0 implementation seems to follow a specific technological trajectory that depends on the firm's overall strategy (Agrawal *et al.*, 2018) and this emerges from the motivations of adoption reported in Figure 2.

Fig. 2: Motivations for adopting Industry 4.0 technologies
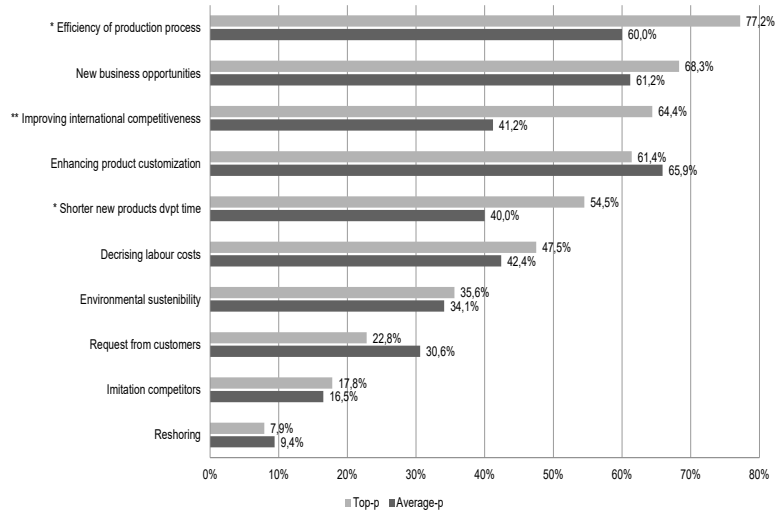
Notes: ** $p < 0.01$; * $p < 0.05$; top performers = 101, average performers = 85.

Source: Authors' elaboration.

Top performers' main motivation for adoption is improving the production process efficiency, which is significantly different from the group of average performers (77.2% vs. 60.0%, $p < 0.05$). This correlates with the higher investments in technologies used in the production domain, such as robotics, that characterize the top performer adopting firms. Other significant differences refer to the higher relevance of adoption related to the improvement of international competitiveness and the new product development process for the top performers in respect to the average performers (respectively, 64.4% vs. 41.2%, $p < 0.05$; 54.5% vs. 40.0%, $p < 0.01$). In this case, facing international competitiveness plays a key role for the implementation of Industry 4.0.

The analysis on the barriers of adoption shows that top and average performers are very similar (see Figure 3). For both groups, the main barrier relates to the difficulty in finding professional competences related to Industry 4.0, followed by the length of the implementation process. The only significant difference among the two groups of adopters refers to the higher lack of broadband for average performers when compared to the top performers (respectively, 37.6% vs. 22.8%, $p < 0.05$). Despite the similarities between adopters in the difficulties of finding key competences to manage Industry 4.0 adoption, the comparative analysis between top and average adopting firms highlighted a significantly higher investment of top performers in the recruitment of new competences to manage the

Industry 4.0 technologies (54.7% vs. 45.1%, $p < 0.05$). Instead, both top and average performers stated that the adoption and use of new technologies needed of specific training courses.

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Fig. 3: Barriers of Industry 4.0 technologies adoption
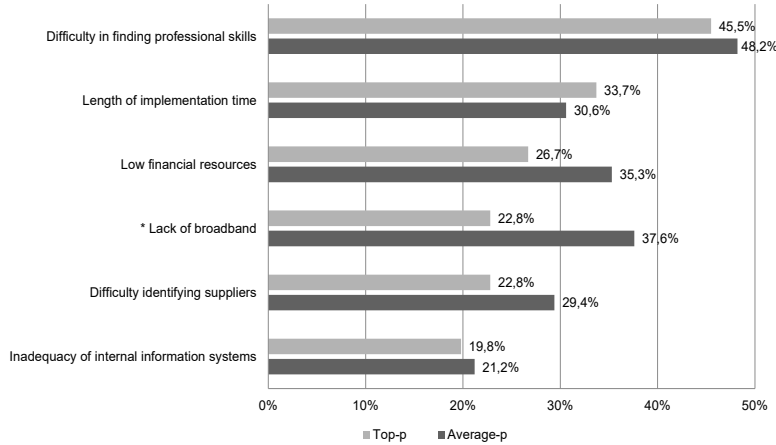
Notes: * $p < 0.05$; top performers = 101, average performers = 85.

Source: Authors' elaboration

Finally, as far as access to public financial funds to support Industry 4.0 investments are concerned, in a counterintuitive way, the comparison between the two groups of adopting firms showed that 34.2% of top performers compared to only 21.0% of average performers requested and accessed public funds. This could be interpreted as the top performers' stronger ability to gain access to public incentives for innovation. This interpretation is supported by the fact that top adopting firms show higher willingness in future adoption of the Industry 4.0 technologies (64.3% vs. 40.0%, $p < 0.01$), even without public funds.

5. Discussion

The multivariate analysis performed to compare the Industry 4.0 implementation paths of SMEs with different levels of economic and financial performances highlighted some interesting findings. Despite the differences in the performance profiles, the adopting firms of both groups show similarities that highlight common features at the basis of digital transformation-such as the human resource endowment (Schneider, 2018) and the R&D investments that may be considered as baseline resources that stress the firm's readiness for digital transformation (Mittal *et al.*, 2020). Research and development activities are essential for the successful implementation of Industry 4.0, independent from the firm size or from performance (Szalavetz, 2019). Indeed, top and average performers adopting Industry 4.0 technologies have a similar R&D expenditure

percentage. This result suggests that the financial endowment may support the adoption, but the firm's innovation resources and capabilities are the main dimensions that may affect the investment in new digital technologies, consistent with their broader innovative strategies.

Prior to analysing the Industry 4.0 implementation, we performed a comparative analysis aimed at exploring the ICT endowment of two groups of SMEs. The use of previous technologies could be seen as a strategic enabling factor that may affect the adoption of new technologies as well as the type of technologies adopted because of the relevance of dynamic capabilities that SMEs could improve over the years (Lin *et al.*, 2016). The most interesting results of the ICT endowment concern the differences between Industry 4.0 adopters and non-adopters. In this regard, the differences between adopting and non-adopting firms are similar for both the top and average performers groups. The adopting firms of both groups are technologically more advanced as they show a higher percentage of all technology use and of the number of ICT used and have some specific features and maturity that do not depend from the level of performance (Mittal et al 2018). Instead, respect to the differences between the top performing adopters and average performing adopters, the former show to give a higher relevance to the management of relationships with customers. This finding may be relevant in the evaluation and understanding of the Industry 4.0 paths of the two different groups.

In regards to the Industry 4.0, cloud computing is the technology that both groups adopt the most. It could be considered a basic technology that firms need to have to manage the huge amount of data related to Industry 4.0 (Liu and Xu, 2017). Instead, in terms of differences, top performers show a higher adoption rate of robotics (advanced and innovative) and of big data and analytics. While robotics could be industry-specific, the adoption and use of big data and analytics could be related to some specific company's features and, in particular, to the human resources and availability of in-house competencies that higher performance allows them to more easily overcome (Côrte-Real *et al.*, 2017). In addition, the higher adoption rate of big data may be linked to the higher importance of CRM for top performers. The relevance of this technology is consistent with the strategic attention to the development of an offering based on product variety that, in addition to flexibility and product customization, represents a key competitive feature of adopting top performers and adopters more generically. Such results highlight the key role of the differentiation strategy for the top performers, where flexibility and product uniqueness are the main sources of competitiveness, in addition to cost-effectiveness. Moreover, consistent with the evidence on ICT endowment, top performers are adopted in a significantly higher number of technologies than average-performing adopters. This could be related to the differing levels of economic and financial performances.

When it comes to the motivations for adoption, top and average performers put the main emphasis on efficiency, new business opportunities, and product customization. However, for the top performers the production efficiency is much more important than for the average performers and the former group significantly differs from

the latter in terms of higher relevance of the international competitiveness and the development of new products. In this sense, the adoption of new technologies may allowing to face the global competition enhancing product quality and production efficiency as well as improving flexibility (Fatorachian and Kazemi, 2018), thereby reducing the competitive distance with the larger multinational companies (Horváth and Szabó, 2019). The analysis of adopted technologies and the motivations of adoption outline some interesting differences between top and average performers. The former adopts more technologies to manage the different business process as well as the data created within the Industry 4.0 paradigm; this is related to the enlarged global competition that they have to face (Agostini and Nosella, 2019).

Finally, in terms of barriers of adoption, despite the similarities in the difficulties of finding key competences to manage Industry 4.0 adoption, the comparative analysis highlighted as top performers have significantly invested in the recruitment of new competences to manage new technologies. This finding could be related to the breadth of Industry 4.0 technologies adopted that may require different skills (Orlandi, 2016), showing also a higher willingness to invest in the future in Industry 4.0 to compete.

6. Conclusions

The study aimed at evaluating the adoption paths of SMEs by exploring the role of economic and financial performances in the implementation of Industry 4.0. Top performers are able to adopt several, and most of time complementary, Industry 4.0 technologies, acting like larger firms (Horváth and Szabó, 2019). Moreover, top performers, when compared to average performers, are more interested in the production domain of being competitive in an international scenario by means of efficiency (Fettermann *et al.*, 2018) and without losing control over processes and markets through a higher adoption of big data and analytics that allow them to improve the product development process (Gupta *et al.*, 2019).

Theoretically, the study advances literature on the adoption of Industry 4.0 by SMEs (Horváth and Szabó, 2019; Masood and Sonntag, 2020; Moeuf *et al.*, 2020), highlighting the relevance of economic and financial performance for reducing the distance from the large and multinational companies, especially in terms of higher level of investment that may guarantee higher level of digitalization (Mittal *et al.*, 2018). Although SMEs with higher economic and financial performances are technologically more advanced, thereby stressing the relevance of financial resources in shaping the digital transformation of SMEs, the study highlights that the adopting firms of both groups show higher technology maturity when compared to the non-adopting groups. This finding could be related to the previous technological investment that could allow SMEs to improve their own digital and technological skills and capabilities, in addition to the improvement of the technological culture (Mittal *et al.*, 2018). The investment in new technologies follows a detailed business strategy as

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well as a technological trajectory that aims to reach certain business goals. Specifically, higher performance links to higher levels of Industry 4.0 maturity (Mittal *et al.*, 2018) with positive effects on the strategic approach to the market, pursuing contemporary efficiency and differentiation effects and thus mass customization goals (Wang *et al.*, 2017). In so doing, human resources and digital skills and competences play a key role in the implementation stage as well as for the achievement of business benefits related to Industry 4.0. Finally, this paper shows that the financial support that national governments introduced to favour the diffusion of Industry 4.0 is not directly linked to the spread of digital transformation of SMEs. In this sense, and also for receiving public funding, the firms with higher economic and financial resources are more ready than others.

6.1 Practical implications

In terms of managerial implications, our research suggests that firms approaching Industry 4.0 should have a clear technological investment strategy consistent with their overall business strategy. Firstly, prior investments in ICT could become an enabling factor that smooth the adoption of Industry 4.0 technologies, and in terms of competences, develop the digital skills and culture that are needed to approach the new technological revolution. Moreover, it should also be considered the potentialities of adopting a large breadth of technologies (captured in terms of different Industry 4.0 technologies adopted) because of the exploitation of the synergy effects of the different technologies on both processes and product innovation (Lee *et al.*, 2019). For manufacturing SMEs, our evidences highlight the potentialities of enhancing both efficiency and the offering of the firms in terms of product customization, flexibility. Investing in Industry 4.0 technologies could become an effective strategy for small firms to strengthen their international competitiveness by coupling technologies for improving production processes-both for efficiency and customization-as well as customer interaction.

At the same time, due to the higher complexity and the multi-technology adoption, SMEs should pay great attention to the specific skills needed to manage the higher complexity of Industry 4.0, as one of the most important challenges is being ready to manage several areas of (digital) transformation within the firm at the same time (Schneider, 2018). Our research also indicates that human resources are important for the successful implementation of Industry 4.0-especially in terms of breadth of adoption (number of different technologies adopted)-that needs different skilled resources. Indeed, top performers invest in skilled resources and, thus, managers should favour training. Finally, entrepreneurs/managers of average performers should be more ready to apply to public announcements to use public funds.

6.2 Research limitations and future research

The limitations of this study create opportunities for future research. First, considering the explorative feature of the research, our results could

be influenced by the use of a multi-industry sample. Therefore, future studies should focus on a specific industry to better analyse how top performers differ from other SMEs with respect to the implementation of Industry 4.0. Another limitation regards the focus on a large set of technologies. It would be useful to focus on some technologies and specifically to link with the industry, especially for the technologies that affect the operation/manufacturing process. From this perspective, a limitation regards the missed analysis of value chain activities where firms used the technologies adopted. Therefore, future research should take into consideration this strategic variable as it could affect the motivations of adoption.

Furthermore, some limitations relate to the methodology and the quantitative method adopted where the use of a single source (questionnaire) could expose the results to the risk of common method variance. However, remedies were adopted to limit these potential biases, such as the use of different measures. Future research will include qualitative analysis through case study development. Finally, future research should also consider the concept of dynamic capability for deeper understanding of whether a superior performance affected the firm's technological asset that enables the development of digital and technological skills and capabilities.

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New value creation opportunities for Start-ups with I4.0: resources and capabilities capitalisation and effects on the Value Chain

Niccolò Fiorini

Abstract

Purpose of the paper: *this research aims to investigate how I4.0 enables new opportunities of value creation for start-ups using internal or external resources and capabilities related to Industry 4.0 (I4.0).*

Methodology: *we use a qualitative case study research approach, mainly because of the exploratory nature of the research and the newness of the analysed trend.*

Results: *the research points out three possible opportunities for starting new businesses: using a mix of internal and external resources/capabilities (Grafting 4.0), a combination, coordination and management of external resources and capabilities (Pollination 4.0), or internal resources and capabilities with a comprehensive 4.0 approach (Blooming 4.0). For each of them the required 4.0 technologies and the new paradigm's application are examined.*

Research limitations: *The analysed cases are all based in Italy, for a better validation it would be interesting to expand the study to other countries.*

Practical implications: *this paper may be helpful for prospective entrepreneurs that should ask themselves which kind of opportunity they could grab in consideration of the internal and external resources and competencies.*

Originality of the paper: *to the best of our knowledge this paper is amongst the first ones analysing the opportunities given by I4.0 to start new businesses.*

Key words: value creation; start-up; Industry 4.0; supply chain; business models.

1. Introduction

The increasing diffusion and adoption of I4.0 technologies has opened new challenges for all, bigger and smaller companies. It is interesting that empirical evidence suggests that some technologies at the basis of I4.0, for example big data and cloud computing (Schmidt *et al.,* 2015), are used in other fields or for other applications (Drath and Horch 2014). This goes beyond the role and the intervention of policy makers, hence it is interesting to understand how start-ups create and capture value (i.e. business models; Zott *et al.*, 2011) exploiting I4.0 technologies. Researches about this specific issue are, at the best of our knowledge, still at their infancy. From an analysis of the literature comes out an interesting aspect: chain integration. More precisely, some authors (among others: Kang *et al.*, 2016; Liao *et al.*, 2017; Wahl, 2015) enlighten that, products, things, data and even humans and not only machines are connected thanks to the paradigms of I4.0. This leads to the need of a re-examination and

reorganisation of the whole industrial processes (Hermann *et al.,* 2016) to achieve the superior benefit deriving from integration. Integration and connections are two words commonly used in I4.0. Connection is the cornerstone for new organizational structures (Fantoni *et al.* 2017), and this is true not only those of the production systems but also in the value chain, especially in manufacturing industries (Rüßmann *et al.,* 2015) as well as in agribusiness. In the first case the term Cyber Physical Systems (CPS)systems are widely used, while in the latter case the whole supply chain (SC) could be integrated with certification of food products thanks to the blockchain (Fantoni *et al.,* 2017a). Another interesting aspect related to I4.0 and value creation concerns customisation, according to which smaller volumes of tailored goods will be preferred to mass production (Rüßmann *et al.* 2015). Technologies 4.0 that can be easily integrated, e.g. Internet of Things, Additive Manufacturing (Ngo *et al.*, 2018) and Big Data, are acknowledged to be core driving forces that, thanks to interconnectivity, are able to capture advantages from synergies based on customisation (Kumar *et al.*, 2016) or to modify the SC outline (Bucy *et al.*, 2016; Zhong *et al.*, 2016). In the near future many players will rely on digitised horizontal and vertical value-chain processes (Geissbauer *et al.*, 2016), since digital SC is already considered to be the core of all the activities 4.0 implemented in the ecosystem (Schrauf and Berttram, 2016). In order to better understand the effects of I4.0 in the SC (the so called "SC4.0") it is important to examine the resources' flow both for internal and external perspectives (Kogut and Zander, 1992; Wahl, 2015) in order to understand the complicated interconnections above mentioned.

We have noticed that mainly scholars and experts, when looking to how I4.0 technologies are used in companies, focus their attention on established big and SMEs companies, while little is known about how new entrepreneurs may exploit them. Moving from entrepreneurship and innovation management research, the aim of this paper is to explore how start-ups exploit I4.0 technologies for creating new value. To do so we must analyse the aspects related to Business Models (BMs) because, as extensively discussed by many scholars, new technologies enable the emergence of new BM (Zott *et al.*, 2011, Baden-Fuller and Haefliger 2013, Teece 2017). It is indeed true that this reasoning also appears when existing technologies are applied for other purposes (Casprini *et al.*, 2014). As a matter of fact, in case of new (in the analysed sector) and distinctive external resources, which are one of the two paths analysed in this research (together with internal ones), adopted by a company, scholars have underlined the increase in efficacy and efficiency of value creation, provision, and capture (Amit and Zott, 2001; Pucci *et al.*, 2013): thus, they originate BM reconfiguration inside firms (Morris *et al.*, 2005). However, if it is widely accepted that I4.0 technologies enable new BMs and the adoption of specific BMs is associated to the possession of distinctive capabilities (Pucci *et al.*, 2017), how the internal or external resources and capabilities create or enhance value and how they affect the BMs have been hardly investigated. Therefore, to provide a first analysis of start-ups and I4.0 in the Italian context, the following main research questions are proposed:

1. What are the opportunities for start-up creation in the I4.0 context?
2. Where do the resources and capabilities originate from to foster these opportunities?
3. Do these start-ups have traditional BM or adapted/new ones?

The paper is organised as follows: In the next section an analysis of the literature is performed; then the methodology is described. Findings are reported thereafter. Practical implications are illustrated, also using a table. Conclusion and limitations are at the end.

2. Literature review

Being a "planned" industrial revolution (Lasi *et al.*, 2014), the term has been given before the real revolution happened, oppositely to what happened with the previous three revolutions (Rojko, 2017). This did not prevent I4.0 from having the same impact as the previous three (Kagermann, 2015). Furthermore, Zheng *et al.* (2019) underlined the "disrupting breakthroughs" and the consequent harsh impact on production and associated processes everywhere in the world. Scholars agree in considering velocity, scope, and system impact are the distinctive features of I4.0 (Xu *et al.*, 2018). I4.0 caused a paradigm shift (Lasi *et al.*, 2014) towards decentralised production processes starting from a centralised control (Hermann *et al.*, 2016). A key aspect of I4.0 is the approach toward technologies and their application (Rojko, 2017) rather than the introduction of new technologies itself: what makes a difference is the capitalisation of the involved technologies (Baur and Wee, 2015), that represent the disruptive elements enabling the transformation from "pre-I4.0" to a completely new environment that goes far beyond this (Almada-Lobo, 2015). The effects are disruptive regardless industries and geographical location (Xu *et al.*, 2018). I4.0 sinks its roots in the integration of the traditional hardware and software (the so-called operational technology) with information technology (Thames and Schaefer, 2016) and then it allows data and information sharing at inter- and intra- organisational levels (Zheng *et al.*, 2019). Therefore, another crucial aspect of I4.0 is the exchange of information between people, machine, and resources (Hermann *et al.*, 2016) hence leading to CPS. According to Schumacher *et al.* (2016) the integration is about physical objects, humans, smart machines, production lines, and processes crosswise organisational borders. The connection of sophisticated technologies and the mixture of physical, digital, and biological domains represent a key differentiation of I4.0 and a fracture between I4.0 and "not-4.0" (Xu *et al.*, 2018).

If we consider the involved technologies and the effects of the fourth industrial revolution, it is not possible to include I4.0 in a single discipline, since it belongs to the interconnection of engineering computer science, and business administration sectors (Lasi *et al.*, 2017). Therefore, scholars from both academia and business analysed I4.0 related topics from various different points of views, e.g. (not exhaustive list): engineering, social sciences, computer sciences, production and logistics (Hermann *et al.*, 2016; Kang *et al.*, 2016; and Liao *et al.*, 2017). According to Xu *et al.* (2018), I4.0 has a disruptive effect in all the industries everywhere in the world.

The above cited literature has enlightened that there is a difference between technologies, included the enabling ones, applied without following the disruptive I4.0 paradigm and those implemented following it.

I4.0 creates a smart, networked, and agile new kind of value chain (Schumacher *et al.*, 2016). According to this reasoning, the present research analyses the exploitation of resources and capabilities specifically through an I4.0 perspective.

From 2012 to 2019 the academic literature on I4.0 grew exponentially, with scientific disciplines being the most represented in terms of publications (engineering, computer science and material sciences among the most common) and a significant portion of papers also from the "business, management and accounting" side (Muhuri *et al.*, 2019; Oztemel and Gursev, 2020). Many researches analysed I4.0 focusing on specific enabling technologies, considering their impact on processes and production of firms: 3D Printing, additive manufacturing, advanced manufacturing solutions, augmented reality, Big Data and analytics, blockchain, Cloud, Cyber-security, Horizontal/vertical integration, Industrial Internet, Internet of Things, Simulation and Smart Manufacturing (Almada-Lobo, 2015; Schumacher *et al.*, 2016; Barreto *et al.*, 2017; Fantoni *et al.*, 2017; Majeed and Rupasinghe, 2017; Witkowski, 2017; Khaqqi *et al.*, 2018). Others investigate I4.0 on specific issues or effects, also considering business and management topics: digitalisation and value creation (Kagermann, 2015; Garzoni *et al.*, 2020), e-business (Saniuk *et al.*, 2019), logistics (Hofmann, and Rüsch, 2017; Winkelhaus and Grosse, 2020), maintenance services (Macchi *et al.*, 2016), optimisation (Hsu and Yang, 2016), smart cities (Lom *et al.*, 2016), SC management (Witkowski, 2017), and the impact on the design and manufacturing processes (Tjahjono *et al.*, 2017; Ghobakhloo, 2018). Many scholars wondered how companies assimilated I4.0. Schumacher *et al.* (2016) interviewed I4.0 experts and from this analysis came out that the perception of companies of the I4.0 paradigm is about an extremely complex concept. The impact of I4.0 is different if compared to the ones of the previous three revolutions. In fact, until the third revolution the impact was on the "shop-floor", while in I4.0 it is more comprehensive, extending its influence towards other areas (Schuh *et al.*, 2014). This leads to the need for a clearer idea and an understanding of related benefits and outcomes, thus making the companies able to perceive their own I4.0 capabilities and to identify whether I4.0 represents an opportunity planning their I4.0 best strategy (Bibby and Dehe, 2018) and approach (Bienhaus and Haddud, 2018).

Some scholars then focus their attention on innovation related issues. This may happen in terms of technologies (Ahram *et al.*, 2017; Kouhizadeh *et al.*, 2020), even if some scholars analyse innovation as a system (Reischauer, 2018; Wilkesmann and Wilkesmann, 2018). However, other scientists focus their attention on product innovation (Ancarani *et al.*, 2019; Li *et al.*, 2020) or process innovation (Sjödin *et al.*, 2018). There are researchers that study the collaboration, the (horizontal/vertical) integration topics and the effect of I4.0 on SC. Schuh *et al.* (2014), together with others (e.g.: Ilvonen *et al.*, 2018; da Silva *et al.*, 2019; Kipper *et al.*, 2020), state that collaboration, within the company and/or with other

players, has a central role in taking advantage of the I4.0 potentialities. This is supported by other scholars (Bibby and Dehe, 2018) that affirmed the revolutionary modification of the interaction of companies with suppliers and partners which reshapes the business process, too. This is in line with real time visibility (da Silva *et al.*, 2019), service integration and access to the ecosystem's information alongside the whole SC (Li Da Xu *et al.*, 2018). Collaboration, information sharing, and transparency are some of the I4.0 effects which generates disruptive changes to the entire SC and fosters, at the same time, SC progresses (Witkowski, 2017). Among these effects it is possible to include flexibility and efficiency (Ding, 2018; Dalenogare *et al.*, 2018), also because materials and resources, when smart, are not coupled entities (Almada-Lobo, 2015) making it possible to enable flexibility, integration and combination alongside SC. In fact, I4.0 has the ability to combine and blend the domains both vertically and horizontally (Ghobakhloo, 2018); therefore, in the SC companies are without borders, and they have both integrated BMs and inter organisational relationships (Halldórsson *et al.*, 2015; Ericson *et al.*, 2018). Hence, also thanks to ICT platforms, in the SC4.0 we have total coordination and control in a clear integrated ecosystem that allow co-creation and co-innovation (Schrauf and Berttram, 2016; Atti, 2018). In the SC4.0 all the players are independent but at the same time they all aim to reach a collaborative advantage for all the actors (Chen and Paulraj, 2004; Qin *et al.*, 2016). According to Kagermann (2015) these collaborations are fostering not only complexity, as previously reported, but they also require an architecture framework and a new organisation model especially for work. He is not the only one studying the new organisational and BMs linked with I4.0. Several scientists analyse the new organisational and BMs (Rüßmann *et al.*, 2015; Strange and Zucchella, 2017; Ślusarczyk, 2018). This because I4.0, as all digital technologies' progresses, is affecting how goods are designed and produced (Ślusarczyk, 2018; Grandinetti *et al.*, 2020), influencing companies also from the organisational point of view (Gölzer and Fritzsche, 2017; Prause and Atari, 2017; Horváth and Szabó, 2019; Kouhizadeh *et al.*, 2020). Hence, as stated by many scholars (among others: Rüßmann *et al.*, 2015; Gerlitz, 2016; Strange and Zucchella, 2017; Bienhaus and Haddud, 2018; Ślusarczyk, 2018; Trivelli *et al.*, 2019; Kiel *et al.*, 2017; Moeuf *et al.*, 2020), adapted (innovated) or new BMs are appearing. Indeed, academics have identified several non-traditional BMs that better fit with the needs of companies in this changing environment (Müller *et al.*, 2018). According to Ibarra *et al.* (2018), when dealing with I4.0 and BMs there are three different approaches for studying this connection: the service-oriented approach, the network-oriented approach and the user-driven approach. In fact, it is true that I4.0 entails new paradigms that ask for new managerial methods (Fettermann *et al.*, 2018). The service-oriented approach, i.e. service-oriented BM (Wiesner and Thoben, 2017; Kohtamäki *et al.*, 2019), implies changing from being product oriented to service oriented and also include all the players of the chain in a networked ecosystem. The network-oriented approach, i.e. "network-oriented" BM (Stary and Neubauer, 2017; Thuemmler and Bai, 2017), deals with vertical and horizontal integration that allow the emergence of

new actors. Instead, the user-driven approach, i.e. "user-driven" or "new value proposition" BM (Bawono and Mihardjo, 2020; Culot *et al.*, 2020), deals with advanced and flexible value propositions when customisation and user experience has a role. It is then clear that in such a complex, dynamic and sundry environment new opportunities emerge and hence there will be competition between incumbents and entrants to propose new BM (Mihardjo *et al.*, 2019) or innovate the existing ones in order to be at the cutting edge. Scholars know from decades that technological discontinuities allow the entrance of new companies (Tushman and Anderson, 1986). Furthermore, Baumol (2002) adds that entrepreneurial innovators are sources for breakthrough innovations. More recently, Hahn (2020) analysed innovation under an I4.0 light and reached to a similar statement, writing that radical changes, when adopting I4.0, are made by start-ups and not by established companies. This is supported also by Ferrás-Hernández *et al.* (2019) that affirmed the leading role of start-ups in developing winning dominant architectures when the new technologies are competence destroying. Therefore, it is not unexpected what written by Rojko (2017): most of the companies immediately implementing I4.0 were start-ups. However even if it represents a promising research, little is written in the current literature, to the best of our knowledge, about start-ups and I4.0.

3. Methodology

Due to the novelty of the phenomenon and the exploratory nature of the research question, a qualitative case study research approach is used (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 2003).

Considering the fervent environment and the potentialities, in terms of I4.0 applications and development, of the Tuscan Region in comparison to other Italian regions (Bertini, 2017; CERVED, 2019), together with the presence of renewed Universities and research centres, the three cases were identified among Tuscan start-ups. In order to choose amongst the most innovative start-ups at regional level, the sample was selected considering the most promising start-ups which had already received support from universities and/or business hubs. In particular, the three start-ups were selected since all of them were start-ups related to I4.0 with different approaches, hence allowing a good analysis according to the aim of this research. Furthermore, the three start-ups were selected for being representative of the three main areas individuated by Ibarra *et al.* (2018) when analysing I4.0 and BM: service-orientation, network-orientation and user-orientation/customisation.

For each start-up, data were collected through direct in-depth interviews and then they were triangulated with data from other sources as archival data (Gibbert *et al.*, 2008), achieving an appropriate level of internal validity (Yin, 2003). The interviews were conducted using telecommunications applications for video chat, hence having a "virtual face-to-face" interview, and they lasted between 80 and 110 minutes. Interviews were conducted between November 2017 and January 2018. All the interviewees were the

founders of the companies and two of them were also the CEOs (start-up 1&2), while one was the CIO (start-up 3). The interviews were recorded and then transcribed. For each of the three start-ups we identified how entrepreneurial opportunities arise and how the entrepreneurial team used I4.0 technologies in creating new value. Moreover, we tried to enlighten how they adapted the BM for creating such value.

In the coming sections the results of the within case analysis and the cross-case analysis are presented. For each case it is described how the idea was born, how the I4.0 technologies have been used, where they came from and if the start-up enhanced or build a new resource/capability.

4. Findings

Within case analysis

Start-up 1. The first start-up is a spin-off of a Tuscan university. This innovative start-up was born in 2015. They invented a new technology for 3D object optimisation. The whole project fits perfectly with one of the nine technologies enabling I4.0: additive manufacturing. The proposed solution came out in order to fill the gap they found about the need for more precise 3D objects in comparison to standard 3D printing results, already quite extensively used by other companies and proposed as additive manufacturing, too. More specifically, the company invented a new technology based on ABS and cellulose acetate. Other methods may be used to pursue these results, but the designed technology makes things cheaper and faster, with crucial savings in terms of time and money. The highest competitive advantage comes from the reduction of the time-to market, which can be reduced, as claimed by the founder, from two weeks to approximately to an hour. Moreover, it can count on scalability. Therefore, we can say that the proposed technology enhances an existing offering giving a significant competitive advantage to both the seller (i.e. the start-up) and the customer. Furthermore, the technology was secured by the company, which patented it. Sure enough the products they supply are very specific and do not cover the whole production chain, they provide competitive advantages to costumers by significantly optimising a process while increasing the quality of the output. The technology they provide does not enable the whole company production process to I4.0, however it accomplishes the task to introduce I4.0 in a definite level of the whole organisation. The start-up creates product optimization in I4.0 manufacturing and, at the same time, its business involves several pillars of I4.0 (cloud, web connection sensors etc.). Furthermore, everything, from technology to products, is scalable. It operates within the additive manufacturing sector, and it offers solutions for both SMEs and big companies. Products are different, but the technology and the purpose behind is identical, emphasising the adaptability and the scalability of the invention designed. The core team is composed by six people. The core team invented and designed the proprietary technological solution, which is at the basis of the offering. However, there are also several external people which help the start-up in several ways, accordingly to their

expertise. Their role can be considered as crucial for the value offered to the market as that of the founders. That is why we can consider that the start-up is efficiently combining internal and external resources and capabilities to offer a superior enhanced value to the market. For example, a patent-expert fell in love with the project and is helping the start-up with his specialised skills. Similarly, other collaborators are helping in other fields, adding value to the whole business. In total there are about ten/fifteen people sharing this passion and being, with different degrees of partnership, involved in the project. However, the start-up can also count on several partners on specific issues. The start-up believes that an excellent service/product must be delivered to the customers to succeed and to obtain, at the end of the chain, a distinguished result. Because of this, a specialised manufacturer produces the machines they designed and other technical partners oversee important but non-core activities, like e.g. certifications. The possibility to add extra features and services (e.g. virtual and augmented reality), both from the company itself or from its partners, enable a complete customisation that represent, to the founder's eyes, both a competitive advantage and a tremendous shock for the BM of their customers.

Start-up 2. The second one is a start-up born in 2014 in a technology hub of one of the Tuscan towns. It provides an app related to the food industry and was born thanks to the on-field experience of one of the founders. Being an agronomist, and keeping practicing his job meanwhile running the start-up, he recognized a gap in the market and consequently a big opportunity to create a new business, without having neither all the technical competencies nor the technologies for implementing it. The food industry had the inner desire to implement traceability for food products and the need to provide information to customers, not only about traceability but also about food origin, food safety, ingredients origin, food contact materials etc. This gap was mainly enlightened by those producers that wanted to appear as clear as possible to the customers, but also by other companies (especially those producing PDO/PGI, organic or farm-to-table food) expressed a similar need even if for pure marketing purposes. Together with other co-founders, he decided to integrate existing technologies already present in the market, sometimes used in other fields, for providing a free smartphone application that allows customers to access data stored in a database. This application also gives the possibility to share ideas, thoughts and information with the community and to directly contact the producers, hence having a SC connected in both directions. In this way the app can fulfil two main needs: information/communication and general marketing purposes. The value added by the start-up, thanks to the integration of external resources made possible by the deepen knowledge of the market by the founder, comes from the utilisation of a simple existing technology in a way that allows customers (i.e. food companies) to both complain safety rules and to exploit marketing opportunities for product differentiation at the same time. Moreover, the product offered can be considered a perfect fit of three 4.0 technologies, thus mixing cloud storage, image (i.e. label) recognition and databases.

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Even though the technology employed is not innovative itself the solution they designed is completely new and unique. If considered in absolute value, the diverse technologies exploited by the offering of the start-up are not new since they have been extensively used in other industries for many years. However, many of them are rather new in the market targeted by the start-up and according to the founder's experience, the proposed solution represents the only application able to integrate all the technologies in order to offer a comprehensive and useful instrument for all the players (producers, suppliers, partners and customers). The start-up is currently formed by four members and several co-workers acting as partners, which varies according to the needs. They strongly believe that specialisation is crucial to succeed in this new "environment 4.0", therefore all the technical issues about the smartphone application are carried out by a partner company specialised in software development even if the main decision and the contents in the app derive from the capabilities internally owned in the start-up. The co-workers help the founders/entrepreneurs with activities needed to offer the services they provide. This makes it possible to offer a high value service/product to consumers and to jointly operate with partners through the whole chain with mutual benefits, in terms of value creation, for all. Consumers will benefit from an integrated service where any high skilled player along the chain adds his own specialised expertise to make the product excellent. This makes it possible to fill the gap in the market offering new value to the whole chain. In term of resources and competencies the start-up, thanks to the internal knowledge of the four founders (e.g. agronomical and managerial ones), was able to recognise the gap and to consequently individuate the external partners with the requested resources and competences to offer the right product and service. To fully integrate the SC and to attract and involve users the product is free for the customers' use and it is economically sustained by participating food and wine companies and consortiums. The need to involve consortiums in this comes from the importance of the maximum participation of a high number of SC members. This makes easier and more efficient the coordination activities of any player (i.e. partners and SC companies) done by the start-up.

Start-up 3. The third start-up originates from a cross-department collaboration of researchers and professors within a Tuscan university. Its aim is to "bring the research into companies". According to this statement, the founders of this spin-off used their competences and knowledge acquired in an academic environment to design a special service/product for introducing I4.0 in outdated SMEs since the start-up offers services to convert a traditional, "old" company into a 4.0 factory. It uses PLC technology, where present, or, if needed, it adds sensors to old machineries. Then, cloud storage allows data collection which are finally analysed. Therefore, the start-up uses several I4.0 enabling technologies, as for example industrial internet, cloud, big data and analytics and advanced manufacturing solutions. Thanks to their academic experience and network and to their ability to bring academic knowledge into business, the entrepreneurial team can internally exploit new opportunities deriving

from the I4.0 development with a double role: consultant and technology provider. Additionally, due to their passion for academia, they were also able to understand the needs of the market and to tailor a business to fulfil them: many micro, small and medium enterprises (MSMEs) do not have the competencies and the knowledge to understand I4.0. Therefore, they face many difficulties to individuate and then adopt solutions, strategies, and the needed technology. This also means that SMEs are not even aware of the big opportunities they are missing. Some SMEs do not have the knowledge of I4.0. For example, accordingly to the founder's experience, they are not aware of the possibilities deriving from data analysis. Moreover, they do not know which kind of data they would like to analyse. The main reason is that they do not have any competence in these fields, and this means they do not know neither what they need nor what they are looking for. The start-up adopted an extremely efficient method to spread knowledge and awareness to entrepreneurs and managers, in which all the value is added by the members of the company. It initially offers consultancy services and assessment, thus making companies aware of technologies, opportunities and advantages. Often, when the companies understand that it is possible to have I4.0 benefits without adopting expensive and complicated software and technological solutions sold by tech multinationals, they are willing to buy the start-up's services and products. If the first step was successful and the customer is satisfied, the start-up offers several solutions, which depend on needs and size, to enable I4.0 in the company. Furthermore, this system is scalable making and it makes things faster, cheaper and highly replicable still maintaining high customisation. In this third example all the value provided to customers come from internal capabilities of the entrepreneurs and from the technological development of the start-up itself.

5. Cross case analysis

Comparing the three start-up cases on the basis of the origin of the prevalent resources and/or capabilities (i.e. internal or external), the type of technological offering (i.e. existing or new) together with the I4.0 technologies used and the BM adaptation needed, we identified three value creation mix granted by I4.0. With the term resource/capability 4.0 we identify any technology enabling I4.0 described in the paradigm of I4.0 (Fantoni *et al.*, 2017a) or any ability or knowledge able to take advantage of them. From the analysis of the three cases, we have identified whether the value creation's origin comes mainly from outside, from inside or is a combination of internal and external resources and capabilities and, consequently, the adaptation needed to the BM of the start-up. We named them "*Grafting 4.0*", "*Pollination 4.0*" and "*Blooming 4.0*".

In the first start-up case even if, generally speaking, 3D printing technologies were already exploited by many companies before the value proposed by the interviewed start-up, they were able to design and offer a new technological solution thanks to a perfect combination of internal and external excellent resources and competencies. Hence it was possible to

gain a significant completive advantage and to create value. Specialisation is at the basis of the value chain collaboration. The entrepreneurs believe that each player must provide a specific, yet extremely advanced, product/service adding a small however significant value to the final offering. The I4.0 technology used, i.e. additive manufacturing (Ngo *et al.*, 2018), is very specific too. This case, as well as the other two, also pointed out the need of an adapted BM. To understand why the company needs an adapted BM to fully exploit the potentiality of I4.0 we need to stress the need for excellence enlighten by the founder. Excellence is considered critical for the success of this business and it is asked not only to the start-up itself but also to all its partners. Only thanks to excellence they are able to offer superior value and to gain a competitive advantage. In order to pursue excellence each partner is in charge of a very specific task. Each task is considered as a block of the final offering. Hence, we can state that the fundamental adaptation needed to have a BM able to fully use I4.0 is modularity. Modularity is the basis for the perfect integration of internal and external resources and competencies and furthermore it allows customisation. In fact, the start-up is able to offer the perfect product/service for each customer by requesting or not the help of a specific partner (e.g. by introducing Virtual or augment reality services; Azuma, 1997; Remondino and El-Hakim, 2006), therefore by adding or not a block to the offering. Since the enhanced offering was obtained by integrating internal and external resources/capabilities, we call this phenomenon "*Grafting 4.0*".

Fig. 1: Grafting 4.0
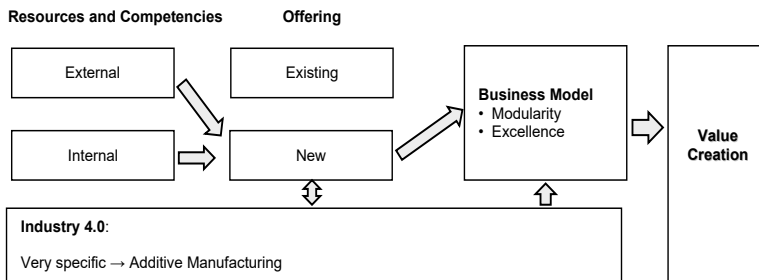
Source: Own elaboration

In the second case, the entrepreneurs were able to smartly combine and coordinate several existing I4.0 technologies, commonly used in other fields, to fulfil a need in the chain. Thanks to their internal knowledge and to the resources and capabilities of their partners, some of them not previously involved in the agribusiness value chain, they were able to fully exploit the potentiality of I4.0 through the combination of several technological resources and capabilities along the whole SC. The upstream and downstream integration of external resources and capabilities made possible the creation of value for all the players enhancing the offering proposed to the final customer. The integration and coordination are leaded by the owners of the start-up, that manage the work of the partners while performing their main job outside the start-up. Nobody is fully working

for the company; therefore, a crucial role is played by the partners. As written before some of them originally operated outside the agribusiness industry and thanks to the start-up have started to use their technologies and competencies in this "new" industry. Therefore, the most relevant aspect about I4.0 technologies is not linked with a specific technology itself, instead the contamination of several existing I4.0 technologies originating from other industries represents the main characteristic here.

In this second case the adaptation of the BM is affected by the need to combine and coordinate all the players. The start-up operates as an integrator of the whole SC, therefore the value added is related to the knowledge of the industry and the ability to involve and manage all the players: the start-up's partners, the start-up's customers (i.e. companies in the SC using the app) and the final consumers.

Since the start-up individuates, manages and then spreads the value brought by external partners, to offer significant benefits to both chain members and customers, we identified this phenomenon using the name "*Pollination 4.0*".

Fig. 2 Pollination 4.0
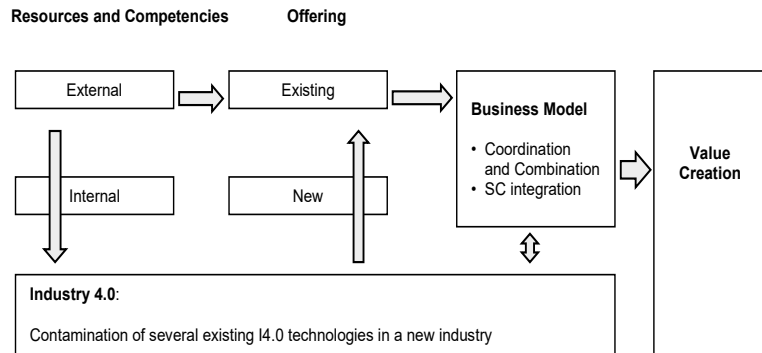
Source: Own elaboration

The third phenomenon differs from the previous two in the view of the resources and capabilities exploited. The background and the "double" role of entrepreneurs made possible the creation of new and significant value for the customers by using internal resources and competencies. Furthermore, the proposed solution enables the start-up to avoid the competition of bigger companies operating in the market of enabling MSMEs to I4.0. As a matter of fact, the offering of the start-up, as mentioned above, is double: at first it consists in a consultancy (and sometimes even dissemination) service and then the customer can demand a tailored product, designed thanks to the analysis made in the first step. According to the founders' experience this two-step, service-based, value proposition has a dual effect: attracting and convincing also the companies without any idea of the potentiality of I4.0 and furthermore understanding how to efficiently combinate the internal resources to design an excellent customised offering using scale economies. Hence the final offering gives a competitive advantage both to the start-up, being the only one to offer such services to MSMEs, and

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to the customers, that will be able to exploit I4.0 and to obtain the related advantages. In term of the I4.0 paradigm, the offering of this start-up integrates several technologies and allows the introduction of I4.0 in "old style" companies. However, also I4.0 is considered in a service-oriented approach. Servitization (see among other: Vandermerwe and Rad, 1988; Lee *et al.*, 2014; Thoben *et al.*, 2017) is the crucial element, according to the founder, of this third case. It has deeply affected also the BM of the company that displays a poor interaction with partners while stresses an intense customer relationship based on a direct engagement and on a value proposition increased by critical services.

Considering the fully internal origin of the value created, we defined this phenomenon "*Blooming 4.0*".

Fig. 3: Blooming 4.0
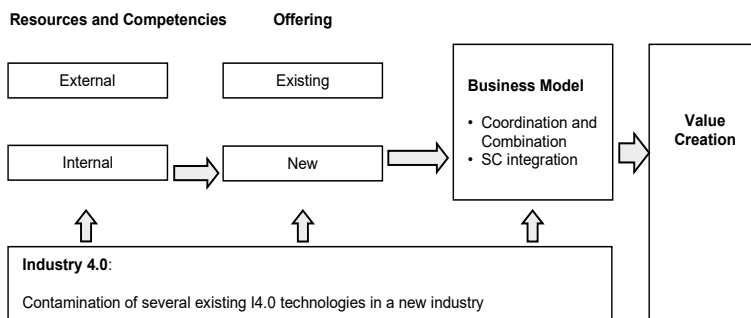
Source: Own elaboration

6. Practical implications

I4.0 delineates new levels of organisation and control (Vaidya *et al.*, 2018), defining new paradigms, models, and principles (Ivanov *et al.*, 2019). Strandhagen *et al.* (2017) identify as key drivers of the fourth industrial revolution the combination of the so-called enabling technologies of the I4.0 paradigm.

Integration, data exchange, enhanced flexibility, efficiency, and communication are just some of the effects and benefits deriving from I4.0 (Rüßmann *et al.*, 2015; Ding, 2018, and Dalenogare *et al.*, 2018). Allowing flexibility and efficiency (Ding, 2018; Dalenogare *et al.*, 2018), I4.0 gives the possibility to accelerate processes (Xu *et al.*, 2018). I4.0 increases flexibility, also empowering the effect of lean manufacturing (Rüttimann and Stöckli, 2016), receiving an extra force not achievable otherwise (Buer *et al.*, 2018). Other significant effects of I4.0 are modularity, decentralisation, and simulation (Qin *et al.*, 2016). Even if modularity already existed in the "Traditional" concept (Koren and Shpitalni, 2010), with I4.0 it is linked with flexibility, and the 4.0 paradigm allows to overcome the rigidity of the whole context that created a barrier to fully take advantage of modularity (Pirola *et al.*, 2020). Furthermore, I4.0 does have significant effect also towards the whole SC (Pereira and Romero, 2017; Popkova *et al.*, 2019)

mainly in terms of process innovation (Lin *et al.*, 2017). There are effects also on the companies' delimitations, since I4.0 blurs their boundaries (Ilvonen *et al.*, 2018; Kohtamäki *et al.*, 2019). Pre-I4.0 companies mainly had Stiff boundaries and so manufacturing processes were not connected across boundaries (Roblek *et al.*, 2016). Thanks to I4.0 the companies in the SC have both integrated BMs and inter organisational relationships (Halldórsson *et al.*, 2015; Ericson *et al.*, 2018). In this way it is possible to use the full potential of I4.0 thanks to within and outside collaboration (Ilvonen *et al.*, 2018; da Silva *et al.*, 2019; Kipper *et al.*, 2020). Having indirect effects of technologies 4.0, i.e. effects not directly coming from the implementation of those technologies alone, is possible thanks to the fact that this is not a mere technological innovation but it is a completely new paradigm that enable additional possibilities and gives extra benefits. All those beneficial effects facilitate the rise of new opportunities for start-ups to create value by exploiting the technologies following the I4.0 paradigm. The empiric results of the case studies analysed reveal that there are three ways in which start-ups can generate new value thanks to I4.0. Start-ups can generate value by smartly mixing internal and external resources and competencies. Here start-ups take advantage of softened boundaries, modularity, and flexibility that are all beneficial effects of I4.0. In fact before I4.0, or without implementing I4.0, companies could use the same technologies but could not profit from those effects, hence not being able to generate any value and therefore to find a profitable way to start a new business. As for the grafting in botany, we mix internal resources, the "rootstock", with external ones, the "scion", generating value. In this case resources and capabilities originate both internally and externally. Since I4.0 plays a crucial role hence the label for this is "Grafting 4.0".

