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The coevolutionary relationship between digitalization and organizational agility: Ongoing debates, theoretical developments and future research perspectives

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Abstract

This study proposes, for the first time, a systematic review of the literature focused on the interconnections between digitalization and organizational agility (OA). It uses the perspective of digital transformation to investigate the enablers, barriers and benefits of the processes aimed at providing firms with the agility that is necessary to effectively face an increasingly volatile, ambiguous and turbulent environment. The study applies the bibliographic coupling method to 159 peer-reviewed contributions published by 31 December 2020. It discovers and analyses three different, though interconnected, thematic clusters, focusing on big-data analytic capabilities as crucial drivers of OA, the relationship between digitalization and agility at a supply chain level, and the role of information technology capabilities in improving OA. This paper overcomes the traditional view according to which digital capabilities are mainly considered enablers of OA rather than as possible outcomes by theoretically arguing that, in addition to being complex, the relationships between digitalization and OA have a bidirectional character. This study also develops twelve original research propositions concerning new research pathways to be followed and new managerial solutions to be designed and implemented.

Keywords: Organizational agility; Digitalization; Information and communications technology, Digital technologies; Digital transformation; Literature review

Paper type: Literature review

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1. Introduction

The global economy evolves rapidly, and most marketplaces are highly turbulent due to ever-changing market dynamics, the constantly changing needs of both consumers and workers, and the emergence of new digital technologies. The digital revolution is disrupting global competitiveness and paving the way to strong improvements in the efficiency, productivity, fluidity, flexibility and effectiveness of millions of companies' business processes (Schwab and Zahidi, 2020). The pandemic that shook the world at the beginning of 2020 has accentuated this turbulence (Accenture, 2020), while at the same time it has exerted significant speeding up effects on digital transformation processes.

Organizational agility (OA) is the ability to anticipate and quickly detect and analyse opportunities and threats, even in their latent state, and effectively respond to them by adopting the required changes and actions (Barlette and Baillette, 2020; Felipe et al., 2020). In this era of growing complexity and uncertainty, agility represents a crucial dynamic capability (Overby et al., 2006; Teece, 2016) for firms to be able to respond appropriately to continuous environmental changes, seize emerging business opportunities, defend and strengthen their competitive advantages (Inman et al., 2011; Vickery et al., 2010) and enhance overall financial performance (Hatzijordanou et al., 2019). In fact, organizations with strong agility capabilities generate revenues 37% faster, with a profit that is 30% higher than that of non-agile companies (Glenn, 2009; Wang et al., 2013).

At the same time, it has been estimated that by leveraging digitalization, firms can increase their profit margins by more than 80% (Škare and Soriano, 2021). A large part of the potential effect of digitalization on company performance depends on the positive impact exerted by new digital technologies on OA. Consider, for example, how effectively today big data analytics (BDA) and the Internet of Things (IoT) allow the collection, structure, management, sharing and interpretation of huge volumes of information (Prescott, 2014; McAfee and Brynjolfsson, 2012) and provide insights for real-time effective marketing investigations (Ahn, 2020; von Alberti-Alhtaybat et al., 2019), blockchain technologies ensure significant and scalable processing power and high levels of accuracy and security (Nandi et al., 2020; Saberi et al., 2019; Sheel and Nath, 2019) while at the same time allowing the elimination of many wasteful and costly control tasks (Gunasekaran et al., 2019; Nandi et al., 2020; Rane and Narvel, 2019), enterprise social media facilitate day-to-day workflow agility (Huang et al., 2015; Kane, 2015; Pitafi et al., 2020), the IoT reduces machinery maintenance times, efforts and costs (Dijkman et al., 2015; Rane and Narvel, 2019), digital cloud-based technologies and big data enhance IT infrastructure flexibility and the integration between functional departments (Fosso Wamba et al., 2020; Liu et al., 2018).