Another possibility for start-ups is to create value through the capitalization of communication, data exchange, and integration. Thanks to the integration of the traditional hardware and software with information technology (Thames and Schaefer, 2016) it is possible to enable data and information sharing, hence having transparency alongside the whole chain (Fatorachian and Kazemi, 2021) and enabling a holistic approach of SC. Integration makes possible the creation of a new value chain 4.0 (Schumacher *et al.*, 2016). These I4.0 effects could go together with another opportunity boosted by I4.0: technological contamination. This phenomenon is particularly visible nowadays in those sectors previously not much full of technology, i.e. "traditional sectors" not usually prone to change like agribusiness (Blasi *et al.*, 2017). In the agribusiness sector there has been a rise, during the past ten years, in the application of technologies coming from other industries. Therefore, those technologies are the "old" ones in the industry from where they originate, being quite new in the agribusiness one, and even if this phenomenon does not originate with I4.0 (Ruiz-Garcia and Lunadei, 2011; Muangprathub *et al.*, 2019), it experienced a rise thanks to the new paradigm (Zambon *et al.*, 2019; Lezoche *et al.*, 2020). The adoption in a new (i.e. where the technology was not employed before) industry of technologies extensively used in other sectors it is not something enabled by I4.0. However, integration, modularity, blurred boundaries, service-orientation and other relevant aspects strictly related

with I4.0 gave a significant boost to this phenomenon. A central role is played by the radical change in the way of thinking when the I4.0 paradigm and its potentiality are fully understood. Technology contamination, horizontal and vertical integration, and the possibility to smartly combine diverse external resources and competences are all strictly linked with the 4.0 paradigm. Without I4.0 it would not be possible to fully take advantage of them. In consideration of the value creation obtained through the management, mix, and combination of external resources to fertilise the SC as the process done with the pollen in the botanic world, the label is "*Pollination 4.0*", where "4.0" enlightens the essential role of the I4.0 paradigm. The origin of resources and capabilities in this case is external.

The third possibility that comes out from the case study analysis refers to a fully internal origin of the resources and competences. The pivotal aspect linked with I4.0 relies in this case on the ability of the start-up to interpret in the best way I4.0 and fully comprehend this new paradigm for gaining a competitive advantage by internal resources and capabilities use. Furthermore, the other critical aspect is that the start-up has a "service mindset", that allows to create a networked ecosystem with customers and partners (Ibarra *et al.*, 2018). As in botany, here we have new value, which is mainly a service, that originates from the start-up and that has a beneficial effect also for the other actors of the chain. As in the case study *start-up 3*, everything is intrinsically tied to the 4.0 paradigm. Hence, we are not referring to the mere ability to exploit internal resources, which is something that has always been done by many companies. Here we are dealing with the ability to use resources and competencies linked to the fourth industrial revolution (e.g. enabling technologies) following, in all respects, the 4.0 paradigm. This is definitely not only, as repeated several times throughout the whole paper, about using specific technologies but it is a way of thinking, understanding how to take the best from all the resources by, e.g., smartly combining and perfectly integrating them, enabling customisation and service-mind orientation. For this reason, we think about "*Blooming 4.0*".

Therefore, answering the first RQ, "What are the opportunities for start-up creation in the I4.0 context?", they are: "*Grafting 4.0*", "*Pollination 4.0*", and "*Blooming 4.0*".

To answer the third RQ, "Do these start-ups have traditional BM or adapted/new ones?", we use an approach similar to that of Ibarra *et al.* (2018). They both consider BM, from traditional to new, and innovation, from incremental to radical. It is fruitful to consider such approach because the three case studies also suggest the need for companies to adapt their BM for an absolute use of I4.0. According to the type of technology 4.0, the role of the company in the SC, the kind of value created and the source of the decisive resources and competencies the BM should be adapted in different ways.

The two transformations that better fit our research are about "new ecosystems and value networks" and "new BMs: smart product and services". In the first case a radical innovation of the BM is proposed. Furthermore, it may focus on the core activity, as in the case of the *start-up 3*, and/or using resources from partners, as in the case of *start-up 2.*

Therefore, there are two radical innovated BM: one linked with network-orientation, and one with service-orientation. In the first one (*start-up 2*), which can be called also "chain integration BM", the company acts as a coordinator and integrator of SC players and therefore the BM is focused in efficiently and effectively bringing together the external key partners, activities, and resources. While in the second (*start-up 3*), that can be named "service-oriented BM, confirms what has already been extensively indicated by the literature (among others, see: Vendrell-Herrero, 2017; Reim *et al.,* 2015; Bustinza *et al.,* 2015): an increasing trend towards service-orientation that consequently affects also the BM. I4.0 affects "traditional" service orientation by innovating BM (Cimini *et al.*, 2018). With I4.0 services change into smart services that, based on smart data, can generate value for both companies and customers also enabling product-service-development (Kaltenbach *et al.,* 2018). In the first start-up case there is a new disruptive innovation that needs a new BM where other actors are also involved in the process. Because of this characteristic and the need for flexibility, it is possible to name it "modular BM". In this BM, both the company and the partners are extremely specialised and the offering is composed by several modules that can be used or not accordingly to the needs. To fully answer the second RQ, it is possible to state that the studied start-ups do not have a traditional BM, since it would not allow them to fully take advantage of I4.0.

The three phenomena may be helpful for entrepreneurs in contemplating the employment of I4.0 related resources and capabilities for value creation and so for obtaining a competitive advantage. More precisely, considering the new paradigm of I4.0, managers should ask themselves whether they have internal resources or capabilities for exploiting the I4.0 paradigm and creating value (i.e. *Blooming 4.0*); if there are external resources and competencies (also not already used in their specific industry) that can be found, coordinated and managed by the company for creating values, hence acting as SC integrators (i.e. *Pollination 4.0*) and whether it is possible to combine internal and external resources and capabilities for creating value and obtaining a competitive advantage for everyone (i.e. *Grafting 4.0*).

7. Conclusions

This study represents, to the best of our knowledge, a first step in the analysis of the opportunities enabled by I4.0 for start-ups. This is particularly important considering that both public authorities, business associations and experts are continuously and increasingly recognizing the need of investing in start-ups and businesses linked to I4.0. Indeed, this is a great issue that policy makers should tackle: to boost technological rejuvenation and innovation, it is necessary to solve the lack of early capital and bet on our start-ups (Inguscio, 2018).

The present research proposes three opportunities to start new businesses thanks to I4.0. All of them consider as an essential element the full comprehension and application of the 4.0 paradigm, which enables new opportunities and/or empower existing ones. Hence, a first

opportunity comes from smartly mixing internal and external resources and competences taking advantage of modularity, blurred boundaries and flexibility. A second one comes from the smart combination and management of external resources and capabilities through full integration, communication and data exchange and technology contamination. The third one, in which all the resources and competencies are internal, deals more with the paradigm itself and a (smart) service mindset for achieving empowered benefits.

Furthermore, it is interesting to note that the usage of technologies in other fields than the one of origin, even if existing before the starting of the fourth industrial revolution, is empowered by the new paradigm and its effects, hence representing an opportunity for expanding this concept for more technologies.

Additionally, it is examined whether these start-ups should have a traditional BM or a adapted/new one. In two cases a radical innovation is proposed, while in the third one a completely new BM with the involvement of external actors, too. Hence this would lead to the need for adaptation also for their BM, as suggested from our case studies. However, the suggestion given by the interviewed start-ups to their partners about redesign the BM to the new chain is hardly followed by them, maybe because it may takes time to develop new BMs from I4.0 technologies maybe because BM are more "context-dependent" than technology (Teece, 2017).

For the managers and other entrepreneurs, reading this paper may be inspiring and could lead to further thought in their business and markets. This research enlightens some aspects that lead to start-up creation opportunities, hence they would represent a good starting point for entrepreneurs-to-be. Furthermore, it stresses the benefits deriving from an extensive comprehension of I4.0 and related benefits, not only for start-ups but also for the whole value chain.

There are several limitations in this study. Being a first study about the proposed issue, there is the need to further validate it, also using data analysis. Furthermore, it would be interesting to expand this study to companies not based in Italy. Then it would be interesting to propose a similar analysis for already established companies, both in Italy and abroad.

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Toward the strengthening of enabling technologies in Italy: results of the second survey on procurement 4.0[1]

Silvia Bruzzi - Nicola Balbi - Leonardo Barcellini
Vincenzo Genco

Abstract

Purpose of the paper: This paper presents the results of the second survey on Procurement 4.0 in Italy, focusing on the skills needed for digital transformation.

Methodology: The study is conducted through an online questionnaire (CAWI), transmitted by ADACI via email to its members. The results are presented in a comparative format relative to the first survey developed in 2018.

Results: The survey suggests that enabling technologies have evolved, at least in the larger companies, from an infancy phase to a real introduction phase with greater involvement of the procurement function, called to act as a gateway for innovation.

Limitations: Our second survey has a low participation, though higher than the first. As with the COVID-19 pandemic, the role of enabling technologies in ensuring business continuity has been pushed to the fore, we hope that the third wave of the survey will involve more enterprises.

Practical implications: This study provides useful information to researchers, policymakers, and practitioners also suggesting the most appropriate skills to invest in. The findings indicate a strong need for a new training paradigm toward a new integrated mindset.

Originality of the paper: The surveys carried out in the framework of this research project are the first to be developed in Italy on Procurement 4.0. The results contribute to illuminating a phenomenon that remains underexplored. Through a university-business partnership, the study can feed decision-making processes at different levels to support the digital transformation of the Italian economic system.

Key words: enabling technologies; digital transformation; industry 4.0; procurement 4.0; skills; Italy

1. Introduction

The impact of enabling technologies on enterprises and economic systems has been at the forefront of the scientific and institutional debate for almost a decade. The challenge is to promote the establishment of

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[1] The Authors share the responsibility of the paper. Silvia Bruzzi wrote paragraphs 1, 2.2, 2.3, 3.1 and 5; Leonardo Barcellini wrote paragraphs 2.1 and 4.1; Vincenzo Genco wrote paragraph 3.2; Nicola Balbi wrote paragraph 4.2. Conclusions were written jointly by the Authors.

hybrid integrated networks (Porter and Heppelmann, 2014) in which the physical and virtual components and know-how of the various players in the supply chain are interconnected and integrated, producing synergistic effects.

The technologies of the Fourth Industrial Revolution seem to be destined to profoundly transform the production paradigms and the methods of managing relations between economic actors. Enabling technologies increase the visibility and transparency of operations and the supply chain through real-time sharing of data, information, and know-how. This will open up the space for an increase in the decentralization of decision-making, which is destined to profoundly transform the humans' role in economic processes and the productive and organizational paradigms that have thus far supported economic development. The transfer of routine and tiring tasks from the humans to the machines that had already began with the Third Industrial Revolution will be strengthened; new abilities of the machines to generate new knowledge autonomously are added by the so-called artificial intelligence. This will allow workers to devote themselves to the more creative and strategic parts of decision-making processes, through which they maintain control of the production systems (Ji *et al.*, 2019).

All business functions are involved in this transformation because with enabling technologies the competitive advantage will strongly depend on the enterprises' ability to manage the processes that cross their functions and their supply chains. Therefore, a holistic approach to supply chain management is needed to acquire and maintain a competitive advantage through enabling technologies.

The procurement function plays a central role in this predominantly cultural transformation as it is called upon to support not only the enterprise but all the enterprises of the supply chain, particularly the suppliers, in the adoption of these technologies. In a Cloud manufacturing context, such as that of the Fourth Industrial Revolution, the procurement function represents a fundamental decision-making centre in which critical information regarding suppliers and supplies is concentrated.

Procurement practitioners need an upskilling process to meet this challenge. New technologies increase the data and information available for decisions, and procurement practitioners need a toolbox to manage them properly (Hughes and Ertel, 2016).

In light of this, the present study aims to contribute to the advancement of this process by supporting policymakers and practitioners in promoting the dissemination of enabling technologies. The study presents the results of the second edition of the first Italian Survey on Procurement 4.0, launched in 2018 in partnership with the University of Genoa and ADACI.

The issue must be addressed urgently as several studies highlight Italy's widening gap with respect to the adoption of enabling technologies compared to other countries, resulting in considerable damage to the competitiveness of the Italian economic system (Probst *et al.*, 2018). Despite the process of adopting enabling technologies having begun, substantial gap is being created in Italy between large enterprises which are catching up, and small-medium enterprises that face various barriers,

such as insufficient capital for the initial investment and inadequate skills. The lack of skills is one of the most important reasons for this gap between large and the small- and medium- sized companies, for which it is also difficult to ascertain the necessary skills to invest in (La Repubblica, 2019; Ambrosetti, 2017). Finally, even if the procurement function plays a central role in the adoption of these technologies, it is not involved in this process in Italy (Zheng *et al.*, 2020).

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This study aims to fill these gaps through a descriptive survey of Italian enterprises. We propose the following research questions to understand the diffusion of enabling technologies in Italy in general and in the procurement function, as well as to identify the top skills required for the procurement practitioners require to face changes and challenges in Industry 4.0:

RQ1. What is the adoption level of enabling technologies?

RQ2. What are the main characteristics of the enterprises that adopt enabling technologies (Adopters)?

RQ3. What is the engagement of the procurement function in the adoption of enabling technologies?

RQ4. Which are the skills most required for the procurement function for the digital revolution?

This paper is divided into the following sections. Section 2 describes the diffusion of enabling technologies in Italy, current literature on Procurement 4.0, and procurement skills in digital transformation. Section 3 describes the research methodology with a focus on the research sample. Section 4 presents the main results of the survey, focusing on the Adopters and the skills needed. These results are presented in a comparative format with respect to the analysis conducted in 2018. Section 5 discusses the main results of this study. In Section 6, the managerial implications of the results are discussed, and some conclusions for future research are presented.

2. Background and Literature Review

2.1 Background: The Digital Transformation in Italy

The rapid evolution of new digital or enabling technologies is transforming the production processes of enterprises and the entire industrial system. They are defined as technologies with a high R&D component, rapid innovation cycles, high capital intensity, and highly skilled labor. They enable the innovation of processes, goods, and services in many productive sectors by integrating processes along the entire supply chain (European Commission, 2009).

If adopted correctly, enabling technologies can lead to several benefits, such as greater flexibility and velocity of production and greater integration between processes along the supply chain. Furthermore, the reduction of machinery set-up times and errors increases productivity levels, while the presence of sophisticated sensors that control the production in real-time guarantees high quality (MiSE, 2016).

The COVID-19 pandemic has highlighted the importance of adopting enabling technologies to address supply chain disruptions in a more flexible and resilient way (Deloitte, 2020). During the COVID-19 pandemic, enterprises that adopted enabling technologies were able to react to this external shock: intelligent machinery enabled the quick conversion of production and ensured business continuity; robotics enabled many actions to be carried out automatically or remotely in many fields other than production and logistics, IoT solutions enabled collaborative operations and remote control, 3D printing enabled the quick production of parts that the disrupted supply chain could not provide; and augmented reality systems enabled the real-time use of expertise anywhere to support on-site staff. The pandemic has thus initiated a lively debate on promoting the adoption of enabling technologies which require significant investments by enterprises in a time of crisis (Industria Italiana, 2020a).

In Italy, this phenomenon is still in its infancy. According to a sample survey conducted by the Ministry of Economic Development on 23,700 enterprises between October 2017 and February 2018, 8.4% of respondents use at least one of the Industry 4.0 technologies, 4.7% have planned to invest in the next three years, and 86.9% do not intend to adopt enabling technologies in the near future (MiSE, 2018). Additionally, a study by the University of Padua investigating the presence, impacts, and results of the adoption of Industry 4.0 technologies in Italian SMEs finds that only 18.6% of the 7,293 sample companies declared they had adopted enabling technologies (University of Padua, 2018).

Another survey presented by Cassa Depositi e Prestiti identifies a cluster of "dynamic 4.0 enterprises," representing 11.8% of the 24,000 enterprises analyzed (CDP, 2018). A study by Ernst & Young to assess the digitization of the Italian companies reveals that only 14% of the 150 sample companies have reached an advanced level of digitalization and interconnection, about half (49%) are in the introduction phase and 37% are in the experimental phase. Among those who have already adopted the new technologies, 5% have a structured and automated system for integrating data with suppliers and customers (La Repubblica, 2019).

Compared to the other countries in Europe, the situation in Italy remains immature. The Digital Transformation Scoreboard 2018 evaluates the degree of digital transformation of a country through two pillars and seven dimensions:
- Output pillar: Integration of digital technologies and changes in the start-up environment;
- Enabler pillar: Digital infrastructure, investments and access to finance, supply and demand of digital skills, e-leadership, and entrepreneurial culture;

Two indexes are calculated to measure the output pillar: the Digital Technology Innovation Index (DTII) and the ICT Start-up evolution Index. The Digital Transformation Enablers' Index (DTEI) is calculated to measure the enabler pillar. For DTII and DTEI, Italy scores under the EU averages. Considering the Enabler pillar Italy's score is above the EU average (2%) in just one dimension: investments and access to finance (Probst *et al.*, 2018).

The low maturity stage of the Industry 4.0 Revolution in the context of Italian manufacturing emerges also when considering the results of a descriptive survey conducted in 2017 on 103 manufacturing enterprises of different sizes. According to this survey, 54% of the respondents have adopted one technology, 30% two technologies, 12% three technologies, and 4% more than four technologies (Zheng *et al.*, 2020).

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Despite these constraints, enabling technologies have been growing in Italy. According to the 2020 survey of the Industry 4.0 Observatory of the Politecnico of Milan, investments in enabling technologies have increased; in 2019, Industry 4.0 grew by 22% compared to the previous year, reaching 3.9 billion Euros. IoT, Cloud, and supply chain analytics are the technologies that have grown the most (Industria Italiana, 2020b).

Italy is also characterized by a gap between large and small and medium-sized enterprises. This is evident considering the aforementioned MiSE Report (2018), which highlights a positive correlation between propensity toward these technologies and enterprise size. The Ernst & Young study highlights that 70% of the large companies have a 4.0-development plan and have introduced enabling technologies, while SMEs are characterized by a greater weakness (La Repubblica, 2019).

Also according to Zheng *et al.* (2020), the utilization level of enabling technologies depends on the company size. The majority of SMEs in the sample have no projects related to new technologies, while more than half of large and very large companies have adopted at least one technology.

One reason for the Italian delay, which could further widen this gap, lies in the lack of adequate skills. The literature shows that enabling technologies lead to a recomposition of the workforce, increasing the demand for highly skilled workers. Moreover, enabling technologies require the labor force to develop soft skills, such as flexibility, autonomy and responsibility, openness to change, and openness to continuous interdisciplinary learning (Stanton Chase, 2017; Brettel *et al.*, 2014).

In the report "Italia 4.0: are we ready?" (2018), Deloitte stresses the significant gap in Italy with respect to workforce skills compared to other countries. Moreover Ernst and Young's report indicates that it is difficult for enterprises to find and ensure the updating of the skills required for the development of Industry 4.0 (La Repubblica, 2019). Similarly, Ambrosetti's study with SAP (2017) highlights investment in skills as being a priority to meet the challenges posed by digital transformation. It is not only about investing in digital skills, but also in soft skills, such as autonomy, responsibility, problem-solving, creativity, and critical thinking. Thus, investment in skills is a driving force for a broader cultural transformation.

2.2 The Role of Procurement in the Digital Transformation: Procurement 4.0

Although there is abundant literature on the impact of enabling technologies on the management of enterprises and the supply chain, few studies have considered the impact of these technologies on single business functions (Chandrasekara, Vidanagamachchi, and Wickramarachchi, 2020). This is a central theme for the effective and efficient introduction of new technologies into enterprises. Enabling technologies are destined

to impact the operativity of all the business functions and how they relate with the other actors in the supply chain (Bruzzi *et al.*, 2019).

Among the various functions, procurement has received little attention (Kleman, 2016; Bienhaus and Haddudd, 2018; Chandrasekara *et al.*, 2020). In Italy, as highlighted by Zheng *et al.* (2020), the procurement function does not appear involved in enabling technologies to the extent of other business functions such as R&D, production, IT, and direction.

The literature evidences that enabling technologies valorize the role of procurement in the construction and operation of new interconnected and automated supply chain ecosystems (Bienhaus and Haddudd, 2018).

First, procurement contributes to the choice and acquisition of new technologies and the selection of suppliers in a position to guarantee the interconnectivity of activities along the supply chain (Kleemann and Glas, 2017). Moreover, through the application of the enabling technologies, procurement contributes to make more efficient, faster, more flexible, and more transparent all the processes with regard to the enterprise and the entire supply chain (Chandrasekara *et al.*, 2020). Digital technologies can change the way purchases are conducted. The availability of data and information in real-time allowed by enabling technologies such as IoT, artificial intelligence, and Big Data, for example, can improve the effectiveness of market analysis, supplier evaluation, make-or-buy decisions, and inventory management and can improve predictability and thus make the processes of purchasing goods and services more efficient. Moreover, these technologies increase the visibility of processes, illuminate the different stages of the supply chain, and allow procurement functions to intervene in real-time where necessary (Rejeb *et al.*, 2019; Wang *et al.*, 2019; Killpatrick and Barter, 2020). Procurement can assume the role of enabler of a dynamic cooperation between all the actors of the supply chain (Glas and Kleemann, 2016). The literature highlights how the supplier-buyer relationship changes profoundly with enabling technologies. Digital solutions overcome the traditional one-to-one communication between buyers and suppliers in favor of many-to-many communication (Schmock *et al.*, 2007). In digital platforms powered by different enabling technologies, information and data are concentrated, shared, and managed transparently in real-time by all the actors of the integrated supply chain ecosystem (Bienhaus and Haddud, 2018). Procurement has to be adequately equipped to carry out digital transformation to meet the challenges of enabling technologies and to contribute to their effective adoption. Therefore, the issue of skills is vital for the procurement function. Digital innovation disrupts procurement skills, opening new opportunities to rethink value propositions, and optimizing the end-to-end supply chain (Geissbauer *et al.*, 2016).

2.3 Literature Review on Procurement Skills

The skills of the procurement function have not been sufficiently investigated, especially in light of the digital transformation.

The literature dealing with the evolution of the procurement practitioners' skills remains limited, despite its acknowledgment that

procurement within organizations has developed from a tactical to a more strategic role (Giunipero and Pearcy, 2000). Changes have influenced this shift in the economic environment, both from the supply and demand sides, which are strongly interconnected.

Even if the procurement role varies depending on the sector, country, and cultural contexts of the organization, the literature unanimously acknowledges that facing such a dynamic environment requires procurement practitioners to update their traditional skills (Paulraj *et al.*, 2006).

Within the limited literature dealing with this topic, Bals *et al.* (2019) develop a systematic review on procurement and supply management (PSM) competencies. They reviewed 30 articles published during 1987-2017, among which the study proposed by Tassabehji and Moorehouse (2008) stands out (Bals *et al.*, 2019). Tassabehji and Moorehouse (2008) introduce a new taxonomy of procurement skills to consolidate different taxonomies and nomenclatures into a set of five skill categories: technical, interpersonal, internal and external enterprise, and strategic business.

Technical skills, or procurement-specific skills, are basic skills that Tassabehji and Moorehouse consider necessary for the 21st century procurement professional, and they include product knowledge, computer literacy, total quality management, and government legislation.

According to the authors, the other skills are managerial skills that are beneficial for procurement and other functions. Interpersonal skills concern interaction with people in the team and on an individual level, such as conflict resolution, leadership, group dynamics, negotiation and persuasion, and communication. Internal and external enterprise skills concern relations and interactions among organizational functions within the organization and among supply chain actors and stakeholders, respectively. Finally, strategic business skills include procurement skills such as planning, strategic alliances with suppliers, and risk management that can impact the economic value of the organization (Tassabehji and Moorehouse, 2008).

According to this conceptual framework, analyzing 46 qualitative data interviews from 16 companies, Bals *et al.* (2019) identify a list of 65 competencies that are considered currently necessary by procurement professionals and a list of 56 competencies necessary for the future. Through a ranking of competencies, the authors produce a top-10 list of current and future competencies, revealing that the concern for digital and sustainability skills is growing to the detriment of traditional skills such as negotiation, communication, and basic procurement knowledge.

Bals *et al.* (2019) confirm and update the list of skills by Tassabehji and Moorehouse. More specifically, they reveal 17 new skills: four are related to digitization and innovation (automation, Big Data analytics, innovative sourcing, and innovative sourcing approach) that the authors place in the technical skills category, three skills concern the strategic business category: critical thinking, holistic supply chain thinking, and sustainability; and 10 concern interpersonal aspects: curiosity, dealing with ambiguity, humility, mobility, openness, passion, resilience, self-confidence, self-reflection, and self-reliance (Bals *et al.*, 2019).

These studies highlight the growing importance of digital issues for procurement practitioners and the evolution of soft skills, reflecting the emergence of new and more complex needs.

In addition, consultancy firms have highlighted the topic of skills, publishing various reports focused on procurement skills in the digital era. The Deloitte Global Chief Procurement Officer Survey 2019 identifies a crucial issue for Chief Procurement Officers (CPOs) in the ever-increasing complexity that procurement leaders have to contend with: the skills gap of procurement teams and the urgency to recruit new team members with adequate levels of technical, analytical, and professional competencies to address the complexity of this environment. The survey reveals that 54% of respondents were not confident in the ability of their teams to deliver the procurement strategy (against 51% in 2018)[2].

The survey focuses on the urgency of closing this gap, working on three main training areas: technical, digital, and soft skills. Regarding technical skills, according to the results of the report, the top training areas are strategic sourcing/category management, negotiations, project management, evaluations, ethical sourcing, and auctions. The most important soft training areas are business partnering or relationship management, effective management, conflict management, emotional intelligence, and self-awareness. Finally, regarding digital skills, the top training areas are data visualization, predictive analytics, RPA development, artificial intelligence, blockchain, and IoT.

In the face of a strong need for new skills, not limited to the digital area, the procurement function risks not being equipped to support the process of adopting digital technologies. The literature lacks an adequate reflection on this issue in Italy. The survey aims precisely at filling this gap.

3. Research Methodology

3.1 Research Design

The descriptive survey research design has been adopted to provide up-to-date insights into the knowledge and utilization levels of enabling technologies especially for procurement in Italy and contribute to the understanding of skills to be developed to support Procurement 4.0. Accordingly, an online survey was developed, based on a questionnaire (CAWI detection technique - Computer Assisted Web Interviewing), with multiple-choice, numerical, and open-ended questions.

The structure of the questionnaire was based on a survey conducted in 2018 and an in-depth analysis of the national and international literature on skills for Procurement 4.0 for digital transformation (Delesalle and Van Wesemael, 2019; Flynn and Brown, 2020; Tassabehji and Moorehouse, 2008; Bals *et al.*, 2019; Ambrosetti, 2017; University of Padua, 2018).

According to the research objectives, the questionnaire was structured

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[2]   The results are based on a survey developed with the participation of 481 procurement leaders from 38 countries, representing organizations with a combined annual turnover of US$5 trillion (Deloitte, 2019).

in three sections: the first section, as in the previous survey, focuses on the degree of development and performance of the procurement processes of the respondents; the second section focuses on the issue of skills, to understand the skills required to face the current challenges. We identified 28 critical skills based on the literature, divided into three training areas (Delesalle and Van Wesemael, 2019): technical and technological skills, digital skills, and relational or soft skills. We believe this tripartition is effective, as it can enhance digital skills, which are the focus of our research. Digital skills have a multipurpose and multifunctional nature. Therefore, they must be kept separate from the procurement's technical and technological skills. Additionally, these surveys, which take place during a period of great transformation, aim to raise the enterprises' awareness of specific topics. Since our goal is to promote the dissemination of enabling technologies in the procurement area, it was considered more appropriate to emphasize digital skills.

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The questionnaire was tested by procurement practitioners to verify its clarity and consistency with the research objectives. Then, the questionnaire was sent to the Italian Association of Procurement and Supply Management (ADACI) members by email (about a thousand contacts).

The survey was conducted in January 2020 and received 64 responses, of which 57 complete. Our sample mainly comprises respondents with major responsibilities in procurement (72%); 41% of respondents are Chief Officers. This is consistent with the aim of the survey of increasing the commitment of procurement practitioners and executives to the challenges of the digital revolution.

3.2 Empirical Research: The Research Sample

Our sample consists of 64 Italian companies, mainly located in Northern Italy (87%), with a prevalence from Lombardy (26%), Emilia-Romagna (19%), and Veneto (17%). Together, these regions represent 62% of the respondents.

More than half of the companies belong to four sectors: 23% of the respondents work in the manufacturing sector, 14% in the mechanical sector, 9% in food and beverages, and 8% in consulting. Therefore, the industry is more prevalent (85%) than the tertiary (7%) and advanced tertiary sectors (8%).

Over half of the sample consists of large companies: 56% of the respondents have revenues equal to or greater than € 50 million, and 51% have employees equal to or greater than 250 units. Medium-sized companies account for 30% in terms of revenues (revenues between € 10 and 50 million) and 36% in terms of employees (between 50 and 249 employees). Therefore, the data collected in this survey confirms the participation of several medium-large companies, as in the 2018 survey (Bruzzi *et al.*, 2019).

Regarding procurement, companies have many suppliers: 31% have more than 500 suppliers, while 59% have between 51 and 500 suppliers. The supplier base is international: if 100% of respondents have suppliers in Italy, 55% have suppliers in Asia, 53% in Europe, 23% in North America,

and 13% in Central-South America. The purchases to revenue ratio are high: 51% have a ratio over 51% (in 9% of the cases, the ratio is over 70%).

Regarding the procurement processes, for 69% of the respondents they are very formalized (levels 4 and 5 on a Likert scale from 1 = not at all to 5 = completely), and for 47%, these processes are automated (> 50%).

In addition, the degree of satisfaction with the performance level of the procurement processes is high: 86% have expressed a positive opinion (on a Likert scale from 1 = not at all satisfied to 5 = completely satisfied). More precisely, 42% are satisfied (level 3 scale Likert), 39% are very satisfied (level 4 Likert scale) and 5% are completely satisfied (level 5 Likert scale).

Regarding the attitude of the responding enterprises toward enabling technologies, as in the last survey, there is a strong sentiment to this issue, with the statement "Enabling technologies represent a radical innovation that will transform the way of doing business" reaching an average value of 3.96 on a Likert scale from 1 (I totally disagree) to 5 (I totally agree). Furthermore, the degree of awareness of the companies and the procurement function regarding the impact of these technologies is respectively 3.18 and 3.14. However, as in the previous survey, the awareness regarding the role that the procurement function can take on in this digital transformation is lower.

Tab. 1: Sentiment towards the challenges driven by enabling technologies

	Survey 2020	Survey 2018
Enabling technologies represent a radical innovation that will transform the way of doing business	3.96	3.93
In my company there is awareness of the impact that these technologies can have on the way of doing business	3.18	3.05
In my company there is awareness of the role that the Procurement Function can play in the introduction/implementation of enabling technologies	2.58	2.61
In my Procurement Function there is awareness of the impact that these technologies may have on its management/activity	3.14	3

Source: own elaboration

According to the respondents, the introduction of enabling technologies will lead to profound changes in the procurement function. In particular, 70% of the respondents believe that the introduction of enabling technologies will allow more time for different activities such as strategic planning and the scouting of new suppliers. Moreover, the procurement function will become fundamental in the management of the supply chain and the innovation of processes and products (60%); only 2% believe that the enabling technologies will not impact the operations of this function.

This sentiment is also explained by the fact that the sample is primarily composed of enterprises that have adopted or are in the process of adopting enabling technologies or are willing to do so. In fact, 42% of the respondents have already begun their implementation; of these, 17% have already completed the implementation process, 44% are interested

in doing so (of these, 21% are interested and are evaluating the feasibility); 14% do not intend to introduce them in the near future. According to these results, as in the previous study, the sample was divided into three clusters: the Adopters, who are adopting or have already adopted the enabling technologies, the Interested, who are evaluating to introduce them, and the Non-Adopters, who do not plan to make investments in enabling technologies in the near future (Bruzzi *et al.*, 2019).

Compared to the 2018 survey, the percentage of Adopter enterprises increased from 36% to 42% as the percentage of Non-Adopter enterprises, to the detriment of the Interested enterprises. From the research perspective, the participation of Not Non-Adopter enterprises is considered particularly important, first because this study aims to raise the companies' awareness and second as it also aims to understand the reasons behind not-adoption and the needs of these enterprises.

Despite a higher percentage of Non-Adopters, as in the previous survey, the sample is composed of a very high percentage of Adopter and Interested companies (86%). The high percentage of enterprises active in digital transformation makes the survey results particularly valuable because they refer to innovative enterprises that could drive other enterprises in their territory and their supply chains through their experience and good practices.

Regarding the technologies that the Adopters adopt, there is a greater variety, with the most widespread being cybersecurity (76%), Cloud (68%), Big Data and analytics (66%), followed by horizontal or vertical integration and industrial Internet (both 58%) compared to the previous survey, from which one dominant technology, Cloud (63%), emerged. Confirming the evidence that emerged in the first survey, Cloud is the enabling technology that has reached the most advanced level of development (48% of technology is fully used), followed by cybersecurity (43% fully used) and Robot Process Automation (RPA) (29% fully used).

Fig. 1: The most adopted enabling technologies
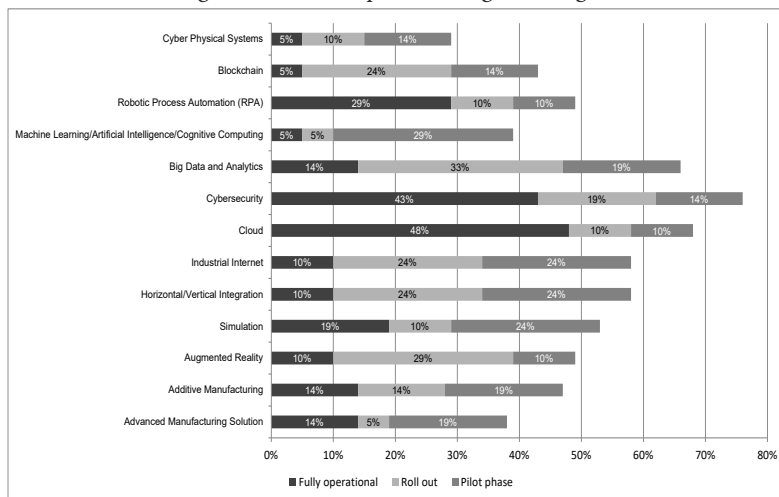
Source: own elaboration

Among Adopters, 71% have also initiated the process for at least three years, while in the 2018 survey, 62.5% of the respondents started the process the previous year.

In the following paragraphs, the analysis focuses on the main results of the survey, focusing first on the Adopters, to understand if a dominant business model 4.0 is under definition, and then on the skills, to understand the most important ones required to face emerging challenges from the digital transformation.

4. Results

4.1 The Italian Adopters

Adopters are mainly large companies (71%) with an important supplier base (63% have more than 300 suppliers). The degree of internationalization of suppliers is higher than that of other companies: the Adopters have a percentage of non-Italian suppliers higher than the overall sample in Asia (58% vs. 51%), in the EU except Italy (58% vs. 53%), Central and South America (21% vs. 12%), and the Middle East (17% vs. 9%).

Regarding the performance of procurement processes, Adopters have more formalized (83% reach a level of at least 4 on a Likert scale from 1 to 5, against 60% of Interested and 38% of Non-Adopters) and automated processes (67% reach a level of automation of over 50%, against 36% of Interested and 13% of Non-Adopters). Similarly, the degree of satisfaction for the procurement processes' performance is higher for Adopters, with 59% of cases reaching a satisfaction level of at least 4 on a Likert scale from 1 to 5; of these, 13% are completely satisfied (level 5 of the Likert scale). Interested reaches level 4 in 48% of cases and Non-Adopters in 13%. None of the Interested and Non-Adopters achieve a satisfaction level of 5.

Regarding the attitude toward enabling technologies, Adopters represent the cluster that most believes that they constitute a radical innovation destined to transform the manner of doing business (48%) and where awareness of the opportunities they offer is greater (68%). Adopters also have a greater awareness with regard to facing the challenges posed by enabling technologies (63%).

The impact of enabling technologies is significant both at an intra-organizational and inter-organizational level. From the first point of view, the functions most involved in the enabling technologies are procurement (76%), operations (71%), supply chain (67%), and R&D (62%). At the inter-organizational level, enabling technologies impact the other actors of the supply chain and the individual company in 65% of the cases.

The supply chain plays a crucial role considering the impact. Among the respondents, 48% believe that enabling technologies will impact automation, efficiency, and information sharing at the company level, while at the supply chain level, 43% believe that these technologies will improve efficiency, 38% believe that they will favor greater sharing of information, 33% that they will make relationships safer, and 29% that they will allow improvements in digital integration and responsiveness processes.

From the perspective of the difficulties, the lack of personnel with adequate skills emerges, in addition to those related to compliance with deadlines already highlighted in the first survey, (both 48%). The lack of awareness about the cost or benefit ratio of these investments (43%), the internal resistance to change (33%), which is decreasing compared to the previous survey when it reached 63%, and the infrastructural inadequacy of the other enterprises in the supply chain are also important.

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The commitment of the procurement function has increased considerably compared to the 2018 survey. The procurement function is involved from the planning phase in 25% of the cases (against 13% in the 2018 survey) and from the choice of suppliers in 40% of the cases (compared to 31% in the 2018 survey). In 2018, its main task was the evaluation of offers (38% of the respondents). From the perspective of the contribution that the procurement function can make to the purchase and the implementation of enabling technologies, the respondents confirm what was already highlighted in the previous survey: in 70% of cases, they believe that the procurement function can contribute to the risk mitigation and the choice of the most appropriate suppliers; 60% think that it can contribute to managing complex contracts.

Of the respondents, 70% have adopted or are adopting enabling technologies for procurement while 45% initiated the adoption process for over three years. In the case of enabling technologies for procurement, there is a greater variety of enabling technologies adopted than in 2018, when the Cloud, with 64% of the responses, was the dominant technology. In the recent survey, the most adopted or in the process of being adopted enabling technologies are cybersecurity (77% of the respondents), Cloud and horizontal or vertical integration (69%), Big Data and analytics, and simulation (both 62%). Blockchain is also important, which is highlighted by 54% of the respondents.

Fig. 2: Enabling technologies adopted for Procurement
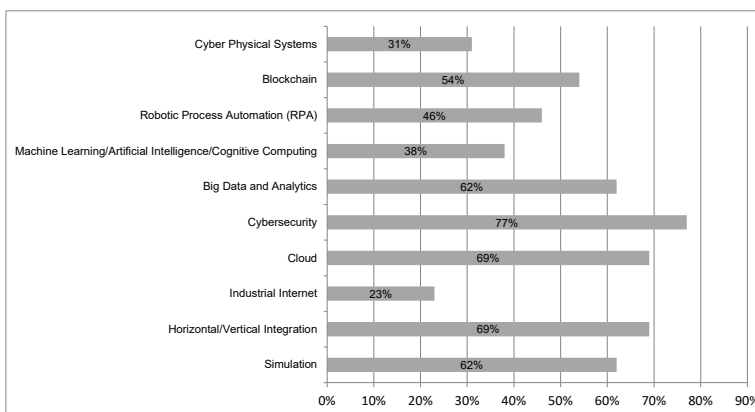
Source: own elaboration

Regarding the objectives pursued, 85% of respondents stated that they aim to simplify internal processes and procedures, 77% want to make business processes and the supply chain more efficient, 54% want to

improve the quality of work, 46% consider enabling technologies consistent with the propensity for innovation and that it aims to reduce costs.

Finally, considering the degree of Adopters' satisfaction with respect to their investments, significant growth is registered compared to the 2018 survey: Levels 3, 4, and 5 of the Likert scale from 1 to 5 are reached in 95% of cases when enabling technologies, in general, are considered (compared to 69% in the 2018 survey). In the case of enabling technologies for procurement, the satisfaction level greater than or equal to 3 is reached in 92% of cases (against 72% in the 2018 survey); 8% are completely satisfied.

4.2 Focus on Skills

Our study confirms the urgency of investing in skills, which has been already highlighted by debate and literature; among the difficulties encountered, the Adopters highlight the lack of human resources with adequate skills.

We investigated the awareness of the great changes that characterize the competitive scenario to address this issue. Accordingly, we focused on risk perception to understand which types of risk are considered the most important and whether companies are confident and prepared to face them. Second, we sought to identify the current priorities of the procurement function. Finally, we focused on the skills, classified into three training areas, to be developed to face the current digital transformation.

Our study registered a high level of awareness: 74% of the respondents believe that the level of risk has increased, with 30% of the opinion that it has increased significantly; 20% believe it remains unchanged, and 6% believe that it has decreased. It emerges that Non-Adopters have a higher perception of risk, with 88% of the opinion that the risk of the procurement function has increased to some extent or significantly, against 71% of Adopters and 68% of Interested respondents.

Regarding the types of risk, those associated with the supply chain (75%) and with suppliers (68.8%) are the most frequently quoted; price volatility (65.6%) and financial risks (64.1%) follow.

Tab. 2: The top risks to be managed (January 2020)

	Adopters	Interested	Non-Adopters	Total
Supply chain risks	58%	76%	100%	75,0%
Suppliers risks	67%	68%	88%	68,8%
Price volatility	58%	72%	63%	65,6%
Financial Risks	71%	56%	63%	64,1%
Legislative changes	29%	36%	25%	31,3%
Tariff policies	33%	28%	0%	28,1%
Cyber Risks	21%	32%	25%	26,6%
Political instability	33%	24%	13%	25,0%
Foreign exchange risk	29%	16%	0%	21,9%
Natural Risks	4%	20%	0%	10,9%
Environmental risks	0%	0%	0%	1,6%

Source: own elaboration

Some differences emerged between the three clusters. Specifically, 100% of Non-Adopters consider supply-chain-related risks a priority, compared to 58% of Adopters and 76% of Interested respondents. Additionally, some risks related to the external environment appear more important for Adopters than for Non-Adopters, such as political instability (33% vs. 13%), risks related to tariff policies (33% vs. 0%), foreign exchange risk (29% vs. 0%), and natural risks (4% vs. 0%).

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Cyber risks are considered a priority by only 27% of the respondents. In this regard, it should be noted that 66% of the respondents have already adopted measures to address cyber risks or are in the process of doing so. Of these, 50% have adopted enabling technologies or are introducing them. Therefore, the adoption of measures to address cyber risks appears to be related to the adoption of enabling technologies.

With regard to these risks, 59% of the respondents have expressed their readiness at managing and mitigating them. Among the clusters 79% of Adopters declared themselves ready; the percentage drops to 50% and 38% for the Interested and Non-Adopters, respectively.

Regarding priorities of the procurement function, the respondents highlight the scouting and assessment of suppliers (64%), followed by the traditional savings (58%) and risk management and mitigation (56%). Enhancing skills is also a priority for the respondents. In particular, the enhancement of technical and technological skills is important to 47% of the respondents; 42% give importance to the enhancement of relational skills, while less importance is given to interventions to enhance digital skills, a priority for 33%.

The picture that emerges from the responses concerning the individual skills identified in our study (Fig. 3) highlight a discrepancy in the importance given to the three training areas and that assigned to the individual skills, which requires more thorough analysis.

Fig. 3: The focus on three training areas and 28 skills

Technical & Technological skills	Digital skills	Soft skills
• Risk management • Evaluation of suppliers and supplies • Project management • Global sourcing • Quality management • Technology management • Tenders • Quality assurance • Ethical purchasing • Management of contracts and legal aspects • Emergency management	• Data analytics and visualization • Systems integration • Cybersecurity • Blockchain • Predictive Analytics • RPA Systems	• Business partnering/relationship management • Negotiation skills • Conflict management • Problem solving • Effective management&Leadership • Stress tolerance • Systems thinking • Emotional intelligence • Multicultural orientation • Self-awareness • Creativity

Source: own elaboration

The most cited skill is predictive analyses, the priority for 84% of the respondents, followed by a soft or relational skill, business partnering or relationship management (75%), and another digital skill, data analytics

and visualization (74%). In fourth place are the technical skills of risk management, and soft skills relating to conflict management and digital systems integration, which are prioritized by 65% of the respondents. These are followed by the evaluation of suppliers and supplies (56%), problem-solving (54%), effective management or leadership (53%), project management (51%), and global sourcing (49%).

Regarding the three clusters, our study highlights the different training needs and interests of Adopters, Interested, and Non-Adopters. In particular, training needs are most expressed by Non-Adopters, with higher demand for many digital and soft skills than the rest of the sample: predictive analysis (100% vs. 84%), systems integration (75% vs. 65%), business partnering/relationship management (100% vs. 75%), conflict management (75% vs. 65%), problem-solving (88% vs. 54%), effective management and leadership (75% vs. 53%), global sourcing (63% vs. 49%), and contract management (64% vs. 46%).

Adopters demonstrate the lowest training needs. The only skills for which Adopters register in significantly higher percentages are stress tolerance, a soft skill that Non-Adopters record the lowest value for (54% vs. 46%), the technical skill of management of contracts and legal aspects (58% vs. 46%), and digital skills related to the blockchain (50% vs. 40%).

In an intermediate position, the Interested cluster exhibits a higher interest in digital skills than the sample except with regard to blockchain (32% vs. 40%). This group also exhibits a higher interest in the relational skills of business partnering/relationship management (84 % vs. 75%) and conflict management (72% vs. 65%). With reference to technical skills, risk management records higher values (72% vs. 65%), while management of contracts and legal aspects registers a significantly lower value (28% vs. 46%) in this cluster.

Tab. 4: The Top 15 Skills

Competences	Adopters	Interested	Non-Adopters	Total
Predictive analytics	75%	88%	100%	84%
Business partnering/relationship management	58%	84%	100%	75%
Data analytics and visualization	75%	76%	63%	74%
Risk management	58%	72%	63%	65%
Systems integration	54%	72%	75%	65%
Conflict management	54%	72%	75%	65%
Evaluation of suppliers and supplies	58%	56%	50%	56%
Problem solving	50%	48%	88%	54%
Effective management & Leadership	42%	56%	75%	53%
Project management	46%	56%	50%	51%
Global sourcing	42%	52%	63%	49%
Cybersecurity	42%	56%	38%	47%
Management of contracts and legal aspects	58%	28%	63%	46%
Stress tolerance	54%	48%	13%	46%
Blockchain	50%	32%	38%	40%

Technical and technological skills

Soft skills

Digital skills

Source: own elaboration

5. Discussion

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The results of our survey enable us to respond to our research questions. Regarding the demand related to the dissemination of enabling technologies (RQ1), the percentage of enterprises that have adopted or are willing to adopt enabling technologies is confirmed to be higher than in other studies on the Italian context (MiSE, 2018). In the 2018 survey, the sample was composed of 36% of Adopters, while in the 2020 survey, this figure is 42%. Some responders have also concluded the adoption process. Considering the main characteristics of the enterprises that adopt enabling technologies (RQ2), Adopters are large enterprises and are very interested in enabling technologies, consistent with the results of research by Ernst & Young and Ambrosetti (La Repubblica, 2019; Ambrosetti, 2017). This seems to confirm that in Italy a gap is being created between large and small companies.

These results suggest that, compared to the 2018 survey, the digital maturity of Adopters is increasing, with Adopters involved in digital transformation over several years with various technologies. The number of technologies that are adopted or are being adopted is greater than in the first edition of the survey, where only Cloud was dominant.

Regarding the attitude toward enabling technologies, Adopters represent the cluster that most believes they are a radical innovation where transformation in the manner of conducting business is imminent (48%) and where awareness of the available opportunities is greater (68%). Adopters have greater self-confidence, being able to face challenges posed by enabling technologies (63%).

Additionally, the level of satisfaction for the adoption of enabling technologies has increased significantly, with 95% of the respondents expressing a level of satisfaction of at least 3 for enabling technologies in general (against 69% in 2018).

Regarding the engagement of the procurement function in the adoption of enabling technologies (RQ3), it appears to have a higher digital maturity compared to the 2018 survey. Procurement is more involved in the decision-making processes related to implementing these technologies and makes an important contribution to areas such as risk mitigation, the choice of the appropriate suppliers, and the management of complex contracts. Additionally, various enabling technologies adopted or under adoption emerge after the domination of Cloud in 2018, including cybersecurity, horizontal or vertical integration, Big Data and analytics, simulation, and blockchain.

Adopters show higher confidence in the procurement function's ability to cope with risks: the percentage of enterprises that declare themselves ready to manage and mitigate risks is higher than that recorded by the Deloitte 2019 CPO Survey (79% vs. 45%) (Delesalle and Van Wesemael, 2019). The results of our study suggest the existence of a positive correlation between performances of the procurement function, for example, regarding formalization and automation of processes, and satisfaction with performance levels on the one hand and the adoption of enabling technologies on the other. This could be a research avenue in future.

The maturity and awareness of the respondents is clear, considering the most required skills for the procurement function to face the digital revolution (RQ4). Our results show that investing in new skills is a priority. The respondents' attention to digital skills confirms the validity of our choice to identify a specific training area for them.

However, notably, the respondents do not merely stress the importance of digital technologies, such as predictive analysis, cybersecurity, and data analytics, but also those of technical and technological skills, such as risk management, management of contracts, and the assessment of suppliers and supplies. Soft skills are also very important; business partnering or relationship management, conflict management, problem-solving, effective management, and leadership are at the forefront, followed by stress tolerance, systems thinking, and emotional intelligence. These skills record higher percentages than other more traditional ones, such as negotiation (chosen by 32% of the respondents), which remains among the top soft skills according to the Deloitte CPO Survey 2019.

Tab. 5: A comparison between the main results of the 2018 and 2020 surveys

	First Survey (2018)	Second Survey (2020)
Enabling technologies are being consolidated	None of the Adopters have completed the adoption process	17% of Adopters have completed the adoption process
The variety of enabling technologies adopted is increasing	The main enabling technology adopted is Cloud, followed by the Internet of Things, while the other technologies were adopted by less than a quarter of the sample.	The diffusion of some enabling technologies grows considerably compared to the previous survey, in particular, in addition to Cloud and IoT, Big Data, Cybersecurity, augmented reality and additive manufacturing are growing.
The degree of satisfaction is increasing	Levels of satisfaction 3, 4, and 5 of the Likert scale from 1 to 5 reach 69% in the case of the adoption of enabling technologies in general. In the case of enabling technologies for procurement, a satisfaction level greater than or equal to 3 reaches 72%, with none completely satisfied.	Levels of satisfaction 3, 4, and 5 of the Likert scale from 1 to 5 reach 95% in the case of the adoption of enabling technologies in general. In the case of enabling technologies for procurement, a satisfaction level greater than or equal to 3 reaches 92%, and 8% are completely satisfied.
Procurement involvement is strengthening	The procurement function is involved from the planning phase in 13% of cases. Its main task is the evaluation of offers (38% of respondents).	The procurement function is involved from the planning phase in 25% of cases and the involvement begins from the choice of suppliers in 40%.
Stable the characteristics of the Adopters	Adopters are generally larger and have a greater degree of internationalization, greater formalization and digitalization of procurement processes, and a higher level of satisfaction with the performance of the procurement function.	

Source: own elaboration

6. Conclusions

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The results presented in this paper enrich the current insight available to decision-makers, primarily policymakers and practitioners, in a field that remains little explored in Italy.

The data suggest that enabling technologies are transitioning from an infancy phase to a real introduction phase in the largest companies, with much greater involvement of the procurement function.

Regarding managerial implications, our results encourage enterprises to prioritize their investment in enabling technologies, and strengthen the capabilities and tools of the procurement function that can act as the gatekeeper of the new infrastructural investments and an enabler of sound and integrated relationships with the other actors in the supply chain.

Moreover the study's results and discussion indicate there is a strong need for a new training paradigm toward a new integrated mindset. There is a need to strengthen skills in the three areas - technical, digital, and soft - in an integrated and transversal way to manage the risks that enterprises face today in a global and complex contest; this appears to be the *fil rouge* of answers provided by the respondents, who believe that investing in digital skills is not sufficient to meet the challenges of the future. Integration among the different training areas can be achieved through new training paradigms, enhancing the on-the-job experience and adopting a holistic view of economic relations. All the ecosystem players, primarily enterprises and universities, must take up the challenge and become active drivers of change.

Considering soft skills, the survey clearly highlights the need for a new mindset to fully exploit enabling technologies. Companies and experts need to reconsider the skills traditionally drawn on, as well as their relevance and validity. The basic skills, which by their nature today are a *conditio sine qua non* to join and grow in the business world, are complemented by those required by the new paradigms. Typical behavioral and relational areas such as leadership development, problem-solving, conflict management, and negotiation, as well as topics such as business partnering, systemic thinking, and management of complexity should be considered, which encompass areas broader than personal attitudes and related to business management. This "upgrade" of skills requires a very different approach from the one dealing with basic skills. A holistic approach that considers the enterprise as a whole is needed. If they decide to invest in new technologies, they must also invest in people and "re-focus" on the value of human capital. If the classical training paradigm for traditional skills - transfer skills to be "learned" - is sufficient in this new area, it pertains to the adoption of more engaging and riskier approaches capable of "transforming" the participants. In other words, experience-driven training would enable people to understand the true meaning of issues they address. This is challenging because prerequisites such as a high level of engagement and participation are required.

Another policy implication of our study concerns the skills gap between enterprises adopting and those that do not adopt enabling technologies. Policymakers should consider providing enterprises with incentives and

tools that enable Non-Adopters to overcome obstacles to fill this gap. Training initiatives that update skills could contribute to breaking down barriers to innovation.

Additionally, research can play a fundamental role in this cultural revolution. Therefore, we continue to investigate this subject in an attempt to strengthen our results. Similar to the first survey, the second remained characterized by low participation, even though higher. We hope to involve a greater number of companies in the third wave, including Non-Adopters. In this case, the study could increase its cultural impact and produce more robust results through a statistical inferential analysis.

The third survey will take place after the COVID-19 pandemic; this emergency has clearly shown that enabling technologies can make operations and supply chains more resilient and favor business continuity in the event of unpredictable external shocks. This crisis can accelerate the process already underway and therefore draw the attention of enterprises and all actors involved to the advantages that enabling technologies can offer. Our study can strengthen this interest and generate a positive impact on the Italian economic system.

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Toward the strengthening of enabling technologies in Italy: results of the second survey on procurement 4.0

Supply Risk Management: an empirical perspective on the Italian manufacturing sector

Marco Perona

Abstract

Frame of the research: This paper presents the preliminary results of a large-scale research conducted through a survey on 147 Italian manufacturing companies, which focuses on supply risk.

Purpose of the paper: Our analysis investigates two main research questions: first, to measure out how likely it is that a supply chain gets disrupted by the sudden and unforeseen interruption of supplies; second, which are the main cause(s)that can lead to such an occurrence

Methodology: We analyzed 157 such cases reported by the 147 firms in our sample.

Findings: Our preliminary results highlight that the occurrence of supply disruptions is rather frequent, and that suppliers' financial default is by and large the most frequent single cause, being at the root of almost half of such cases. By breaking down these results by firm size and industrial sector, we uncover that both these exogenous factors have a deep influence on each of the studied effects, the occurrence frequency, and the causation.

Research limits: This study -as any other empirical research- has limitations in both the number and type of firms scrutinized and is constrained to a specific time period; however, it provides clear outcomes and robust statistical analysis.

Practical implications: Moreover, in doing so it presents managers with some critical considerations about their current curse of action regarding supply chain risk management, and how it could become more efficient and effective.

Originality of the paper: This paper fills a gap in the extant literature by supplying robust quantitative data regarding the frequency of supply interruptions and their causation

Key words: supply chain; risk management; supply risk management; supply interruptions; supplier default

1. Introduction

A Supply Chain (SC) is often defined as an eco-system of enterprises that interact in a networked and interconnected process, in order to fulfill the needs of a certain final customer (Cooper and Ellram, 1993). A supply chain is typically characterized by 3 main flows: the physical flow of materials and goods, that normally goes from up to downstream; the information flow that moves either direction, and the financial flow, that typically moves from downstream up. Consequently, Supply Chain

Management (SCM) can be seen as the coordination of these 3 flows, and the actors that are connected by them. Broadly speaking, the main goal of SCM is to ensure that the correct material or product with the correct information is positioned in the right moment and in the right place when a customer will require it. Cigolini *et al.* (2004) describe a set of different types of supply chain and consequently different goals and coordination strategies.

Amongst the various functions and aims pursued by SCM, supply chain continuity is defined as the capability of a Supply Chain to remain in business despite disruptions that might affect any of the chain's actors or any of the three main flows. Following Blos *et al.* (2015) to ensure supply chain continuity is important not only because it keeps the business running, thus safeguarding the interests of its key stakeholders. It is also of paramount importance to protect the firm's reputation, by keeping its brand and value creating activities alive.

The standpoint approach here considered is the general model of entrepreneurial risks supplied by the ISO 2002 norms. Following ISO (Krolas and Krolas, 2010) any industrial risk can be modelled by: the probability of the unwelcome event to take place, and the amount of the losses it could generate in the focal organization if it was to occur. This model is applied to the context of supply risk from the customer's perspective, by considering the probability of a supply relation's interruption, and the damage it could generate in the customer's business.

This paper presents some highlights from a survey conducted in the Italian manufacturing sector in 2019. To this purpose, the paper is structured as follows: in the following section an aggregate perspective is presented on the theoretical background of supply risk management and its main developments; further, the methodology applied in this study is presented by describing how the survey through which data was collected was designed and executed and by describing the main features of the data sample collected. The description of some of the main empirical findings is then reported. The following section discusses the findings presented, both in a theoretical perspective and in the light of their managerial implications. Finally, a concluding remarks section closes the paper.

2. Theoretical Background

2.1 Business risk and risk management

The concept of risk in business has undergone a sharp development, starting from its first description in the seminal book of the Princeton's mathematician John von Neumann and economist Oskar Morgenstern "Game theory and economic behavior" (1944). In that book they firstly introduced two concepts: the concept of "risk", connected to a harmful event whose probability distribution is known, and the concept of "uncertainty" when we know that a certain detrimental event could happen, but its probability distribution is unknown to us. Their famous "expected utility theory" was the first attempt to model a rational decision-making approach

referred to such situations. Its main limitation, the consideration of a fully rational behavior, was addressed by the psychologists Daniel Kahneman and Amos Tversky (1979). By introducing their "Prospect Theory" on decision making under risk for the first time they took into consideration the idea that decisions can be far from fully rational, for several reasons, such as the usage of empirical and approximated rules or the so called "herd effect". One further credit we owe to these authors is their idea that risk should not only be considered a negative concept, mainly because it is the main source of opportunity.

The modern and generally accepted definition of corporate risk, that is encoded within the «Risk Management - Principle and Guidelines» International Standard ISO 31000:2009 (2009) is to model risk as the combination of two aspects: the likelihood of the harmful event occurrence P(event) and the amount of the losses L(organization, event) that the focal organization would undergo if that same event should occur. Therefore, the risk R that an organization undergoes in connection with a specified event can be expressed as:

R (organization, event) = P(event) x L (organization, event)

With regard to this definition, a wide number of frameworks have been proposed in literature about the classification of corporate risks. For instance, Prandi (2010) proposes two risk classification profiles: the first criterion is about the risks' origin, encompassing "internal" as well as "external" risks. Internal risks derive from events and decisions that are endogenous to the focal organization, such as manufacturing plants failures, while external risks depend on exogenous facts and decisions (e.g. competition or geo-political instability). The second criterion distinguishes among "pure" and "speculative" risks. Pure risks depend on sudden events with a sudden effect, that cannot be foreseen or modified before their occurrence, but can typically be transferred to other subjects, for instance with the practice of insurance: a car accident is the typical example of a pure risk. On the contrary, speculative risks are connected to future and unknown evolution of current and known phenomena such as the economic trend, or the competitive realm, and can thus be addressed by actions performed ex ante.

And indeed, matching the development of both the definition of what is risk and the classification of various types of corporate risks, also the managerial discipline of risk management (Avenn, 1992) has sharply evolved in time. It basically consists in all the courses of action protecting the focal company's assets and revenues in time. Two main schools have built on this basic concept: a financial risk management school that deals with corporate risk by mainly transferring it by means of an insurance policy; and a business risk management school, that has mainly resorted to the contingency planning and business continuity management, aimed at modifying the business practices and managerial choices in a way to reduce both the likeliness of occurrence of unwanted events and their perspective effects (Ahmed *et al.* 2007). By blending these two approaches, corporations have evolved (or are in the process of evolving) their risk management

practices, starting from an unstructured and "silos-oriented" manner in which each manager is entitled to take care of risks occurring within their domain, and moving towards a more integrated and centralized approach in which an appointed and professionally prepared "risk manager" is entitled to identify and measure all risks relevant at a corporate level, and to co-ordinate the plans and policies most appropriate to handle them. This new approach is often referred to as Enterprise Risk Management (ERM), as defined by the International Standard ISO 31000:2009 (2009).

2.2 Supply chain risk management

The idea that theory and practice about risk and risk management could be applied to supply networks started to be considered in the first years of this century. Research in this domain developed at a fast pace in the last 20 years or so, and as claimed by Sodhi *et al.* (2012) it came from many diverse, and complementary fields. The main reason for this fast development, was highlighted by Utta Jüttner (2005) who pinpointed the companies' generalized expectation that the vulnerability of their supply chains could increase in the next five years. On the other side, she argued that the concept of supply chain risk management was still in its infancy for the time being. A first exploratory study of this topic was proposed by Zsidisin *et al.* (2000) and Zsidisin (2003), who interviewed purchasing professionals in several firms. They discovered that purchasing organizations often create contingency plans and implement process-improvement and buffering strategies in response to perceived supply risks discovered in assessments. But, even though risk assessments, contingency plans, and risk management efforts are generally acknowledged as being important, many of those interviewed believed that there was not enough done in their organizations to mitigate supply-related risks. Thus, by putting Jüttner's and Zsidisin's results together, we can observe that on the one side firms expect environmental uncertainty and supply chain's vulnerability to increase in time, while on the other they believe they are not doing enough to prevent and mitigate disruptions.

Once the corporate relevance of supply chain risk became clear, one first stream of research was about how to analyze and measure-up the risk faced by companies. Hallikas *et al.* (2002 and 2004) highlighted how a company can analyze and assess the risks associated with networking, and the main challenges that network co-operation brings to risk management. They outlined the general structure of the risk management process and presented methods for risk management in a complex networked environment. Most importantly, their results indicate that risk management is an important development target in supplier networks, because when the dependency between companies increases, they become more exposed to the risks of other companies. These results can be considered as a suitable explanation of the above-mentioned increase in supply chain risk perceived by firms. Harland *et al.* (2003) also provided a practical tool for assessing risk in networked supply chains; they also highlighted that the growing complexity of supply networks is one major driver of the increase in firms' vulnerability to disruptions. More specifically, they investigated the impact

of such aspects as: product / service complexity, outsourcing, globalization and e,commerce. From this stream of research, thus, we can derive the notion that supply chain risk in both its components of probability and loss is connected to the supply chain complexity, and this in turn explains well why the generalized perception is that the risk is increasing.

Next, researchers started to investigate the specific managerial policies most suited to address supply chain risk, which policies are more effective than others and which are the cause-effect relations that can explain this. For instance, Ojala and Hallikas (2006) tried to improve the understanding of relations between investment decision-making and risks in supplier networks. Their study concentrates on how network companies make investment decisions, what are the main risks related to investing in a network context, and what possible ways are there to manage these risks. By the same token, Micheli and his co-authors (Micheli, 2008 and Micheli *et al.*, 2008 and 2009) worked in deep on how supplier selection can improve supply risk. They developed a risk efficiency-based supplier selection approach for critical supplies, that allows a decision maker to consider the procurement-related "risk" and "investment" with a "total cost" profile related to every supplier and computed as a function of the possible investments that can be made to exploit the upside and to mitigate the downside supply risks. Hult *et al.* too (2010) investigated supply chain investment decisions when facing high levels of risk uncertainty, on the grounds that given the potential dollar value involved in these decisions, an understanding of how these supply chain decisions are made is of significant theoretical and practical importance. By using the theoretical lens of Real Options Theory these authors provide evidence that options operate differently in supply chains than they do in firms. This result was further invigorated by the research of Wagner and Böde (2006). They were among the first to investigate supply chain risk management practices by means of a large-scale survey: building on the grounds of several hundreds of responses from executives of firms operating in Germany, they found that such supply chain management decisions as a firm's dependence on certain customers and suppliers, the degree of single sourcing, or reliance on global supply sources are relevant for a firm's exposure to supply chain risk. Following their path, Thun and König (2011) surveyed 67 manufacturing plants in the German automotive industry. Their analyses reveal that companies with a high degree of implementation of supply chain risk assessment tools show a better supply chain performance than their less developed counterparts. A 2010 study from Wang *et al.* also supported these empirical findings. These authors proposed a model in which a firm can source from multiple suppliers to improve supplier reliability. So, from this stream of research we achieve the notion that the choice of suppliers and the main sourcing policies (such as single vs. multiple sourcing, or local vs. global sourcing) can actually affect the amount of risk incurred, and therefore that these policies play a major role in generating or moderating supply chain risk, both by reducing the occurrence probability and the effects magnitude.

Another research stream went further to identify, define and describe several relevant features of supply chain risk management. In 2012

Wieland and Wallenburg firstly defined two firm characteristics relevant to supply chain risk management: *robustness,* aka the ability to cope with perturbations proactively, and agility, or the ability to cope with them reactively. They empirically found that both *agility* and robustness are important in improving SC performance. While agility has a strong positive effect only on the supply chain's customer value, but not directly on business performance, robustness has a strong positive effect on both performance dimensions. Pursuing the same research path, in 2013 Pettit *et al.* were among the first to speculate on the concept of supply chain resilience, building on the experience gained through an unprecedented sequence of globally harmful events. They propose a Supply Chain Resilience Assessment and Management tool. Through mixed-method triangulation, their research identified hundreds of levers that can be used to guide a resilience improvement process and suggested a correlation between increased resilience and improved supply chain performance. Later on, Heckmann *et al.* (2015) went further by providing an overview of quantitative supply chain risk management approaches, and a comprehensive definition of the main related concepts. In 2021 El Baz and Ruel investigated a sample of 470 French firms in the face of the COVID-19 induced disruption. They found that the implementation of adequate supply chain risk management practices can and does mitigate the effects of the COVID-19 outbreak. They considered four main steps of supply chain risk management, formerly: risk identification, risk assessment, risk mitigation and risk control, and by means of their research structure they tested the effect of these 4 classes of actions on both supply chain resilience and robustness. Their findings reveal that all four supply-chain risk management practices affect positively resilience, while only risk identification and control influences robustness. These works on the one side greatly improved our understanding of the supply chain risk phenomenon, and on the other side provided a long list of mitigating levers, together with rational ways to classify them.

Further developments investigated the respective effectiveness of internal vs. external levers. A study from Wiengarten et al (2016) further built on the concept of supplier relations, and, by means of an international survey, found that supplier integration is an effective lever to improve supply chain performance and decrease supply chain risk also in countries whith a weak rule of law (i.e., intrinsically high-risk environments). This conclusion was further reinforced by Hallikas and Lintukangas (2016), by means of an empirical study on a set of Finnish companies of various sectors. They found that a greater supplier orientation, as well as an improved supplier integration both support an improvement of supply chain risk management performance. Supplier orientation can be characterized as collaboration with suppliers in such areas as: risk measurement, goal setting, business process development, error handling, etc. In 2016 Mishra *et al.* performed an empirical study on 184 Indian firms in order to examine the effect of supply risk management of 2 such focal policies as buffering (aka, decoupling one firm from its supply chain by means of a considerable amount of inventory dislocated both upstream and downstream, and bridging, that is the establishment of strong linkages with trading partners

both up and downstream. They found that both policies are positively connected to a reduction of the supply chain disruption risk experienced by firms, and that in turn this sharply improves the downstream supply chain performance. In 2017 Revilla & Saenz presented one comprehensive survey reporting the correlation of supply chain disruptions with how supply chain risk was managed within each firm. By subdividing scrutinized companies in four supply chain risk management classes, namely: passive, internal, collaborative and integral, they found that firms pursuing an inter-organizational orientation (collaborative and integral) face the lowest levels of supply chain disruption. On the contrary, strategies which simply concentrate on having greater control of internal operations are not vigorous enough to stop the cascade effect of a disruption at the supply chain level. This evidence strongly suggests that it is the inter-company collaboration between suppliers and customers in proactively designing and putting in place countermeasures in advance that decisively improves one supply chain's resilience rather than just putting one company's operations under control.

2.3 Open questions

The literature review just exposed in chapter 2.2. critically illustrates the main developments of the supply chain risk management research in the last 20 years or so. It firstly recognizes the relevance of reducing both the frequency and the impact of supply chain disruptions in improving downstream supply chain performance, as well as the increasing impact of supply perturbations as a result of the multi-dimensional increase in supply chains' complexity. It further developed this discipline's theoretical foundation, by defining such constructs as robustness, agility and resilience and by identifying several levers and policies that can in principle contribute to mitigate the risk by either reducing the likeliness of disruptions or the magnitude of their effects. It further recognized the peculiar value of external levers as compared to internal ones in moderating the risk and provided a rational description of the risk management process by organizing it in 4 well-defined phases. All these advancements have greatly contributed to developing and deepening the theoretical knowledge of this phenomenon, while leaving some space open especially in practice.

In 2011 Tang *et al.* investigated the research developments of supply chain risk management by presenting a comprehensive literature review on this topic, due also to the rise in global attention tributed by the research community in the first decade of the century. Through their review, they identified some relevant gaps between theory and practice: for instance, though they found a pressing need and awareness of supply chain risk management from firms, they report that quantitative models in the field are relatively lacking. Another of their findings is that a statistically significant increase in the research on this topic took place during years 2000-2005 together with an evolution from passively reacting to vague general issues of disruptions towards more proactively managing supply chain risk from a more global perspective. In agreement with Tang *et al.* (2011) the study of Revilla and Saenz (2017) also uncovers that to date studies on supply

chain risk management have been more theoretical and qualitative than empirical and quantitative, so we are failing to know the precise extension of this phenomenon in practice. In facts, Bode and Wagner (2015) as well note that one important element of risk that remains largely unexplored is the frequency (or likelihood) of supply chain disruption. Most studies have investigated the firm's losses if a disruption actually occurs (Hendricks *et al.*, 2009) but have failed to illustrate such relevant aspects as how often this happens and why it occurs.

This gap is precisely this paper's standpoint. We have performed a thorough empirical study in almost 150 Italian manufacturing firms with the aim to take a quantitative picture of the supply chain disruptions they experienced, and to answer to such questions as: how frequently do major supply chain disruptions happen? What are the causes behind these major disruptions? None of these questions finds an answer in any of the studies that were issued in the specialized literature to date, up to our best knowledge.

3. Methodology

3.1 Data collection

The information used by this study belongs to an extensive online survey that was answered by 147 Italian manufacturing firms, in line with Hoffmann *et al.* (2013). The online questionnaire was prepared with the Survey Monkey platform. It consisted of around 150 questions, that took at least 2-3 hours to a generic company to answer. Topics within the questionnaire were arranged as follows:
a) General data regarding the *responding company*
b) How the responding company addressed the definition, measurement and management of *supply risk*
c) Thorough description of (up to) 3 cases of *supply interruption* suffered in the last 10 years
d) Time and cost implied by the search and selection of a *new supplier*
e) The main features of the responding firm's *supply network*
f) The main tasks and responsibilities undertaken by the responding firm's *Purchasing Department*
g) General data about the *respondent person*

The questionnaire was administered to around 2.000 randomly chosen Italian manufacturing firms. Within each firm we chose to address the manager most suited to answer the questionnaire, typically a CPO (Chief Purchasing Officer), a SCM (Supply Chain Manager) or a CEO (Chief Executive Manager), especially for smaller firms.

The questionnaire administration took around 5 months at the end of 2019. The full mailing list was divided in 20 lots, each encompassing around 100 firms. Each week one lot of emails was sent, and the following week all 100 firms were contacted on the phone to expedite the questionnaire filling. Owing to the rather long time required to fill the questionnaire, due to the high number of questions, many of which require quantitative data,

it was necessary to recur to a lot of phone expediting, in order to obtain 163 answers overall, with a hit ratio of around 8%.

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Following the data collection phase, empirical data collected were verified: any time one or more answers were missing or potentially outliers, the information was double checked with the manager that gathered it, and when it was not possible to fix the problem, the corresponding questionnaire was eliminated. At the end of this process, we obtained 147 complete and dependable questionnaires, that were used for the following phase of elaboration.

3.2 Sample description

In order to describe the sample of responding firms, we analyzed various endogenous as well as exogenous aspects. Figure 1 presents the sample breakdown by firm dimensional size and industry. We considered as "micro" firms with sales of 10 million € or less; "small" those in the range 10-50 m€; "middle" in the range 50-200 m€; and "large" if their sales are in excess of 200 m€. Our sample represents well all four classes but fails to match the intrinsic distribution of Italian firms by size, that tends to be much more on the micro and small dimensions. Quite evidently, the very topic addressed by the survey determined a bias, as small and micro companies tend to care less about supply risk than their larger counterparts and as a result had a lesser response rate.

Fig. 1: Firm sample breakdown by dimensional size (left) and by industry (right)
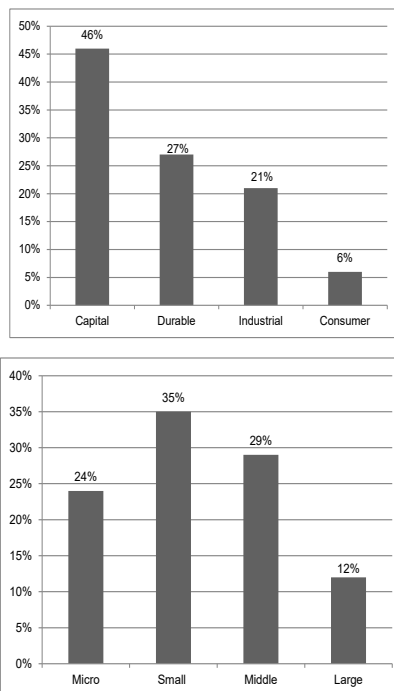
Source: Elaboration from survey's database

A second dimension we used to describe our firms' sample is the branch of industry each company belongs to. In order to simplify this analysis, we used the simplified classification proposed in figure 2.

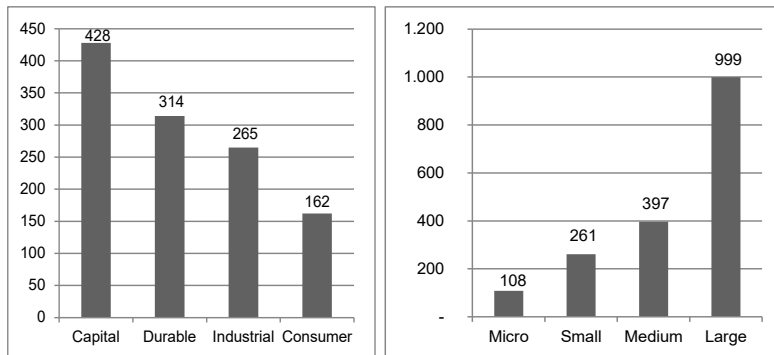*Fig. 2: Classification of firms by industrial sector*

MAIN PRODUCT'S USEFUL LIFE

	SHORT	LONG
B2C	**CONSUMER PRODUCTS** *standard, simple and low unit price goods, that are consumed by a very large number of customers in bulk quantities and at (typically) budget prices such as grocery goods, personal or home care detergents*	**DURABLE GOODS** firms that produce such fairly complex and costly but standard product as cars, lawn mowers, or washing machines, or parts of them
B2B	**INDUSTRIAL PRODUCTS** *simple and standardized industrial commodity goods consumed by no matter which industrial sector in bulk quantities, with a low per unit cost such as: raw materials; screws, nuts and bolts; bearings; metal wire; lubricants, varnishes, detergents, etc.*	**CAPITAL GOODS** firms that produce, install and maintain such typically large, custom, complex and expensive stuff as machinery, industrial equipment, heavy plants and systems, or parts of them

MAIN CUSTOMER

Source: Elaboration from survey's database

Overall, almost half of the responding companies belong to the capital goods sector, mainly within the micro, small (where they constitute almost 2/3 of the sample companies) and medium dimensional sizes. More than 1/4 of the scrutinized companies belong to the durable goods sector, especially in the medium and large dimensional sizes (where they account for almost half the scrutinized firms). And around 1/5 of them belong to the industrial goods sector, while just a limited fraction of scrutinized companies operates within a consumer products sector.

Figure 3 illustrates the average number of active suppliers of direct materials found respectively by firm size and by industry. Fully in line with expectations, we found that the number of suppliers is strongly connected with the firm's size, with an absolutely wide difference among micro (that on average have little more than 100 suppliers) and large firms (with almost 1.000 suppliers on average). Industry, and especially the structural complexity of goods traded in each industry, is found to be another relevant factor at the base of the number of suppliers. Consumer packaged goods firms are at bottom with little more than 160 suppliers on average, despite the fact that they tend to be rather large firms, and capital goods are on top with more than 400 suppliers on average, despite being on average micro or small firms. As a whole, and matching expectations, firms within B2C industries tend to have less suppliers than their B2B counterparts, and short-life products manufacturers tend to have less suppliers than their long-life counterparts.

Fig. 3: Average n. of active suppliers of direct materials by firm size (left) and by industry (right)

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Source: Elaboration from survey's database

3.3 Research questions

As it was highlighted in chapter 2.3, much of the extant literature on this subject adopts a theoretical rather than practical and a qualitative rather than quantitative standpoint. As a matter of fact, there is a lack of studies devoted to measuring out such quantitative aspects as the likelihood and frequency of major supply chain disruptions, or the motivations that determine them. It seems quite awkward that these pieces of information are still missing, especially in the light of the structured and elegant theoretical foundations that were set for the supply chain risk management discipline, since this knowledge is key in order to address and channel both preventive and reactive actions. In fact, El Baz and Ruel (2021) suggested to develop supply chain risk management courses of actions in 4 logically distinct stages: risk identification, risk assessment, risk mitigation and risk control. In other words, they supported that, in order to mitigate risk with appropriate preventive actions and/or control it with suitable reactive actions, you firstly have to know which risk you are coping with (identification) and then you should measure it (assessment). Even more strange, in the light of Jüttner's (2005) claim that on average managers expected their supply chain's vulnerability to increase in years to come. Thus, this study builds on the empirical data collected about major supply chain disruptions in order to shade some light on these very issues. By "major supply chain disruptions" we considered the interruptions of the supply chain continuity that are generated any time one supplier, for one reason or another, stops supplying a customer with one or more (material or immaterial) items in an unforeseen and sudden way, which might leave the customer unprepared to cope with.

Hence, the first research question addressed by this study is about the frequency of occurrence of such events:

RQ1: what is the frequency with which supply chain interruptions occur?

By answering to this question, we firstly fill the corresponding gap in the extant literature, and secondly, we will provide managers with

a fundamental piece of information to identify if this is a marginal phenomenon that does not deserve much of their attention, or if -on the contrary- it is a fundamental issue to keep in control by investing in identification, assessment, mitigation and control activities.

By the same token, the second research question investigated by this paper is about the causes of major disruptions experienced by the investigated firms:

RQ2: is there one "main" cause that generates major supply chain disruptions, or does a full set of different causes play a similar role in this phenomenon?

By answering to this second question not only we will fill the corresponding gap in the extant literature, but we will also provide managers with another valuable piece of information, that will help them to better direct their supply chain risk management efforts.

Secondary to both research questions, we will investigate if and how some exogenous or endogenous factors have an impact in this causation process.
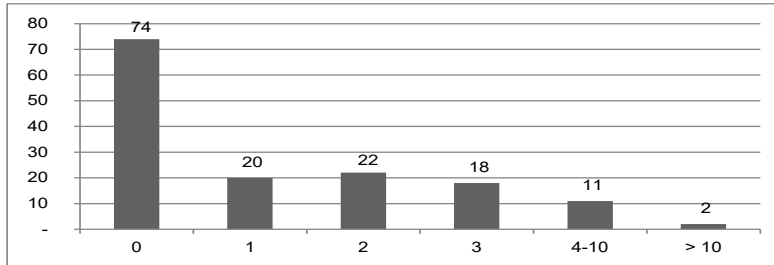
4. Empirical findings

In order to address the two research questions considered by this paper, we asked each of the 147 responding firms in our survey how many major supply-chain disruptions they had experienced in the previous 10 years (i.e. 2010-2019) and -if any- to describe in detail up to three of them that they considered particularly relevant. Our sample of 147 responding firms yielded as much as 261 overall cases, reported by 73 firms (slightly more than 3,5 per firm), while 74 firms did not report any such case. Cases described in detail were 157, with an average of slightly more than 2 per each of the 73 firms that presented them. For the sake of clarity, we collected our data in Italy (slightly) before the COVID-19 outbreak, so this is not considered within the reported causes. All the sample differences illustrated in this chapter have been tested statistically significant at least with a 95% probability.

4.1 Research question 1: evaluating the frequency

As we anticipated, the 147 respondents reported in total 261 supply interruptions in the 2010-2019 decade, with the frequency distribution indicated in figure 4. Note that since data were collected in the middle months of 2019, data regarding this year is not complete. This means an average of 1,77 supply interruptions per company every 10 years, which in turn means that the average firm in our sample has a 17,7% probability of incurring in one unforeseen supply interruption per year. In our sample 74 companies declared to never have incurred a supply chain interruption in the previous 10 years: so, if we exclude these "lucky" firms, the average number of interruptions per company and per 10 years is around 3,6 which takes the average disruption probability per annum at around 36%. These

are by no means trivial frequencies: quite the contrary, considering the financial impact that each supply interruption can have on the company that experiences it, these data definitely suggest taking this problem to the attention of the firms' senior management.

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Fig. 4: Number of supply interruptions experienced by responding firms in years 2010-2019

Source: Elaboration from survey's database

Since in section 3.2. it was illustrated that firms in the sample tend to have very different number of suppliers on the base of their dimensional size and industry, we decided to compute a new variable that makes the rate of supply chain interruptions comparable among firms regardless their number of active suppliers. To do so, we computed for each firm the average n° of supply interruptions experienced per year and per each 100 suppliers. The breakdown of this new variable by firm size and by industry is reported in figure 5.

Fig. 5: Average n. of supply interruptions per year and per 100 suppliers by firm size (left) and by industry (right)
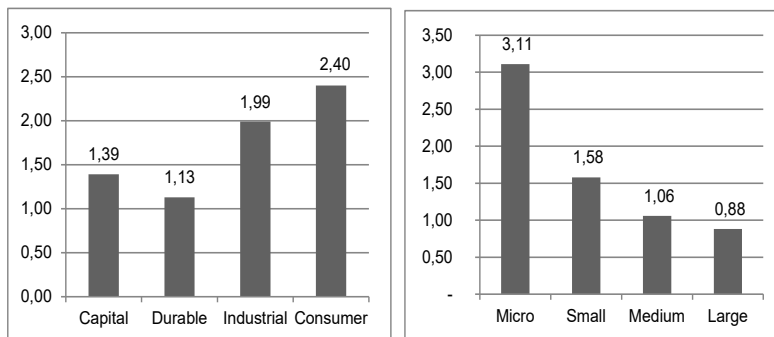
Source: Elaboration from survey's database

The empirical evidence collected here shows that, even though larger firms tend to experience more supply interruptions than smaller ones, when we report this figure to the overall number of active suppliers the result is turned around, because larger firms tend to experience more or less one quarter of the supply interruptions suffered by smaller ones relative to their number of active suppliers. This evidence sets a strong suggestion that

larger firms might count on more complete, straightforward and effective supply chain risk management systems, encompassing more complete organizational procedures, more skilled or experienced managers, and ad hoc software tools, all features that typically micro or small companies lack of.

Much the same observation can be made regarding the breakdown by industry. Firms in Capital and Durable goods supply chains have on average mor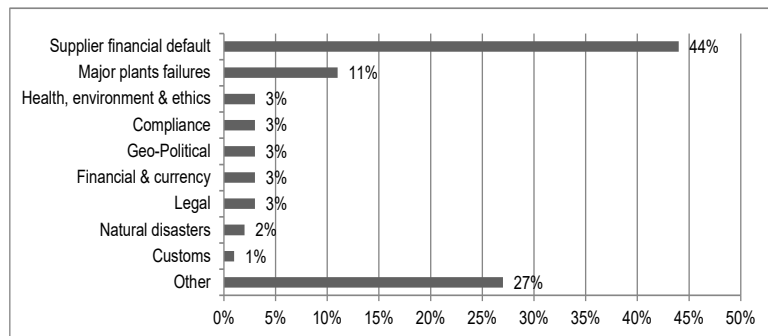e supply interruptions per year than their counterparts in other industries: but if we consider that they tend to have on average more active suppliers than their industrial and consumer goods counterparts, we end up with the evidence that firms in these two industries tend to experience on average less interruptions per year and per 100 suppliers than their counterparts in short-useful-lived products industries, in the face of the higher complexity they have to manage, in terms of product range, product structure, supply base dimension and stability, level of product's customization, etc. This result is partly at odds with previous more theoretical literature, for instance Hallikas *et al.* (2002 and 2004) and Harland *et al.* (2003), that supported a positive relation between supply chain complexity and firms' vulnerability to supply interruptions.

So, we can answer to our first research question that the average probability to experience at least one supply interruption in a given year for firms in our sample, at almost 18%, was found to be higher than expected. Moreover, it was found to be strongly correlated to both the firm dimension and its industrial sector, but in a rather counterintuitive way.

4.2 Research question 2: finding the cause(s)

In order to investigate the causation process that is at the base of the major supply-chain disruption reported, we resorted to the 157 cases described in detail. In order to leave as much freedom as possible in the choice of the cause, we let respondents free to indicate whether they knew or not the precise cause at the root of the supply flow interruption they had experienced, and in case to describe it in words. 100% of reported issues were known and described, and we post-processed them to obtain as few standardized groups as possible. Results are exposed in figure 6.

Fig. 6: Major supply chain disruption breakdown by cause

Source: Elaboration from survey's database

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Unfortunately, we were unable to obtain as few standard groups as we had liked to, on the account of the extreme sample's dispersion. We classified as "other" all the (42!) different reported causes that had happened just 1 time in our data sample and that we could not connect or join to another larger group: this is an extremely wide set of very differentiated causes, from the supplier going out of business following the founder's retirement, to the personal quarrel between the representatives of the two trading partners, and from a cyberattack on the supplier's servers to the supplier's choice to divest from a specific sector, and much, much more. These are all events that can happen, and actually did, but are very, very unlikely, the typical once-in-a-lifetime events that probably could never happen again in the next few years. Next come custom issues, one cause that occurred only 2 times over 10 years in our sample of 147 firms. Natural disasters are reported having caused just 3 supply interruptions out of 157. Legal, currency, geo-political, compliance and health or environmental issues were reported each to have caused between 4 and 5 cases. In short, all of these causes despite recurring sometimes in our sample are clearly very infrequent and unlikely. Slightly more important as a cause of supply chain discontinuity was the recurrence of production plants failures, which happened 17 times in 10 years and over 147 firms: however, while this should be regarded as a non-negligible number of times, it still remains a fairly unimportant occurrence if we compare it with the number of years and our sample dimension.

Without any doubt, on the other hand, suppliers' financial default emerged as the widely most relevant cause of reported interruptions, accounting on its own for almost 50% of cases described in detail. If we apply this percentage to all the 261 reported (but not described in detail) cases we obtain 115 cases over 10 years and 147 firms, which yields an average probability of almost 8% per firm and per year. This is definitely a relevant probability: if we do the same computation for the second most relevant cause, the plants failure, we obtain, by contrast, 29 cases overall, or slightly less than 2% average probability per firm and per year, which appears definitely less interesting from a managerial perspective. If we add that while a plant failure can in principle be fixed while financial default can typically put the entire supplier company out of business forever, it is fair to answer our first research question in an affirmative way: on the ground of our empirical evidences, we find that suppliers' financial default is by and large the most relevant of all the numerous possible causes that can explain why all of a sudden and without much warning a certain supply is interrupted.

It is now interesting to examine whether any of the exogenous factors utilized in section 4.1. has a relevant impact on the causation process as well. To do so, we grouped causes in 2 only classes: supplier financial default and all the other causes. Figure 7 reports the causes breakdown by firm dimension and industrial sector. As it appears very clearly by the two charts, both factors play a major role in shaping also the causation process. More in detail, with regard to firms' dimension, the larger the firm, the larger the portion of supply chain disruptions that is directly and uniquely caused by suppliers' financial default, and the smaller the portion

that can be attributed to the numberless other causes. Since it is fair to think that larger companies can on average count on more sophisticated, complete and effective supplier selection and evaluation procedures than smaller ones, which was already proposed as a suitable explanation for the overall smaller rate of disruptions suffered by larger companies, one possible explanation of this empirical evidence is that large(r) companies might be (much) better than smaller ones at filtering the many small and infrequent causes that seem to haunt micro and small firms' supply chains, while firms' ability at predicting their active suppliers' defaults seems almost untouched by firms dimension. In turn, this could be an indication that these larger companies tend to invest more in supplier selection (so to avoid, for instance, customs or currency issues) and in setting supply contracts (so to prevent, say, legal or compliance issues) than they do in checking their suppliers financial accounts.

Fig. 7: Causes breakdown by firm dimensional size (left) and by industry (right)
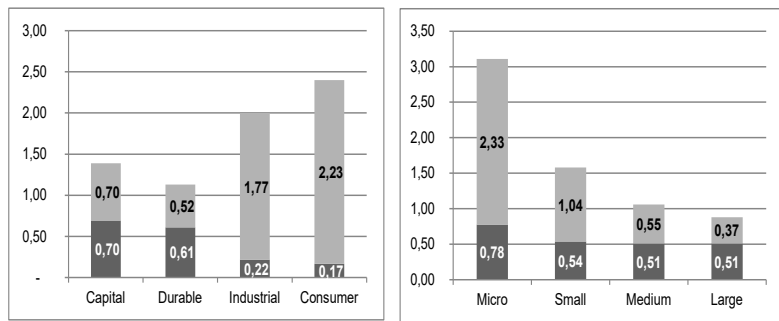
Source: Elaboration from survey's database

The industry to which each responding company belongs plays a major role in the causation process too, as far as we can see from our empirical evidence presented in figure 7. Again, to break down results illustrated in figure 5 by cause, turns our results around. Firms in the two industries that deal with most complex products (namely, capital and durable goods) show a much higher incidence of the supplier's financial defaults than their counterparts in sectors that manufacture simpler and shorter-lived products (industrial and consumer goods). This could be explained by considering that these sectors have by far the most complex supply chains, in terms of number of suppliers (see figure 2), products range variety and structural complexity, number of customers, etc. If this explanation holds true, we could have achieved an empirical demonstration of the supply chain vulnerability vs. complexity connection recalled by Hallikas *et al.* (2002 and 2004) and Harland (2003), an explanation that holds especially true for suppliers' financial default, rather than for any other possible cause of supply interruption.

Our empirical findings support a definitely affirmative answer to our second research question, because financial default was found to be by and large the main cause of supply interruptions, with almost half of the cases,

while the second most frequent cause, namely production plants failures, can explain slightly more than 10% of cases. We uncovered many tens of other causes, all of them happening just episodically over the analyzed firms and time period. The causation process has been investigated also by combining this variable with 2 exogenous factors: all of them proved to have a statistically significant impact on the causation process. We found that larger firms are much better than their smaller counterparts at filtering almost any cause of supply chain interruption, apart from supplier financial default, the largely main one: this evidence is so strong that it holds true even if larger suppliers (that are understandably chosen more frequently by larger firms) tend to have a much reduced rate of default as compared to micro ones (that are particularly abundant on the smaller companies supplier base). A greater percentage of defaults is also found in association with firms that operate in sectors that produce more complex goods with a longer useful life, such as capital or durable goods, as compared to their short useful life counterparts, on the account that both capital and durable goods tend require more complex product range, product structure, supplier bases, etc. confirming the link between supply chain complexity and its vulnerability to perturbations.

5. Discussion

The empirical findings illustrated in this paper are preliminary results achieved through a wide scope research program in the Italian manufacturing sector. While the analysis of the data collected will proceed further and it will hopefully yield new and more relevant evidence, we deem that the evidence presented in this paper is noteworthy both from a theoretical perspective and from a practical point of view.

5.1 Theoretical discussion

One criticism that has been risen by some authors is that, up to date, research on supply chain risk management has been too much oriented towards theoretical vs. practical and qualitative vs. quantitative approaches. This in turn has yielded a set of significant advancements in theory building, measurement methods, or risk management models, while practical and quantitative knowledge regarding the phenomena that are at the root of supply chain interruptions has lagged behind those advancements. For instance, the studies of Bode and Wagner (2015) and Revilla and Saenz (2017), just to cite two noteworthy examples, have claimed that to date studies on supply chain risk management have been more theoretical and qualitative than empirical and quantitative, so we are failing to know the precise extension of this phenomenon in practice, mainly because one important element of risk that remains largely unexplored is the frequency (or likelihood) of supply chain disruptions, since most studies have investigated the firm's losses if a disruption actually occurs (Hendricks *et al.*, 2009) but have failed to illustrate how often this happens and why it occurs.

This study gives answer precisely to these two questions: how often is one supply chain continuity broken? And what are the reasons that make this happen? It does so through a large range empirical data collection that took place in 2019 and involved 147 Italian manufacturing firms. As it happens in any other empirical study, the sample of firms considered by this research is limited both in time and space. The time limitation could lead to biased results because certain periods of time are intrinsically more (or less) perturbated than others. We investigated supply disruptions spanning from 2010 to 2019, so the global financial crisis epitomized by the famous Lehman Brothers default in September 2008 could have had an impact on the default rate of companies in the first years of the considered time period, while if we will repeat this study in years to come, we could uncover a new very perturbated period in connection with the COVID-19 pandemic. The space limitation implies the investigation of a rather limited number of firms, which refer to a certain geographical territory and industrial sector (in our case manufacturing firms that operate in Italy). So, our results might be fully valid only for the considered time period, geographical extension and branch of industry. Moreover, dealing with a limited number of responding firms which therefore imply a rather limited number of defaults, any empirical investigation can encounter difficulties in overcoming the background noise produced by the intrinsically uncertain and uncontrollable way the data are gathered and collected.