To effectively face an increasingly volatile and challenging future, managers have to constantly

explore all the possible emerging applications of digital technologies and, above all, continuously explore new ways to leverage the digital transformation of their companies to maximize OA (Barlette and Baillette, 2020; Kozarkiewicz, 2020; Malekifar et al., 2014)

The connections between digital technologies and OA are challenging to analyse due to the complexity of both the constructs and the numerous approaches adopted in the literature to analyse them (Škare and Soriano, 2021). We found literature reviews on overall organizational agility (Walter, 2020), workforce agility (Muduli, 2013; Al-Kasasbeh et al., 2016), agility in the manufacturing industry (Gunasekaran, 1999; Potdar et al., 2017; Yusuf et al., 1999), supply chain agility (Gligor et al., 2019; Gligor and Holcomb, 2012), agility enablers (Marhraoui and El Manouar, 2017) and IT for organizational agility (Tallon et al., 2019). We also found reviews concerned with the effect of digitalization on organizations (Kuusisto, 2017), the digital transformation phenomenon analysed by adopting different approaches (Nadkarni and Prügl, 2021; Verhoef et al., 2021; Vial, 2019), the digitalization of the supply chain (Shashi et al., 2020), digital innovation in knowledge management systems (Di Vaio et al., 2021), digital servitization in manufacturing (Paschou et al., 2020), the digitalization of SME (Isensee et al., 2020), and the effects of specific types of digital technologies such as IoT (Del Giudice, 2016) and Blockchain (Wang et al., 2019). However, to date, no systematic review of the literature concerned with the interconnections between digitalization and OA has been performed.

This study aims to fill this gap by deeply investigating the existing body of knowledge, uncovering research gaps and understudied topics and leveraging these latter topics to propose a future research agenda. It adopts a two-way connection perspective for analysing the relationship between digital capabilities and agility, thus overcoming and enlarging the traditional view according to which IT and digital capabilities represent crucial enablers of organizational agility (Barlette and Baillette, 2020; Panda and Rath, 2017, 2016), rather than vice versa. Our findings show that OA itself represents a fundamental enabler of effective implementation of digital transformation processes and that several obstacles to digitalization are due to the absence of an agile organization (Barlette and Baillette, 2020; Fachrunnisa et al., 2020; Jermsittiparsert and Wajeetongratana, 2019; Kisielnicki and Misiak, 2016; Kozarkiewicz, 2020; Malekifar et al., 2014).

The next section presents the theoretical background of our review, while Section 3 presents the methodology we have adopted. In the following sections, we present the results of the bibliometric and visualization of similarities (VOS) analyses (Section 4) and the systematic review of the literature (Section 5). In Section 6, we discuss our findings by proposing a future research agenda based on twelve original research propositions (Section 6.1) and synthesising the main theoretical contributions

(Section 6.2), managerial implications (Section 6.3), and limitations (Section 6.4) of our study. A concluding section (Section 7) briefly summarizes the key findings of this study.

2. Theoretical background

OA is the ability of a firm to accelerate decision making, sense market and environmental changes quickly and flexibly as well as effectively exploit emerging opportunities and open new avenues of competitive advantage (Overby et al., 2006; Sambamurthy et al., 2003; Tallon and Pinsonneault, 2011). Starting from studies in the field of flexible manufacturing systems (Sarker et al., 2009; White et al., 2005), OA has received increasing attention from management scholars who have investigated this concept from diverse perspectives. Different types of OA have been identified and analysed, from workforce agility (Crocitto and Youssef, 2003; Patil and Suresh, 2019; Sommer, 2019) to logistic agility (Cao and Dowlatshahi, 2005; Zielske and Held, 2020), from marketing agility (Osei et al., 2018; Zhou et al., 2019) to strategic agility (Cunha et al., 2020; Doz, 2020; Shams et al., 2020a) and supply chain agility (Chen, 2019; Christopher and Ryals, 2014). Adopting a dynamic capability (DC) theory perspective, OA can be seen as a specific subset of DCs enabling firms to sense environmental change and respond appropriately (Overby et al., 2006), effectively manage demand shocks and uncertainties and adapt their strategy accordingly as well as effectively redirect resources towards higher-yield value creation, protection and capture activities in response to the evolution of internal and external circumstances (Teece, 2016). In this regard, OA can be viewed as responsiveness, competency, flexibility, speed (Lin et al., 2006; Zhang and Sharifi, 2000), proactiveness, radicalness, responsiveness, and adaptiveness (Lee et al., 2015) or, more simply, "sensing change and responding to it" (Overby et al., 2006).

Several OA antecedents have been identified in the literature, from technological, such as the role that Information Technology (IT) generally has in improving the company and supply chain capabilities to adapt and anticipate environmental changes (Sambamurthy et al., 2003; Swafford et al., 2006), to behavioural, such as influential leaderships styles and risk-taking mindsets as well as company innovation capacity and culture (Breu et al., 2002; Tallon, 2008); and from organizational, such as those concerning strategic orientations and business models, to environmental, such as those concerning environmental uncertainty and dynamism (Tallon, et al., 2019).