However, while this study undoubtedly has, to some extent, these limitations, it still presents a rather robust and straightforward quantitative analysis of the supply interruption phenomenon and of its cause(s) and provides valid answers to the two basic questions that were left unresolved in the views of the aforementioned researchers. Firms that answered to our questionnaire were found to suffer, on average, slightly less than 2 supply interruptions per year and every 100 suppliers, almost half of them due to suppliers' financial default. While the numerical values could be considered endogenous characteristics of the peculiar businesses and time period studied, the main messages that these numbers bring to our attention has a more general validity: i). the unforeseen and sudden interruption of supply chains is a very relevant phenomenon that deserves to be analyzed by researchers and considered by managers in its own right; ii). while supply chain continuity interruptions happen because of a very large range of differentiated reasons, by and large the most important of them is the financial default of suppliers.

5.2 Managerial implications

In addition to the gap in academic research that this paper contributes to fix, and in close connection with the answers that it gives to the research questions investigated, this paper further supports some considerations that could help managers to ensure their supply chain's continuity.

First of all, the evidence here discussed about supply chain interruptions frequency of occurrence forces companies towards investing in professional managers, organizational procedures and software tools that enable the setting-up of an effective supply chain risk management

preventive system as suggested by El Baz and Ruel (2021), dealing with all the 4 phases proposed: risk identification, risk assessment, risk mitigation and risk control. So, one further topic that the prosecution of this study will deal with is to better investigate what is the attitude of firms towards supply chain risk management, what are they doing in order to prevent and react to interruptions, and which results are they achieving out of these actions.

The evidence that large firms are on average much better than smaller ones in filtering out, preventing and controlling this phenomenon can probably be explained by the fact that supply risk management as a whole is a rather new discipline that requires a very deep and specific knowledge, and therefore large businesses are more likely to be equipped with skilled managers, adequate managerial and organizational procedures and appropriate software applications dedicated to deal with it than their smaller counterparts. We hope to be able to investigate this evidence more in deep in the next phases of this research program. However, while this improved ability seems to do miracles in reducing overall supply chain interruptions by almost three quarters, it proves much less effective when we measure out its ability to reduce those interruptions due to suppliers' financial default, which means that large firms are super-good as compared to micro-ones at reducing all the other numberless causes that can provoke a supply interruption. This, in turn seems to strongly suggest that either even large businesses are not doing enough to cope with this most important of the supply chain interruption causes, or this very cause is the main one just because it is so elusive and difficult to forecast, or both. Indeed, any of these considerations seems quite surprising, in the light of the fact that financial credit scoring is a well-developed industry, and commercial services that crunch corporate financial statements data in order to analyze and forecast firms' financial stability are a widely used commodity. Thus, we believe that to understand more in deep how this apparent paradox can be explained is a major objective of our further analyses.

Another interesting empirical evidence brought to light by this paper is the clear connection between supply chain complexity and its vulnerability to supply chain continuity issues. In fact, responding firms that belong to industry sectors with more complex supply chains (notably: capital and durable goods) experience overall less supply chain interruptions than their counterparts in simpler supply chains, but a much larger impact of suppliers' financial default. On the one side, this is fully in line with previous supply chain risk management literature, for instance Hallikas *et al.* (2002 and 2004) and Harland *et al.* (2003)) and also with supply chain complexity literature (for instance Perona and Miragliotta (2004). On the other hand, it offers an interesting information to better direction the efforts especially of managers within these sectors. Looking at the specific characteristics of these two sectors, there are several reasons why supply complexity can make a supply chain more vulnerable to interruptions. The first and most obvious is that when you have to manage a larger supplier base it is more difficult to keep all your suppliers under control. In addition to that, especially in capital goods, products tend to be less standard, and therefore also the supplier base can be less static, another factor that can add uncertainty. Finally, capital goods are typically produced in rather small

quantities, so volumes purchased can be also rather small, which in turn could prevent firms from recurring to large and well-established suppliers, and instead to address smaller and more "volatile" business partners.

6. Conclusions

Although the full potential of this study will only be achieved through a more complete and straightforward elaboration of empirical results, that will leverage on the whole set of empirical data achieved, the discussion of partial empirical results that is performed in this paper can take us to some relevant and distinctive concluding remarks. This paper fills a gap in the extant literature by supplying quantitative and empirical data regarding the frequency of supply interruptions and their causation. Moreover, in doing so it presents managers with some critical considerations about their current curse of action regarding supply chain risk management, and how it could become more efficient and effective.

A second valuable contribution of this study is that it is the first to analyze the vast dataset collected through a large- scale empirical survey. As such, it opens-up to many further questions that will hopefully find an answer. For instance, it could be more profoundly investigated if and how supply interruptions suffered by companies depend on such endogenous factors of the investigated firms' supply chains, as the procurement and supply policies applied, managers' experience and competence, or their awareness of the problem. In connection to this, it could as well be studied if and how supply interruptions are connected also to how procurement and suppliers are managed, a thesis that is supported, among others, by Caniëls and Geldermann (2007). On top of that, the data collected by means of this research program can also support a study of how do investigated companies provide to the analysis, definition and measure of supply risk, to which an extent they actually care about it, and which are the effects of supply relations disruptions, in terms of time required to get back to a new steady state and cost implied by it.

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Business resilience and risk management during the Covid-19 pandemic: the Amadori case-study[1]

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Abstract

Purpose of the paper: The work aims at exploring business resilience against a natural biological disaster - such as the ongoing Covid-19 pandemic - through the lens of risk management. Specifically, the work seeks to assess the resilience capacity demonstrated in the procurement activity by a specific company used as a case-study by identifying the indicators that enable the dimensions of organisational resilience to be detected in a longitudinal approach.

Methodology: The study implemented a qualitative research approach to develop the case-study. The analysis was carried out by examining internal documents and holding a series of interviews with Amadori's Chief Purchasing Officer (CPO).

Results: Resilience dimensions vary longitudinally and require different organisational responses. In brief, to respond to the different sources of risk, redundancy and rapidity were crucial during the lockdown phase, while robustness, rapidity and resourcefulness became key factors in the post-lockdown phase.

Research limits: The study's results are based on a specific business case, thus limiting generalisation. Moreover, the results are preliminary as the pandemic is still ongoing.

Practical implications: Findings can represent concrete help for other businesses to gain direction and adopt good practices of risk planning and management in view of resilience and business continuity.

Originality of the paper: In the management literature, the study of business resilience is limited. This work contributes to extend theoretical and managerial knowledge on resilience dimensions that can be implemented during the different phases of highly unforeseen events with a consistent and prolonged impact on businesses.

Key words: resilience; risk management; procurement; covid-19; case-study

1. Introduction

Towards the end of 2019, a series of pneumonia cases came to light in China and were subsequently identified as caused by SARS-CoV-2, commonly known as the Covid-19 virus. Since its appearance, a new rapidly evolving situation has been triggered, with the spread of the virus all over the world. On March 11th 2020, Covid-19 was qualified as a global pandemic by the World Health Organization (WHO).

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In most countries, as well as in Italy, urgent legal directives came into force to slow down the spread of the virus, including (local and national) lockdowns, the use of Personal Protection Equipment (PPE), travel restrictions, limitations and stops to a number of sectors and companies, etc. As a consequence, the spread of the Covid-19 pandemic has severely compromised the global economic system, placing the continuity of businesses in serious difficulty and creating a climate of prolonged "deep uncertainty" that is posing unforeseen challenges to business organisations.

The long lockdowns and the on-going circulation of the virus are deeply impacting companies' planning and operations, leading them to revise not only their business models, but also their approaches to risk and crisis management. In the face of an economic and social environment characterised by a level of global uncertainty that has never been experienced before, reducing the level of risk vulnerability of a business organisation through the improvement of its resiliency capability becomes a priority.

In this context, the study aims at exploring business resilience against a natural biological disaster - such as the ongoing Covid-19 pandemic - through the lens of risk management. More specifically, by analysing a case-study, the work seeks to assess the resilience capacity of the observed company, i.e. the Amadori Group, in the procurement area by identifying the presence and impact of some key risk indicators and resilience dimensions within a longitudinal perspective. In fact, the analysis is performed by considering three temporal stages: before the pandemic, during the lockdown phase and in the post-lockdown phase.

The paper aspires at providing the following contributions. First, business resilience is still poorly investigated and empirically supported (Bhamra *et al.*, 2011; Linnenluecke, 2017; Martinelli *et al.*, 2018). The present study extends theoretical and managerial knowledge on the topic by identifying the different kinds of resilience dimensions that are required in the various phases of manifestation of a highly unforeseen event. Second, risk management and organisational resilience have often been treated as independent, if not conflicting, research topics (Berkes, 2007), despite their similarities (Mitchell and Harris, 2012). Our work tries to reconcile these research streams by exploring business resilience through the lens of risk management. Third, the impact of slow-onset natural disasters, such as the current pandemic, on businesses has been under investigated. Such a prolonged and worldwide uncertainty was unexpected, and any possible empirical work like ours that can shed light on its effects is important to create and advance knowledge.

The contribution is also managerial. Its findings can represent concrete help for businesses in order to adopt good practices of risk planning and management in view of resilience and business continuity. Its implications can also be related to public policies, providing useful insights to public institutions and business associations in order to make them more effective in supporting companies in the development of adequate risk management and resilience capacities to prevent and respond to disasters.

The present work is structured as follows: after describing the main points characterising the literature on business resilience against natural

disasters and evidencing its relationship with risk management, the methodology is presented. Subsequently, the case-study's results are described and discussed, and ends by depicting the study's conclusions and limitations.

2. Business resilience against natural disasters and risk management

Natural disasters are destructive events characterised by increasing manifestation all over the world. The impact of these disasters varies: although they fortunately do not always cause loss of lives, they strongly affect the economic and social environment. In fact, natural disasters represent a potentially unpredictable and burdensome threat for the continuity of a company's activities and its survival. However, natural disasters are a broad category of extreme events: earthquakes, tsunamis, volcanic eruptions, floods, and bushfires are classified as sudden-onset disasters, while epidemics, rising temperatures, pollution and coastal erosion are identified as slow-onset disasters (Cutter *et al.*, 2008). Sudden-onset disasters produce unexpected impacts in a limited time-period. Those disasters are often characterised by a relatively defined beginning and end. In contrast, slow-onset disasters emerge gradually: their manifestation is slow, their impact is insidious and they are defined by the cumulative sum of different effects (Staupe-Delgado, 2019). The Covid-19 pandemic may fall into the latter category as it is a biological slow-onset disaster. However, as this biological disaster has shown to be particularly threatening as it is underhanded, global and uncertain in its time-length, thus generating unexpected consequences, the academic debate on its definition and classification is open. Recent papers by Staupe-Delgado (2019), Hsu (2019) and Fiske and Marino (2019) argue for a conceptual reconsideration of the temporal aspect of disasters and advocate greater academic and public policy attention to slowly occurring disasters. The Covid-19 pandemic boosts the discussion, as it presents many specificities that are questioning the traditional way of classifying disasters in terms of time, geographic scope, phasing and positioning (Yamori and Goltz, 2021). Indeed, the spatial limitation aspect that the Covid-19 pandemic has completely discarded is closely related to its temporal confinement in conceptions of disaster. "Disaster agents that are gradual and potentially catastrophic, global in scope and require international cooperation to manage" (Yamori and Goltz, 2021, p. 1) are calling for a new framework for defining and studying disasters.

The academic literature dealing with natural disasters has only recently begun to place companies at the center of the analysis (Zhang *et al.*, 2009). A natural disaster, in fact, produces a direct effect on economic activities, causing physical damages to plants, equipment and stocks. Such direct damages, if substantial, can even lead to the interruption of business activities for long periods of time, thus putting business continuity at risk. To identify the potential risks emerging form natural disasters and prepare to face them, it is important to assess the company's resilience capacity against extreme events, identifying the possible presence of resilience dimensions.

Resilience indicates the capacity characterising systems, individuals and organisations to resist, react and recover from a critical event capable of undermining their stability and functioning (Linnenluecke, 2017; Sutcliffe and Vogus, 2003; Williams *et al.*, 2017). This bouncing-back perspective is overcome by a more recent view - the bouncing-forward one (Martinelli and Tagliazucchi, 2019; Martinelli *et al.*, 2019) - in which resilience can be interpreted not only as the recovery capacity to return to a pre-existing state, but it is also a way to grasp new opportunities (Sutcliffe and Vogus, 2003; Lengnick-Hall and Beck, 2003; Lengnick-Hall *et al.*, 2011; Martinelli *et al.*, 2018) and perform even better than in the pre-crisis situation.

The measurement of organisational resilience remains a difficult exercise that finds little evidence in the academic literature. This also depends on the conceptualisation of resilience, which is far from being agreed upon among scholars (Bhamra *et al.*, 2011) given the multiplicity of disciplines to which the concept applies, as well as its transversality and multidimensionality (Linnenluecke, 2017). Business resilience is based on the constant monitoring of risk management. However, the literature often approaches risk management and organisational resilience as independent, if not conflicting, research topics, since "Resilience thinking challenges the widely held notions about stability and resistance to change implicit in risk and hazard management policies around the world" (Berkes, 2007, p. 287). On the contrary, risk and resilience have many similarities and points of contact and may be considered "as organising frames and the extent to which risk assessment and risk management provide a window on resilience" (Mitchell and Harris, 2012, p. 2). In fact, both approaches focus on the ability to manage impacts and crises by trying to identify possible options to cope with uncertainty and change. In this sense, the ability to be proactive is fundamental (Berkes, 2007). Somers (2009, p. 13) states that "resilience is more than mere survival; it involves identifying potential risks and taking proactive steps to ensure that an organisation thrives in the face of adversity." In this perspective, risk is one of the factors to be identified in order then to act resiliently, while impact analysis is considered as the background on which to take rapid business decisions in the event that adverse situations arise.

Several studies in the managerial field have attempted to identify resilience dimensions. Among these, Kantur and İşeri Say (2012) theorised an integrated model in which organisational resilience is defined on the basis of a number of dimensions that had been previously proposed by Bruneau *et al.* (2003) as the 4 R's, i.e. Robustness, Redundancy, Resourcefulness, Rapidity. The latter responds to the conceptualization offered by the Multidisciplinary Center for Earthquake Engineering Research, which includes both physical and social dimensions of resilience (Tierney, 2003). This view supports the capability of the processes, systems, individuals and resources composing an organisation to face and endure sudden shocks and adversities. Even if this framework was developed in a seismic context and with a community perspective in mind, it was later successfully applied to the organisational (Kantur and İşeri Say, 2012, 2015) and business and management fields (Martinelli *et al.*, 2018, 2019). This theoretical framework has also been adopted in the present study.

3. Methodology

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The study applied the business case methodology (Cadle *et al.*, 2010). This is an investigative approach that is particularly useful in the face of a phenomenon - such as the pandemic in progress - whose duration and consequences are still unknown and therefore requires more qualitative methods of investigation, which allow an in-depth analysis that can produce rich and articulated insights.

The case-study analysed is that of the Amadori group, one of the main companies operating in the meat production sector at a national level, with particular reference to the poultry segment. With a turnover of more than 1.6 million euros in 2019, which increased by +2.9% compared to the previous year, the group develops a market share of around 30% of the total poultry meat sold in Italy and employs over 8,300 people.

The study was carried out by examining internal material and holding a series of meetings with the working group composed of an expert researcher on firm resilience, Amadori's Chief Purchasing Officer (CPO), and a company consultant expert in risk management and business strategy. The focus was on purchasing and on the supply chain processes managed by the company.

The documental analysis consisted in examining documents, presentations, internal provisions and notifications, organisation charts and company protocols that were kindly provided by the group's procurement office at the specific request of the other members of the working group in subsequent phases, based on the elements and factors of risk and resilience that emerged during the case-study's development. The information that was contained in the company's documents was particularly useful to suggest questions that needed to be asked and situations that needed to be observed as part of the research. Moreover, tracking changes and developments in the internal memos and protocols addressed to the employees during the lockdown and post-lockdown phases enabled us to better identify the resilience dimensions emerging in these different phases. For this reason, content analysis was employed as a first-pass document review (Bowen, 2009) to organise the information into the resilience dimensions that are central to our research and trace the impact and risks faced by the company.

The qualitative analysis consisted in the administration of a number of semi-structured interviews to Amadori's CPO. The meetings were recorded, carefully transcribed and then analysed by the researcher and re-discussed with the members of the working group. The first two meetings were carried out on the basis of an initial scheme that had been developed by the researcher with the business consultant and aimed at understanding and discussing the following main topics:
- concept of risk and types of risks that the group usually faces, as well as the risk indicators that are usually applied (on the basis of the classification list in Christophe and Gaudenzi, 2015);
- possible previous experiences and reactions before crisis events;
- financial and performance situation before the critical event;
- productive-organisational-procedural-managerial changes decided

during and after the lockdown phase, with particular reference to the procurement area.

On the basis of the results that emerged during these pilot interviews, other topics of interest were identified and discussed in depth in subsequent meetings. In total, 7 structured meetings were held in the June-October 2020 period on the GoToMeeting platform, along with another series of spot comparisons, also by telephone, to clarify some points that emerged, for a total of about twenty hours of proactive comparison.

Then, the collected texts and information were analysed and systematised in order to draw the study's findings.

4. Results

The analysis identified and evaluated the resilience and risk management responses of Amadori's procurement department in order to propose an example of good practices of company behaviour to face crises that can vary according to the time period in which the pandemic is evolving.

The work highlights Amadori's response approach during the three analysed phases: pre-pandemic; during the lockdown; in the post-lockdown phase, thus emphasizing resilience dimensions and the impact and risks faced in each phase, which are defined as follows:

- Robustness highlights the firm's capacity to face the critical event and the solidity of the undertaken and pursued entrepreneurial project;
- Redundancy consists in maintaining excess resources to cope with the new environmental conditions (increasing stocks, production capacity, etc.);
- Rapidity is the ability to adapt and be flexible in revising the business's path in order to restore the functionality of the organisational system in a timely manner;
- Resourcefulness relates to the resources that are engaged and mobilised in the development of the enterprise;
- Risk likelihood refers to six areas of intervention (economic and financial, production capacity, business process, cultural dimension, risk management, scouting of alternative suppliers) that are assessed in a vendor rating perspective;
- Impact is estimated in terms of costs.

4.1 The pre-Covid phase

The risk that historically characterises the sector is a zootechnical, and more specifically avian one, given the sensitivity of this type of animal to airborne viruses. Poultry meat is produced in Italy by the group thanks to a fully-integrated supply-chain. Attention has always been strongly focused on the phytosanitary safety of live animals, a control procedure carried out with extreme care by the internal sanitary management made up of 10 employees and directed by an expert veterinarian, who mainly deals with viruses. The group did not face any real threat from this point of view in the past, given its accurate procedures the high priority. It should also be borne

in mind that the company already had a resilient approach to minimising risks in place when it decided to distribute farms in different areas of the Apennines, so as to limit the possible risks of virus infection. Therefore, an approach to social distance of animals, goods and food was already present in the company.

In addition to animal raw materials, particular attention is devoted to the sourcing of ingredients that are used to enrich the product, such as spices and "functional" food (flours, preservatives, starters for fermentation, nitrate and nitrites, fibres), in order to minimise the risk of allergens for the consumer. Amadori also offers some non-poultry meat, which is mainly sourced from abroad (with the exception of some pork meat), but for which the level of risk is considered low, as it is supplied from European countries and controlled farms. On the other hand, the greatest risk is related to spices and seasonings that mainly come from non-EU countries. Indirect products, and packaging in particular, are subject to a Just in Time (JIT) supply system, which was built over time and represents a flagship of the group: the trays, film coverings, carton-boxes containing the trays, etc. that are loaded them onto trucks, and then distributed throughout the group's various distribution channels, were delivered daily in the amount that was needed the next day, thus constituting a 24-hour stock involving several suppliers. Amadori is very sensitive to logistics efficiency, which is linked to the naturalness and freshness of the product, to the point that it has specialised in outbound logistics, thus guaranteeing the punctuality and quality standards required by customers, consisting in large retailers and food distribution chains.

With regard to the operational-industrial risk, the animal processing required the use of the surgical masks well before the pandemic, while care of the animals in the breeding sites required FP3 masks. Health checks and definitions of minimum and maximum limits that significantly surpass the restrictive legal regulations in force, have long distinguished the group's approach to certified quality.

The other prevailing risk component usually features in the company's operations is the reputational one, linked to possible negative events that may have an impact on the brand image. Over the years, Amadori has built up a strong brand reputation that is recognised all over the country and has aggregated several product lines with a positioning by target. In the past, "*media terrorist attacks*" on Amadori farms have been the decisive starting point to improve production sites within a modern perspective of animal protection and welfare. It is Amadori's policy to communicate its respect for the food chain by investing in production sites (fences, solar panels, aesthetic optimisation of the farms in a green environment, expansion of spaces dedicated to animals, protection of the reproductive and selective cycle starting from the egg) and opening up to dialogue with animal / environmentalist rights movements/associations.

Several factors have allowed Amadori to start from a potentially resilient basic approach. It operates in a traditional sector in which Italy is self-sufficient but expanding (Ismea, 2020). It is also a large vertically-integrated company in which each phase of the production cycle is carefully controlled through an internal traceability system in order to guarantee

safety and quality for each product. The Quality Assurance function, made up of 48 professionals in the supply chain and in the analysis laboratories, is responsible for guaranteeing the highest standards at all stages of production, from the field to the table. Over 5 million euros are invested every year in the entire Quality Assurance system, which carries out over 535,000 total analyses (microbiological, chemical, serological, molecular biology and diagnostic) in all phases of the supply chain and 80,000 microbiological and chemical checks on finished products. The group is therefore characterised by a strong Robustness dimension, which can also be found in the size of the company. Previous studies have shown how the size of a company can influence its resilience capability: large companies have activities that are often decentralised over several territories, can count on extensive resources and skills to deal with the dramatic impact of the disaster, and are more solid than small companies from an economic-financial point of view (Smallbone *et al.*, 2012; Webb *et al.*, 2000). The financial and performance situation of the company before the disaster is in fact a further factor of possible influence (Wasileski *et al.*, 2011). This is obviously also related to the amount of damages caused by the disaster under observation.

On the basis of the resilience factors highlighted above, it is possible to identify the resilience dimensions characterising Amadori's "normality" before the spread of the pandemic in the presence of both Robustness and Resourcefulness.

Fig. 1 shows the different impacts in relation to the level of risks faced during the pre-covid phase.

Fig. 1: Impact and risks during the pre-covid phase
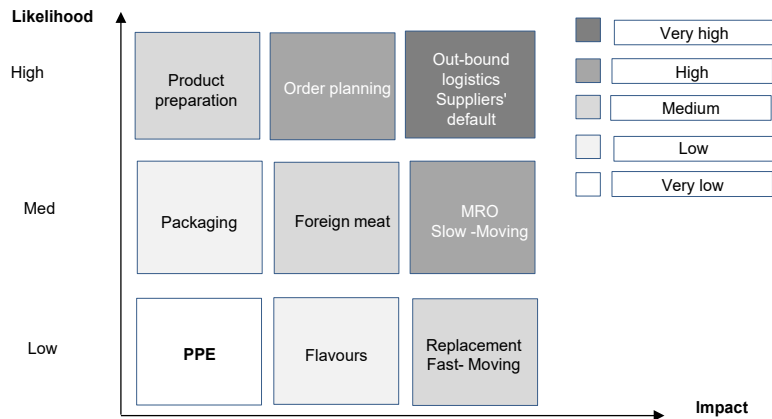
Source: authors' elaboration

4.2 The lockdown phase

During the lockdown, the Amadori group kept its production open and continued to operate, having an ATECO code that was compatible with the ministerial rules in force.

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The group's background in pandemic sensitivity linked to the poultry core business allowed it to minimise the impact on company operations and employees from a sanitary point of view: the company only verified 10 cases of Covid-19 among the total number of employees that were active during that period, with 0 cases in the plant in Brescia (100 employees)[2].

As early as the end of January/beginning of February 2020, the group had already begun to organise itself to protect its workforce and inhibit the occurrence of business continuity problems. The Managing Department, together with the Safety and Environment Department, drew up an internal protocol to organise its internal spacings, the necessary Personal Protection Equipment (PPE) sourcing and the revised layout of the production lines. All departments and employees were equipped with surgical masks and access was controlled. This meant that, by the time PPE was made mandatory in early March, the group was already prepared: it had equipped all employees with the necessary PPE, reduced some of the most crowded departments, diverted production to departments with more available space, and had already secured itself the supply of suitable quantities of PPE. For example, 2 ml masks were purchased in March and supplies were secured until mid-2021. The supplies were first secured by emptying the suppliers' warehouses, thanks to the long-term relationships that had been established with them, thus becoming a priority, but shortly before the stocks ran out Amadori's CPO started to search for new suppliers, which were selected with less stringent criteria than those usually employed, and activating internal referencing and scouting mechanisms to scouting low-risk suppliers. Redundancy started to emerge. This brought to the identification of three new partners: a national purchasing cooperative serving the north-centre Italian hospital system (which was therefore more reliable, in principle); a supplier in San Marino, for reasons of logistic proximity (Amadori's headquarters are located in San Vittore di Cesena) and reduced bureaucratic pressure; and a third player. Therefore, a simpler and more agile procedural approach in relation to the procurement of these indirect goods was introduced, including the acceptance of different payment conditions compared to the usual ones (i.e. advance payment of the order). The prioritisation of the safety of employees and suppliers allowed exceptions to administrative policies in relation to T&C with suppliers, such as the assumption of financial risk by paying for the goods in advance upon order confirmation.

The extremely serious situation of the external context required the company to respond to adjustments to ministerial decrees in real time and to maintain effective control of company's sites. Right from the beginning, management set up a central restricted committee - the so-called "ProCovid Committee" - composed by the General, HR, Healthcare, Strategic Marketing and Sales and Production Directors, which was summoned 3 times a week and to which three crisis committees for the Commercial,

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[2]   It is important to consider that 10 cases out of more than 8,000 employees is an unbelievably positive result. The Brescia area was one of the most affected in Italy during the first wave of the Covid-19 pandemic. Reporting 0 cases in those circumstances underlines the group's strong attention and effectiveness in preventing the spread of the virus within the workforce.

Production and Supply-chain sectors had to report, with specific priority levels. It therefore acted as a sort of first aid committee that acted on all company's issues. The Purchasing Director organised his area into three crisis areas, which were aimed at bringing the situation under control in response to the central committee's updates.

At this stage, Redundancy and Rapidity became key dimensions of resilience, confirming the stream of extant literature that considers redundancy, agility and decision-making flexibility as key organisational resilience dimensions (Sullivan-Taylor and Branicki, 2011; Vargo and Seville, 2011). Amadori's case also confirms the ways to develop business resilience that had been identified by Sheffi and Rice (2005) in relation to supply chain resilience:
- Increasing redundancy;
- Increasing organisational flexibility;
- Acting on corporate culture.

Amadori's top management was very sensitive to risk management and chose to tackle it by deciding which performances to focus on a priori: ensuring supply to distribution channels, and keeping the internal organisation active and productive by playing on redundancy and speed/flexibility (Fig. 2).

Fig. 2: Impact and risks during the lockdown phase
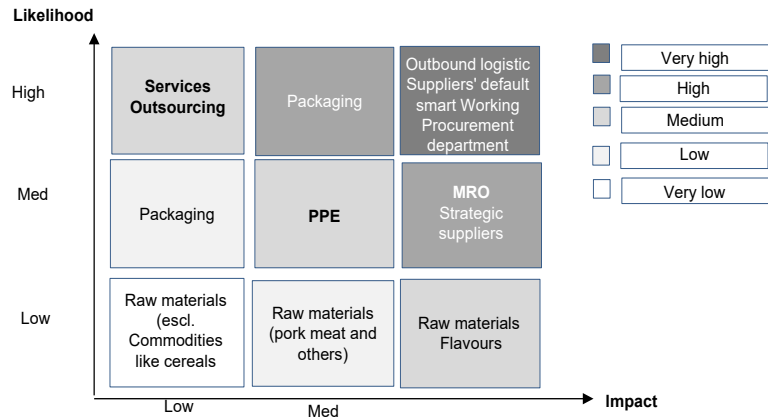
Source: authors' elaboration

However, as Kantur and İşeri-Say (2012) and Sheffi and Rice (2005) also pointed out, redundancy is a short-term tactical lever, while in the long term "...robustness and rapidity are seen as being key in measuring system […] resilience" (Bruneau *et al.*, 2003, p. 8).

4.3 The post-lockdown phase

Amadori is gradually reducing redundancy in its warehouses and inventory and plans to re-establish the JIT system at 60% by the end of the year.

The group is cautious in its inventory management and reduction policy, in line with the decrease in storage costs. Its new objective is to start from 6 months of stock during the lock-down period to the current 3 months and potentially reduce coverage to one month. The area of packaging components (trays, films and card-boxes) is critical, as it raises the risk of customer delivery and production continuity due to the nature of this very fresh product.

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The impact of the pandemic then led to a full revision of the ways in which employees and work activities are organised and managed. Currently, many workers in non-productive departments are smart working. This working mode has proved to worth keeping in the future for part of the staff, at least.

In July 2020, a new Prime Ministerial Decree (DPCM) was enforced in the Emilia Romagna region. In order to prevent Co-vid outbreaks in slaughterhouses, additional measures were taken and the company, by strongly relying on non-EU workers, implemented a return for holiday plan for these workers to avoid possible infections. The HR strategy of the company to employ its own personnel rather than outsource from external organisations - unlike its competitors-prevented the company from incurring in production stops, thus reducing health risk for employees; moreover, the company imposed a strict protocol on the workforce concerning respecting social distancing in the workplace and at home. This resulted in a COVID Free policy (which is of relevant value in industrial policies, based on organisational redundancy). When schools opened in mid-September, prevention for self-screening and personal training became key factors. In fact, resilient organisations: 1) Informed employees through strong internal communication, which is particularly important when a disruptive event occurs so they can make better and faster decisions in the face of the unforeseen event; 2) Distributed power so that teams and individuals could be enabled to take the necessary actions quickly, thus increasing the chances of limiting disruption; 3) Conveyed passion for their work: successful companies engendered a sense of the greater good in their employees. Excepting the second point, these approaches were also found in the Amadori case.

Fig. 3 highlights the impact and risks faced by the company during the post-lockdown phase, in which Robustness and Resourcefulness will be displayed, but Rapidity continues to play an essential role.

Some limits of the new ways of performing activities became evident, including the loss of brainstorming (active to passive) due to smart working; changes in conducting relationships with suppliers, which are now managed on a remote-negotiation basis. Digital scouting of suppliers started to occur on specialised platforms, changing the traditional procurement process and practices. New categories needed to be managed for procurement, as well as hyper-accredited categories, thus opening to more risky suppliers.

Fig. 3: Impact and risks during the post-lockdown phase
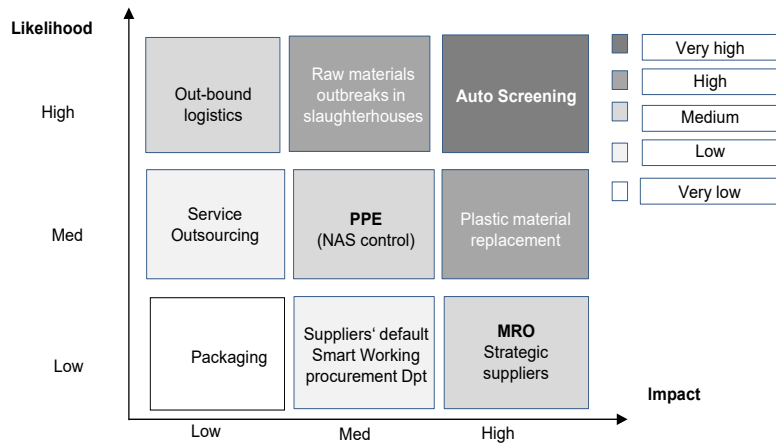
Source: authors' elaboration

5. Discussion

The ongoing health pandemic caused by the global spread of Covid-19 has opened a situation of deep uncertainty that had never been faced by companies before. In such a context, an in-depth analysis - such as the one conducted in the present study, aimed at identifying the dimensions of resilience that allow an organisation to reduce its degree of vulnerability to risks by strengthening its resilience capacity - makes it possible to indicate dimensions, indicators and possible examples of behaviour that may be useful to companies and managers to strengthen the resilience capacity of their organisations and improve risk management in procurement.

Results highlighted that the Amadori group's capability to generate Robustness and Resourcefulness before the spread of the pandemic boosted its resilience capacity when the pandemic spread. However, during the first lockdown in the spring of 2020, Redundancy and Rapidity became key dimensions of resilience, and the group's sensitivity towards risk management issues underwent a tremendous improvement by paying major attention to keeping the internal organisation active and productive, increasing the number of suppliers and stocks, and led to a revision of strategic choices in terms of procurement. Starting from the summer of 2020, with the end of the first lockdown, Robustness and Resourcefulness returned to be key factors, even if Rapidity continued to play an essential role and risks shifted to auto screening processes and material procurement, including a revision of operations concerning planning and working patterns.

In sum, in order to not jeopardise business continuity, it has been crucial to:
- Ensure production by protecting workers with the necessary Personal Protective Equipment (PPE);

- give up the usual weekly planning following the lean methodology and accepting to lose in terms of efficiency in order to gain in agility and flexibility;
- Increase stock redundancy and adopt the Just in Time (JIT) system;
- Activate cross-functional immediate response teams.

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The establishment of these processes allowed the company to weigh the risks and shift the focus from it to the compatibility of business objectives, and therefore how and what the organisation can risk, adapt and prevent.

The implications stemming from the present study are numerous. Firstly, this study contributes to extend the theoretical and managerial understanding of the manifestation of highly unforeseen events with a consistent and prolonged impact on business continuity in view of organisational resilience. In this perspective, the study applies a theoretical model of organisational resilience to a concrete case, thus improving empirical knowledge on the subject and combining the dimensions of resilience with the identification of specific risk indicators. In fact, this study is also original as an integrated reading of business resilience capacity through models and risk management indicators, with particular reference to the procurement area.

A further aspect that qualifies the contribution may be found in the specific natural disaster investigated, i.e. a health pandemic that is classifiable as a slow-onset calamitous event in the literature (Cutter *et al.*, 2008) but on which a rich academic debate is developing and which, as such, can lead to different consequences and response models compared to those that occur when natural disasters of immediate destructive impact occur, such as hurricanes, earthquakes and floods. Despite its limitations, the literature on the subject of disaster management and resilience to natural disasters with immediate impact is certainly broader than the one aimed at studying slow-onset disasters. In this sense, our contribution offers a fresh and deep knowledge of a phenomenon that is still poorly investigated.

Indeed, a key contribution of this analysis consists in a preliminary identification of the organisational resilience dimensions arising in accordance with the different phases and risks characterising the spread of a biological natural disaster. As regards the analytical framework used in this study, findings underlined that the 4R's model is not comprehensive: rather, resilience dimensions can occur with different intensity in relation to the different phases a company may undergo when facing a peculiar natural disaster like the Covid-19 pandemic. Indeed, the 4R's model should not be conceived as linear, but applied in a longitudinal way, by weighing the resilience dimensions' occurrence differently in relation to normal rather than crises periods, and differentiating between emergency times and post-emergence times when shocking events are investigated. Within such a perspective, this study tends to confirm Martinelli *et al.*'s (2018) results. The Amadori case-study shows that dealing with risk does not mean removing it, but knowing it, managing its evolution, assessing its impact in a variable and unpredictable context. The options are manifold and the alternatives/choices produce different effects. The drastic choice of removing risk at the source is costly and in the case of the pandemic, not pursuable. The ability of procurement to respond to adverse events, the

ability to rebound (homeostasis) and to react quickly to unexpected events, clearly emerged in the case-study analysis, resulting in a significant amount of material in terms of strategic and operational options capable of driving companies to regain positive and increasing performances. The analysis of organisational resilience was assessed with particular attention from a longitudinal perspective, considering three time periods - i.e.: before the pandemic, during the lockdown phase and in the post-lockdown phase. In each phase the possible impacts, the type of activated organisational resilience dimensions, and organisational responses vary.

Last but not least, the analysis is also appreciable for its methodological approach. In fact, the study is proposed as an innovative form of cooperation between academy-company-consultancy. This involves rather different cognitive schemes, languages and backgrounds that have allowed an in-depth and innovative interpretation of the investigated topic.

As for managerial implications, more in-depth knowledge of the determinants of organisational resilience can allow companies to better assess which resilience dimensions to invest more in during the various phases when facing unforeseen events. Management practices need examples of resilience measures linked to concrete business cases. Uncertainty will be a long-standing feature of markets and institutions, and only companies that have built resilience over time will be able to overcome such a large and severe crisis. Resilience is not an organisational capacity that emerges suddenly, but rather the result of proactive adaptation and a processual vision capable of settling and consolidating over time yet difficult to perceive and measure. Conventional approaches to risk management designed to address traditional impacts - such as minor natural disasters or single management crisis - are not always effective when a company is faced with unforeseen disasters characterised by prolonged persistence and uncertainty like the ongoing Covid health pandemic. The predominant approach in business risk management requires risk identification and quantification, which are not always possible in absence of empirical data (Pettit *et al.*, 2013). Our findings can represent concrete help for businesses, giving them some guidelines in order to succeed when trying to translate good practices of risk planning and management in their specific organisational context in view of resilience. The results of the analysis of the Amadori case-study may offer useful guidelines not only to companies and managers, but also to policy actors to identify the correct support policies for economic players with a view to resilience.

6. Conclusions

Natural disasters are events of increasing manifestation in their frequency and intensity that are particularly threatening for business continuity and require distinctive management skills and the reconfiguration of resources in order to be overcome. However, to put a resilient response in place, it is necessary to understand the dimensions that contribute to enhancing organisational resilience more in detail.

Despite the useful contributions that the current study offers, some limitations are present. The results of the study are based on the analysis of a specific business case and therefore do not allow generalisability. It is, however, a very useful approach in the face of a disaster context, i.e. a pandemic health crisis, which had never occurred so intensely before at a global level and on which, therefore, academic and managerial knowledge is limited. Focusing on a single case study, while allowing deep and detailed understanding of the investigated phenomenon, could be spoiled by industry-specific elements, given that in the resilience literature some sectors, albeit limited, were found to be more vulnerable to natural disasters than others (Wasileski *et al.*, 2011; Dolfman *et al.*, 2007; Martinelli and Tagliazucchi, 2018). Verifying the used model and the postulated responses by and of companies in other sectors could reveal a different intensity of the investigated dimensions of resilience, as well as possible differentiated business behavioural models based on the different risk management approaches that were adopted.

We are also aware that the pandemic context is evolving and it is still difficult to make predictions about the near future. The analysis should therefore be extended over a longer time horizon in order to more robustly support our preliminary findings.

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Business resilience and risk management during the Covid-19 pandemic: the Amadori case-study

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How to close the loop? Organizational learning processes and contextual factors for small and medium enterprises' circular business models introduction[1]

Sara Scipioni - Federico Niccolini

Abstract

Frame of the research: The paper is framed under the organizational learning (OL) theory, to investigate the circular economy (CE) transition of small and medium enterprises (SMEs).

Purpose of the paper: This paper focuses on the identification of enabling factors and processes able at influencing the introduction of circular business models (CBMs) in SMEs, with a specific attention toward OL processes.

Methodology: In the light of grounded theory, the study offers an interpretative analysis of focus group discussions among Italian construction SME managers.

Results: Four key OL contextual factors - external environment, supply chain context, organizational features, and culture - appear to favor the application of CBM-oriented intraorganizational and interorganizational learning processes among SMEs.

Research limitations: The paper's limitations are mainly linked to a single-context analysis and the qualitative approach to the investigation.

Practical implications: We identify OL processes to be encouraged among SMEs for CE application, the related dynamics, as well as the contextual factors to be managed in the CE transition.

Originality of the paper: The paper's originality resides in the disclosure of the Italian context as one of the most advanced EU countries in the CE, and in the analysis of its the related traditional construction sector evolution process.

Key words: organizational learning; sustainable management; circular economy; supply chain; small and medium enterprises

1. Introduction

Scholars and practitioners have paid attention to the circular economy (CE) as an alternative to linear production (Ghisellini *et al.*, 2016) focused on a balanced use of environmental resources (Ellen MacArthur Foundation, 2015). Recently, CE studies have focused on understanding how organizations (Ünal *et al.*, 2019) - including small and medium

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enterprises (SMEs) (Dey *et al.*, 2020) - could holistically address the circular transition. Among industrial sectors, the construction sector attracts the European Union (EU) legislators' attention, as it is responsible for "25% of solid waste generated in the world" (Benachio *et al.*, 2020, p. 121046); hence, scholars increasingly analyze this sector for waste reduction and material value maximization solutions (Hossain *et al.*, 2020), and for developing business models aimed at introducing CE within organizations, - the circular business models (CBMs) (Geissdoerfer *et al.*, 2020), - particularly among SMEs (Prieto-Sandoval *et al.*, 2019). Recent studies highlight the need to identify CBMs in the construction sector (Benachio *et al.*, 2020), and contextual factors that might contribute to seeking a wider applicability of CE-related interorganizational processes (Dzhengiz, 2020), and organizational solutions (Pieroni *et al.*, 2019).

The study focuses on SMEs and traditional sectors, which present peculiar structural and cultural barriers that need to be addressed (Rizos *et al.*, 2016; Ünal *et al.*, 2019). Specifically, we explore the construction sector, as it represents an inherently traditional sector, yet "undergoing important transformation processes, driven by (..) greater attention to environmental sustainability" (European Observatory for Clusters and Industrial Change, 2019, p. 7). Recent studies emphasize the relevance of addressing "how the current business models of construction companies can adapt to this change" (Benachio *et al.*, 2020, p. 10).

Under these circumstances, the study aims at contributing to the CE discussion through the qualitative identification of OL contextual factors and organizational processes positively influencing CBM implementation. Precisely, our analysis focuses on Italian construction SMEs.

We identified the OL theoretical framework as the activation of intraorganizational, and interorganizational learning supports an effective sustainability-oriented evolution (Dzhengiz, 2020). The OL literature offers well-established conceptualizations of contextual factors influencing OL (e.g., Fiol and Lyles, 1985), including CE-oriented OL processes.

This paper also addresses recently-proposed OL research questions, such as the investigation of SMEs' OL processes within countries where SMEs play a dominant role (Chikweche and Bressan, 2018) to "provoke critical reflection that results in action and the development of new practice for future and current managers" (Anderson *et al.*, 2020, p. 30). Furthermore, we answer the call for the identification of "factors that facilitate or inhibit" knowledge transfer (Argote and Miron-Spektor, 2011), knowledge creation, and retention processes (Argote, 2011). Five propositions provide more granular perspectives on the study's theoretical background, to guide the analysis.

2. Theoretical background

2.1 Organizational learning processes and circular economy

OL is widely analyzed by scholars and practitioners in psychology, education, management science, and organization theory, as it searches

a better understanding of the "social phenomena that are considered the core of organizational learning" (Easterby-Smith, 1997, p. 3). Thus, OL literatures result in multiple definitions ranging from organizational actors' cognitive and behavioral changes (e.g., Crossan *et al.*, 1999), to knowledge-related dynamics across organizational levels (e.g., Nonaka, 1994). In this sense, different focuses, - e.g., antecedents, stages of learning, - and levels of analysis (Mazutis and Slawinski, 2008) have fragmented the research.

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In this study, we specifically consider OL as knowledge creating, transferring, and retaining processes (Argote, 2011) moving across the individual, group, organizational (Crossan *et al.*, 1999; Nonaka, 1994), and interorganizational level, thus identifying a multi-level set of processes. This conceptualization offers several connections with the knowledge management field, contributing to a more effective outlining of innovative and radical evolutions (Berends *et al.*, 2016; Sanz-Valle *et al.*, 2011).

At the intraorganizational level, OL takes place via knowledge creation and transfer processes within structured and practice-oriented environments, including internal working groups, and communities of practice (Wenger, 1999). Internal training activities and knowledge-sharing tools (Barba Aragón *et al.*, 2014; Michalski, 2014) might activate OL processes for environmentally-related activities. Consultants (Clegg *et al.*, 2004) and external good practices represent other sources of knowledge transfer and retention affecting the organization from the outside, foreseeing the activation of internal OL processes (Bulkeley, 2006). At the interorganizational level, strategic alliances and interorganizational networks - e.g., business networks and supply networks - activate learning processes (Gulati *et al.*, 2009; Van Hoof, 2014).

OL processes have been aligned with the concept of exploitation, as they could refine existing organizational processes, and also support an organization's exploration, aimed at introducing new technologies and knowledge from external sources (March, 1991). Holmqvist (2004) aligns the conceptualization of explorative and exploitative OL processes with the intraorganizational and interorganizational levels, identifying opening-up/focusing, and internalization/extension OL orientation. Exploitative and explorative OL processes are, in fact, equally important for an organization, which should simultaneously activate them for a complete achievement of specific objectives (Crossan *et al.*, 1999) - i.e. applying the organizational ambidexterity (Felício *et al.*, 2019). However, organizations frequently decide to choose either an explorative, or an exploitative approach, as the organizations, and especially SMEs (Felício *et al.*, 2019; Rizos *et al.*, 2016) "compete for scarce resources" (March, 1991, p. 71).

For the CE evolution, scholars suggest organizations to search for a circular business model (CBM)-enabling activities to stimulate, first, the organization's cultural, structural, and strategical change toward circularity (Tura *et al.*, 2019) and, second, networking solutions within supply chains (Chen *et al.*, 2020). These two objectives might be achieved as with OL intraorganizational processes aimed at transitioning organizational culture toward CE, - with the support of specific structures and technologies (Sanz-Valle *et al.*, 2011), - as with interorganizational learning processes oriented toward the creation of collaborative solutions in the value networks (Van

Hoof, 2014). Adapting the Holmqvist's model (2004) to CE, we propose that SMEs should seek the connection among the involved OL levels-i.e. the organizational, and supply chain levels-by using two dynamics: first, with extension OL processes, thus intraorganizational learning processes (exploitative or explorative) that generate interorganizational ones at the supply chain level; second, through internalization processes, i.e. interorganizational learning processes that stimulate the activation of intraorganizational ones (Figure 1).

Fig. 1: Extension and internalization OL processes for CBM introduction
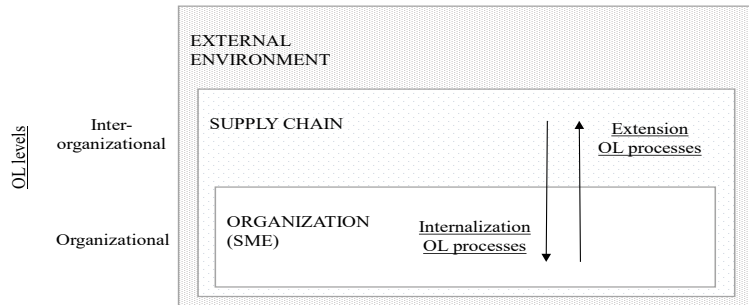
Source: own elaboration

In this context, we aim at investigating how an ambidextrous approach could be envisioned within SMEs, and which OL processes might be more effectively activated for CE, as stated in Proposition 1.

Proposition 1: Ambidextrous SMEs, which activate intraorganizational and interorganizational learning processes oriented toward exploitation and exploration, are more likely to sustain the introduction of CBMs.

2.2 OL contextual factors for CBM application

OL theory can help in the detection of those factors influencing the effectiveness of CBM-oriented learning processes; Fiol and Lyles (1985) identify organizational culture, strategy, structure, and environment as contextual factors that influence the occurrence of OL processes (Chatterjee *et al.*, 2018). In the light of CE literature, the above-mentioned factors appear to influence the implementation of CBMs, as they imply the redesign of organizational business models (Ünal *et al.*, 2019), together with the evolution of the surrounding environment (Rizos *et al.*, 2016; Tura *et al.*, 2019). Compared to other innovations, the CE transition involves specific levels, i.e. the organizational level, the interorganizational level, and the societal level (Pieroni *et al.*, 2019). Through the cross-pollination of OL and CE literatures, we propose a CE-related set of contextual factors that appear to influence the occurrence of CBM oriented OL processes: external environment, supply chain context, organizational features, and multi-level culture.

External environment is the macro-level environment, composed of external stakeholders, (Abrahamson and Fombrun, 1994). Among

them, public institutions are important to support and stimulate the environmental change (Dey *et al.*, 2020; Dzhengiz, 2020), as they might activate CE-oriented planned processes, regulations, and incentives (Van Bueren and Priemus, 2002) to encourage sustainability-oriented solutions at the organizational level (Rizos *et al.*, 2016; Tura *et al.*, 2019). SMEs might appear more willing to introduce sustainable innovations if they are culturally stimulated from the external environment and sustained by "effective taxation policy, laws and regulations" oriented toward CE (Rizos *et al.*, 2016, p. 4). Thus, the external environment identifies a relevant contextual factor influencing the application of CBM-oriented OL processes within SMEs, as stated in Proposition 2.

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Proposition 2: The external environment - composed of external organizational stakeholders - represents a macro-level contextual factor positively influencing OL processes oriented toward CBM implementation within SMEs.

Supply chains, as "organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users" (Christopher, 2011, p. 4), should evolve towards CE to guarantee the widest sustainable impact (Boström *et al.*, 2015). Regarding SMEs, collaborative solutions can reduce structural limitations, introduce innovations through resource sharing and OL (Van Hoof, 2014); moreover, supply-chain-level collaboration is a key strategy to implement CE within SME (Prieto-Sandoval *et al.*, 2019). We therefore propose that supply chain context, embedded in the overall external environment, represents a separated contextual factor, as reported in Proposition 3.

Proposition 3: The supply chain context is embedded within the external environment, and represents a separated and positive contextual factor influencing OL processes oriented toward CBM implementation within SMEs.

At a single-firm level, organizational factors can influence the activation of OL processes: formal structures, adopted business models (Berends *et al.*, 2016), internal practices (Edenius and Yakhlef, 2007), physical and virtual teams of internal actors (Kauppila *et al.*, 2011), internal/external training, economic, physical, and human resources (HR) (López *et al.*, 2006). Organizational features matters also for organizational resilience, defined as the organizational ability to respond to external threats: resourcefulness of personnel, and redundancy of structures, in fact, can support responsive business model adaptation and redesign (Bruneau and Reinhorn, 2006; Linnenluecke, 2017). For CE and SMEs, the cited organizational elements are critical for introducing CBMs, both as barriers and drivers (Dey *et al.*, 2020; Prieto-Sandoval *et al.*, 2019). In this context, the investigation of organizational structures' and processes' role as contextual factors for CBM-oriented OL processes appears necessary (Proposition 4).

Proposition 4: The organizational features - specifically organizational processes, structures, and HR - are embedded in the supply chain context, as in the external environment, and represent a positive contextual factor influencing OL processes oriented toward CBM implementation within SMEs.

Lastly, culture represents a key element in the activation of OL processes. We conceptualize culture as multi-level underlying assumptions in terms of values and beliefs shared among actors (Erez and Gati, 2004; Schein, 2004), encompassing the organizational level, (Durst and Wilhelm, 2012), the supply chain level, and the macro-level concept of national culture (Abrahamson and Fombrun, 1994). At the organizational level, certain typologies of organizational culture can stimulate the overall organizational capacity of acquiring new knowledge (Harrington and Guimaraes, 2005) and of opening up the organization toward external collaborations (Pérez López *et al.*, 2004). At the supply chain level, a collaborative culture appears fundamental to activate the CE-oriented networking solutions and OL processes required to develop CBMs (Van Hoof, 2014), while the sustainability-oriented national culture is an overall support for the transition (Chen *et al.*, 2020). Proposition 5 summarizes the multi-layered culture as a key contextual factor for CBM-oriented OL processes.

Proposition 5: The multi-layered culture represents a positive and key contextual factor influencing OL processes oriented toward CBM implementation within organizations and particularly within SMEs.

We explore the five propositions in the context of Italian construction SMEs, to identify involved dimensions, and dynamics among factors and processes in the transition toward CE in traditional, yet evolving, sectors. Figure 2 conveys the interrelation among the proposed CBM-oriented OL contextual factors.

Fig. 2: Contextual factors for CBM-oriented OL processes activation
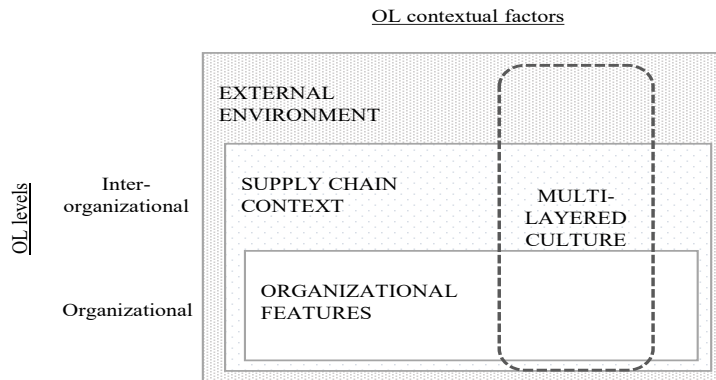
Source: own elaboration

3. Methodology

To explore the developed propositions, following previous scholars we employ a qualitative methodology (e.g., Ünal *et al.*, 2019).

To employ a managerial-oriented investigation, we consider the CBMs described in the BS 8001:2017 (BSI, 2017) standard. This standard is increasingly used in academic studies as a basis for CBM-related analyses (e.g., Chen *et al.*, 2020), as it includes the following CBMs: on-demand, -

production based on customers' demand, - dematerialization, - replacing physical infrastructure and assets with digital/virtual services, - product life-cycle extension, - repairing, reusing, and reselling products for an extended durability, - recovery of secondary raw materials, - recovery of resources from waste or by-products, - product-service system, - which considers the product as a service, - and collaborative consumption, - i.e., connection among actors to share resources and giving rise to synergies in product use. We have integrated the BS 8001's list with the circular supply CBM (Lacy *et al.*, 2015) focused on the use of renewable resources, as it identifies an envisioned evolution path for constructions (European Observatory for Clusters and Industrial Change, 2019). Scholars have used this standard to certify exemplary CE projects within the Italian construction sector (Scipioni, 2021), thus, it identifies a realistic tool SMEs can use for the evaluation, development, and assessment of CBMs.

We focus on construction SMEs, as they represented around 80% of total value added in Europe and 99.9% of enterprises' total number (Eurostat, 2020). Among EU countries, Italy covers a prominent position in CE, holding the first place in the circularity index ranking (Circular Economy Network & ENEA, 2020). Furthermore, the Italian construction sector is totally characterized by SMEs, "accounting for (...) a significant share of total value added generated by SMEs" (European Commission, 2019, p. 20), and by an increasing number of recognized CE-oriented companies (about 10% of Confindustria's 2020 CE awarded companies; Confindustria, 2020).

The focus group methodology represented an appropriate research design, as it favors the investigation of multiple perspectives and the activation of in-depth responses and discussions of CBM-related interpretations, limiting the subjective influences (Morgan, 1997).

We held four focus group discussions during the spring 2020 COVID-19 lockdown period via a virtual platform over two days. In the sessions, the top managers of 24 Italian private and public building construction SMEs qualitatively evaluated CBMs' use. Moreover, the top managers identified learning activities and contextual factors at the organizational, the supply chain, and the external environment levels. We selected the participants covering from North to South Italy (Chart 1). The participants, furthermore, represented micro, small, and medium enterprises (Chart 2). Other details related to the participants (age, gender, year of experience) are presented in Table 1. Before and after each session, we performed a double survey evaluation through online platforms. First, we conducted a survey to understand the CE/CBM knowledge prior to the focus group sessions, proposing the above-mentioned list of CBMs as a reference. Second, we administered another questionnaire after the session to weigh a set of OL processes rooted in the OL literature. All the questions presented a five-point Likert scale for the different items. The quantitative assessment enabled a more precise evaluation of the qualitative impressions raised during the focus group discussions and, thus, more objective results.

Chart 1: Participants' area of activity
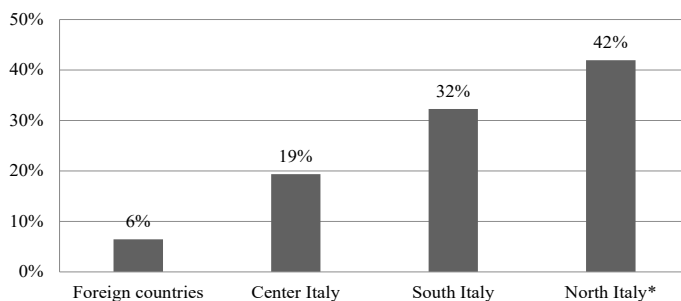
Source: own elaboration

Chart 2_SME included in the analysis
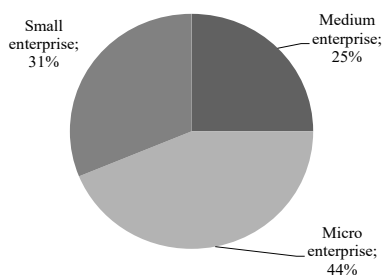
Source: own elaboration

Tab. 1: Personal details of focus groups' participants

Personal details	Possible answer	n°	%
Age	Under 35 yrs	11	45.83%
	35 yrs or more	13	54.17%
Gender	Woman	6	25.00%
	Man	18	75.00%
Experience	Less than 7 yrs	8	33.33%
	8-14 years	11	45.83%
	More than 14 yrs	5	20.83%
Total		24	

Source: own elaboration

Using NVIVO software and informed by the logic of grounded theory (Suddaby, 2006), the two researchers double-coded each focus group's transcriptions. Particularly, the researchers identified first-order themes as in-context meanings aligned with the informants' viewpoints on OL and CE theoretical concepts. The coding followed an iterative process (Langley, 1999) until data and concept saturation, resulting in 87 first-

order concepts. Following Gioia's *et al.* (2013) methodology, we identified similarities and differences among the obtained themes, reducing first-order concepts to a "more manageable number" (Gioia *et al.*, 2013, p. 20), trying to maintain informants' terminology. Through the aggregation of first-order concepts into wider structures of meanings, we identified eight second-order theory-centric themes. The overarching dimensions were distilled by the grouping of second-order themes, as three main theoretical elements clearly emerged from the second-order themes. The derivation of concepts, themes, and overarching dimensions followed an interpretative and non-mechanical process (Langley, 1999) through the engagement in mutual discussions among the researchers to arrive at a final consensus on data interpretation and coding. The overall qualitative data analysis process enabled the construction of the data structure, which highlights the progression from raw data to the overarching dimensions (Figure 3).

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Fig. 3: Data structure: from first-order concepts to overarching dimensions
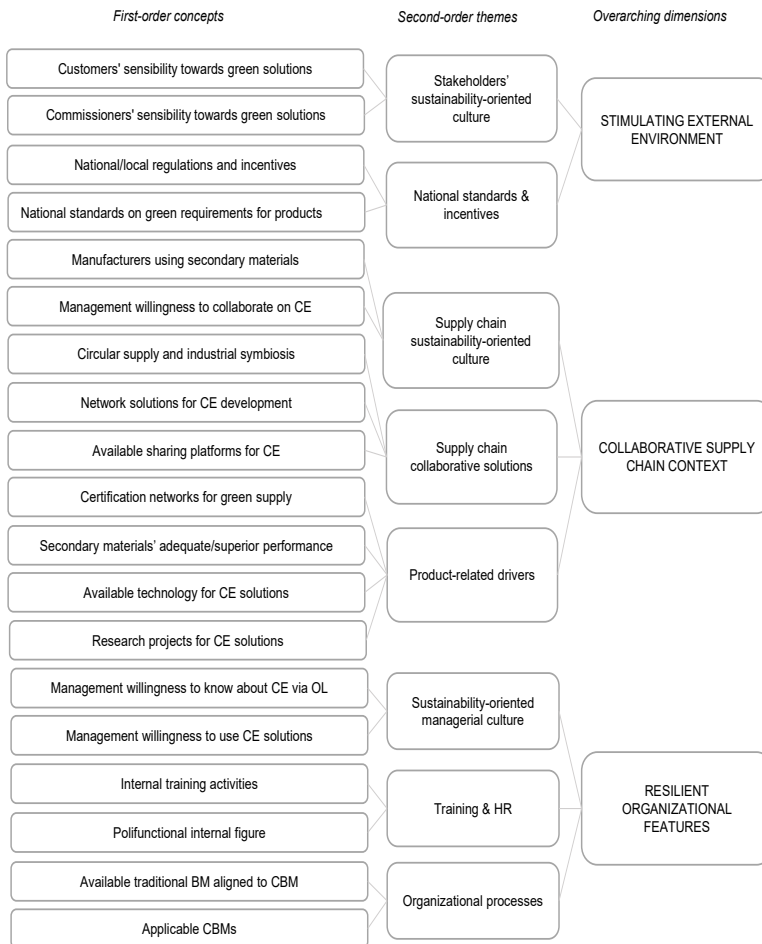
Source: own elaboration

4. Results

As a result of the interpretative qualitative phase, and in the light of the theoretical propositions, we highlight three dimensions of contextual factors influencing CBM-oriented OL processes: stimulating external environment, collaborative supply chain context, and resilient organizational features. As a transversal dimension embedded in the three dimensions, we highlight a fourth factor - i.e. the sustainability-oriented multi-layered culture - as a key element for the development of CBM-oriented OL processes.

First, we have identified several contextual factors related to the external environment which are capable to stimulate the implementation of CBMs, grouped into national and stakeholder-related drivers. From a normative point of view, Italian standards required the use of green requirements for public procurements, prescribing construction firms to conform to the regulation for public tenders. Furthermore, private tenders increasingly ask for the use of sustainable products, stimulating their use among Italian construction firms. Moreover, national incentives for renovating private buildings, and specific local regulations for specific material reuse, stimulates the implementation of CE solutions. The mentioned national and local directives appear to identify positive conditions for the activation of CBM-oriented OL processes, at the macro level.

"Nowadays you need to respect certain norms that enable the development of the circular economy." - Focus group (FG) 4

Regarding stakeholders' culture, an increasing sensibility toward green products and sustainable construction techniques is present in private customers and public commissioners. This sensibility stimulates a sustainable-oriented evolution of construction firms, even if slightly differentiated across the country.

"I have proof that the private sector gives positive feedback on the circular economy." - FG 2

The combination of normative (*National standards & incentives*) and customer-related second-order themes (S*takeholders' sustainability-oriented culture*) enabled the identification of the first overarching dimension, identified in the stimulating external environment contextual factor.

We also identify three supply-chain-related aspects from the discussions. As first element, the *Supply chain sustainability-oriented culture*; Among SC stakeholders, manufacturers offer several products composed of recycled materials (Lieder & Rashid, 2016) and thus foresee CE-oriented collaborations. Moreover, technical laboratories and landfills act as central actors in secondary material reuse activities and as joining element across stakeholders, facilitating the activation of circular processes along the supply chain. Furthermore, construction firms' cultural approach toward CE-oriented collaborations among SC stakeholders envisions the willingness to activate CBM-oriented OL processes at the interorganizational level.

"I think a sharing platform to promote CE and product reuse is a great idea." -FG 2

As second element, the presence of Supply chain collaborative solutions, stimulate the overall applicability of CBMs, i.e. industrial symbiosis and circular supply opportunities, and CE-oriented networks, such as those related to specific products' certifications (e.g., the KlimaHaus-CasaClima certification; CasaClima, 2020). Moreover, nationally- and privately-developed technological platforms for collaborative consumptions (e.g., waste sharing for direct reuse and renting machinery solutions) envisage the feasibility of collaborative CE application in the construction sector's SC.

"I am a consultant for CasaClima and through this network we have specialized in the biobuilding sector." - FG 3

Lastly, product-related drivers motivate building constructors' interest, as secondary products - i.e. products composed of a percentage of recycled materials - can present superior properties than virgin ones. Projects focused on CE are carried out by researchers, while product certifications guarantee technicians' and public authorities' approval. Furthermore, available high-tech solutions, such as those concerning advanced electrical systems and green energy production, help introducing CE solutions at supply chain level: all the mentioned factors form the *collaborative supply chain context.*

"Together with the university (...) we continue with innovation in the construction sector (...) we try to create insulation coatings with limestone and canvas, which are sustainable materials." - FG 1

As a third dimension, a set of organizational elements appear to be connected to the organizational resilience and sustainability of firms, particularly culture, HR, and processes. First, *CE-oriented managerial culture* is essential to envision CBM applicability. Scholars have emphasized organizational culture as one of the most important contextual factors for CE and technical innovation (Sanz-Valle *et al.*, 2011; Tura *et al.*, 2019); since the top management often shapes culture in SMEs (Durst and Wilhelm, 2012), we have conceptually aligned organizational and top-managerial culture. Some construction SMEs' managers appear to show an environmentally-oriented culture, and a willingness to understand practically-applicable CE-oriented solutions.

"I would like to know more about CE for my firm." - FG 1

Second, HR is fundamental to implement CE via internal competences and training activities. Construction SMEs - as all SMEs - are usually structurally limited in terms of economic resources (Rizos *et al.*, 2016) to hire additional employees for the implementation of specific activities, thus internal training solutions for the existing personnel formation is highly appreciated to create multifunctional figures. Training and HR represent key elements to develop spanner (Stan and Puranam, 2017) both at the intraorganizational level and among SC stakeholders.

"It makes a difference (...) to find polifunctional figures able to do two or three things (...); we need to train internally, to hire young engineers(...), and make them develop." - FG 3

Third, *organizational processes*. Certain traditional processes are aligned with CE, such as building construction on commission, secondary material reuse, and modular building construction. Moreover, in the Italian

context several good practices are available as innovative BM solutions in a circular approach, for example, circular supplies, virtual renderings, and renting solutions for activities and products. On a process level, CBMs appear easily applicable-if not already applied.

"We have experience in circular economy (...) another firm was digging materials suitable for making aggregates. We had it analyzed (...), we prepared the recovery plan, and we have reused all the material." - Focus group 3

The above-mentioned factors demonstrate construction SMEs' resilient organizational features, especially in the resourcefulness of management and internal personnel, able to quickly react to changing priorities. The identification of resilience highlights the construction SMEs' ability to adopt radical changes required for employing CE (Buliga *et al.*, 2016).

As part of the qualitative analysis, we employed a quantitative analysis of focus groups' questionnaires' responses1, which show prior knowledge about the CE and CBMs, and the evaluation of OL processes for CBM implementation. Particularly, managers should select CBMs definition that, in their knowledge, was related to CE. The assessed managers appeared not to fully understand CE and CBM conceptualizations prior to focus group sessions: scholars recognize only a limited set of CBMs as related to CE application (Chart 3).

Second, we asked managers to rate the listed OL processes' importance for CBM implementation on a 1-5 points Likert scale (post-focus group survey): managers identified the creation of strategic alliances, and network contracts as the most important interorganizational OL activities, as well as intraorganizational good practices, internal-external training. Positive evaluations are shown for benchmarking activities, internal working groups, internal/external knowledge-sharing tools and consultants (Chart 4). OL processes' evaluation differ slightly when correlated to the different types of SME (Chart 5). Internal training appears more important for medium enterprises, while the use of internal/external knowledge-sharing tools are considered more significant for small enterprises, and the use of external consultants appears more relevant in small and medium enterprises.

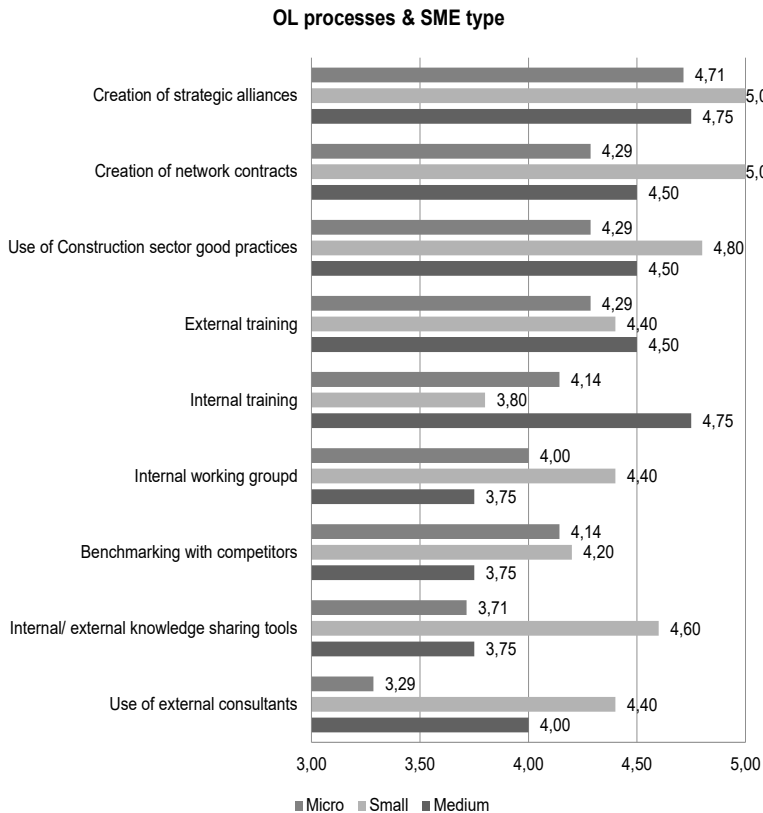*Chart 3: Participants' definition of CE: pre-focus group evaluation*

What does Circular Economy means?
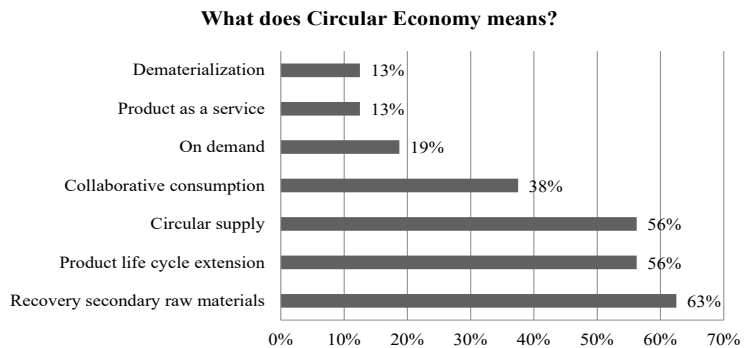
Source: own elaboration

Chart 4: Participants' evaluation of OL processes for CBMs application

OL processes

Process	Value
Creation of strategic alliances	4,81
Creation of network contracts	4,56
Use of Construction sector good practices	4,50
External training	4,38
Internal training	4,19
Internal working groups	4,06
Benchmarking with competitors	4,06
Internal/ external knowledge sharing tools	4,00
Use of external consultants	3,81
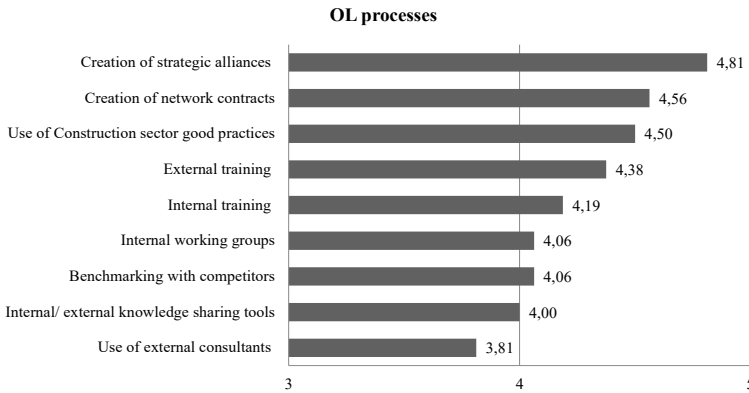
Source: own elaboration

Chart 5: Participants' evaluation of OL processes for CBMs application related to SME type

OL processes & SME type

Process	Micro	Small	Medium
Creation of strategic alliances	4,71	5,00	4,75
Creation of network contracts	4,29	5,00	4,50
Use of Construction sector good practices	4,29	4,80	4,50
External training	4,29	4,40	4,50
Internal training	4,14	3,80	4,75
Internal working groupd	4,00	4,40	3,75
Benchmarking with competitors	4,14	4,20	3,75
Internal/ external knowledge sharing tools	3,71	4,60	3,75
Use of external consultants	3,29	4,40	4,00

■ Micro ■ Small ■ Medium

Source: own elaboration

Generally, micro firms give a lower evaluation to each OL process compared to small and medium enterprises (see light orange bars in Chart 5), while strategic alliances and network contracts, the use of good practices and external training, together with internal working groups and benchmarking activities essentially present the same results.

5. Discussion

The analysis raises various important aspects that result in a better understanding of this evolving panorama, with a particular attention toward CE-oriented OL processes and related contextual factors. Following the data analysis and informed by the proposed theoretical background, Figure 4 proposes the interrelation of the identified contextual factors - *stimulating external environment, collaborative supply chain context, and resilient organizational features* - that can encourage the implementation of CBM-related OL processes at the single SME, supply chain, and macro environment levels, to highlight the relationships among the defined elements. Furthermore, the *sustainability-oriented culture* is identified as an additional CBM-related OL contextual factor, transversal on the three dimensions.

The research confirms the macro environment's relevance (Proposition 2), with a specific importance of national standards/incentives, and stakeholders' sustainability-oriented culture. The first element is not directly controllable by a single firm, as it depends on institutional bodies, national policies, and local dispositions. On the contrary, SME stakeholders' awareness-raising activities for the development of a sustainability-oriented culture could be included in organizational, network and supply chains strategies.

At the SC level, together with the cultural collaborative approach of SC stakeholders, collaborative solutions and product-related drivers appears to contribute positively toward a SC related implementation of CBMs, confirming and expanding Proposition 3. This result suggests that key elements for a collaborative evolution of the construction supply chains are potentially already available in the sector, i.e. CE-oriented processes and products.
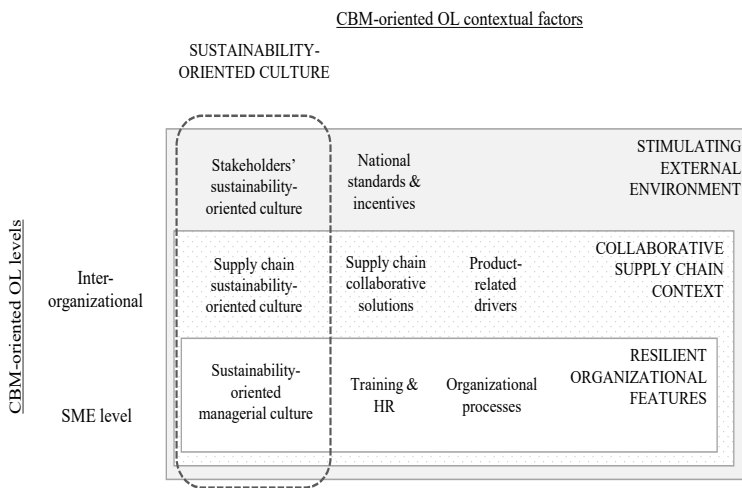
At the single SME level, results emphasize that, among organizational features, a CE-oriented managerial culture, HR-related activities, and specific organizational processes represent important factors influencing CBM-oriented OL. As CE is commonly viewed as a radical innovation, especially for traditional sectors (Ghisellini *et al.*, 2016; Ünal *et al.*, 2019), organizational features contribute also to SMEs' resilience in terms of resourcefulness of personnel and the redundancy of structures (Bruneau and Reinhorn, 2006).

The organization is influenced both by the supply chain context and the external environment, while the SC context is conditioned by the external environment, in the activation of interorganizational learning processes, supporting Proposition 4.

The sustainability-oriented culture acts as contextual factor characterized by organizational, supply chain, and external-environment-related elements, influencing all the involved OL levels, corroborating Proposition 5.

Figure 4 offers the mentioned multi-level representation of CBM-oriented OL processes and contextual factors, to strengthens the need for a simultaneous investigation of the intraorganizational and interorganizational levels. The proposed multi-level framework also highlights the need to give particular attention to the organizational, supply chain, and sectoral stakeholders' cultural attitude to stimulate an overall CE-oriented transition.

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Fig. 4: OL contextual factors

CBM-oriented OL contextual factors

SUSTAINABILITY-
ORIENTED CULTURE
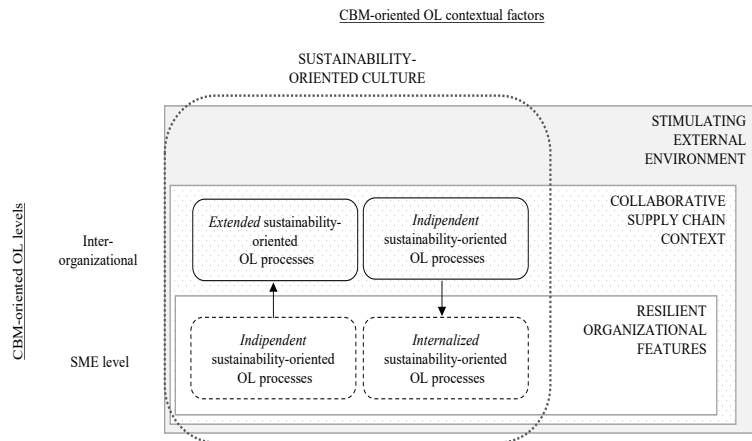
Source: own elaboration

Both intraorganizational and interorganizational OL processes are essential for CE (Proposition 1): to convey the proposed dynamics, we have enriched the theoretical framework with CBM-oriented OL processes (Figure 5). Intraorganizational learning processes - i.e. training, benchmarking activities, working groups, internal knowledge-sharing processes, and the use of consultants and good practices - stimulate the introduction of CBMs. This aspect confirms that intraorganizational OL processes can enable the exploitation of internal resources and structures in the CE transition of SMEs. Available resources and existing organizational structures are, concurrently, shaped by the organizational culture, thus managerial commitment toward CE (Dey *et al.*, 2020) is essential to sustain the transition.

Interorganizational processes are also important to support the CE-oriented transition of construction SMEs, moving bi-directionally (Holmqvist, 2004). Learning processes activated among external stakeholders can induce the activation of OL processes that the single

SME would not have activated independently; similarly, single SME's OL processes could stimulate external learning processes in the related network. Both types of OL processes could act independently from the other levels and create effects only within the organizational boundaries or within the supply chain context (*Independent processes*); however, it would not be preferable in the CE context, as the ambidextrous approach (Felício *et al.*, 2019) produces the most relevant sustainable effects for SMEs (Tura *et al.*, 2019). In this sense, *internalized and extended processes* link the organizational and supply chain levels, in a top-down, and bottom-up direction.

In Figure 5, we present the patterns separated; however, it is possible to seek dynamic interconnections among OL processes within the levels as in relatively circular knowledge-related movement across levels (Nonaka, 1994). It might be fruitfully to combine the four CBM-oriented OL contextual factors with the identified processes to fully understand the sector's learning dynamics in the CE context.

Fig. 5: CBM-oriented OL contextual factors and OL processes

Source: own elaboration

6. Implications and future research

This paper contributes to the identification of contextual factors and enabling processes oriented to support the implementation of CBMs, with a specific attention to OL processes. Particularly, we answer to a call from recent CE literature (Dzhengiz, 2020; Hossain *et al.*, 2020; Pieroni *et al.*, 2019), specifying policy level, supply chain, and organizational elements that might contribute to an effective introduction of CBMs within SMEs of the analyzed traditional sector, i.e. the construction sector (Benachio *et al.*, 2020). The conceptualization of the most influential levels involved in CBM implementation - i.e. external environment, supply chain, and organizational levels - as well as the theorization of specific factors and processes able at influencing the activation of OL processes

in the CE transition of traditional SMEs, would orient other countries' traditional sectors moving toward CE (European Commission, 2016). The conceptualizations of CE-oriented supply chains, and of sustainability oriented multi-layered culture represent novel and effective factors influencing the transition. The study, therefore, contributes to a wider understanding of the SME-related CBM implementation process (Rizos *et al.*, 2016; Ünal *et al.*, 2019).

On a policy level, awareness-raising processes for CE conceptualization and applications appear important in this evolving sector. We carried out this research within a leading context in terms of the CE (Circular Economy Network & ENEA, 2020), thus sensibilization processes might gain even more importance in countries with a less advanced approach to circularity. Furthermore, we confirm CE-related cultural awareness as a key factor for CBM application at all levels, underlining the need of specific multi-level processes of knowledge creation, transfer, and retention.

As managerial implications, the study proposes that ambidextrous organizations would seek an easier transition toward CE, and specific internalizing and extending intraorganizational and interorganizational learning processes perceived as the most effective.

Future research should consider a deeper analysis of the external environment, and the qualification of extended/ internalized learning processes. Moreover, the use of the proposed frameworks in other national contexts, - e.g., other EU countries, facing the sustainability-oriented transition (European Commission, 2016), - and traditional sectors (e.g., the maritime sector; Klein and Spychalska-Wojtkiewicz, 2020), would assess the relevance of this study.

7. Research limitations

The study presents limitations, tied to the qualitative interpretations. To reduce the subjectivity bias, we iteratively discussed coding and interpretations until we identified a common set of theoretical concepts (Gioia *et al.*, 2013), also in alignment with previous literature on CE and OL. This approach is considered useful in rendering the analysis more objective (Langley, 1999), limiting personal positions. Furthermore, a single context of analysis limits the generalizability of the presented results; however, we answered the call to gather in-depth insights on CE, SMEs (Prieto-Sandoval *et al.*, 2019), and "specific cases and their real implications" from the construction sector (Hossain *et al.*, 2020, p. 109948).

Originality of the paper

The paper's originality resides in the in-depth investigation of SME managers' perception regarding an innovative organizational approach, within a specific sector hardly analyzed in the management and organization science literature. The proposed qualitative analysis of the Italian context offers a unique perspective of this traditional yet evolving

sector, presenting distinct insights related to the role of OL contextual factors and processes in the implementation of CBMs, which might support both practitioners and researchers in the transition toward CE. Furthermore, this study generally offers a novel perspective in the CE analysis using OL theories, simultaneously answering a call for a deeper analysis of OL processes (Argote and Miron-Spektor, 2011) in countries where SMEs play a dominant role (Chikweche and Bressan, 2018).

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Blockchain technology, social capital and sustainable supply chain management

Kunle Francis Oguntegbe - Nadia Di Paola - Roberto Vona

Abstract

Purpose of the paper: *This study integrates social capital and resource-based theories to expound on the contribution of blockchain technology to sustainability in supply chain management through the development of social capital.*

Methodology: *This study employs an abductive approach. Empirical data were obtained from six companies participating in the recently launched Italiafashion project (a disguised name to protect anonymity) in the Italian fashion industry. A qualitative content analysis was applied to data extracts from the six cases.*

Results: *Three key sustainability objectives firms pursue with the use of blockchain technology were identified; three propositions also emerged regarding the role of that technology and social capital in sustainable supply chain management.*

Research limits: *This study relies on a case study methodology due to its exploratory nature. Future studies could extend the investigation by considering a complete supply chain network with a higher number of observations selected from each category of stakeholders, and the possibility to use quantitative approaches.*

Practical implications: *This study identifies three key sustainability objectives (product safety, brand authenticity and strategic positioning), which could guide managers when considering the use of digital technologies for supply chain management.*

Originality of the paper: *A research framework is presented that illustrates the resource-based view of social capital in a digital supply chain management system. We argue that a blockchain-enabled supply chain system bolsters partnering firms with digital supply chain social capital such as improved inter-organisational trust, patterns of connections and shared understandings.*

Key words: Blockchain, digital supply chain, digital technology, fashion industry, social capital, sustainability.

1. Introduction

The emergence of digital technologies has brought substantial improvement to firm performance and global supply chains (Jabbour *et al.*, 2020). In the field of digital technologies, blockchain stands out as one that distinctly constitutes technological disruption with its potential benefits to business operations and general supply networks, which have recently stimulated research attention in the Supply Chain Management - SCM literature (Paliwal *et al.*, 2020; Di Vaio and Varriale, 2020; Nayak *et al.*, 2019). Blockchain has been recognised as enhancing safety, cost control,

traceability, provenance and security, among other benefits to supply chains (Kouhizadeh *et al.*, 2020). The essential drivers of sustainability in a blockchain-enabled supply chain have equally been identified to include quality, accessibility, safety and decentralisation of data, among other factors (Yadav and Singh, 2020). The ability of blockchain to reduce carbon emission as a sustainability goal in supply chains has been discussed in the literature (Wang *et al.*, 2020). However, there are other objectives of sustainability that have not received adequate attention in the blockchain/ supply chain management research context. Hence, this study resolves to conduct an empirical investigation of the aspect of sustainability that has received the most significant attention from firms with regards to the use of blockchain for managing supply chains. Not only will knowledge in this regard deepen the understanding of blockchain/supply chain integration, but it will also be beneficial for supply chain actors to identify the core aspects of sustainability, with blockchain resources being concentrated for performance optimisation in supply chain management.

Any discussion on supply chain management would be incomplete without considering sustainability (Jabbour *et al.*, 2020), which is the alignment of the triple bottom line of societal (people), economic (profit) and ecological (planet) objectives with corporate practices and the central decision-making processes of partnering firms to improve long-term business and supply chain performance (Krumme, 2019; Orji *et al.*, 2020). Considering the influx of digital technologies in global businesses, modern industries can no longer be sustained by traditional frameworks and management models (Yadav *et al.*, 2020). The increasing concerns of sustainability along supply chains has therefore necessitated the discovery of new strategies and technological interventions that could produce efficient and innovative solutions to sustainability challenges.

Premised on their capability to facilitate intrinsic connections between an organisation and its customers, suppliers and other actors, as well as their potential advantages of market enlargement, security enhancement, process automation, transparency and provenance along the supply chain, digital technologies like social media, AI, robotics, IoT and blockchain have certain advantages for promoting corporate performance and for supply chain sustainability (Sanders *et al.*, 2019). Furthermore, if combined effectively, some digital technologies could be complementary, and this further enhances sustainable operations through resource circularity in supply chains (De Sousa Jabbour *et al.*, 2018). However, the capability of technological integration to transform supply chain management and facilitate improved sustainability has not been sufficiently explored (Chiang *et al.*, 2021).

Some studies have attempted to test empirically the separate effects of certain digital technologies on sustainable supply chain management (SSCM) (Nasrollahi, 2018; Di Vaio and Varriale, 2020; Choi *et al.*, 2018), and supply chain management areas have been identified to include new product development, sources, making, delivery, retail, return and governance (Macchion *et al.*, 2018). Notwithstanding, a lot still remains unknown about the contributions of digital technologies to supply chain management (Wei *et al.*, 2019), especially which of the identified elements

of sustainability receives the most focus from firms in the engagement of digital technologies. Additionally, digital technologies could constitute strategic resources through which firms gain capabilities (Shibin *et al.*, 2020). However, the path to the development of capabilities has not been sufficiently explored in the literature, particularly the role social capital could play in the development of competitive advantages from the use of digital technologies. For example, the competitive advantage added through the use of blockchain is ascribable to its innovative features like decentralised storage and the consensus mechanism of reaching business agreements that accentuate the relationships between supply chain actors, thereby improving social capital in the supply chain. Social capital improvement can be traced along three basic dimensions: structural, relational and cognitive (Zhang *et al.*, 2020). This line of reasoning is, however, yet to receive adequate attention in the blockchain/supply chain management literature.

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It is on this note that this study chooses to explore the role of digital technologies in SSCM, and in particular to focus on blockchain technology, highlighting the aspects of sustainability that receive more attention from firms when deploying such technologies. Thus, the following broad research question is raised: what role does blockchain technology play in implementing an SSCM system?

This question will be addressed by examining the following sub-questions:

Q1: What are the top sustainability objectives firms pursue with the use of blockchain technology?

Q2: How does technological integration influence SSCM?

Q3: Which dimensions of social capital are embedded in a blockchain-based supply chain?

The aim of this research is to investigate the sustainability objectives on which firms concentrate their efforts when using blockchain technology, as well as the role of technological integration in SSCM. The topic is investigated in the fashion supply chain, which is very fragmented and looks for new solutions that are able to improve security, sustainability and transparency throughout the chain. The results of this study will expand the frontiers of knowledge on blockchain/supply chain integration in three ways. First, in response to the call for more empirical research on blockchain/supply chain integration (Wei *et al.*, 2019), the role of digital technology, namely blockchain, in implementing an SSCM system is examined. Second, the research question is empiricised using multiple cases selected from the newly launched Italiafashion, from which, to the best of our knowledge, this is the first empirical research study to draw data. Third, while this study is not the first to integrate the resource-based view and social capital theories (See Mora-Monge *et al.*, 2019; Hsu *et al.*, 2014; Rauch *et al.*, 2012), this study contributes to theory by applying the theoretical integration to a specific research problem contextualised in the blockchain/supply chain management system, thus responding to the call by Shibin *et al.* (2020) for a consideration of supply chain social capital in the resource-based view of blockchain-enabled supply chains. Accordingly, the social capital and resource-based theories are integrated

to explain the contribution of blockchain technology to SSCM and observe if supply chain social capital plays any role in this linkage. Therefore, this study deepens the understanding of how firms' resources (including digital technology) translate into capabilities and competitive advantages, and this study explores if blockchain is an important resource for developing social capital gains by supply chain firms.

2. Theoretical background

Digitalisation and blockchain technology in SSCM

Sustainable supply chains achieve stability in terms of the triple bottom line of economic, social, and environmental factors (Orji *et al.*, 2020), which entails paying enough attention to profit, people, and the planet (Krumme, 2019). As shown in Table 1, studies have recently explored SSCM and digital technologies. For instance, while some studies were conducted broadly on the role of industry 4.0 technologies in creating sustainability (Tuffnel *et al.*, 2019; Bag *et al.*, 2018), others examined the contributions of social media and big data (Jabbour *et al.*, 2020; Sivarajah *et al.*, 2020), while some explored the link between AI and sustainability in supply chains (Dash *et al.*, 2019; Di Vaio *et al.*, 2020). The last category of studies is those that focussed on blockchain, that is "a decentralized, distributed, anonymous, time-stamped ledger of data records" (Sharma *et al.*, 2019: 3). This group of studies includes systematic reviews of the literature to examine the contribution of blockchain to SSCM (Paliwal *et al.*, 2020), those studies that utilised a combination of case study and literature review to explore the antecedents of a blockchain/supply chain management system (for example, Di Vaio and Varriale, 2020), others that presented a concept for blockchain adoption in supply chains (for instance, Saberi *et al.*, 2019) and those that theoretically investigated the success factors for a blockchain-managed supply chain (for example, Yadav and Singh, 2020).

While the link has been explored between the individual digital technologies and SSCM, there is also the possibility of exploring the potential of integrating technologies such as social media and other associated industry 4.0 technologies to further enhance sustainability in digitally enabled supply chain management. Moreover, extant studies have established that the interrelation of digital technologies for supply chain management helps improve financial performance (Ardito *et al.*, 2019) and reduce supply chain risks (Ivanov *et al.*, 2019); nevertheless, there is room for further research on the integration of digital technologies into supply chain management (Jabbour *et al.*, 2020). Furthermore, the need has also been stressed for an investigation of the blockchain-SCM linkage using empirical data (Ardito *et al.*, 2019).

Studies have attempted to provide theoretical underpinnings for the utilisation of digital technologies and other technological innovations in building sustainability in supply chain management. For instance, in the field of engineering management, Choi *et al.* (2018) proposed the "systems of systems" theory for achieving a sustainable fashion supply chain, while Kusi-Sarpong *et al.*, (2019) employed a framework known as the

"best-worst multicriteria decision making model" for evaluating supply chain sustainability in the manufacturing industry. Two theories and one framework, technology-organisation-environment (TOE), human-organisation-technology (HOT) and the best-worst framework were utilised by Orji *et al.* (2020) to identify the essential success factors for the use of social media in creating supply chain sustainability in the freights and logistics industry.

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Similarly, with a focus on blockchain, the barriers of digitally enabled supply chain have been investigated through the lens of the decision-making trial and evaluation laboratory framework (Kouhizadeh *et al.*, 2020). The effects of supply chain connectivity and information sharing on SSCM have been measured through a combination of the resource-based view and institutional theory (Shibin *et al.*, 2020), while performance improvements stemming from the acquisition and control of unique resources enabled by the integration of blockchain into supply chain systems has been examined through the theoretical lens of the resource-based view (Nandi *et al.*, 2020). Interestingly, on the one hand, blockchain has been recognised as strengthening supply chain social capital through collaborative inter-organisational relationships by improving trust between partners (Rejeb and Rejeb, 2020). On the other hand, studies have considered blockchain as a unique resource that supply chain firms could leverage to gain competitive advantages and performance improvements (Gölgeci and Kuivalainen, 2020). By extension, blockchain possesses unique features that aid the assessment of product quality, environmental accounting and social impact, thereby promoting SSCM (Kshetri, 2021). However, there is still room for further research regarding the pathways to sustainability gained through the strategic use of blockchain resources in supply chains. An essential consideration in this direction could be the role of social capital in SSCM (Nandi *et al.*, 2020). In particular, traditionally, through its influence on consumers' buying intentions, social capital has been recognised as a prime driver of sustainability (Kim *et al.*, 2020). Whether or not similar information could be empirically verified about social capital in a blockchain-managed supply chain system is yet to be adequately explored. Against this backdrop, it is conjectured that it is crucial to expand knowledge in the area of blockchain-supply chain management integration by examining, through an integrative philosophical lens of the social capital and resource-based theories, the role of blockchain-enabled social capital in implementing SSCM. Integrating social capital and resource-based theories will provide a theoretical background that further boosts the understanding of the process through which blockchain, as a strategic resource, contributes to sustainability in the supply chain system. Our reasoning is that blockchain has important characteristics capable of enhancing collaborations between partners (Wang *et al.*, 2020), thereby improving supply chain social capital within the digital system. Intuitively, digital social capital constitutes sources of capabilities for firms to edge out competitors and improve sustainability. Deepening knowledge in this regard could therefore provide novel means of expounding the sustainability gains arising from the use of blockchain for supply chain management.

Incidentally, the literature has stressed the need for more empirical research on how digital technologies promote sustainability in supply chains (Visconti & Morea, 2019), as well as the challenges firms encounter when utilising digital technologies to enhance supply chain management (Vona and Di Paola, 2018; Jabbour *et al.*, 2020). In light of this, the barriers to digitally enabled supply chains fall into four categories: technological, organisational, external environment and supply chain. It has been proven that technological and supply chain barriers are the most critical for both industry and academic practitioners (Kouhizadeh *et al.*, 2020). Despite these barriers, one critical consideration for the adoption of digital technology in supply chain management is its perceived benefits (Orji *et al.*, 2020). We deepen the theoretical proposition by empirically exploring the social capital gains stemming from the integration of blockchain into supply chain systems. This would enable the identification from an empirical perspective of the capabilities firms could attain with the use of digital platforms.

Tab. 1: Research trends for digital technologies and SSCM

S/N	Dimensions	References
1	Industry 4.0 and SSCM	Tuffnell *et al.,* 2019; Bag et al., 2018; Yadav *et al.*, 2020; Mastos *et al.,* 2020; Bhagawati *et al.*, 2019; Müller 2020;
2	Big data, social media and SSCM	Jabbour *et al.*, 2020; Sivarajah *et al.*, 2020; Chalmeta and Santos-deLeón 2020; Wang *et al.*, 2016; Tiwari *et al.*, 2018; Hazen *et al.*, 2016; Nguyen *et al.*, 2018; Singh and El-Kassar 2019; Bag *et al.*, 2020; Nasrollahi, 2018; Orji *et al.*, 2020; Tseng 2017
3	Artificial intelligence and SSCM	Dash *et al.*, 2019; Di Vaio *et al.*, 2020; Govindan *et al.*, 2019; Baryannis *et al.*, 2019; Sanders *et al.*, 2019; Dauvergne 2020)
4	Blockchain and SSCM	Paliwal *et al.*, 2020; Di Vaio and Varriale 2020; Nayak *et al.*, 2019; Saberi *et al.*, 2019, Cole *et al.*, 2019; Kouhizadeh *et al.*, 2020; Yadav and Singh 2020.

Source: own elaboration

Digital supply chain social capital

Social capital theory has transcended its origin in sociology to be relevant in the related fields of economics and business, and it has gained wide application in supply chain management (Johnson *et al.*, 2013) to explain how supply chain firms acquire capabilities through the deployment of valuable resources gained through strategic alliances with internal and external stakeholders (Yim and Leem, 2013). Social capital is a critical element of inter-organisational relationships such as those created between firms in a supply chain (Gölgeci and Kuivalainen, 2020). It refers to the valuable assets arising from access to resources made available through social ties (Nahapiet and Ghoshal, 1998). It is defined as the "sum of the actual and potential resources embedded within, available through and derived from relationships possessed by an individual or social unit" (Nahapiet and Ghoshal, 1998, p. 243). An individual or organisation's networks of relationship constitute valuable resources through which benefits are derived, including data sharing information access and synchronisation of activities (Kilubi and Rogers, 2018).

Three dimensions of social capital are identified in the literature: structural, relational and cognitive (Zhang *et al.*, 2020; Villena *et al.*, 2011). The structural dimension refers to the strength, pattern and frequency of connections between buyers and sellers. The denser the structure of social relations between supply chain partners, the more regular the connections between individuals in the network and the better the social capital. This connotes that a dense structural social capital helps supply chain stakeholders to collaborate more, and it provides a better medium for information exchange (Wu and Chiu, 2018).

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The relational dimension of social capital involves the goodwill that is expressed in the form of the trust, reciprocity and friendship gained as a result of social interactions between buyers and sellers (Alghababsheh and Gallear, 2021). Relational social capital evolves from repeated interactions, which in turn enable trustworthiness among members of the supply chain network. Trust, therefore, is an essential element of relational capital as it reduces information asymmetry in the buyer-supplier relationship (Wu and Chiu, 2018).

The cognitive dimension has to do with shared values, codes, language and common understandings among partners (Barroso-Castro *et al.*, 2016; Lee, 2015). Supply chain actors have their rules of engagement spelled out in a formal contract to ensure orderliness in task execution targeted towards the realisation of their common goals (Jia *et al.*, 2020). Common understanding among stakeholders in a supply chain helps them share the same thinking process and establish uniform ideologies, thereby facilitating market exchange (Alghababsheh and Gallear, 2020).

Intentionally established networks, such as the supply chain, facilitate the accumulation of the relational, structural and cognitive dimensions of social capital (Ali and Gölgeci, 2021). It is important that supply chain firms create a dense social capital structure that enables a constant flow of knowledge and information sharing by building networks and maintaining frequent interactions, thus fostering cooperation (Gölgeci and Kuivalainen, 2020; Chu *et al.*, 2017). Likewise, the relational dimension of social capital is equally important to supply chain firms because of the need to develop trust and reciprocity from long term partnerships and repeated transactions, thereby reducing transaction costs (Villena *et al.*, 2011; Lee, 2015). In the same vein, supply chain actors need to pay attention to the cognitive dimension of social capital, which includes resources that help them develop shared representation, meanings (Polyviou *et al.*, 2019), goals, visions and understandings regarding the contracting rules and management principles guarding the network (Zhu and Lai, 2019). Therefore, building upon this theoretical foundation, the three dimensions of social capital present in a digital supply chain are investigated.

The literature has linked social capital to firm performance (Lins *et al.*, 2017; Barroso-Castro *et al.*, 2016; Krause *et al.*, 2007) and supply chain sustainability (Zhang *et al.*, 2020; Chu *et al.*, 2017). Social capital has also been acknowledged as one of the strategic resources that supply chain firms can leverage to create competitive advantages and hedge against risks (Gölgeci and Kuivalainen, 2020). The introduction of digital technologies into supply chains has given rise to digital social capital. Social capital is

generated from relationships through exchange (Nahapiet and Ghoshal, 1998). Similarly, supply chain social capital is created through relationships between supply chain partners (Yim and Leem, 2013); one way such relationships are serviced is through the exchange of information (Gölgeci and Kuivalainen, 2020). Digital technologies facilitate the exchange of information between supply chain partners, thereby strengthening the structural and relational dimensions of supply chain social capital. For instance, the blockchain improves the relational dimension by enhancing transparency, trust, safety and provenance in the supply chain, while social media applications such as Facebook, Twitter and Instagram affect the structural dimension of social capital by increasing the volume of transactions and the strength of social ties, influencing the pattern of connection between supply chain actors. Therefore, the term "digital supply chain social capital" indicates the dimensions of social relationships (in terms of connection pattern, inter-organisational trust and common understanding) between partners that are enabled by the use of digital technologies for supply chain management.

Conceptual model

The resource-based view, which takes its origin from the strategic management literature (Barney, 1991), holds that a firm can attain sustainable competitive advantages by harnessing its unique resources and capabilities (Das and Teng, 2000).

The resource-based view provides the best framework for explaining the pathway to competitive advantages gained through resources (Shibin *et al.*, 2020). Resources in a firm may be tangible (people, assets) or intangible (information, partnerships) and provide useful means for firms to attain capabilities. Studies have identified technology as one of the strategic resources that improves firm value (Sabherwal *et al.*, 2019; Lioukas *et al.*, 2016). Using the resource-based view, Nandi *et al.* (2020) model the performance improvement resulting from a blockchain-enabled supply chain system. We extend the theoretical proposition in this study by arguing that a blockchain-enabled supply chain system bolsters partnering firms with digital supply chain social capital such as improved inter-organisational trust, patterns of connections and shared understandings.

This is expounded on through a combination of social capital theory and the resource-based view. It is posited that the three dimensions of social capital could be accumulated from an integrated blockchain/supply chain system and that these include digital structural capital (connection patterns enhanced by smart contracts), digital relational capital (inter-organisational trust enabled by distributed ledger technology) and digital cognitive capital (common understandings enabled by the peer-to-peer mechanism through which blockchain operates).

3. Method

To answer the research questions, this study employs an abductive approach, which is a research process in which real life issues are explained

through an iterative juxtaposition between existing theory and empirical data (Nandi *et al.*, 2020). This approach becomes necessary since this study investigates a complex, emerging phenomenon in which data collection and the search for relevant theories proceeded simultaneously; hence, it is not fit for deductive or inductive approaches (Dubois and Gadde, 2002). Additionally, the abductive research approach is appropriate for this study since the aim is to make propositions that could aid theory development (Brodie *et al.*, 2017). Moreover, this study seeks to explore a phenomenon (blockchain implementation in supply chain management) that is still in a budding stage.

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In line with the abductive research process, this research employs multiple case study analyses, an approach that has been employed in previous sustainability studies of this nature (see Formentini and Taticchi, 2016; Macchion *et al.*, 2018). Case studies are more suitable for answering how, why and what questions in exploratory, explanatory or descriptive research involving contextual conditions where little is known about the subject of enquiry (Baxter and Jack, 2008) as it allows the generation of valuable insights as well as testable propositions that can be subsequently subjected to further empirical validations. Moreover, findings from a multiple case study design are more convincing, and this type of study is generally regarded as more robust compared to a single case design (Yin, 2003). Exploring the contribution of digital technologies to supply chain sustainability using a multiple case study methodology would not only help explicate the pathway through which blockchain influences SSCM but also allow the replication of findings across cases and comparisons with empirical explanations for organisational differences in the use of digital technologies to foster sustainability objectives. Moreover, the specific sustainability objectives firms seek to achieve through the utilisation of blockchain for supply chain processes could be established from multiple sources, just as the role of technological integration in SSCM can be investigated.

To contextualise the research question, the focus here is on the fashion supply chain, where sustainability is essential because of the heavily fragmented and globally dispersed nature of the chain (Choi *et al.*, 2018). More importantly, the adoption of blockchain is gaining importance in the fashion industry due to the need to ensure trust, security and transparency among supply chain partners (Macchion *et al.*, 2018). The significance of the fashion sector to the Italian economy cannot be overemphasised as the phrase "made in Italy" has become synonymous with the Italian luxury industry. To further promote the "made in Italy" brand in the United States of America and across global markets, an Italian institution recently launched a project named Italiafashion, a disguised name used to ensure anonymity. Italiafashion provides a digital platform consisting of a virtual boutique, 3D animations, social media integrations, music, and compelling stories in which designers, retailers, consumers and other stakeholders of the supply chain can connect for business transactions, whether B2B (business-to-business) or B2C (business-to-consumer). Hence, Italiafashion is considered a good proxy for technological integration because of its rich blend of digital technologies, blockchain in particular.

Against this backdrop, cases were selected from companies participating in the project.

Data for this study were collected in two phases. First, between March and August 2020, prior to the launching of Italiafashion project, the Twitter pages of fashion companies were tracked on an application programming interface known as "followerwonk" using the keywords "fashion", "blockchain" and "sustainability". To ensure that only firms operating in the fashion supply chain were captured, Twitter handles were regularly reviewed to verify the pages with information available on the companies' official websites. The second phase of data collection took place between September and October 2020, when Italiafashion was already operational. We focussed on companies participating in Italiafashion, leveraging the information available on the project website. Data collected from the platform were triangulated with other sources, including social media pages (Facebook, LinkedIn and Instagram), as well as the 2019 corporate responsibility and sustainability reports of the selected companies.

Following the methodological framework presented in Figure 1 and the procedure for conducting multiple case study research, established in Baxter and Jack (2008) and Yin (2003), cases were selected by focussing on companies operating in the fashion supply chain, specifically brands originating in Italy. The criteria for case inclusion were that the company should be participating in the Italiafashion project and, by implication, be a stakeholder in the fashion supply chain, and such company must be operating in a blockchain-managed supply chain system. The information obtained from secondary sources was continually reviewed to identify the firms that met these two criteria.

Fig. 1: Methodological framework
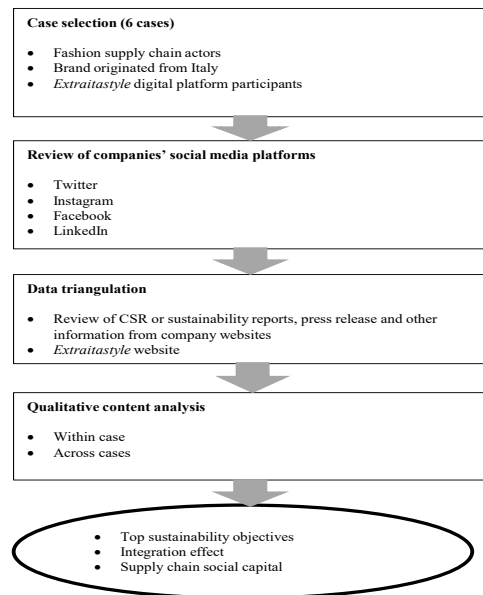
Source: (Adapted from Macchion et al., 2018)

Following this process, from a total of 80 companies participating in the project, only six fashion brands made it into the final analysis. They are labelled A-F for the sake of anonymity, as shown in Table 2.

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Tab. 2: Cases

Case	Year of establishment	Firm size (No of employees)	Digital technologies
A	1913	Large (14,000)	Blockchain, social media
B	1921	Large (13,030)	Blockchain, social media
C	1925	Large (3,000)	Blockchain, social media
D	1975	Large (7,309)	Blockchain, social media
E	1985	Large (519)	Blockchain, drones, social media
F	1978	Large (1,250)	Blockchain, social media

*Social media here comprises Facebook, Instagram, Twitter and LinkedIn.

Source: own elaboration

Using the keywords stated previously, the selected firms' social media and sustainability reports were explored for communications bordering on blockchain and supply chain sustainability. The data extracts were prepared and imported into Nvivo-12, where qualitative content analysis was performed.

For the data analysis, each firm's sustainability objectives were coded with respect to the use of blockchain. Other digital technologies the firms integrated with blockchain in their pursuit of sustainability objectives were also identified. Based on the measures defined in Table 2, the dimension of social capital embedded in the sustainability objectives targeted by the blockchain/supply chain system of each firm was identified. Table 3 gives a summary of the constructs and measures employed in this study.

Tab. 3: Constructs and measures

Constructs	Measure	References
Digital technology	Blockchain adoption	Saberi *et al.*, 2019; Kouhizadeh *et al.*, 2020
Brand authenticity	Product quality	Moulard *et al.*, 2016; Beverland *et al.*, 2010
Product safety	Risk level	Zhu *et al.*, 2019
Positioning	Advertising	Iyer *et al.*, 2019
Digital structural social capital	Social connection pattern	Gölgeci and Kuivalainen 2020; Lee, 2015;
Digital relational social capital	Trust	Villena *et al.*, 2011, Yim and Leem 2013
Digital cognitive social capital	Shared understanding	Barroso-Castro *et al.*, 2016

Source: own elaboration

A comprehensive assessment of sustainability objectives was conducted to identify the social capital measures contained in each. For example, a consistent indicator of relational social capital in the literature is trust (Weiss *et al.*, 2019; Zhang *et al.*, 2017); therefore, firms whose sustainability efforts are concentrated on improving trust were coded as being focussed on relational social capital, those with the core objective of reshaping the pattern of connection among the supply chain partners were coded as being

focussed on structural social capital while those with sustainability goals bordering around common understanding or mutual vision were coded as being oriented towards cognitive social capital. Again, the multiple data sources were continually triangulated to ensure the consistency of the findings. The previously identified sustainability objectives were further integrated with the social capital dimensions to develop the propositions.

4. Results

Top sustainability objectives targeted with the use of blockchain

With respect to the first research sub-question, from the case analyses, three categories of sustainability objectives emerged based on firms' use of digital technologies. These are product safety, brand authenticity and strategic positioning.

Product safety is the reduction in the tendency of a product to cause harm, illness, injury, death or other negative consequences to its intended users, property or equipment (Marucheck *et al.*, 2011). Product safety concerns are capable of creating disruptions in supply chains and can result in product recalls; hence, it is widely considered an integral sustainability objective in the fields of operations, risks and supply chain management (Speier *et al.*, 2011). With regards to the fashion industry, safety issues might arise from the use of adulterated supplies, such as harmful chemicals, poor production mechanisms or incorrect packaging in the preparation of textile materials. It is therefore essential for partnering firms to reach consensus on appropriate supplies, adequate packaging and acceptable textile designs with the aim of identifying likely negative consequences for corrective measures before production. Product safety as a sustainability objective that firms target with the use of digital technologies was drawn from sample data:

In order to promote widespread safety awareness, thanks in part to regulatory developments on this matter, the Company uses on-line safety courses with specific IT platforms that are easy and simple to use. (Firm#, sustainability report 2019)

Brand authenticity is a known strategy in the field of marketing and has been incorporated into supply chain management due to the increasing need to curb the problem of counterfeiting in supply chains (Li and Yi, 2017). In the fashion industry, counterfeiting results from deliberate changes to labels, poor branding and other unsustainable practices by one or more elements of the supply chain. Fashion firms therefore desire to safeguard their brands by ensuring that their genuineness is not compromised throughout its movement along the supply chain. Table 4 shows that the objective of brand authenticity is the most prevalent among the studied cases, as it is indicated by four (approximately 67%) of the companies.

Tab. 4: Sustainability objectives, digital supply chain social capital and data extract

Cases	Sustainability objectives	Digital supply chain social capital	Reference from cases
A	Product safety	Relational	'In order to promote widespread safety awareness, thanks in part to regulatory developments on this matter, the Company uses on-line safety courses with specific IT platforms that are easy and simple to use'.
B	Brand authenticity	Relational	'Protect your Brand from counterfeit, use Authlink to issue a verifiable certificate of authenticity to all products and safeguard your Brand.
C	Positioning	Structural	'Smart Contracts, Blockchain and hidden advertising on social Media" Conference at Brand# Exploring next generation solutions for luxury business. Great Job...'
D	Brand authenticity	Relational	'One of the best advantage of #BlockChain is that #Companies can ensure there is no counterfeit products reaches to any consumer.'
E	Brand authenticity	Relational	'Luxury Brands Authenticity Flourishing with Blockchain http://Blockchain.luxury Premium Domain For Sale.'
F Sample cases: 35.8%	Brand authenticity	Relational	'Agreed! Check out how Brand 1, Brand 2, Brand 3, Brand 4, Brand 5 use digital #authentication to protect consumers now. It solves the problem of #counterfeit links to #digital records, so when #Blockchain is ready for prime time, they are too'.

Source: own elaboration

Here is an example of data from which brand authenticity was identified:

Luxury Brands Authenticity Flourishing with Blockchain http:// Blockchain.luxury Premium Domain For Sale. (Brand#, Posted on social media, 7th January 2020)

Strategic positioning, which relates to the development of new products or the discovery of new markets, refers to the way in which a business differentiates itself from its competitors and offers value to a specific category of customers (Guo *et al.*, 2018). In the contemporary business world, where competition is inevitable across supply chains, companies need to develop supply chain differentiation strategies either with respect to price, quality or design in order to increase their chances of long-term survival (Iyer *et al.*, 2019; Aktan and Akyuz, 2017). With more than 80 brands currently competing for the global market on the Italiafashion virtual boutique, positioning strategy remains key for supply chains to attain competitive advantage. An example of data from which positioning was identified as a sustainability objective targeted with the use of blockchain is the following:

Smart Contracts, Blockchain and hidden advertising on social Media" Conference at Fendi Exploring next generation solutions for luxury business. Great Job. (Brand#, Posted on social media, 31st January 2019)

Summarily, as shown in Table 3, In terms of the primary sustainability objectives sought by businesses in their use of blockchain to manage

supply chain systems, four of the six cases (B, D, E, and F) prioritise brand authenticity; one (C) specifies strategic positioning; while one (A) recognises product safety as key to its supply chain sustainability.

Effect of technological integration on SSCM

With reference to the second research sub-question, the Italiafashion platform facilitates collaborations along the supply chain, thus enhancing digital supply chain social capital by improving the pattern of connection and increasing the strength of social relations between supply chain stakeholders.

Prior to the launching of the Italiafashion digital platform, there existed a lack of integrated digital platforms for supply chain collaborations. However, with Italiafashion, supply chain collaborations are enhanced by the digital platform.

This is further illustrated by the sample data:

Of course, in the aftermath of the pandemic, with social distancing guidelines and travel restrictions still in place, this opportunity is a major boost for many designers. The digital discovery platform will also seek to help these bright stars grow their businesses in the United States by connecting them with the media, retailers, and consumers. (Italiafashion Website)

The Italiafashion digital platform represents a mix of digital technologies, allowing the exploration of the joint influence of integrated technologies on SSCM, taking references from the data extracts. The findings indicate that the Italiafashion digital platform facilitates supply chain collaborations, which is an indicator of supply chain social capital. By extension, improved collaboration is necessary to sustain the economic and ecological gains resulting from social interactions between supply chain firms. Intuitively, this connotes that technological integration improves sustainability in supply chain management by increasing supply chain social capital.

The importance of integrated digital platforms like Italiafashion cannot be overemphasised, especially in the post-pandemic period where there are social distancing guidelines and less physical interaction is required of businesses and their stakeholders. Essentially, because of the nature of traded goods, the fashion industry is one that requires more interactive and holistic digital platforms with which actors can visualise products and ensure provenance by tracking products' movement along the supply network. Consistent with the findings of Bertola and Teunissen (2018), an ecosystem of digital technologies helps firms to be more customer-oriented, maintain a good positioning strategy, and capture new markets, thereby making the supply chain more sustainable. Hence, a first proposition is made:

Proposition 1: Compared to individual digital technologies, technological integration is more likely to advance SSCM through improved customer orientation, better positioning strategy and increased market access.

Dimensions of social capital in a digital supply chain

In answering the third research sub-question, two dimensions of supply chain social capital were found in the blockchain-managed supply chain system investigated. These are here called digital structural social capital and digital relational social capital. The dimensions differ in the aspect of sustainability that enjoys the most significant focus by the firm in the management of supply chains.

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Digital structural social capital

Digital structural social capital in this case refers to the blockchain-enabled pattern of connections and the nature of contracts existing within an organisation and its supply chain partners. Table 3 shows that one of the cases (C) is committed to improving the structural dimension of social capital by using blockchain to develop a positioning strategy for its supply chain. A major constraint on traditional supply chain management systems is the complexity of business processes brought about by the presence of multiple and geographically distributed actors (Sauer and Seuring, 2019). The blockchain, through its decentralised, peer-to-peer system, has brought considerable transformation to the pattern of connection in supply chains by removing the need for intermediaries and facilitating business processes, thus making the system less complex. Moreover, the smart contract feature of the blockchain, which is a set of rules guiding transactions between supply chain participants, operates through consensus mechanisms (Saberi *et al.*, 2019) in which transactions are ratified by all parties involved and no actor can alter business processes without the agreement of all partners. Moreover, with the digitised supply chain systems, buyers could trade directly with suppliers, thus significantly altering the pattern of connection and increasing the strength of social relationships between supply chain partners. Similar results were reported by Kim *et al.* (2021), who found that digital healthcare supply chains improve structural capital. Based on this understanding, a second proposition is made:

Proposition 2: Digital supply chain systems are more likely to strengthen structural social capital through smart contracting, which facilitates direct buyer-seller transactions without the need for intermediaries.

Digital relational structural capital

Digital relational structural capital has to do with the trust and reciprocity resulting from long-term partnerships. Supply chains are global in nature, involving the participation of several stakeholders, which reduces visibility and transparency along the chain (Di Paola, 2018; Ruta *et al.*, 2017). With the use of digital technology such as blockchain, transactions are managed in a distributed ledger technology that enables verifiability and transparency of business processes (Manupati *et al.*, 2020). More importantly, one of the critical issues blockchain addresses in supply chain management is a lack of trust between partnering firms and end users; blockchain ensures the creation of an immutable record of reliable data (Choi, 2019). The smart contract ensures that consensus is reached for transactions to be validated, and every partner has a digital record of the transaction. Similar advantages are available to end users as the blockchain enables them to verify the origins of products.

Table 3 shows that four of the cases indicate brand authenticity as their top sustainability target with respect to the use of blockchain. Embedded in the concept of brand authenticity is trust, which is a key element of relational social capital. This is because for a brand to be considered authentic, consumers need to have a certain level of trust, believing that the product must have been made with acceptable levels of honesty and transparency, without compromising quality and necessary ethical standards. To ascertain the authenticity of a brand, blockchain provides a robust, immutable system suitable for tracing the movement of products along the value chain. Another sample case (A) recognises product safety as of major concern in blockchain/supply chain integration. Zhang *et al.* (2020B) similarly reported that digital supply chains increase relational social capital. The blockchain enables the monitoring of business processes, thus ensuring compliance with safety standards by all supply chain entities and enhancing transparency and security along the chain. It is on this note that a third proposition is made:

Proposition 3: By improving trust amongst stakeholders, digital supply chain systems are more likely to increase relational social capital than non-digital supply chain systems.

Integrating digital social capital with sustainability objectives

The digital social capital identified is further integrated with the sustainability objectives pursued by firms as identified from the cases. The results are presented in Table 4.

Table 4 shows that two sustainability objectives are associated with the relational dimension of digital supply chain social capital, and these objectives include brand authenticity and product safety, while only one sustainability objective (positioning) is connected with the structural dimension of digital supply chain social capital. Generally, the two sustainability objectives that are focussed on relational social capital are shared by five of the six companies considered in this study, which is an indication that firms may be more interested in using digital technologies to achieve relational social capital than structural social capital in their supply chains. Implicitly, inter-organisational trust is more important to supply chain firms than their patterns of connection.

*Fig. 2: Resource-based view of social capital
in a digital supply chain management system*
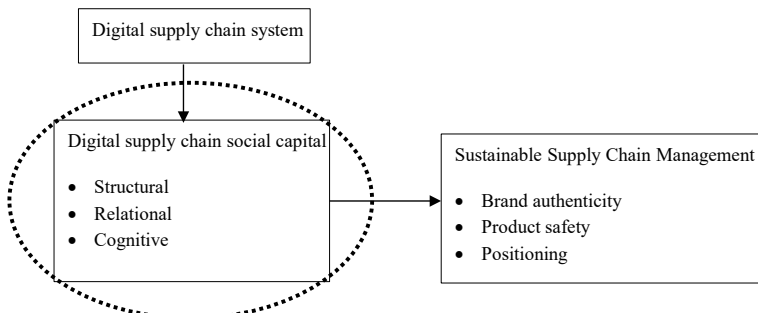
Source: own elaboration

Figure 2 shows that the dimensions of social capital in a digital supply chain system are valuable resources that can be leveraged by firms to gain capabilities and are key to implementing SSCM as they influence the achievement of the sustainability objectives established in the supply chain network.

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5. Discussion and conclusions

Employing a multiple case study approach, this study has explored the role of digital technologies, particularly blockchain technology, in SSCM through the integrated theoretical lens of social capital theory and the resource-based view. Secondary data were obtained from six fashion firms participating in the Italiafashion project by retrieving the information made available on their social media accounts, particularly Twitter, which was accessed using an application programming interface. Also, companies' Facebook, Instagram and LinkedIn pages were considered, triangulated with other sources such as sustainability reports, as well as the *Italiafashion* project website, to ensure that the information obtained was genuine. The results of qualitative content analysis conducted on the data extracts suggest that there are three top sustainability objectives firms seek to achieve with the utilisation of digital technology: brand authenticity, product safety and strategic positioning.

Of the three dimensions of social capital considered in this study, only two (structural and relational) were found to be relevant in a blockchain-based supply chain system. This suggests that blockchain has a profound influence on both structural and relational social capital, but its effect on cognitive capital might be negligible. The rationale behind this is that blockchain, through its unique features such as smart contracts and immutability, can influence the structural and relational dimensions of social capital but has little or no significant influence on shared meanings or common understandings among supply chain partners. A plausible explanation for this finding is that understanding is subjective and can rarely be influenced by a third party application or technology as it depends solely on the subjects. Hence, the influence of blockchain on cognition is rarely felt.

Although not a direct objective of this study, comparisons are drawn across cases to determine which of the three dimensions of social capital are of most importance to firms in the use of digital technologies. The results indicate that the relational dimension of digital supply chain social capital is more important to firms than the structural and cognitive dimensions. Hence, firms are more interested in achieving inter-organisational trust than influencing the pattern of social connections in their supply chains.

In line with the findings of this study, it is recommended that supply chain firms consider the blockchain as a key enabler of social capital and as a major strategic resource that could be integrated with other digital technologies to gain capabilities over competitors and promote the sustainability of the supply chain.

Theoretical and practical implications

This study, which stands at the intersection of digitalisation and SSCM, lends some relevant contributions to the theory and practice of sustainability in supply chains. As a theoretical contribution, this study has synthesised the social capital theory and resource-based view to advance a framework that explicates the contribution of digital technologies to SSCM through the development of social capital, culminating in the emergence of capabilities in an integrated blockchain/supply chain system. Furthermore, this study has also demonstrated that digital technology, specifically blockchain, through its smart contract, helps strengthen structural capital; improves relational capital through its immutability features, which boost trust among supply chain participants; and that technological integration enhances SSCM through improved customer orientation, better positioning strategy and increased market access.

Another theoretical contribution of this study is the advancement of the concept of digital supply chain social capital, which is defined as the dimensions of social relationship (in terms of connection pattern, inter-organisational trust and shared codes and languages among partners) enabled by the use of digital technologies for supply chain management.

As a practical implication, this study identifies three key sustainability objectives (product safety, brand authenticity and strategic positioning), which could guide managers when considering the use of digital technologies for supply chain management. Invariably, the sustainability objectives identified in this study could constitute the focal points for supply chain managers in the use of blockchain for promoting sustainability. Moreover, extant literature has identified blockchain as a strategic resource that firms can leverage to edge out the competition (Nandi *et al.*, 2020,). This study advances this school of thought by showing that the ability of blockchain to boost social capital and enhance sustainability offers a more lucid explanation to the competitive advantage gained through its use. Consequently, this new line of reasoning holds that the dual complementary roles of blockchain as a strategic resource and a key enabler of social capital help improve sustainability in the supply chains, and this could provide further incentives for stakeholders to consider investing in blockchain for supply chain management.

Therefore, blockchain is not just a vital technological resource but a means of accumulating social capital in supply chain systems, and it can be leveraged to attain competitive advantage. Additionally, this study illustrates the greater influence of integrated technologies on SSCM rather than engaging one type of digital technology. This encourages firms to consider multifunctional digital platforms that holistically incorporate the attributes of different technologies for the management of supply chains. For example, firms could engage blockchain alongside social media platforms to have a more sustainable supply chain.

Limitations and suggestions for further research

This study has certain limitations. First, blockchain remains an emerging technology with an abundance of anecdotes but few real-life use cases, even in the fashion industry where it seems to have gained prominence. Despite

the fact that this study considers a real-world experience, however future studies could extend the investigation by considering a complete supply chain network with a higher number of cases selected from each category of stakeholders. Second, this study relies on a case study methodology due to its exploratory nature. Another interesting avenue for further research is to consider a quantitative approach in which surveys could be conducted to collect primary data for a more robust empirical analysis. Particularly, it is suggested that the three propositions made here should be quantitatively investigated such that the impact of digital technologies on SSCM may be measured while also testing the mediating effect of social capital on the blockchain-SSCM relationship. In this regard, hopefully, pragmatic implementation of blockchain will have matured sufficiently in fashion and other industries in the near future, such that additional studies can heavily rely on interviews with supply chain managers to gain a better understanding of the roles of digital technologies in driving supply chain sustainability.

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Greening SCM through SC integration: an exploratory investigation among Italian supply chain managers[1]

Francesco Rizzi - Eleonora Annunziata - Marina Gigliotti

Abstract

Purpose of the paper: The study contributes to the debate on the nature of links between supply chain integration and green supply chain management (GSCM). In particular, we empirically tested the existence of relations between supply chain integration, organisational culture, and the adoption of GSCM practices.

Method: We carried out an online survey on a sample of Italian firms. After building research hypotheses and measurement models through a literature review, we administered an online questionnaire to purchasing managers or directors, logistics managers or directors, and managers in charge of supply chain management.

Results: Our results show that internal and external integrations have a multifaceted impact on GSCM practices. Internal integration is an essential condition for their implementation. In particular, technological integration with suppliers is more relevant than informative integration with suppliers in greening the supply chain. The results also show that companies develop different forms of supply chain integration depending on their organisational culture and not on their size.

Research limitations: The main limits of this study consist in the use of data from cross-sectional observation (and not longitudinal data) and the collection of data in a single country.

Practical implications: This study allows supply chain managers to better understand how to pursue a high level of coherence between supply chain integration, organisational culture and GSCM practices. In particular, our results help supply chain managers select integration pathways that support targeted GSCM practices and are more likely to succeed in their specific organisational context.

The originality of the study: This study adopts specific metrics for each component of supply chain integration, organisational culture and GSCM practices, which allows for a detailed analysis of the underlying relationships.

Key words: GSCM; internal integration; external integration; organisational culture

1. Introduction

Nowadays, companies are increasingly urged to pursue greener production not just by improving efficiency in their operations, but also by unlocking greening potential throughout the supply chain (SC). This

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fact has led SC managers to strive harder to develop cooperative and collaborative practices aimed at mobilising the necessary resources and competencies both within and outside their organisation. On the grounds of the need to understand which factors determine the success or failure of these efforts, this paper aims to investigate the role of SC integration in implementing green SC management (GSCM).

The literature on these topics is abundant but still fragmented. Companies are becoming increasingly aware of the need to increase their control over direct and indirect environmentally relevant business relations throughout the value chain (Annunziata *et al.*, 2019; Carter and Rogers, 2008). Many scholars and practitioners have made tremendous efforts towards understanding the dynamics that characterise SC management in the green setting, which has led to the emergence of a specialised stream of literature on GSCM (Wu and Pagell, 2011).

In parallel, scholars have paid equal attention to SC integration, a concept that has emerged as particularly useful to describe the evolution of purchase managers towards SC managers. SC integration refers to the involvement of SC managers in vast and complex roles and responsibilities that are necessary to overcome the traditional professional silos and logics of isolation of business functions and enable more effective and flexible logics of inter-functional or inter-organisational coordination.

Besides the abundant scientific evidence that the cross-fertilisation of skills and competencies among SC managers, marketers, operations managers, finance managers, logistics managers and environmental managers might help achieve competitiveness in complex and fast-evolving markets (Armistread *et al.*, 1993; Flynn *et al.*, 2010; Stank *et al.*, 2001), SC integration has been often confused with a universal best practice among practitioners who pursue GSCM. This means that positive prejudices might, therefore, affect the perceived possibility of improving green performance through the mimetic implementation of trendy forms of SC integration.

Recent findings on the links between organisational culture (OC) and GSCM practices (Elbaz and Iddik, 2020) instead suggest that it is worth investigating how SC integration approaches should vary to better suit specific organisational characteristics and green strategies.

In this framework, our study aims to bridge GSCM and OC literature with SC integration literature to provide empirical evidence on their cross-influences. In particular, based on previous contributions that have started to disentangle different forms of integration dynamics in SCM (Frohlich and Westbrook, 2001; Flynn *et al.*, 2010) the paper aims to shed some light on the need to pursue configurational approaches to integration to better achieve GSCM goals, which is a promising yet undeveloped avenue for research.

To this end, the section that follows reviews the extant literature to build the present study's research hypotheses concerning the links between SC integration and, on the one hand, GSCM practices as well as, on the other hand, OC. Next, the Method section describes how we gathered information from 381 Italian SC managers and tested our research hypotheses. After presenting the results, which offer solid evidence that the

way organisations develop SC integration depends on their OC and pursued GSCM practices, the paper expounds on managerial and theoretical implications and concludes by underlying the importance of building comprehensive models to further disentangle the interdependencies among these variables.

2. Literature review and hypotheses development

2.1 GSCM practices and SC integration

GSCM is a multifaceted concept that lacks a univocal definition (Sarkis *et al.* 2011) (Table 1). In this regard, the study adopts the definition by Srivastava (2007), which considers GSCM as a set of practices aimed at improving environmental performance throughout the SC of a product. This definition, compared to others, refers to a life cycle perspective as it encompasses all the different stages that range from design to manufacturing, distribution, consumption and disposal or any other available alternative for end-of-life management. By adopting Srivastava (2007)'s definition, GSCM practices can be under the direct responsibility either of a given manufacturing company (e.g. eco-design, reverse logistics, etc.) or of other companies involved in the related supply chain (e.g. certifications, responsible sourcing, etc.).

Tab. 1: Main definitions of GSCM

Paper	Definition of GSCM
Hervani *et al.*, 2005	"Green Supply Chain Management (GSCM) = Green Purchasing + Green Manufacturing/Materials Management + Green Distribution/ Marketing + Reverse Logistics".
Srivastava, 2007	"Integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life".
Zhu *et al.*, 2007b	"An important new innovation that helps organisations develop 'win-win' strategies that achieve profit and market share objectives by lowering their environmental risks and impacts, while raising their ecological efficiency".
Sarkis *et al.*, 2011	"Integrating environmental concerns into the inter-organisational practices of SCM including reverse logistics".
Wee *et al.*, 2011	"The green-supply chain management (GSCM) that emerged in the last few years has integrated environment considerations into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the greening products".

Source: Authors' elaboration

The current literature offers a broad view on a continuously increasing variety of practices that organisations can consider if they have the ambition to foster the development of GSCM (Massaroni *et al.*, 2015). However,

this variety can be sorted by identifying the relevant practices that emerge from a literature review of various available papers representing highly influential contributions (according to citation dynamics and visibility within the international scientific community) that cover GSCM topics (Table 2).

Tab. 2: GSCM practices emerging from current literature

GSCM practices	Description	References
Green procurement	Green procurement means purchasing products, semi-products and services with minimal environmental impacts.	Çankaya and Sezen (2018); Rao and Holt (2005); Carter and Carter (1998); Zhu *et al.*, (2008a); Holt and Ghobadian. (2009); Lee *et al.*, (2012); Inman and Green (2018); Paulraj (2011); Younis *et al.*, (2016); Wu *et al.*, (2012); Zaid *et al.*, (2018); Zhu *et al.*, (2008a-b); Zhu *et al.*, (2007 a-b-c); Zhu *et al.*, (2012).
Internal environmental management	Internal environmental management is represented by all the practices that support the continuous improvement of green performance within the organisation.	Çankaya and Sezen (2018); Green *et al.*, (2012); Zhu *et al.*, (2008a); Holt and Ghobadian (2009); Kirchoff *et al.*, (2016); Lee *et al.*, (2012); Inman and Green (2018); Rao and Holt (2005); Zaid *et al.*, (2018); Zhu *et al.*, (2008a-b); Zhu *et al.*, (2007a-b-c); Zhu *et al.*, (2012); Zhu and Sarkis (2004).
Eco-design	Eco-design refers to the implementation of designing or redesigning products, services, processes or systems to avoid or reduce environmental impacts.	Zhu *et al.*, (2008a); Green *et al.*, (2012); Hartmann and Germain (2015); Kirchoff *et al.*, (2016); Lee *et al.*, (2012); Mitra and Datta (2013); Younis *et al.*, (2016); Wu *et al.*, (2012); Zaid *et al.*, (2018); Zhu *et al.*, (2008a-b); Zhu *et al.*, (2007 a-b-c); Zhu *et al.*, (2012); Zhu and Sarkis (2004).
Green partnership and cooperation	Green partnership and cooperation consist in sharing information and cooperating along the SC to reduce the environmental impact of the production process.	Zhu et al (2008a); Green *et al.*, (2012); Hong *et al.*, (2009); Lo *et al.*, (2018); Gimenez and Sierra (2013); Kirchoff *et al.*, (2016); Lee *et al.*, (2012); Huo *et al.*, (2019); Inman and Green (2018); Mitra and Datta (2013); Rao and Holt (2005); Paulraj (2011); Vachon and Klassen (2006); Vachon (2007); Vachon and Klassen (2008); Younis *et al.*, (2016); Wu *et al.*, (2012); Yu *et al.*, (2014); Zaid *et al.*, (2018); Zhu *et al.*, (2008b); Zhu *et al.*, (2007 a-b-c); Zhu *et al.*, (2012); Zhu and Sarkis (2004)
End-of-life management	End-of-life management represents the systematic approach to identify and implement effective actions for managing the final stages of products by avoiding their final disposal in landfills (if possible).	Zaid *et al.*, (2018); Younis *et al.*, (2016); Ageron *et al.*, (2012); Zhu *et al.*, (2012); Kirchoff *et al.*, (2016); Kumar *et al.*, (2016); Holt and Ghobadian (2009)

Source: Authors' elaboration

The implementation of GSCM practices might be affected by different factors. Therefore, previous studies investigated the factors driving the adoption of GSCM practices (Sarkis *et al.*, 2010; Walker *et al.*, 2008). Moreover, Vachon and Klassen (2006) highlight that GSCM practices resulting from the company's coordination with customers and interactions with suppliers might be affected by these relationships. Nevertheless, there is a scarcity of studies considering the influence of each driver on specific practices (Tachizawa *et al.*, 2015).

SC integration is recognised as an influencing factor (Yu *et al.*, 2019) among the antecedents that affect the adoption of GSCM practices. In this regard, SC integration, referring to "the degree to which a manufacturer strategically collaborates with its SC partners and collaboratively manages intra- and inter-organisation processes" (Flynn *et al.*, 2010), represents a composite concept. Indeed, literature has proposed different types of SC integration (Huo, 2012): internal integration, customers integration, supplier integration, technological integration, etc. However, many studies converge on the definition of SC integration that identifies three dimensions: internal integration, downstream integration with customers, and upstream integration with suppliers (Kim, 2013). In this context, integration with suppliers and customers can be interconnected with another SC integration dimension represented by technological integration with suppliers to share information and knowledge (Vachon and Klassen, 2006).

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Moreover, Bae *et al.* (2021) highlight the importance of simultaneously and independently considering the role played by internal and external perspectives of SC integration (i.e., integration with customers, integration with suppliers and technological integration). Because of the dimensionality of SC integration, it is important to investigate the effect of its dimensions on each GSCM practice. Indeed, extant studies have tested the relationship between SC integration and one specific GSCM practice (Liu *et al.*, 2018; González-Benito *et al.*, 2016). On the grounds of this rationale, it is possible to hypothesise that:

H1a: Internal integration has a positive impact on each GSCM practice

H1b: Integration with customers has a positive impact on each GSCM practice

H1c: Integration with suppliers has a positive impact on each GSCM practice

H1d: Technological Integration with suppliers has a positive impact on each GSCM practice

Figure 1 shows the conceptual model for verifying the relationship between SC integration and GSCM practices.

Fig. 1: Integration and GSCM: the proposed conceptual model
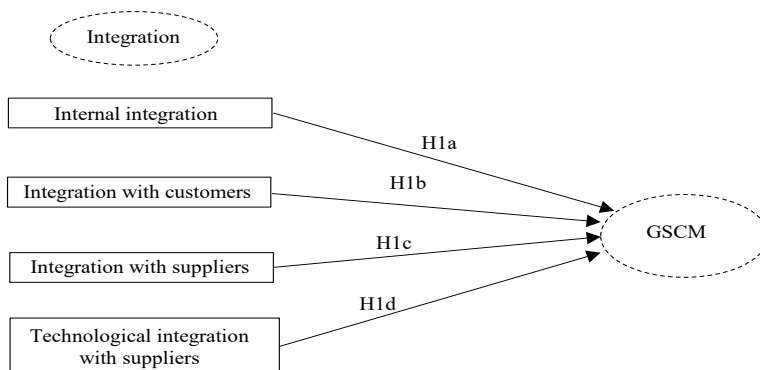
Source: Authors' elaboration

2.2 Organisational culture and supply chain integration

The extant literature has recognised that SC integration requires cultural changes to align all SC partners (Porter *et al.*, 2019). Braunscheidel *et al.* (2010) argue that this cultural alignment benefits firm performance and SC partners. Since OC represents the set of shared assumptions, values, and beliefs about organisational functioning (Deshpande & Webster, 1989), its compatibility among SC partners is needed. Therefore, specific OC types might affect propensity towards SC integration efforts (Porter *et al.*, 2019).

Several studies have adopted the competing values framework (CVF) developed by Quinn and Rohrbaugh (1983) to investigate behaviours associated with OC. The CVF describes four culture types: group, developmental, rational, and hierarchical. These types of culture are characterised by two dimensions: internal versus external focus, and stability/control versus flexibility/change (Naor *et al.*, 2008; Tong and Arvey, 2015). Group culture represents flexible structure and internal focus. Rational culture results from controlled structure and external focus. Developmental culture is based on a flexible structure with an external focus, while the hierarchy culture represents a controlled structure with an internal focus.

By adopting these four types, OC might exert a different effect on SC integration. In this regard, Porter (2019) highlights that few studies investigate the relationship between SC integration and OC. First, empirical evidence has demonstrated that the hierarchical culture promotes specialisation and efficiency within a stable and unchanging business context (Cao *et al.*, 2015). Moreover, Braunscheidel *et al.* (2010) found that hierarchical cultures have a negative impact on internal and external integration. However, further investigation is needed to intersect OC with SC integration efforts to adopt GSCM practices. This leads to the following hypotheses:

H2a: Organisational culture has a positive impact on internal integration
H2b: Organisational culture has a positive impact on integration with customers
H2c: Organisational culture has a positive impact on integration with suppliers
H2d: Organisational culture has a positive impact on technological integration with suppliers

Figure 2 depicts the conceptual model for testing the relationship between OC and SC integration mentioned above.

Fig. 2: Organisational culture and integration: the proposed conceptual model
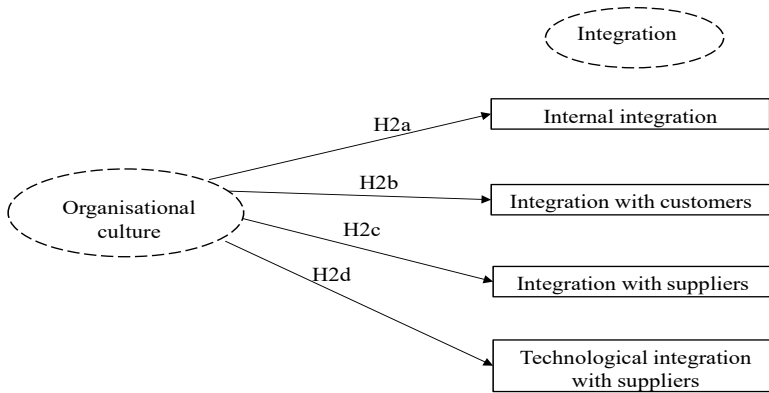
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Source: Authors' elaboration

2.3 Company size in relation to implementing GSCM practices and SC integration

The size of companies is traditionally one of the most debated influencing factors among scholars in the sustainability field. Silva *et al.* (2021) point out that larger firms are typically more pressured to address society and stakeholders' demand for greener products and operations. On the other hand, small and medium enterprises (SMEs), representing the backbone of many national economies, should assume an active role in reducing their environmental impacts along with their SC (Lewis *et al.*, 2015). Therefore, several studies have recognised the importance of verifying the role of company size in adopting GSCM practices (Elbaz and Iddik, 2020). Some studies found low adoption of GSCM practices by SMEs (Zhu *et al.*, 2008a). Moreover, Scur and Barbosa (2017) revealed that large firms have positive relationships with the implementation of GSCM practices. This empirical evidence might stem from the presence of more resources for SC activities owned by larger companies.

In this regard, SC integration promoting the sharing of knowledge and collaboration among SC actors might be affected by company size in terms of the availability of implemented resources and efforts for adopting GSCM practices. For example, Zhao *et al.* (2011) found that company size positively impacts supplier and customer integration. However, other studies achieved mixed results in terms of the relationship between SC integration and company size (Frohlich and Westbrook, 2001; Pagell, 2004). Therefore, further investigation is needed in the GSCM field.

Regarding the effect of company size on OC, extant literature has investigated its role in adopting SC integration in larger firms (Cao *et al.*, 2015) or the implementation of quality management and innovation among SMEs (Shuaib and He, 2021). However, previous studies have not investigated the specific effect of company size on the relationship between OC and SC integration.

Therefore, we formulated the following hypotheses:

H3: Company size influences the positive relationship between SC integration and GSCM practices.

H4: Company size influences the positive relationship between organisational culture and SC integration.

3. Method

Research design and the sample

To address our research questions and understand the relationships among GSCM, integration, and culture, we carried out an online survey on a sample of Italian firms. More specifically, we administered an online questionnaire to purchasing managers or directors, logistics managers or directors and managers in charge of supply chain management. We considered these positions as the most suitable for providing the required information about GSCM for two reasons. First, these professionals work on the interface between the organisation and suppliers, which is a privileged condition for observing GSCM dynamics. Second, they are usually formally identified in more structured organisations, where it makes more sense to observe inter-functional collaboration dynamics.

To identify the participants in the research covering the roles mentioned above within their companies, the study consulted the Linkedin social network and members of the Adaci (Italian Association of Purchasing and Supply Management Directors) Association. This ensured the reliability and specificity of the selection criteria. Out of the nearly 1,300 qualified managers who expressed their interest in the topic of the study and who, therefore, received the questionnaire, 381 self-selected respondents fully completed the online form in the period between January and June 2020.

Variables and measurements

This study considers three main constructs: i. GSCM practices; ii. Integration; iii. Culture. As shown in Table 3, we adopted well consolidated and validated scales for their measurement and, as regards GSCM practices in particular, the measurement model from Zaid *et al.* (2018). In line with the main contributions that emerged from our literature review, they proposed the following GSCM practices: eco-design; internal environmental management; green purchasing; environmental cooperation; end-of-life.

Regarding the level of integration, we measured the four features that emerged from our literature review: internal integration, customer integration, supplier integration, and technological integration with suppliers. More specifically, we adopted the original scale proposed by Zhao *et al.* (2011) for internal integration. For supplier integration, we adopted 12 of the 13 items used in the same manuscript. In addition, we selected the items for measuring customer integration (six-items scale) from Cao *et al.* (2015) and the ones for measuring technological integration with suppliers (four-scale items) from Vachon e Klassen (2006). We adopted the four components considered by Naor *et al.* (2008) for measuring OC: hierarchical culture, group culture, rational culture, and developmental culture. Each component was measured through four items.

All the items were measured by means of a 7-point Likert agreement scale, with "1" for "strongly disagree" and "7" for "strongly agree".

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Tab. 3: Variables, labels, scales, and items used for the questionnaire design

Variables	Labels	Scale	N. items
GSCM			
Eco-design	GSCM.Eco	Zaid *et al.* (2018)	5
Internal environmental management	GSCM.IEM	Zaid *et al.* (2018)	6
Green purchasing	GSCM.GP	Zaid *et al.* (2018)	5
Environmental cooperation	GSCM.EC	Zaid *et al.* (2018)	6
End-of-life	GSCM.EoL	Zaid *et al.* (2018)	3
Internal integration	Intgr.Intern	Zhao *et al.* (2011)	9
Customer integration	Intgr.Cust	Cao *et al.* (2015)	6
Supplier integration	Intgr.Suppl	Zhao *et al.* (2011)	12
Technological integration with suppliers	Intgr.Tech	Vachon e Klassen (2006)	4
Organisational culture			
Hierarchical culture	OrgCult.Hier	Naor *et al.* (2008)	4
Group culture	OrgCult.Group	Naor *et al.* (2008)	4
Rational culture	OrgCult.Ration	Naor *et al.* (2008)	4
Developmental culture	OrgCult.Devel	Naor *et al.* (2008)	4

Source: Authors' elaboration

The questionnaire also included the measurement of control variables such as the respondent's age and gender, seniority within the company, and the dimension of the company in terms of the number of employees.

4. Results

Descriptive analysis

Tables 4 and 5 show the main descriptive statistics for the control variables used to identify the respondents' profile.

Tab. 4: Age of respondents: a descriptive analysis

Age	N.	%	Cumulative %
22-34	11	2.89	2.89
35-44	88	23.10	25.98
45-54	112	29.40	55.38
55-64	145	38.06	93.44
65-74	25	6.56	100.00
Total	381	100.00	

Source: Authors' elaboration

Tab. 5: Seniority and number of employees: a descriptive analysis

Variable	Obs	Mean	Std. Dev	Min	Max
Seniority	381	20.61	10.19	1	47
N. of employees	381	614.62	3933.61	4	60

Source: Authors' elaboration

The sample is mainly composed of men (83.7% of the sample), aged between 45 and 64 (67.5%), with seniority within the company equal to 20 years on average. The companies in the sample whose managers were employed in the study are highly variable in size, with an average of 614.6 employees. Such heterogeneity of features allows us also to analyse how the observed variables act differently based on the class of company size described in Table 6, which are: small (<= 50 employees); medium (> 50 and <250), and large (> 250) companies.

Tab. 6: Size of the companies: frequencies and percentage

Size	N.	%	Cumulative %
Small	110	28.87	28.87
Medium	203	53.28	82.15
Large	68	17.85	100.00
Total	381	100.00	

Source: Authors' elaboration

Hypotheses testing

Before analysing the relationships between the variables considered in the model, we performed a reliability test, i.e., the Cronbach's α, and a sampling adequacy test, i.e., the KMO (Kaiser-Meyer-Olkin) test. In combination with the tests of convergent validity and discriminant validity that were obtained through the exploratory factor analysis, these results support the construct validity for all the variables. Table 7 shows these results.

Tab. 7: Construct validity tests

Variable	Number of items	Cronbach's α	KMO Test	Factor loadings	Item average	Item stand. dev.
				(min-max)	(min-max)	(min-max)
GSCM.Eco	5	0.97	0.92	0.73-0.77	3.44-3.96	1.96-2.43
GSCM.IEM	6	0.97	0.93	0.86-0.91	4.70-4.83	1.71-1.95
GSCM.GP	5	0.96	0.91	0.67-0.81	4.55-4.92	1.75-1.97
GSCM.EC	6	0.98	0.94	0.72-0.79	3.84-4.16	1.98-2.21
GSCM.EoL	3	0.90	0.74	0.81-0.89	1.96-3.11	1.14-1.73
Intgr.Intern	9	0.99	0.96	0.81-0.85	3.98-4.12	2.15-2.28
Intgr.Cust	6	0.96	0.91	0.80-0.87	2.48-2.85	1.31-1.53
Intgr.Suppl	12	0.98	0.96	0.86-0.91	3.99-4.32	1.98-2.11
Intgr.Tech	4	0.97	0.87	0.81-0.89	3.90-4.06	2.02-2.12
OrgCult.Hier	4	0.94	0.85	0.76-0.87	3.60-4.01	1.68-1.75
OrgCult.Group	4	0.97	0.86	0.80-0.82	3.97-4.04	2.02-2.12
OrgCult.Devel	4	0.98	0.88	0.79-0.81	4.18-4.28	2.03-2.14
OrgCult.Ration	4	0.97	0.88	0.76-0.80	4.07-4.25	2.03-2.11

Source: Authors' elaboration

To test the hypotheses, we first verified the OLS assumptions, namely linearity, normality, homogeneity of variance, and independence for all the relations, including those where potentially irrelevant variables were included. After that, we estimated the effect of the integration variables on

each GSCM practice. Table 8 shows the results of the regression models where, in addition to the first model, which considers the entire sample of respondents, we tested three additional models, one per class of company size (i.e. small, medium, and large, respectively in models 2, 3, and 4).

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Tab. 8: GSCM practices and integration: results of the multivariate regression model for the whole sample and based on company size (dependent variables in italics)

Variable	model_1 (whole sample)	model_2 (small size)	model_3 (medium size)	model_4 (large size)
GSCM.Eco				
Intgr.Intern	.31*** [.19 .43]	-.08 [-.39 .23]	.28* [.34 .67]	.50*** [.06 .50]
Intgr.Suppl	.05 [-.06 .16]	.07 [-.20 -35]	-.01 [-.14 .13]	.12 [-.11 .34]
Intgr.Tech	.53*** [.42 .64]	.80*** [.49 1.10]	.44*** [.30 .58]	.49*** [.27 .71]
Intgr.Cust	.07* [.01 .14]	.17* [.03 .31]	.01 [-.07 .10]	.10 [-.08 .29]
cons	.00 [-.04 .04]	.05 [-.05 .15]	-.03 [-.08 .03]	.02 [-.10 .13]
n. obs.	381	110	203	68
R-sq.	.80	.73	.84	.82
GSCM.IEM				
Intgr.Intern	.82*** [.57 1.08]	.97*** [.42 1.52]	.70*** [.33 1.08]	.87*** [.41 1.33]
Intgr.Suppl	-.82*** [-1.04 -.59]	-.91*** [-1.40 -.42]	-.83*** [-1.15 -.51]	-.69** [-1.16 -.22]
Intgr.Tech	-.00 [-.23 .22]	-.02 [-.56 .51]	.11 [-.22 .43]	-.19 [-.63 .26]
Intgr.Cust	-.11 [-.24 .02]	-.20 [-.45 .05]	-.05 [-.24 .15]	-.06 [-.44 .32]
cons	-.00 [-.09 .09]	-.01 [-.19 .17]	.02 [-.10 .15]	.02 [-.23 .27]
n.obs.	381	110	203	68
R-sq.	.17	.18	.16	.21
GSCM.GP				
Intgr.Intern	.72*** [.46 .98]	.76* [.16 1.36]	.69*** [.31 1.05]	.61* [.12 1.10]
Intgr.Suppl	-.70*** [-.93 -.47]	-.83** [-1.36 -.30]	-.75*** [-1.06 -.44]	-.63* [-1.12 -12]
Intgr.Tech	.03 [-.02 .026]	.15 [-.43 .73]	.12 [-.20 .44]	-.13 [-.60 .34]
Intgr.Cust	-.22** [-.36 -.09]	-.31* [-.58 -.04]	-.22* [-.41 -.03]	-.03 [-.43 .37]
cons	-0.00 [-.09 .09]	.031 [-.16 .22]	.06 [-.07 .19]	.15 [-.42 .11]
n.obs.	381	110	203	68
R-sq.	.11	.10	.11	.15
GSCM.EC				
Intgr.Intern	-.00 [-.19 .18]	-.36 [-.77 .06]	.05 [-.23 .32]	.14 [-.19 .47]
Intgr.Suppl	-.02 [-.19 .15]	.10 [-.27 .47]	-.16 [-.39 .07]	.21 [-.12 .54]
Intgr.Tech	.66*** [.49 .82]	.82*** [.41 1.21]	.76*** [.52 .99]	.27 [-.05 .58]
Intgr.Cust	.21*** [.12 .31]	.26** [.07 .44]	.24** [.09 .37]	.27 [-.00 .53]
cons	-.00 [-.07 .07]	.02 [-.11 .15]	-.01 [-.10 .09]	.13 [-.04 .31]
n.obs.	381	110	203	68
R-sq.	.54	.51	.57	.56
GSCM.EoL				
Intgr.Intern	-.63*** [-.88 -.38]	-1.02*** [-1.51 -.53]	-.50** [-.87 -.13]	-.45 [-.98 .07]
Intgr.Suppl	.21 [-.02 .42]	.59** [.15 1.02]	.13 [-.18 .44]	.14 [-.39 .67]
Intgr.Tech	.40*** [.18 .62]	.22 [-.25 .69]	.42** [.10 .74]	.24 [-.26 .74]
Intgr.Cust	.34*** [.21 .47]	.54*** [.32 .76]	.27** [.08 .46]	.39 [-.04 .82]
cons	-.00 [-09 09]	-.06 [-.22 .09]	-.04 [-.17 .09]	.26 [-.03 .54]
n.obs.	381	110	203	68
R-sq.	.10	.20	.08	.10

Legend:
Coefficients appear as unstandardised betas [95% C.I. in brackets]
* p<0.05; ** p<0.01; *** p<0.001
model_1= whole sample
model_2 = small size
model_3 = medium size
model_4 = large size

Source: Authors' elaboration

Our findings show how internal integration plays a relevant role in adopting GSCM practices. In fact, there is a positive link with eco-design, internal environmental management and green procurement, and a negative correlation with end-of-life management. However, environmental cooperation is not influenced by internal integration. For this reason, H1a is partially confirmed.

Integration with suppliers seems to have an irrelevant or negative role in affecting GSCM practices. Upstream cooperation oriented towards sharing information is negatively linked to internal environmental management and green purchasing. On the other hand, it is not significantly correlated to eco-design, environmental cooperation and end-of-life management. Thus, H1b is not confirmed.

Technological integration with suppliers positively affects three of the GSCM practices analysed, namely eco-design, environmental cooperation and end-of-life management. In contrast, internal environmental management and green purchasing are not favoured by a technological integration with suppliers. Hence, H1c is partially supported.

Integration with customers has a diversified influence on practices for greening the SC. While it has a positive link with eco-design, environmental cooperation and end-of-life management, it negatively correlates with green purchasing. Finally, integration with customers and internal environmental management are not significantly correlated. According to our results, H1d is partially confirmed.

To answer the second group of hypotheses, table 9 shows the results of the regression models relating to the relationship between the elements of OC and components of SC integration that have been considered. Also in this case, in addition to the model on the entire sample (model_1), we estimated the parameters of the regressions for the models relating to the different company sizes (small, medium, and large).

Tab. 9: Integration and culture: results of the multivariate regression model for the whole sample and based on company size (dependent variables in italics)

Variable	model_1 (whole sample)	model_2 (small size)	model_3 (medium size)	model_4 (large size)
GSCM.Eco				
Intgr.Intern	.31*** [.19 .43]	-.08 [-.39 .23]	.28* [.34 .67]	.50*** [.06 .50]
Intgr.Suppl	.05 [-.06 .16]	.07 [-.20 -35]	-.01 [-.14 .13]	.12 [-.11 .34]
Intgr.Tech	.53*** [.42 .64]	.80*** [.49 1.10]	.44*** [.30 .58]	.49*** [.27 .71]
Intgr.Cust	.07* [.01 .14]	.17* [.03 .31]	.01 [-.07 .10]	.10 [-.08 .29]
cons	.00 [-.04 .04]	.05 [-.05 .15]	-.03 [-.08 .03]	.02 [-.10 .13]
n. obs.	381	110	203	68
R-sq.	.80	.73	.84	.82
GSCM.IEM				
Intgr.Intern	.82*** [.57 1.08]	.97*** [.42 1.52]	.70*** [.33 1.08]	.87*** [.41 1.33]
Intgr.Suppl	-.82*** [-1.04 -.59]	-.91*** [-1.40 -.42]	-.83*** [-1.15 -.51]	-.69** [-1.16 -.22]
Intgr.Tech	-.00 [-.23 .22]	-.02 [-.56 .51]	.11 [-.22 .43]	-.19 [-.63 .26]
Intgr.Cust	-.11 [-.24 .02]	-.20 [-.45 .05]	-.05 [-.24 .15]	-.06 [-.44 .32]
cons	-.00 [-.09 .09]	-.01 [-.19 .17]	.02 [-.10 .15]	.02 [-.23 .27]
n.obs.	381	110	203	68
R-sq.	.17	.18	.16	.21
GSCM.GP				
Intgr.Intern	.72*** [.46 .98]	.76* [.16 1.36]	.69*** [.31 1.05]	.61* [.12 1.10]
Intgr.Suppl	-.70*** [-.93 -.47]	-.83** [-1.36 -.30]	-.75*** [-1.06 -.44]	-.63* [-1.12 -.12]
Intgr.Tech	.03 [-.02 .026]	.15 [-.43 .73]	.12 [-.20 .44]	-.13 [-.60 .34]
Intgr.Cust	-.22** [-.36 -.09]	-.31* [-.58 -.04]	-.22* [-.41 -.03]	-.03 [-.43 .37]
cons	-0,00 [-.09 .09]	.031 [-.16 .22]	.06 [-.07 .19]	.15 [-.42 .11]
n.obs.	381	110	203	68
R-sq.	.11	.10	.11	.15
GSCM.EC				
Intgr.Intern	-.00 [-.19 .18]	-.36 [-.77 .06]	.05 [-.23 .32]	.14 [-.19 .47]
Intgr.Suppl	-.02 [-.19 .15]	.10 [-.27 .47]	-.16 [-.39 .07]	.21 [-.12 .54]
Intgr.Tech	.66*** [.49 .82]	.82*** [.41 1.21]	.76*** [.52 .99]	.27 [-.05 .58]
Intgr.Cust	.21*** [.12 .31]	.26** [.07 .44]	.24** [.09 .37]	.27 [-.00 .53]
cons	-.00 [-.07 .07]	.02 [-.11 .15]	-.01 [-.10 .09]	.13 [-.04 .31]
n.obs.	381	110	203	68
R-sq.	.54	.51	.57	.56
GSCM.EoL				
Intgr.Intern	-.63*** [-.88 -38]	-1.02*** [-1.51 -.53]	-.50** [-.87 -.13]	-.45 [-.98 .07]
Intgr.Suppl	.21 [-.02 .42]	.59** [.15 1.02]	.13 [-.18 .44]	.14 [-.39 .67]
Intgr.Tech	.40*** [.18 .62]	.22 [-.25 .69]	.42** [.10 .74]	.24 [-.26 .74]
Intgr.Cust	.34*** [.21 .47]	.54*** [.32 .76]	.27* [.08 .46]	.39 [-.04 .82]
cons	-.00 [-09 09]	-.06 [-.22 .09]	-.04 [-.17 .09]	.26 [-.03 .54]
n.obs.	381	110	203	68
R-sq.	.10	.20	.08	.10

Legend:
Coefficients appear as unstandardised betas [95% C.I. in brackets]
* $p<0.05$; ** $p<0.01$; *** $p<0.001$
model_1= whole sample
model_2 = small size
model_3 = medium size
model_4 = large size

Source: Authors' elaboration

The results confirm how internal integration is significantly linked to all forms of OC in almost all of the analysed models. Although a group or rational culture seems to encourage more internal integration, a developmental or hierarchical culture also positively influences cooperation within the firm's boundaries. These results fully support H2a.

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Integration with customers results stronger in the case of a group culture that allows constructive dialogue among functions on how to relate with customers, which is not only necessary in large companies. The hierarchical culture positively impacts the integration with customers in the entire sample and in small firms, which might depend on the tendency of top management, in these companies, to directly manage business relations with customers. Developmental (except for large companies) and rational cultures do not influence integration with suppliers. Hence, H2b can be partially confirmed.

The integration with suppliers is supported by a culture that is oriented towards hierarchical relationships and company incentive systems in all the estimated models. These two approaches usually entail a clear definition of the procedures and actions to be implemented, thus facilitating strategic relationships with suppliers. Also, the values of belonging and participation, which are typical of a group culture, promote coordination with suppliers. Only a developmental culture is not linked to the integration with suppliers. Thus, H2c is partially confirmed.

Technological integration with suppliers is positively related to group, developmental, and rational cultures. Rational culture allows for a stronger technical and operational integration with suppliers but approaches towards participation (group culture) or flexibility (developmental culture) also seem to encourage it. Hierarchical culture has a significant relationship with upstream technological integration, but it acts, albeit weakly, in a negative way. For this reason, H2d is partially confirmed.

Finally, the empirical research aims at testing whether the company size is relevant in understanding the dynamics between SC integration and GSCM practices and between OC and SC integration. To this end, along with the analysis of the entire sample (model 1), we propose three other models related to the dimension of the firms. At first glance, the results do not reveal a univocal situation. After careful observation, however, the cases in which models 1, 2, 3 and 4 show divergent results are sporadic. This means that, in disentangling the relationships between SC integration and GSCM practices and between OC and SC integration, company size is not a dimension capable of explaining different interactions and dynamics. Therefore, both H3 and H4 are not confirmed.

5. Discussion

The empirical research confirms that both SC integration and GSCM practices are multifaceted constructs that need to be analysed in all their components to disentangle the underlying dynamics.

Although our findings confirm first insights from the extant literature (Yu *et al.*, 2019) on the positive role that SC integration plays in pursuing

green practices throughout the SC, this study highlights diversified influences among their dimensions.

Internal integration is an essential condition for implementing green practices, which are thus strictly connected to coordination among all business functions. While this seems obvious in the case of the adoption of internal environmental management, it provides interesting cues on the necessity of a common internal approach also in the case of practices that go beyond the firm's boundaries. Companies can effectively adopt eco-design and green procurement practices only if shared commitment, coordination, and integration among functions are granted. Internal integration seems to hamper the take-back and remanufacturing logic, probably because of a contingent reduction of the need for inter-functional coordination that deserves further investigation.

Upstream integration is conceptualised both in terms of integration with suppliers and technological integration with suppliers. This breakdown allows us to understand the different influences of sharing information and operational and technical coordination (Vachon and Klassen, 2006). In fact, our research provides interesting results on how these two dimensions act differently in promoting GSCM practices. Our results reveal how exchanging information with suppliers is not the key to ensuring the adoption of GSCM practices. In fact, it sometimes even hinders their implementation, as in the case of environmental management and green purchasing. This latter result may appear counter-intuitive but it might depend on the fact that the more the supplier is strongly connected with the organisation, the less the selection process is based on other formal criteria, including those related to the environmental dimension.

Further investigation might be helpful to verify whether suppliers' environmental performance represents a pre-condition for establishing strong connections throughout the SC. In contrast, technological integration is directly linked to eco-design, environmental cooperation, and end-of-life management, which are typically factual manifestations of integrating environmental thinking throughout the SC. Not surprisingly, upstream coordination on technical issues strongly affects practices that directly involve the product, from its green development to its end-of-life management. Technological proximity with suppliers is therefore an inevitable condition for including intrinsic green characteristics into a company's product.

A similar reasoning also concerns integration with customers. This dimension also positively influences eco-design, environmental cooperation, and end-of-life management practices. Firstly, this result reflects the need to understand customers' needs and attitudes before developing a product. Greater collaboration and information sharing allow for understanding the customer's requests and matching them in the product development stages, also in the case of green features. Moreover, integration with customers supports end-of-life policies because it allows companies to effectively involve customers in this green practice. Practices such as take-back are quite challenging to implement without the customers' cooperation, which facilitates the reverse flow of products.

Our results also show how different forms of organisational culture impact GSCM practices through both internal and external integration dimensions. In particular, the more companies guide and inform the actions of all their members through shared values, expectations, and practices - no matter if this is through a hierarchical, group, developmental or rational culture - the more they are internally integrated.

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Interestingly, this convergence of behaviours among internal functions also seems to be linked to integration with suppliers, which is therefore a goal that does not just depend on buyers' intentions. Each organisational approach, except for developmental culture, positively influences informational coordination with suppliers. This fact can be explained as a result of a stability-oriented approach (typical of hierarchical and rational cultures) that facilitates long-term relationships. Additionally, group culture influences integration with suppliers by inducing values of belonging and participation that can be extended to inter-organisational teams. However, these results confirm that organisations are a mixture of subcultures (Braunscheidel *et al.*, 2010)

Technological integration with suppliers is hindered only by a hierarchical culture, which seems to limit the creation of strong technological ties along the upstream supply chain. This kind of cultural approach is oriented towards control and internal focus. As already shown in previous studies (Porter, 2019), this fact means that, while it does not hinder information sharing, it might restrain more engaging cooperation in relation to technical and strategic issues due to the perception of loss of control they can imply. On the other hand, technological integration is favoured by group, developmental and rational cultures which, thanks to their orientation towards flexibility and external focus, are typical of companies that are less rigid in sharing technical and operational assets.

Integration with customers is enhanced by hierarchical and group cultures. In this case, similarly to the integration with suppliers, this interconnection can benefit from a downstream extension of the sense of affiliation and membership that is mainly represented by group culture (Cao *et al.*, 2015; Porter, 2019). Interestingly, the culture that is oriented towards development and that oriented towards incentives do not have significant influence on building strong interactions with customers. This fact might depend on specialisation logics that deserve further investigation (e.g. full control of the marketing function over information flows concerning customers) that are counterbalanced, as discussed above, only by a collaborative culture.

Replying to the call of extant studies (Elbaz and Iddik, 2020), to analyse the role of company size in pursuing green strategies throughout the SC, we performed an analysis that could also provide insight on this topic. Only in some scattered situations did the analysed links vary according to the company's size. Thus, the results do not confirm the role of the dimension in explaining the mutual dynamics among the considered variables. In synthesis, our study reveals how the implementation of single GSCM practices is interconnected to the dimensions of integration, regardless of company size. Once a (small, medium or large) firm can build specific coordination dynamics (internally and externally), it can generate the right

conditions to boost its intention to implement strategies for greening the SC. Finally, our results suggest that establishing internal coordination and solid partnerships along the SC is not a prerequisite of a specific company in terms of size. It is instead linked to the cultural approach the company adopts.

6. Theoretical and managerial implications

This study contributes to the debate on GSCM practices by comparing, through empirical evidence, the factors that explain their adoption within companies. In particular, we proposed an integration perspective to test the role of the dimensions of internal and external integration on the adoption of GSCM practices. At the same time, we offered some insights into the influence of different types of OC on each dimension of the integration. Observing the dynamics behind these two interconnections allowed us to observe the entire phenomenon, analyse it more extensively, and have a clearer vision of the underlying relationships.

On grounds of the ongoing lively debate on which practices can be considered part of this phenomenon, we have included different components of GSCM in our analysis that are thus not necessarily considered as a unitary manifestation of a mono-dimensional phenomenon. This choice was driven by the purpose to contribute to the current GSCM literature with a more detailed and, at the same time, complete vision of the phenomenon.

Moreover, we contributed to the extant literature by providing detailed empirical results on the link between SC integration and GSCM practices and suggesting how this relationship could be further disentangled by considering the cultural approach rather than company size.

From a managerial point of view, our results show that internal and external integration dimensions cannot be reduced to a single, simplified concept, as they have a multifaceted impact on GSCM practice, which means that the creation of enabling conditions for cross-fertilisation and collaborations among competencies in small, medium or large companies should be carefully interpreted from both inter-functional and inter-organisational perspectives. In comparative terms, internal integration seemed to prevail over external integration when focusing on adopting eco-design, internal environmental management, and green purchasing. Instead, internal integration significantly hampered reverse logistics. This is quite obvious for closed-loop SCs, where the functions concerning operations and R&D prevail over the others in the definition of procurement criteria and routines. In contrast, the importance of internal interaction was more revelatory for practices like eco-design, internal environmental management, and green purchasing, which are frequently implemented in open-loop and more complex SCs.

Interestingly, informative integration is generally less relevant than technological integration with suppliers when pursuing GSCM. This suggests that data-sharing along the SC is mainly driven by non-primarily environmental goals, such as product quality, flow and stock control, or

lead-time control, which might divert attention from environmental issues. Moreover, the sharing of environmental information - probably because of its complexity - does not enable GSCM practices as much as technological integration, which instead reduces the cognitive distance between buyers and suppliers by increasing the understanding of how the two organisations might orchestrate their environmental efforts.

According to our results, SC managers, both in small, medium and large firms, cannot ignore the role of the OC in guiding the integration dynamics that, in turn, affect the adoption of one GSCM practice or another.

In summary, this study allows purchasing and supply chain managers to better understand how to adopt GSCM practices depending on the culture of their companies. In particular, the study permits the identification of the integration processes to be favoured to exploit different GSCM practices. In defining the GSCM implementation path, our findings underlined the importance of taking the type and level of integration adopted by the company and its organisational culture into account in order to manage and combine economic and human resources in a targeted way.

7. Limitations and directions for future research

As with any empirical study, this research has some limitations. First, to test the conceptual model, we used data from cross-sectional observation, which does not help further disentangle the dynamics of interaction that determine the adoption of GSCM practices over time. Future studies might benefit from using longitudinal data to increase the understanding of causal relations among the investigated variables. Second, we collected data in a single country from formally appointed SC managers, regardless of the length of their experience and of the market (e.g., national/international) in which they operate. Future studies could compare results among different countries and collect more detailed information about the SC managers' activities. Third, we did not include control variables concerning different industrial sectors. Despite not being a priority according to our literature review, future studies could usefully investigate the differences that might arise between industries (e.g. more or less pollutant). As these features might be associated with differences in both the OC and the structures of the involved SCs, such a comparative approach could further support the potential for generalisation of our findings regarding the relations between integration and GSCM practices.

Fourth, we verified a positive relationship between SC integration and GSCM practices and OC and SC integration. These results suggest the implementation of future studies to test the mediation effect of SC integration between GSCM practices and OC.

Finally, we did not investigate the relations between SC integration and other practices that can potentially contribute to the circulation of knowledge and the activation of skills in the pursuit of greener production. Future studies could search for the convergence between SC integration and other forms of development and orchestration of organisational resources, and especially human resources.

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Original Research Papers

Diversity and inclusion management: an analysis of practice developments in Italy[1]

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Abstract

Frame: Diversity and inclusion management is a fast-growing concept and practice in Italy. An analysis of practice developments requires focusing on the Italian contextual change (i.e., macro-national trends) while also considering organizational-specific conditions.

Purpose: To explore how diversity and inclusion management is currently understood and acted upon in the Italian workplace, taking into consideration practice developments.

Methodology: Two case studies of large, multinational companies operating in Italy based on interviews and documentary analysis.

Results: The comprehension and practices related to diversity and inclusion in Italy are evolving towards a leveraging variety perspective to increase innovation and competition outcomes. Furthermore, a nuanced and holistic approach emerges, embracing the variety of the whole person for motivation and wellbeing purposes too. Finally, to manage the risk of losing a shared purpose of the organizing process coming from heterogeneity, internal variety is valued by balancing the need for coherence and unity of action with a culture of diversity and an inclusive language, integrating diversity and inclusion management into core processes and implementing it as part of the company mission.

Research limitations: More cases should be analysed to delve further into current approaches and explanatory contingency factors.

Practical Implications: Organizations should base their approach to diversity and inclusion on nation- and organization-focused sensitivity, considering among others legal and societal expectations and restraints as well as organizational priorities and culture. Furthermore, organizations should adopt ad hoc practices to balance the tensions between the quest for heterogeneity and the quest for a shared purpose.

Originality: This article contributes to diversity research outside of the US, which is much needed. In particular, it scrutinizes practice developments in Italy by building on previous studies carried out in this country according to a longitudinal perspective. Moreover, it offers a detailed qualitative examination accounting for organizational contextual elements too.

Key words: diversity management; inclusion; equality; valuing people; macro-national system; organizational context

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1. Introduction

Equality, diversity and inclusion are intertwined terms (Frémeaux, 2020) that have been at the centre of societal, academic and organizational debate for a long time. North America was the first to introduce legal protections and business policies to facilitate job openings and improve working conditions for minorities (Jonsen *et al.*, 2011). The same term "diversity management" was introduced for the first time in the US in 1987, when the report *Workforce 2000* by Johnston and Packer popularized the increasing heterogeneity of the American workforce and the need for society and organizations alike to face this reality (Kandola and Fullerton, 2004). Since then, national and supra-national laws and recommendations, academic and professional publications and conferences as well as organizational practices have been developed all over the world, under the pressure exerted by globalization, immigration, labour mobility and greater sensitivity in society towards minorities' rights and organizations' socially responsible conduct (e.g., De Anca and Vásquez, 2007; Shen *et al.*, 2009). From an academic viewpoint, research in this area crystallized as a management subfield in the late 1980s (Konrad, 2003) and from that moment on has been developing fast offering a significant variety of conceptualizations, models, empirical results, and management principles. Most of these studies have been developed in the US, which points to the need for non US centric diversity research (Klarsfeld, 2009; Jonsen *et al.*, 2011).

In Italy, diversity management is a fast-growing concept and practice that started to disseminate in the 2000s (Mazzei and Ravazzani, 2008, 2012; Murgia and Poggio, 2014; Ravazzani, 2016). It has been gaining ground over recent years driven by the increased labour-force participation of women and immigrants, the extention of the working age, the guidelines offered by the EU, and the exemplary initiatives imported by multinational companies. Recent reports depict the main current challenges for Italian organizations. For example, the Global Gender Gap Report 2020 of the World Economic Forum (2019) highlights that the average index for wage equity for equal work between males and females is 61.3% worldwide, whereas the index drops to 52.9% in Italy. The European LGBTI Survey conducted by the European Union Agency for Fundamental Rights (2020) outlines that 53% of LGBTI rarely or never declare their sexual orientation; in Italy, this percentage rises to 62%. Moreover, this survey shows that 21% of LGBTI in Europe perceive discrimination at work, with Italian respondents being aligned (22%). Lately, the Covid-19 pandemic has created new challenges for diverse employees, above all for women and working parents (Ellingrud *et al.*, 2020).

Previous research carried out in other European countries (e.g., Svetelik, 2006) stressed that differences in the social, economic, and historical contexts of countries shape employment policies and practice at both organizational and institutional levels, as well as individual experiences in the labour market. Such country-rooted social, economic, and historical contexts therefore frame and influence diversity and inclusion strategy and practices and must be accounted for through contextualized explanations

(Jonsen *et al.*, 2011). While previous research in Italy (e.g., Mazzei and Ravazzani, 2008, 2012; Murgia and Poggio, 2014; Ravazzani, 2016) started to explore diversity management characteristics and practices, there is a need for a new investigation that considers the changed social, economic, and historical conditions in which Italian organizations currently operate.

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While framed within the macro-national context, a company's approach to diversity and inclusion is likely to be shaped also by organization-specific variables (Olsen and Martins, 2012; Shore *et al.*, 2009). Among others, the company's diversity climate or culture embedded into the larger core corporate culture and values, its demographic makeup, level of internationalization, industry, business strategy and market position.

This article takes into consideration the need for contextualized explanations of diversity and inclusion practices, responding to the call for country-sensitive research and especially developed outside of the US (Klarsfeld, 2009; Jonsen *et al.*, 2011) as well as for research considering organization-specific elements (Olsen and Martins, 2012; Shore *et al.*, 2009). Building on previous theoretical and empirical contributions focused on diversity and inclusion in Italy (specifically Mazzei and Ravazzani, 2012; Ravazzani, 2016) in a longitudinal perspective, this qualitative study aims to investigate *how diversity and inclusion management is currently understood and acted upon in Italy, taking into consideration practice developments.*

This article first introduces organizational approaches to managing diversity and arrives at illustrating a comprehensive model based on practice-driven indicators that was previously tested in the Italian context. Second, it presents an empirical study based on two case studies of Italian organizations. Findings articulate the diversity and inclusion policy features linked to the country characteristics as well as to the specific organizational contexts under study. After discussing key insights deriving from the empirical study, the article concludes with theoretical and managerial implications and avenues for future research.

2. Organizational approaches to managing diversity

The rich history of research on and practice of diversity and inclusion starts in the 1960s in North America, where equal employment opportunity laws were first introduced (Jonsen *et al.*, 2011). Over the years, organizations started to adopt a more proactive and deliberate approach pushed by the emerging conviction that diversity creates competitive advantages (Cox and Blake, 1991). This entailed a shift from a focus on few socio-demographic dimensions to an enlarged array of diversity dimensions, with the development of strategies aimed at embracing the variety of the whole person (Mazzei and Ravazzani, 2012; Milliken and Martins, 1996; Ravazzani, 2016).

In the academic field, international scholars put their effort in developing typologies classifying diversity-related managerial approaches based on the level of organizational heterogeneity and/or cultural perspective adopted towards diversity (Cox, 1991; De Anca and Vásquez, 2007; Liff, 1997; Thomas and Ely, 1996). Such typologies contributed to inspire a large

debate both in the academic and professional communities. Nonetheless, they present some major limitations: they do not take into consideration contextual factors, especially the country where an organization operates which influences diversity issues, organizational priorities, legal and societal restraints (Klarsfeld, 2009; Shen *et al.*, 2009); they do not put in sufficient light the fact that organizations do not necessarily follow an evolutionary path in approaching diversity management (Süβ and Kleiner, 2008; Klarsfeld, 2009); most of them neither detail practice-driven indicators to understand how organizations behave beyond espoused statements (Olsen and Martins, 2012) nor link overarching approaches with organizational contextual factors (Jonsen *et al.*, 2011).

Keeping in mind such limitations, Mazzei and Ravazzani (2008, 2012) and Ravazzani (2016) developed a model that builds on and extends extant typologies from international literature. The model details three possible approaches to diversity management: "Assimilating Minorities", focused on guaranteeing equal opportunities for traditionally under-represented groups and legally protected attributes, with few practices and resources in place; "Integrating Diversity", geared towards addressing social expectations with voluntarily actions considering a greater array of socio-demographic features and of managerial practices; and "Leveraging Variety", a more structured approach attentive towards competitive advantages accessible through the variety of competencies and knowledge-related differences of employees. The model outlines a set of indicators that help detect which approach organizations embrace based on what they actually do, i.e., aim, dimensions, practices, management structure, benefits, negative effects. Additionally, it assumes that elements typical of an approach can co-exist in a particular organizational context and be re-elaborated according to the specific national context of reference.

Figure 1 visualizes in detail this research model, which offers a tool for understanding how companies might work with diversity in practice under a certain dominant perspective.

To test this model in Italy, Ravazzani (2016) conducted an empirical study based on a survey and two focus groups with managers and experts. Results related to the practice-driven indicators revealed the prevalence of an "Integrating Diversity" approach: companies mainly focused on addressing internal and external social expectations, placed centrality on gender and parenthood discourse, and valued practices aimed at internal wellbeing (e.g., work-life balance policies) and external reputation (e.g., partnerships with external institutions), which clearly reflects the priorities in the social agenda and legislative make-up of Italy. She also tested the role of organizational contextual factors that may influence the adoption of a certain organizational approach (Olsen and Martins, 2012; Shore *et al.*, 2009): diversity culture; level of internationalization; and business strategy. Interestingly, results indicated that companies most focused on meeting social expectations are of Italian origin and do not have a long history of diversity commitment, apparently influenced by isomorphic pressures and the need to secure legitimacy in their environment. Also, equal opportunities appeared as an ever-present milestone in Italian organizations, regardless of the length of their commitment and corporate

culture, while only internationalization explained the probability that Italian organizations would pursue competition through diversity. On the whole, previous empirical findings highlight that Italian organizations have not followed a temporal or stepwise progression in their diversity approach and that the business case for diversity in this country reflects both the macro socio-cultural system and organization-related contextual factors.

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Fig. 1: A practice-driven framework: from Assimilating minorities, to Integrating diversity, to Leveraging variety

Approach / Indicators	Assimilating Minorities	Integrating Diversity	Leveraging Variety
Aim	Equal opportunities	Social expectations	Competition
Dimensions	Gender, parenthood, and disability	Race, nationality, language, religion, sexual orientation, age	Competencies, knowledge, networks
Practices	Quota systems	Flexible working, work-life balance, expansion of the recruitment pool, training, partnerships with dedicated institutions and networks, internal and external communication	Heterogeneous teams, employee networks, diverse suppliers, employment in innovation-related areas, evaluation of policy objectives
Management structure	Barely existent	Dedicated role and planning	Dedicated structure, planning and budget
Benefits	Equity of treatment, reduced lawsuits	Employee motivation, corporate image	Innovation, new markets
Negative effects	Lowering of hiring and promotion standards, negative self-perceptions of competence	Increased conflicts, reverse discrimination	Pigeonholing

Source: Ravazzani, 2016.

3. Methodology

Following this line of context-sensitive diversity research and adopting a longitudinal perspective, this study builds on the practice-driven framework and related empirical findings (Mazzei and Ravazzani, 2012; Ravazzani, 2016) and adopts a case study methodology for gaining rich insights into *how diversity and inclusion management is currently understood and acted upon in Italy, taking into consideration practice developments.*

Case study research allows researchers to produce concrete knowledge embedded in real-life situations and with multiple wealth of details (Flyvbjerg, 2006). Following an information-oriented selection to maximize the usefulness of information from small samples and single cases, this study considered for in-depth analysis two organizations of large size, with multinational presence, and with a formal diversity policy as publicly stated on their corporate website. Company A has foreign origins and operates in the telecommunications sector, employing about 6,000 people in Italy. Company B is Italian and is an energy infrastructure operator, employing about 3,000 people in Italy.

The researchers collected multiple forms of evidence for quality case study research (Yin, 2003) between November 2020 and February 2021 through desk data analysis focused on corporate documentary sources, e.g., corporate presentations of diversity policies and practices and dedicated pages from the corporate website; and field data analysis focused on qualitative interviews with managers responsible for diversity and inclusion in their organization. The two managers interviewed from Company and A and the one from Company B work in the areas of human resource management and of employee communication.

Interviews were carried out to gather perspectives and concrete experiences of "knowledgeable agents" (Gioia *et al.*, 2013) telling their own stories in their own words (Daymon and Holloway, 2011). Following a semi-structured approach, interviews addressed managers' experiences, behaviour, and opinions (Patton, 2002) in relation to their understanding of diversity, the specific make-up of their workplace, and practice-driven indicators. Interviews were conducted electronically via Microsoft Teams due to the current pandemic context, each lasting on average 60 minutes. They were video-recorded and transcribed for analytical purposes to identify central concepts and then themes and patterns within and across interviews (Gioia *et al.*, 2013), which were further integrated with insights from the thematic analysis performed on company documents.

Below, key results from the analysis are firstly presented case by case, and then visually compared through Figure 2 according to the practice-driven framework. The comparison is further expounded in the discussion section.

4. Findings

In Company A, the diversity management *aim* changed over the years. The path started in 2014 with some internal initiatives, but a more structured commitment started in 2016 when the company joined the United Nations Global Solidarity Movement for Gender Equality with the "HeforShe" programme. The global CEO was an ambassador for the programme. In the same year, the company organized an internal roadshow in Italy involving 600 employees to define the company inclusion agenda, the so-called "Manifesto". With a bottom-up approach, employees worked together to outline more than 100 proposals in four inclusion areas: gender, to increase equality; sexual orientation, to foster respect for people of any orientation; generation, to value the contribution of people of all ages; background, to embrace employees of different cultures or from different company branches. Employees, moreover, co-created the company inclusive mission: "*a declaration that is still hanging on all company billboards*", the internal communication manager reveals. The "Manifesto" was a fundamental step in the diversity management approach of Company A, also leading to the concrete implementation of a series of initiatives proposed by employees themselves. On that occasion, the figure of the Inclusion Leader was also established: about twenty managers were assigned to all of the four areas.

In 2020, the aim of Company A shifted from managing diversity to managing inclusion. In the words of the HR manager, "*if diversity was seen primarily as an ethical issue, inclusion is now framed as a business value in terms of corporate reputation and employee engagement and attractiveness*". "Inclusion for all" is now one of the three purpose pillars of the company strategic framework. Again, the HR manager underlines: "*This puts diversity and inclusion at the core of the corporate mission. The goal is also to create a workforce that mirrors and understands customers' differences*".

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Gender and parenthood emerge as the main diversity *dimensions* currently addressed. In fact, most common *practices* are mostly related to promoting equality through: maternity and parental leave policies that go beyond those granted by law; parental smart working policies; work shifts policies that accommodate childcare needs. In addition, over the years Company A developed two hiring programmes for women: "Plus 1 Woman", an internal programme consisting in hiring one more woman in a managerial position for each department; and "ReConnect", an external programme focused on reintegrating women into the labour market after having resigned or lost their jobs. Considering the gender dimension, the company is also a founding member of "Valore D", a project supporting companies in developing growth paths for female talents and supporting their path to top management positions. In Company A, approximately 30% of people having managerial responsibilities are women. Company A is also committed against domestic women violence with internal policies and external actions, e.g., a mobile app that helps women to react to domestic violence.

In the last few years, Company A worked actively also on another diversity dimension: sexual orientation. The HR manager highlights in this context that "*one of the first steps was working on inclusive language*": in 2017 the company promoted a training programme for all managers called "Be Inclusive" focused on the LGBT theme. Nowadays, there is an internal community on sexual orientation with a chairperson and a top manager as a sponsor.

For the future, Company A intends to work more on the age dimension, after realizing that only 18% of employees are over the age of 50. Another future topic is neurodiversity to develop talent.

While in the past local offices could independently decide on the focus and intervention in the area of diversity and inclusion, nowadays the global Group is "*much more directive and enlightening, because there are issues that we don't see, or we do see too late*" as the HR manager highlights. For instance, the global headquarters suggested to focus on ethnicity, following the Black Lives Matter movement, even though this was not initially perceived as a hot topic by the Italian local office.

Practices are communicated internally through the newsletter and the Intranet. Also, the HR manager reveals the company's efforts "*to make communication more interactive involving employees as ambassadors*". Externally, Company A communicates only the most important initiatives. To improve the storytelling of their commitment, in 2020 they carried out a communication campaign to address the issue of diversity inequality in the technology industry.

Considering the *managerial structure*, Company A does not have a dedicated organizational unit but a person in charge of managing diversity and inclusion initiatives. A specific budget is allocated to this area. Considering the global company, each country has a referent who communicates with the headquarters. Moreover, the Inclusion Leaders still exist even if less involved. For the future, the company intends to locate a sponsor for each stream of work, responsible for creating communities and coordinating with the D&I Lead.

Regarding the benefits, Company A measured greater voice behaviours among employees about diversity. The HR manager cites as an example that "*after the roadshow the company witnessed a growing number of employees coming out, and also in the last internal climate survey more than 80% of employees declared their sexual orientation*". Moreover, in 2021 Company A was recognized as one of the twenty most inclusive brands in Italy by the Diversity Brand Index 2021, a research project promoted by Diversity and Focus MGMT and aimed at measuring the ability of companies to effectively develop a company culture oriented to diversity and inclusion. Company A was selected specifically for its commitment to fighting all forms of violence against women.

On the other side, Company A experienced negative effects in forcing a KPI related to achieving a greater gender mix in the "Plus 1 Woman" initiatives. As explained by the HR manager, "*establishing a percentage of women to be placed in top positions created an opposite effect in the male workforce who did not recognize the value of this initiative*". Moreover, women seem to remain a step back to men: "*typically, a woman does not ask more in terms of salary and career in comparison to a man with the same experience and competence in the company*". This is also an effect of the KPI in that "*women wait and do not claim*". Company A is now working on mending these issues. According to the manager, another negative effect of forcing a greater gender mix is that "*managers aiming for one man and one woman often fail to search for the best talents regardless of their gender*".

In Company B, the diversity management aims are making the company more competitive and innovative through different skills and competences, fostering integration between different business areas, and increasing effectiveness in innovation processes and interdisciplinary projects. Moreover, in the words of the interviewed manager, Company B aims to create "*a corporate culture that is inclusive and respectful of diversity, thanks to a safe and welcoming work environment*". Safety is one of the key company values and "*protecting diversity is a way to make employees feel safe when they express their personality and needs*". The diversity commitment started in 2017 thanks to the CEO's endorsement.

Considering the diversity *dimensions*, gender was the first to be addressed with the goal to attract and promote women in the professional fields linked to the company. Like Company A, Company B is a founding member of "Valore D", and participates in the Inclusion Impact Index developed by this Italian association which provides a sector benchmark related to governance and ability to attract and retain female talents. The company's index in 2019 was 54.1/100, with a satisfactory recognition in terms of talent development but a lower performance in terms of

attractiveness towards the female labour market. In terms of numbers, in Company B women account for nearly 15% of the employees, 1.5 points more than in 2017; four of them work in the leadership teams. Recently, Company B has begun to work also on: generational diversity, where 36% of the employee population is represented by Millennials; sexual orientation, becoming a member of Parks, a non-profit organization focused on people belonging to the LGBT category; disability; and cultural diversity.

Regarding the choice of the diversity dimensions to work on, Company B regularly performs an international benchmark to assess whether there are dimensions that are not current issues in the Italian context but are much more important in other countries, for instance LGBT in the US.

The key *practices* are focused on promoting a culture of respect towards diversity in a broader sense. Company B has begun to work on all the diversity dimensions with the aim of valuing "*personality diversity*". Such practices cover four main areas: employer branding and talent acquisition, to ensure equal opportunities to external candidates; training, to increase internal awareness of diversity issues; development, to consolidate a diversity culture within the company's value system; communication, to spread an inclusive language throughout the organization. Examples of practices include a diversity policy considered by the manager as essential "*to guarantee fairness in all phases of employment, training, and work-life balance initiatives*"; a training video on unconscious biases in the selection process; training talks about diversity issues; a diversity performance management system; a Manifesto promoting the use of an inclusive language. Regarding inclusive language, Company B has organized two training sessions for People managers focused on generational and sexual orientation diversity.

Considering the gender dimension, the first to be addressed by this company, some practices aim to attract and promote women in the scientific fields. They cover three stakeholder groups: community, e.g., through scholarships devoted to high school female students; employees, e.g., through programmes that develop managerial skills of working parents; partners, e.g., through the collaboration with actors and institutions expert in the area of gender diversity.

Practices are communicated internally through the Intranet and emails, regarded by the manager as crucial "*to push initiatives to all the company population*". Externally, Company B relies on social media, especially LinkedIn and Instagram, and press releases to give visibility in the media to the most important initiatives.

Considering the *managerial structure*, in 2020 Company B created a new team called "Human Capital Development, Diversity & Inclusion". This unit supports the diversity and inclusion goals defined by the top management, in alignment with the corporate strategy. These goals are integrated with environmental, social and governance (ESG) factors in both long and short-term incentive policies. While cooperating with the function responsible for ESG policies, the unit also coordinates a cross-functional team called "Inclusion team". The team involves 35 employees responsible for proposing, directing and monitoring all initiatives related to the development of an inclusive organizational culture. To find the

members of the Inclusion team, Company B launched a call to action to which 150 employees signed up. The manager explains that the company selected the Inclusion team members "*covering all the company functions and considering diversity in terms of age, gender, hierarchical level, country of origin, culture, disability, sexual orientation and personal style*". The team has a dedicated budget and presents its plan and results twice a year to a steering diversity and inclusion committee.

Regarding the *benefits*, since 2020 Company B has measured how much employees felt included getting excellent results according to the company's expectations. Considering the gender and generational diversity, the company ended up hiring more women and young people. Moreover, in 2020 Company B had their first female factory worker. Perceived benefits also include the possibility of being part of a network of companies dealing with diversity issues. All in all, the manager states that for the time being Company B "*does not experience significant negative effects related to their diversity initiatives and policies*". Figure 2 offers a comparative view of the two analysed cases based on the practice-driven framework.

Fig. 2: A comparison of the two diversity and inclusion programs based on the practice-driven framework

Indicators	Company A	Company B
Aim	Social expectations, yet inclusion is increasingly regarded as a business value and part of the corporate mission	Competitiveness through different skills and competences coupled with attention to creating a safe and welcoming work environment, where inclusion ensures employees' feelings of safety and well-being
Dimensions	Gender, parenthood, sexual orientation, age/generation	Gender, parenthood, sexual orientation, age/generation, disability, culture from a perspective of "personality diversity"
Practices	Gender -based hiring quotas, work-life balance policies, training, internal communication (e.g., billboards with diversity mission and manifesto of inclusive language), external communication and actions (e.g., partnerships with institutions, public awards)	Employer branding and extension of the recruitment pool, work-life balance initiatives, training, internal communication (e.g., manifesto of inclusive language), external communication and actions (e.g., partnerships with institutions)
Management structure	Coordinating role, Inclusion Leaders, and dedicated budget; top management endorsement	Dedicated unit also coordinating a cross-functional Inclusion team, budget, planning accompanied with diversity performance evaluation and in alignment with corporate strategy; top management endorsement
Benefits	Improved corporate reputation, employee engagement and attractiveness for less represented categories, voice behaviours, customers' understanding	Improved employee engagement and attractiveness for less represented categories, networking with other companies, innovation capabilities
Negative effects	Reverse discrimination felt by men; quotas do not guarantee that the best talents are hired	Perceived as not surfaced yet

Source: own elaboration

5. Discussion and conclusions

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This study investigated how diversity and inclusion management is evolving in the Italian workplace looking at practice developments. From the analysis of the two case studies some common elements stand out.

First, taking stock of the practice-driven indicators (Mazzei and Ravazzani, 2008, 2012; Ravazzani, 2016), the companies reveal a diversity and inclusion management approach paying equal attention to social and business-oriented aspects. Company A places strong focus on meeting social expectations, according to an "Integrating Diversity" approach, but most recently also on increasing company competitiveness, closer to a "Leveraging Variety" approach. On the one hand, the action geared towards safeguarding equal opportunities for women is coupled with practices focused on a greater array of differences that increase equity of treatment as well as employee motivation and wellbeing, addressing the heightened sensitivity in society towards these issues. On the other hand, diversity and inclusion are placed at the core of the company strategy with the competitive goal of better understanding the customers' diverse makeup and needs, where "systemic diversity" (Christensen *et al.*, 2008) helps to sense and acknowledge differences in the organizational surroundings. Company B is more clearly inspired by a "Leveraging Variety" approach where diversity, especially in its dimensions of competencies and skills, is pursued for and evaluated against competitive and innovation outcomes. Still the wide array of diversity dimensions considered by Company B and its focus on ensuring employees' safety and well-being highlights its holistic vision of diversity. This is in line with what Frémeaux (2020) suggests: companies should not see the rationales for equality, diversity, and inclusion as separate but rather embrace and mould economic, social, and moral aspects.

Second, the companies' diversity and inclusion strategy and practices reveal sensitivity and responsiveness to the macro socio-cultural system in which they operate (Jonsen *et al.*, 2011). Gender and parenthood appear as the most relevant dimensions addressed in both cases with practices focused on flexible working, work-life balance, extension of the recruitment pool. This finding could be linked to the specific Italian societal context, where women's rights and gender equality issues are at the centre of the current public debate agenda in terms of gender pay gap (World Economic Forum, 2019), low presence of women in the C-suite (Osservatorio 4. Manager, 2020), lack of women in scientific studies (Save the Children, 2021), violence against women (Istat, n.a.), and sexual harassment (Save the Children, 2020).

Considering these two common features, this study confirms a nuanced and holistic view of diversity and inclusion management in Italy, as already emerged in the previous study of Ravazzani (2016). Society (societal demands), organization (corporate culture) and individual (personal awareness and growth) levels are to be seen as equally relevant and pursued simultaneously in a more balanced approach to diversity and inclusion (De Anca and Vásquez, 2007). Results show that both Company A, which has foreign origins, and Company B, which is Italian, do not

follow a predetermined path but rather build their own approach based on macro socio-cultural influences as well as organization-related factors and needs. Considering organizational conditions, the international nature of both companies makes them exposed to the globalisation of diversity management concepts and prone to see diversity as an asset to innovate and respond to heterogeneous customer needs (Ravazzani, 2016). Other organization-specific elements, however, explain differences in their approach: for example, linking diversity to their corporate strategy, Company A places more emphasis on women and (technological and non-technological) gender divides, while Company B focuses on safety and varied competencies for interdisciplinary collaboration.

The analysis of the two companies also gives insights into the organizational challenge created by the increase of heterogeneity in workplaces, regardless of the national context in which an organization may operate: the risk of losing shared organizational identity and purpose leading the organizing process. Organizations look for integration and consistency while, simultaneously, hope to retain sufficient diversity to operate and better respond to complex markets (Christensen *et al.*, 2008). The two case studies show three practices capable of containing the risk of losing shared organizational identity and purpose: a) developing a culture of diversity and an inclusive and respectful language; b) integrating diversity into core processes; c) implementing diversity as part of the company purpose.

a) Both companies are highly involved in the *development of a culture of diversity*: Company A puts diversity and inclusion at the core of the corporate mission and tries to build a shared diversity agenda with a bottom-up process (the Manifesto) involving the entire organization; similarly, Company B aims to create an inclusive corporate culture. Literature underlines that to take advantage from internal diversity, organizations should develop an organizational setting where diversity is present at all organizational levels and conceived as a basic value in the corporate culture to be embraced and encouraged (Cox, 1991; Holzinger and Dhalla, 2007). Interestingly, both companies strive to build an *inclusive and respectful language*. This supports the idea of language as a means for leading cultural change in organizations through sensemaking (Weick, 1995) and as a starting point for creating a common background for mutual understanding (Pless and Maak, 2004). People inside an organization should foster the "*competencies of inclusions*": respect and empathy, recognition of differences together with equality, appreciation for different voices, frank communication, participation, integrity, consultative leadership (Pless and Maak, 2004). While a language respectful of all differences is key to sensemaking, scholars advise to preserve strategic ambiguity to create a unified diversity: the ability for differences to co-exist within the unity of the organization, essential to the process of organizing (Christensen and Cornelissen, 2011; Eisenberg, 1984). To this end, polyphony may even be a conscious organizational strategy designed to foster identification and reduce tension by allowing different audiences to apply multiple interpretations to what is seen as one corporate message (Christensen *et al.*, 2010).

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b) A second practice is the effort to *integrate diversity into the core processes* of the two organizations for a better competition. Company A wants to increase diversity for a better understanding of customers' needs; Company B values diversity to sustain innovation processes and interdisciplinary projects. This strategic take on diversity allows to manage the so called "controlled chaos" (Wang and Rafiq, 2009, p. 17), i.e. integrating diversity into the implementation of organizational goals to protect the effectiveness of coordination, cohesiveness, and collaboration, as well into the company's mainstream work and core functions (Thomas and Ely, 1996).

c) Finally, the two case studies underline how the companies are implementing *diversity as part of the company purpose*. In both companies, diversity commitment is of quite recent introduction but is part of the corporate mission, sponsored by the top management and linked to social causes. The analysis shows that in these two companies, diversity is becoming part of the organizational purpose (Danesh, 2020; George *et al.*, 2021). Having a socially desirable purpose facilitates the coexistence of multiple perspectives, values, and cultures (Di Fabio, 2017). Developing at the organizational level a purpose that is oriented to the societal pressures and that can be recognized as desirable from all organizational members allows organizations to create a zone of acceptance in the long run (De Anca and Vásquez, 2007).

To sum up, this study contributes to understanding practice developments related to diversity and inclusion in Italy and does so from a longitudinal perspective, building on previous research efforts (i.e., Mazzei and Ravazzani, 2012; Ravazzani, 2016). First, it confirms the relevance of a nuanced approach embracing the variety of the whole person to increase motivation and wellbeing as well as to value individual competencies and knowledge-related differences for competition. Second, it highlights the significant effort of both companies towards the gender issue, showing that country-specific factors contribute to steer the diversity and inclusion management practices of organizations in Italy. In this sense, this study underlines the relevance of adopting a national perspective (Klarsfeld, 2009) since specific factors that shape the understanding and practice of diversity and inclusion management in organizations, such as anti-discrimination legislation, history of immigration, productive system, social and cultural features, all differ among countries. Also, such a country-sensitive perspective must be complemented by attention to organizational factors and needs that may similarly shape the organizational approach (Olsen and Martins, 2012; Shore *et al.*, 2009). In line with these context-aware considerations, this study also shows the need to balance the quest for employee heterogeneity with the quest for collective meaning creation and shared purpose by developing a truly inclusive culture, embedding diversity into core organizational processes, and adopting an organizational purpose that is oriented towards societal expectations and evolution.

Practical implications

Considering the findings of this study, organizations are advised to take into consideration their context specificities when shaping their diversity

and inclusion approach and initiatives. This can help organizations to sustain the relevance of their efforts at a societal level and sustain the engagement of their employees in diversity and inclusion management initiatives. Moreover, organizations are to face the crucial challenge of balancing the quest for heterogeneity with the quest for collective meaning creation and shared purpose. This challenge can be overcome by adopting organizational practices such as the creation of an inclusive organizational culture, where variety is one of the key organizational values; the incorporation of diversity into organizational processes; the creation of an organizational purpose oriented to societal pressures which function as a centre of gravity for the organizing process around which a certain degree of diversity can be tolerated. The acceptance of the organizational purpose represents the minimum degree of similarity required to engage people in a meaning creation process with an acceptable rate of success.

Future research

From a methodological point of view, the case study approach allowed to delve into the specificities of selected organizational realities to see how diversity is understood and acted upon in practice. Similarly, other studies carried out in different national contexts with a case study methodology have offered such detailed examinations, revealing for example the ambiguities, contradictions, and paradoxes created in the efforts to implement diversity management (e.g., Risberg, 2020).

Additional studies are needed to enlarge the number of companies and organization-specific conditions explored in Italy, including for example local companies as well as multinational companies of Italian and non-Italian ownership. Moreover, findings are to be integrated with a deeper analysis of explanatory contextual factors, including the organizational factors already explored in Ravazzani (2016), to understand "whether and how an organization's approach might change over time and/or in accordance with environmental demands" (Olsen and Martins, 2012) following the "rhythms of contingencies" (Risberg, 2020). In this sense, this study lays the foundations for new quantitative research to continue in this longitudinal perspective. Finally, future comparative research could analyse in more detail if and how formal policies and guidelines play out the way they are stated, and are given shape in the interpretation of the managers responsible for these policies; also, particular attention should be given to the employees' perspective to understand how they perceive both corporate policies and managers' efforts.

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The influence of green practices and green image on customer satisfaction and word-of-mouth in the hospitality industry

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Abstract

Frame of the research: *As sustainability aware consumers represent a substantial market segment, green practices and green positioning are becoming strategic to enhance competitive advantage.*

Purpose of the paper: *This study investigates whether the presence of green practices or a green image in the accommodation sector influences customer satisfaction and eWOM and whether this differs between different accommodation categories.*

Methodology: *The TripAdvisor reviews of 1701 Italian hospitality business were analysed using descriptive and inferential statistics.*

Results: *Accommodation facilities with green practices present high scores in guest satisfaction and eWOM, particularly those with a green image. The differences in customer satisfaction between accommodation types is smaller for businesses with a green image. B&Bs, agritourism facilities, and other accommodation facilities, even those without a green image, can rely on green practices to increase customer satisfaction and eWOM.*

Research limitations: *We considered the use of green features in the name of the accommodation facility as a proxy for sustainability alignment. Customer satisfaction could be affected by other variables. The sub-sample of "green name" companies is limited. The size and age of the accommodation facility could impact the number of reviews.*

Practical implications: *Our results provide valuable insights into the determinants of customer satisfaction and intention to review a green practice and suggest the need to communicate a green orientation.*

Originality of the study: *Our study extends the investigation to different accommodation types; considers the green image of the accommodation facilities rather than green certification; compares customer satisfaction and eWOM with or without a green image by accommodation type.*

Key words: Hospitality industry; sustainable tourism; customer satisfaction; green practices; online reviews; eWOM

1. Introduction

Over time, growing environmental concern has led many consumers to consider the environmental impact of their purchases. According to the Eurobarometer surveys on climate change, consumers who pay attention

to sustainability issues represent a substantial market segment (Egea and Frutos, 2020).

In the tourism industry, destinations, transport operators, attractions, accommodation facilities, and intermediary companies are implementing green practices increasingly often (Blanco *et al.*, 2009) in order to respond to a growing segment of tourists who pay attention to environmental protection. In this way, tourism companies aim to maintain or even enhance their competitive position (Goffi *et al.*, 2018).

However, consumers' growing sensitivity towards ecological issues does not automatically translate into sustainable consumer behaviour for several reasons, such as force of habit, product performance, availability, affordability, conflicting priorities, and scepticism towards corporate greenwashing (Goh and Balaji, 2016; Miniero *et al.*, 2014). Therefore, despite the commitment to developing eco-friendly products, tourism companies sometimes face challenges in changing consumer preferences, suspicion regarding ecological advertising claims, and an unfavourable consumer perception towards these eco-friendly products (Rahman *et al.*, 2015).

It is therefore crucial to explore whether consumers pay attention to environmentally friendly practices related to tourism. Recent literature has investigated whether the adoption of green practices, eco-certification, and the communication of these environmental protection efforts in the hotel industry correlate with customer satisfaction, customer loyalty, or willingness to pay more and recommend the hotel to others (e.g., Abrate *et al.*, 2020; Baratta and Simeoni, 2021). However, previous studies have been carried out in the context of hotels, particularly green-certified hotels (e.g., Tang and Lam, 2017; Trang *et al.*, 2019; Wu *et al.*, 2016), without considering other kinds of accommodation types, and presented mixed results. Small and medium enterprises, which are prevalent in the tourism industry and include other types of accommodation facilities, seem to be reluctant to communicate their sustainability messages and to use their sustainability actions to attract customers (Font *et al.*, 2016). However, it is essential to convey sustainability messages to attract sustainable tourists (Hedlund *et al.*, 2012).

Using the data from TripAdvisor reviews, we studied Italian hospitality businesses to empirically investigate whether the presence of green practices pays in terms of customer satisfaction and activate eWOM on the green practices adopted; whether strongly green-focused accommodation facilities stand out both in terms of customer satisfaction and in terms of customer willingness to spread eWOM on the accommodation facilities' green practices; whether there are any differences both in terms of customer satisfaction and in terms of customer willingness to spread eWOM on accommodation facilities' green practices between strongly green-focused and not strongly green-focused accommodation facilities by accommodation types.

Our findings show that Italian hospitality businesses with green practices that activate guests' eWOM on these practices seem to show high overall scores in terms of guest satisfaction, and that strongly green-focused accommodation facilities (e.g., with green attributes in the name)

outperform others both in terms of customer satisfaction and eWOM on the green practices adopted. Furthermore, the analysis by accommodation type suggests that, beyond accommodation facilities with a solid green image, B&Bs, agritourism facilities, and other accommodation facilities, even those a green image, can rely on green practices to increase customer satisfaction and improve customer behaviour.

By comparing accommodation facilities with or without a green image in terms of customer satisfaction and eWOM on green practices, we provided a broader picture on sustainable tourism from a consumer perspective, and we provided insight into the conditions under which the presence of green practices in the tourist accommodation sector is perceived and stimulates a reaction from guests. The differences identified could help to explain the contrasting results of previous research on green consumer behaviour and sustainable tourism. The following section provides an overview of the literature regarding green practices in the hospitality industry, green image, and their effect on customer satisfaction and behavioural intentions. Next, the authors describe the methodology, including data and measures, followed by the results. Subsequently, the theoretical and managerial implications are presented, together with research limitations and suggested future lines of research.

2. Literature review

2.1 The influence of green practices on customer satisfaction and behaviour

Research on consumer attention to green practices in the accommodation sector is gaining importance (D'Acunto et al., 2020). The recent literature has investigated whether the adoption of green practices, eco-certification and the communication of these environmental protection efforts in the hotel industry correlate with customer satisfaction, customer loyalty, or willingness to pay more and to recommend the hotel to others (Olya et al., 2021). However, the results are discordant: on the one hand, some scholars showed that customer satisfaction is not reduced if green practices are not implemented (Bruns-Smith et al., 2015), on the other hand, several studies revealed that there is a significant relationship between green practices and customer satisfaction (Prud'homme and Raymond, 2013). Some authors found that the communication of green practices can create suspicion and scepticism among consumers (Rahman et al., 2015).

Ettinger and colleagues (2018) showed that among guests' comments on hotels' corporate social responsibility (CSR) engagement, green practices are most commented upon in online customer reviews together with supplier relations. D'Acunto et al. (2020) documented that green practices in the hotel industry lead to more positive emotions and higher ratings in consumers' reviews, though only a limited number of reviews pay attention to green practices. Likewise, Lee et al. (2016) showed that the majority of guests respond positively towards green practices when they are able to recognize them, whereas a lack of awareness about hotels' green practices can cause guests to feel inconvenienced during their stays.

As far as we know, previous studies have been carried out in the context of hotels, particularly green-certified hotels (e.g., Wang *et al.*, 2018), and presented mixed results. It should be noted, however, that not all green hotels are certified. Indeed, since committing to a certification procedure is time-consuming and expensive, many hotels choose not to get an official certification. Therefore, previous literature has neglected the hotels that, even without an official certification, might be adopting green practices and communicating a green message to their customers (Yusof *et al.*, 2017).

Hence, and in light of the aforementioned restricted focus, a further empirical examination is necessary to more fully understand whether adopting a green practice pays in terms of customer satisfaction and behaviour, for instance, online reviews (i.e., eWOM) of accommodation facilities green practices, regardless of whether or not the facility has a green certification.

Thus, this study aims to address the following research question:

Research question 1 (RQ1): Does adopting a green practice in the accommodation industry pay in terms of customer satisfaction and activate eWOM on the green practices adopted?

2.2 The influence of green image on customer satisfaction and behaviour

Some scholars have also tried to study the relationship between green image in the hospitality industry and customer satisfaction and behaviour. For example, the adoption of eco-certification and the communication of these environmental protection objectives in the hotel sector are related to customer satisfaction by some authors (Gerdt *et al.*, 2019; Merli *et al.*, 2019). Previous articles argued that a green image could improve perceived quality level among customers (Robinot and Giannelloni, 2010), though few empirical research papers have studied this phenomenon. In the study by Lee *et al.* (2018), a positive correlation between green image and perceived quality was explained by customers considering the hotel's green practices as a value. Therefore, when the customer notices the hotel's efforts towards environmental protection, the perceived quality level increases or at least does not decrease in the event of lower service performance.

Regarding the relationship between a green image and customer behaviour, Lee *et al.* (2010) showed that a green hotel's overall image positively influences customer behavioural intentions to revisit and to spread word-of-mouth, as well as willingness to pay a premium. On the contrary, Leaniz *et al.* (2018) did not find any significant effect of green image on the intention to spread positive word-of-mouth about environmentally certified hotels.

In particular, as far as we know, no studies are investigating the effects of a clearly communicated green image, such as where the accommodation facility uses a green reference in the name in order to obtain a green positioning, nor are there studies comparing the difference between implementing of green practices and adopting solid green positioning.

Therefore, we aim to answer the following research questions:

Research question 2 (RQ2). Do strongly green-focused accommodation facilities stand out in terms of customer satisfaction?

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Research question 3 (RQ3). Do strongly green-focused accommodation facilities stand out in terms of customer willingness to disseminate eWOM on the facility' green practices?

In addition, as already highlighted, previous studies have been carried out in the context of hotels, particularly green-certified hotels, which do not cover all accommodation categories although they are gaining importance in many tourist destinations (Candela and Figini, 2010). In this study, several types of accommodation facilities (i.e., businesses that offer a place to sleep and related services to tourists) are considered as different categories of offer corresponding to diverse demand segments. Generally, consumer sensitivity towards sustainability differs between segments. In particular, consumers' reactions to green practices change across specific hotel segments (Barber, 2014), and therefore we can also expect them to change across accommodation segments. Therefore, other types of accommodation facilities such as agritourism facilities, bed and breakfasts, and hostels should be considered. The agritourism concept refers explicitly to a joint practice of agricultural and tourism activities that offers guests an experience of countryside living and culture, an active or passive involvement in farming, and authentic food (Phillip *et al.*, 2010). Bed and breakfasts are mostly family-run; they are cheaper than most hotels and they suit travellers who want to meet and engage with local people (Chiu, 2018). Hostels typically have shared rooms with bunk beds, and therefore, they are one of the cheapest forms of accommodation (Veríssimo and Costa, 2019).

Subsequently, we intend to answer the following research questions in the context of different types of tourism accommodation facilities:

Research question 4 (RQ4). Are there any differences in customer satisfaction between strongly green-focused and not strongly green-focused accommodation facilities by type of facility?

Research question 5 (RQ5). Are there any differences in customer willingness to spread eWOM on accommodations' green practices between strongly green-focused and not strongly green-focused accommodation facilities by type of facility?

3. Methodology

3.1 Data and measures

In order to collect data on Italian hospitality businesses with green practices that activate eWOM on the facility's green practices, we used the TripAdvisor database. TripAdvisor is the world's largest travel platform. It has collected more than 859 million reviews and opinions in 28 languages on 8.6 million accommodation facilities, restaurants, experiences, airlines, and cruises across 49 countries, and it is browsed by 463 million travelers each month[1]. Several scholars have used online reviews to evaluate consumers' awareness of environmental and social issues (e.g., Brazytė

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[1]   https://tripadvisor.mediaroom.com/us-about-us [22/07/2020]

et al., 2017), as the opinions are posted spontaneously by tourists, unlike traditional surveys and interviews. Online reviews are considered more objective, without sample and results bias (Schuckert *et al.*, 2015). We collected the online reviews through Import.io, a web data extractor. We extracted the data from TripAdvisor webpages on accommodation facilities located in Italy. We looked for reviews containing the following keywords: sustainable, ecological, renewable, photovoltaic and bio-architecture. The crawler was run on 25 January 2020. We collected 2724 mentions of the keywords related to 1701 Italian accommodation facilities. For each review containing one or more keywords, we extracted the following data regarding the corresponding accommodation facility: the name of the accommodation facility, the total number of reviews, its address, and the number of times each keyword was mentioned in the reviews.

The initial database exported from Import.io was completed with the following variables: the total TripAdvisor score assigned by the guests (from 1= Very poor to 5=Excellent) (SCORE); the accommodation type (B&Bs, Agritourism facilities, Hotels, Other accommodation facilities) (TYPE); the total number of keywords mentions (GREEN eWOM). Finally, we added a dummy variable to indicate the absence or presence of a green attribute in the accommodation name (e.g., green, eco, bio, vegan) called GREEN NAME.

3.2 Method

The data were analysed using descriptive and inferential statistics. The statistical software SPSS was used for this purpose. The statistical analysis aimed to investigate whether green practices and the use of green attributes in the name of the accommodation facility have an effect firstly on consumer satisfaction and secondly on guests' eWOM on the facility's green practices and whether this differs by accommodation type.

The statistical comparison of consumer satisfaction and guests' reactions to green initiatives in terms of reviews across the different groups of Italian hospitality businesses with green practices that had captured guests' attention was performed using a t-test and one-way ANOVA, depending on whether the comparison was between two or more groups.

Specifically, the t-test was used to compare SCORES and GREEN eWOM in terms of GREEN NAME (i.e., with or without). The one-way ANOVA was used to compare SCORES and GREEN eWOM across TYPE. The sample used for the ANOVA analysis was subdivided into two sub-samples, one containing the cases with a GREEN NAME and a second containing the cases without a GREEN NAME, because of the considerably different number of cases between the two. Therefore, the results show whether the mean SCORES are different between the different accommodation types, whether or not they have a green name. The F-statistic for the one-way ANOVA tests the null hypothesis that all the sample groups have the same population mean. Therefore, in the case of statistical significance (i.e., prob.< 5%), the null hypothesis is rejected, meaning that at least two means are different. In order to identify the

groups as statistically different from each other, we performed HDS Tukey's post-hoc test.

Furthermore, three basic assumptions were checked and verified: independence, normality, and homogeneity of the variance of the residuals through Levene's test. The assumption regarding the normally distributed dependent variable in the population is not respected in our sample. However, we used a large sample, which renders most tests robust to violations of normality due to the central limit theorem.

4. Results

Table 1 provides an overview of the cases included in the analysis by TYPE and GREEN NAME. There are 96 cases with a GREEN NAME, representing 5.6% of the sample. Most companies did not have a green name (94.4%). Hotels represent 38% of the total sample; B&Bs represent 25.3%; Agritourism facilities 13.8%; and Other accommodation facilities 22.8%. Therefore, the sub-sample of cases with a GREEN NAME has the following composition: Hotels (22.9%), B&Bs (37.5%), Agritourism facilities (18.8%), and Other accommodation facilities (20.8%).

Tab. 1: Frequencies of cases per TYPE and GREEN NAME

			GREEN NAME		
			NO	YES	Total
TYPE	AGRITOURISM FACILITIES	Count	217	18	235
		% in TYPE	92.3%	7.7%	100.0%
		% in GREEN NAME	13.5%	18.8%	13.8%
	B&BS	Count	395	36	431
		% in TYPE	91.6%	8.4%	100.0%
		% in GREEN NAME	24.6%	37.5%	25.3%
	HOTELS	Count	625	22	647
		% in TYPE	96.6%	3.4%	100.0%
		% in GREEN NAME	38.9%	22.9%	38.0%
	OTHER ACCOMMODATION FACILITIES	Count	368	20	388
		% in TYPE	94.8%	5.2%	100.0%
		% in GREEN NAME	22.9%	20.8%	22.8%
Total		Count	1605	96	1701
		% in TYPE	94.4%	5.6%	100.0%
		% in GREEN NAME	100.0%	100.0%	100.0%

Source: own elaboration

The SCORE frequencies are listed in Table 2. The majority of the scores lie between 4 and 5 (from good to excellence), equal to a cumulative percentage of 86%, while the remaining scores from 1.5 to 3.5 account only for 14% of the sample. Only one case has a score of 1.5, and 3 cases have a score of 2. Therefore, the Italian hospitality businesses with green practices

that activate the eWOM on the accommodation facility's green practices seem to show high overall scores in terms of guests' satisfaction (RQ1).

Tab. 2: Frequencies of cases per SCORE

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	1.5	1	.1	.1	.1
	2.0	3	.2	.2.	.2
	2.5	16	.9	.9	1.2
	3.0	49	2.9	2.9	4.1
	3.5	169	9.9	9.9	14.0
	4.0	390	22.9	22.9	36.9
	4.5	685	40.3	40.3	77.2
	5.0	388	22.8	22.8	100.0
	Total	1701	100.0	100.0	

Source: own elaboration

The number of GREEN eWOM detected ranges from 1 to 53, as shown in Table 3. Most cases have only 1 green mention (77.4%). The cases with 1 to 3 green eWOM account for 94.2% of the sample.

Tab. 3: Frequencies of cases per GREEN eWOM

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	1	1316	77.4	77.4	77.4
	2	209	12.3	12.3	89.7
	3	78	4.6	4.6	94.2
	4	28	1.6	1.6	95.9
	5	22	1.3	1.3	97.2
	6	19	1.1	1.1	98.3
	7	6	.4	.1	98.6
	8	5	.3	.3	98.9
	9	2	.1	.1	99.1
	10	2	.1	.1	99.2
	12	2	.1	.1	99.3
	14	1	.1	.1	99.4
	15	1	.1	.1	99.4
	16	2	.1	.1	99.5
	17	1	.1	.1	99.6
	18	1	.1	.1	99.6
	20	1	.1	.1	99.7
	26	2	.1	.1	99.8
	27	1	.1	.1	99.9
	28	1	.1	.1	99.9
	53	1	.1	.1	100
	Total	1701	100.0	100.0	

Source: own elaboration

4.1 Customer Satisfaction, Green Name and Accommodation Type

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The mean score of cases without a GREEN NAME equals to 4.321, lower than the mean score of cases with a GREEN NAME, equal to 4.521. B&Bs in both sub-samples achieve the highest mean score, while hotels without a GREEN NAME achived the lowest.

The t-test statistic (t) shows that the mean score of cases without a GREEN NAME and cases with a GREEN NAME are significantly different. Therefore, we can answer our second research question in the affirmative, as the analysis showed that strongly green-focused accommodation facilities (e.g., with green attributes in the name) outperform others in terms of customer satisfaction (RQ2).

One-way ANOVA was conducted to assess whether the means of SCORE differs among different of accommodation types. The ANOVA test results showed that SCORE means are significantly different between TYPES at a 0.05 significance level (F = 92.289; p = 0.000) for the sub-sample of cases without a GREEN NAME. However, SCORE means are not significantly different between TYPES at a 0.05 significance level (F = 2.524; p = 0.062) for the sub-sample of cases with a GREEN NAME (Table 4).

Tab. 4: ANOVA Tests between subject effects of SCORE per TYPE and GREEN NAME

Dependent Variable: TRIPADVISOR SCORE							
GREEN NAME	Source	Type III Sum of squared	df	Mean Square	F	Sig.	Partial Eta Squared
WITHOUT	Corrected Model	72.660[a]	3	24.220	92.289	.000	.147
	Intercept	26662.472	1	26662.472	101595.794	.000	.984
	TYPE	72.660	3	24.220	92.289	.000	.147
	Error	420.161	1601	.262			
	Total	30453.750	1605				
	Corrected Total	492.821	1604				
WITH	Corrected Model	1.594[b]	3	.531	2.524	.062	.076
	Intercept	1801.845	1	1801.845	8560.545	.000	.989
	TYPE	1.594	3	.531	2.524	.062	.076
	Error	19.364	92	.210			
	Total	1983.000	96				
	Corrected Total	20.958	95				
a. R Squared = .147 (Adjusted R Squared = .146)							
b. R Squared = .076 (Adjusted R Squared = .046)							

Source: own elaboration

In order to test the Homogeneity of Variances, we carried out Levene's test. It assesses whether the population variances of our dependent variable are equal over the levels of our factor. Levene's test shows different results for the two sub-samples. Indeed, for the sub-sample of cases with a GREEN NAME, Levene's test does not reject the assumption of equal variances that

is needed for ANOVA (p > .05), while Levene's test for the sub-sample of cases without a GREEN NAME rejects the assumption of equal variances (p < .05).

For this sub-sample, we then carried out the robust Welch and Brown-Forsythe F-tests. Both tests confirm that SCORE means for the sub-sample of cases without a GREEN NAME are different.

The post hoc comparisons using Tukey's HSD test show that for the sub-sample of cases without a GREEN NAME, the SCORE means are significantly different between TYPES (p-value = 0.000), except for the SCORE means between Agritourism facilities and B&Bs (p-value = 0.281) and between Hotels and Other accommodation facilities (p-value = 0.498). Conversely, as anticipated by the ANOVA, there are no statistically significant differences in the mean SCORE of types for the sub-sample of cases with a GREEN NAME.

The Tukey HDS analysis allows us to identify two homogeneous subsets with similar SCORE means among cases without a GREEN NAME: Hotels and Other Accommodation facilities with a Sig. equal to 61.7% (sig. = .616) with the lowest SCORE means, and Agritourism facilities and B&Bs with a Sig. equal to 19.1% (sig. = .191) with the highest SCORE means.

These results allowed us to answer our fourth research question (RQ4). There are differences in customer satisfaction by type of accommodation facility within the sub-sample of not strongly green-focused accommodation facilities (without a green name). However, there are no significant differences within the sub-sample of strongly green-focused accommodation facilities (with a green name).

4.2 Green eWOM, Green Name and Accommodation Type

The mean of green eWOM of cases without a GREEN NAME equals to 1.5, lower than that of cases with a GREEN NAME, equal to 3.22. The highest mean of green eWOM is achieved by HOTELS in the sub-sample of cases with a GREEN NAME (7.59), and the lowest by Other accommodation facilities with a GREEN NAME (1.3). The t-test statistic (t) shows that the GREEN eWOM means of cases with or without a GREEN NAME are significantly different.

This result allows us to confirm that strongly green-focused accommodation facilities (e.g., with green attributes in the name) stand out in terms of customer eWOM on the facility's green practices (RQ3). Interestingly, not all the cases with more than 6 GREEN eWOM have a green name: this means that there are accommodation facilities that are implementing green practices that capture the attention of their guests without a clear positioning through the green name. In such a case, it might be that these accommodation facilities are relying on other communication tools beyond the name.

One-way ANOVA was conducted to assess whether the means of GREEN MENTION is different among the different accommodation types. The ANOVA test results showed that: GREEN eWOM means are significantly different between TYPES at a 0.05 significance level (F = 4.342; p = 0.005) for the sub-sample of cases without a GREEN NAME;

GREEN eWOM means are also significantly different between TYPES at a 0.05 significance level (F = 5.490; p = 0.002) for the sub-sample of cases with a GREEN NAME (Table 5).

Tab. 5: *ANOVA Tests between subject effects of GREEN eWOM per TYPE and GREEN NAME*

Dependent Variable: GREEN eWOM							
GREEN NAME	Source	Type III Sum of squared	df	Mean Square	F	Sig.	Partial Eta Squared
WITHOUT	Corrected Model	41.319[a]	3	13.773	4.342	.005	.008
	Intercept	3205.567	1	3205.567	1010.677	.000	.387
	TYPE	41.319	3	13.773	4.342	.005	.008
	Error	5077.896	1601	3.172			
	Total	8753.000	1605				
	Corrected Total	5119.215	1604				
WITH	Corrected Model	557.638[b]	3	185.879	5.490	.002	.152
	Intercept	990.512	1	990.512	29.256	.000	.241
	TYPE	557.638	3	185.879	5.490	.002	.152
	Error	3114.768	92	33.856			
	Total	4667.000	96				
	Corrected Total	3672.406	95				
a. R Squared = .008 (Adjusted R Squared = .006)							
b. R Squared = .152 (Adjusted R Squared = .124)							

Source: own elaboration

Levene's test rejects the assumption of equal variances for both sub-samples of cases, whether or not they have a GREEN NAME or otherwise (p < .05). Therefore, we carried out the robust Welch and Brown-Forsythe F-tests. Both tests confirm that GREEN eWOM means for both sub-samples are different.

The post hoc comparisons using Tukey's HSD test show that in the sub-sample of cases without a GREEN NAME, the GREEN eWOM means in TYPE are significantly different between B&Bs and Other accommodation facilities (p-value = 0.005) and between Hotels and Other accommodation facilities (p-value = 0.015). In this sub-sample, the Tukey HDS analysis allows us to identify two homogeneous subsets with similar GREEN eWOM means: Hotels, B&Bs and Agritourism facilities with the lowest means for green mentions, with a Sig. equal to 84.5% (sig. = .845), and Other Accommodation facilities and Agritourism facilities with the highest means for green mentions with a Sig. equal to 8.1% (sig. = .081). In the sub-sample of cases with a GREEN NAME, the GREEN eWOM means in TYPE are significantly different between Hotels and all the other three groups (p-value < .05). In this sub-sample, the Tukey HDS analysis allows us to identify two homogeneous subsets with similar GREEN eWOM means: Other accommodation facilities, B&Bs and Agritourism facilities with the lowest means for green mentions, with a Sig. equal to 92.3% (sig.

= .923), and Hotels with the highest means for green mentions, with a Sig. equal to 100% (sig. = 1.000).

These results allowed us to answer our fifth research question (RQ5.) There are differences in customer willingness to spread eWOM on accommodation facilities' green practices between strongly green-focused and not strongly green-focused accommodation facilities by type of accommodation.

5. Discussion and conclusion

The paper investigated whether green practices or a green image in the hospitality sector affect customer satisfaction and behaviour, especially in terms of eWOM, and whether this differs for different types of accommodation.

The study showed that the Italian hospitality businesses with green practices that activate guests' eWOM on the green practices of an accommodation facility seem to show high overall scores in terms of guests' satisfaction (RQ1). It also showed that strongly green-focused accommodation facilities (e.g., with green attributes in the name) outperform others in terms of customer satisfaction and eWOM on the green practices adopted (RQ2 and RQ3).

In general, the difference in the green eWOM means between the cases with or without a green name could be explained by the fact that the majority of guests respond positively to green practices if they recognize them (Lee *et al.* 2016). However, if an accommodation lacks a clear positioning concerning environmental protection, this may mean that guests less sensitive to sustainability would not recognize them. Besides, a lack of awareness about the accommodation facility's green practices can cause inconveniences to the guests (Lee *et al.* 2016), which is also reflected in lower scores in terms of customer satisfaction. Therefore, to overcome the problem of misalignment between an accommodation facility's green practices and guest awareness about their sustainability engagement, the accommodation facilities could leverage on communication channels, tools and messages to strengthen their green image.

The results allowed us to answer our fourth research question (RQ4). There are differences in customer satisfaction by type of accommodations within the sub-sample of not strongly green-focused accommodation facilities, i.e., hotels and other accommodation facilities with the lowest score means, vs agritourism facilities and B&Bs with the highest score means. This difference could be explained by a higher consumer's sensitivity towards sustainability on the part of guests choosing agritourism facilities and B&Bs.

However, there are no significant differences within the sub-sample of strongly green-focused accommodation facilities (with a green name). This could be due to the fact that for accommodation facilities with a green image, the implementation of green practices strongly affects customer satisfaction and perceived quality, regardless of the type of accommodation. This is not surprising as customer satisfaction can be

defined as a cognitive process in the customer who compares a product's perceived performance to his or her expectation (Xu and Gursoy, 2015). Thus, when an accommodation facility with a solid green image implements several green practices, and it does not betray the expectation of its guests, which are expected to be particularly sensitive to environmental issues, they are satisfied. In other words, when the customer has confirmation of the environmental protection efforts promised by the accommodation facility's image during his or her stay, on the one hand, the perceived quality increases, and on the other hand, variables related to the choice of accommodation type become less influential on customer satisfaction.

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Conversely, other variables related to the accommodation type may affect customer satisfaction for the accommodation facilities without a green image. These differences could also explain the contrasting results of previous research (Goh and Balaji, 2016; Miniero et al., 2014).

Subsequently, the study also provides interesting insights regarding the differences in customer willingness to spread eWOM on the accommodation facility's green practices between strongly green-focused and not strongly green-focused accommodation facilities by type of accommodations (RQ5). For cases without a green name, two homogeneous subsets with similar green eWOM means were identified: Hotels, B&Bs and Agritourism facilities with the lowest means for green mentions; and other accommodation facilities with the highest means for green mentions. The highest means for green mentions could perhaps be explained by the fact that the guests at other accommodation facilities without a green image do not expect green practices to be implemented. They are more surprised and therefore more inclined to spread eWOM. Consequently, to overcome the problem of misalignment between the green practices and guest awareness about their sustainability engagement, all types of accommodation facilities without a strong focus on sustainability could leverage on more effective communication tools. For cases with a green name, two homogeneous subsets with similar green eWOM means have been identified: other accommodation facilities, B&Bs and agritourism facilities with the lowest means for green mentions; and hotels with the highest mean for green mentions. This difference between the two groups could be because the guests at hotels with a green image have lower expectations in terms of green practices in comparison to the guests at other kinds of accommodation, then they are more surprised at finding these and therefore more inclined to spread eWOM.

We can conclude that all the different accommodation types, with or without a green image, gain an effective advantage when they implement green practices both in terms of customer satisfaction and behaviour. In particular, the customer satisfaction of all accommodation types with a green image, and that of agritourism facilities and B&Bs without a green image, seems to be particularly relevant in the case of implementation of green practices. In the same way, the eWOM of other accommodation facilities without a green image and that of all accommodation types with a green image, especially of the hotels, seem to be especially high in the case of implementation of green practices.

6. Theoretical implications

This article makes theoretical contributions to the existing literature on sustainable tourism in several ways. First, our findings allow us to confirm that the implementation of green practices (Prud'homme and Raymond, 2013) and the use of a green image (e.g. Gerdt *et al.*, 2019; Merli *et al.*, 2019; Lee *et al.*, 2018) improve perceived quality level among customers. Furthermore, the use of a green image fosters customer eWOM on the accommodation facility's green practices (Lee *et al.*, 2010), and this finding disconfirms studies that did not find any significant effect of green image on the intention to spread positive word-of-mouth (Leaniz *et al.* 2018). Second, by comparing customer satisfaction and eWOM on the green practices between accommodation facilities with or without a green image, we provided a broader picture on sustainable tourism from a consumer perspective, different from the previous studies. Even though the Italian hospitality businesses with green practices that activate guests' eWOM seem to show high overall scores both in terms of customer satisfaction and eWOM, both scores are higher for accommodation facilities with a solid green image. Third, we extended the analysis to several accommodation types (i.e., agritourism facilities, B&Bs, hotels and other accommodation facilities), assuming that they serve to diverse demand segments, both with and without a solid green image, rather than on a single sample of green hotels as proposed in previous studies (e.g. Leaniz *et al.*, 2018; Lee *et al.*, 2010; Merli *et al.*, 2019). This allowed us to identify, beyond accommodation facilities with a strong green image, those that can rely on green practices to increase customer satisfaction (i.e., B&B, agritourism facilities) and improve customer behaviour (i.e., other accommodation facilities) even without a green image. In addition, our results shed light on the alternative forms of accommodation, which can no longer be neglected anymore by the literature on sustainable tourism.

Finally, this analysis allowed us to identify differences that could explain the contrasting results of previous research on green consumer behaviour (Goh and Balaji, 2016; Miniero *et al.*, 2014).

7. Managerial implications

A thorough understanding of guest perceptions of green practices can help tourism and hospitality professionals seize the opportunity to improve tourist satisfaction and to activate eWOM by adopting green practices and allowing the customer to perceive the green positioning of the accommodation facility, considering that customer satisfaction is an essential determinant of economic performance in the hospitality industry.

The accommodation facilities that have a strong sustainability position stand out in terms of customer attention to green initiatives, particularly in the tendency to review these practices encouragingly by activating positive word-of-mouth. Companies with a robust ecological vocation often suffer from myopia in sustainability marketing by neglecting to communicate essential messages and giving incomplete information that

does not affect the decision-making process (Villarino and Font, 2015). Furthermore, the results confirm the need for managers to communicate their green orientation to current and potential customers to differentiate their offer from that of competitors. These results could be extended to other sectors as consumers who pay attention to sustainability issues represent a substantial market segment (Egea and Frutos, 2020). In other words, implementing green practices and powerfully communicating the company's green positioning could result in high customer satisfaction and word-of-mouth.

8. Limitation of the study

In terms of limitations, the study considered the use of green attributes in the name of the accommodation as a proxy for its sustainability orientation and positioning. This does not take into account other possible communication activities that contribute to the green image of the accommodation facilities. Furthermore, customer satisfaction could be influenced by several other variables that were beyond the scope of our study. Future research will have to better investigate the concept of green positioning and communication activities of sustainable green practices, also ascertaining their specific effectiveness and the interaction of customer satisfaction with other variables.

Since the Italian sub-sample of companies with a green name is limited, further analysis could extend the geographical area of inquiry to increase the number of companies investigated. Furthermore, the study does not consider the size and the age of the accommodation facility, which could affect the number of available reviews.

Finally, as we can expect an increase in customer attention and sensibility to green issues in future years, a longitudinal approach could be adopted to observe changes in guests' perception of different types of hospitality venue.

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Year 2021 Reviewers

Sinergie Italian Journal of Management

Useful information for readers and authors

Aims and scope

What is the positioning of Sinergie Italian Journal of Management?

Sinergie Italian Journal of Management, the official journal of the Società Italiana di Management (SIMA-the Italian Society of Management), is a peer-reviewed scholarly publication that presents leading research across all business and management areas and focuses on the main trends and boundary-pushing ideas in management studies.

What is this journal's topic coverage?

The journal has a broad thematic profile and covers various areas in the business and management field, such as strategic management, corporate governance, entrepreneurship, international business, sustainability, small and family business, operations and supply chains, strategic communication, marketing, retailing and service management, innovation and technology management, tourism and culture management and, of course, business ethics and general management.

What is "Italian" in Sinergie Italian Journal of Management?

This journal aims both to bring the Italian management perspective to the international debate and to encourage scholars worldwide to contribute through an innovative approach on topics relevant to the sound conduct of businesses and other organisations. The journal's keywords include, but are not limited to, management applications specially relevant to the Italian economy and other mature economies, such as manufacturing, creativity, sustainability, open innovation, digital transformation, entrepreneurship in small and medium-sized enterprises, family business, networks, alliances and territorial ecosystems, innovative value proposals and circular business models, as well as to the management of specific businesses, such as food, fashion, furniture, industrial equipment, art, culture, tourism, design and luxury.

How broad is the scope of this journal?

Sinergie Italian Journal of Management aims to balance relevance with methodological rigour and encourages interpretation, reasoning and critical, context-aware discussion about phenomena and their managerial implications. Narrow discussions focussed only on highly specific sub-fields will be regarded as non-priority.

Which research approach does this journal welcome?

The journal is open to different research approaches and welcomes both conceptual and empirical contributions that employ a qualitative, quantitative or mixed methods research approach. It also accepts case

studies, provided the analysis is adequate. Review articles that move beyond description to propose critical reflection and sound theoretical contributions are also welcome.

Issues frequency and coverage

When is the journal published during the year and are special issues part of the editorial planning?

The journal is published every quarter. It welcomes both the submission of manuscripts to be published in its regular issues and of manuscripts to be published in special issues edited by guest editors. Special thematic issues have always been a prominent feature of Sinergie Italian Journal of Management. Currently, the Editors are encouraging the development of special issues on relevant management themes that fit the journal's scope.

Principles and vision

What principles drive the conduct of this journal?

A few fundamental principles drive the conduct of Sinergie Italian Journal of Management:

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Connections between research, ethics, creative thinking and managerial action are the foundational premises on which to build a future based on the common good.

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- acceptance subject to substantial modifications
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The paper should not exceed 7,000 words, including charts, figures, tables, footnotes and references.

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