Developing adequate digital skills and capabilities (Li et al., 2018) and effectively integrating digital technologies and business processes (Liu et al., 2018; Vial, 2019) currently represent necessary steps for firms that want to be able to cope with the challenges of an increasingly volatile, uncertain, complex and ambiguous (VUCA) competitive world (Millar et al., 2018). To avoid losing market opportunities, becoming obsolete or even extinct (Chan et al., 2019; Lucas and Goh, 2009),

companies must appropriately face the disruptive digital innovation that is taking place by evolving their business models, structures and processes (Hess et al., 2016), as well as their culture and approach to collaboration (Warner and Wäger, 2019).

The impact of digital change on company value chains varies according to the different phases of the digital transformation process. In the "digitization" stage, in which the analogical to digital information conversion takes place (Verhoef et al., 2021), company value creation processes are not significantly affected. In the "digitalization" phase, where IT and digital technologies act as key enablers of processes of transformation and optimization of business activities such as communications, manufacturing or customer relationship management, a relevant restructuration of operative value creation activities occurs. Finally, in the "digital transformation phase", new business models and new ways of interacting with the competitive environment that deeply impact the value creation system are the usual outcomes (Seetharaman, 2020).

The digital revolution we are witnessing represents a disruptive innovation (Karimi and Walter, 2015; Vial, 2019) based on a new generation of information technologies such as social media, mobile, data analytics, IoT and embedded devices (Fitzgerald et al., 2014). It disrupts consumer behaviour and expectations by allowing clients to assume a proactive role in dialogue with organizations and the cocreation processes of goods and services; it also disrupts business models (Ciampi et al., 2021) and the competitive landscape by moving competition from physical to virtual products and environments (Günther et al., 2017; Vial, 2019). Therefore, new capabilities, intended as a firm's skill, talent, and expertise to manage digital technologies (Khin and Ho, 2018), are needed (Kane et al., 2015). Digital capabilities represent an emerging category of dynamic capabilities (Teece et al., 1997) that allow firms to transform and evolve their operational processes, business models and customer experiences (Westerman et al., 2011). They are based on two building blocks: a well-developed information management capability and a flexible IT infrastructure (Levallet and Chan, 2018). They can be declined as intelligence capabilities, connecting capabilities, and analytic capabilities, referring to the ability to configure hardware components to sense and capture information, the ability to connect digitalized products through wireless communication networks and the ability to use the data available to make business decisions, respectively (Lenka et al., 2017).

IT and digital capabilities have been identified as crucial enablers of several aspects of organizational agility (Barlette and Baillette, 2020), such as operational and partnering agility (Liu et al., 2018; Sambamurthy et al., 2003; Vagnoni and Khoddami, 2016), business process and market-responsive agility (Panda and Rath, 2016), market capitalizing and operational adjustment agility (Lu and K. (Ram) Ramamurthy, 2011; Mao et al., 2015; Melián-Alzola et al., 2020), and sensing and responding agility (Panda and Rath, 2017). Finally, effectively leveraging the interactions between digital

capabilities and OA is crucial for organizational innovation (Cai et al., 2019; Cepeda and Arias-Pérez, 2019) and performance (Liu et al., 2013; Martínez-Caro et al., 2020; Sambamurthy et al., 2003), even at a supply chain level (Alzoubi and Yanamandra, 2020; Chen, 2019; Swafford et al., 2008).

3. Methodology

First, a bibliometric analysis based on the VOS algorithm (Van Eck et al., 2006; van Eck and Waltman, 2010) was conducted. Bibliometric methods allow effective synthesis and interpretation of vast volumes of bibliographic data as well as the detection of research streams in specific fields (van Eck and Waltman, 2010) while at the same time avoiding potential bias typically generated by the subjective interpretations characterizing the exclusive recourse to systematic literature reviews (Zupic and Čater, 2015). Thereafter, based on the results of the bibliometric analysis, a systematic literature review was performed (Tranfield et al., 2003). A reproducible and rigorous process was followed to select the sample of papers to be the object of our analysis (Akter et al., 2019; Akter and Wamba, 2016; Bresciani et al., 2021; Kraus et al., 2020; Marzi et al., 2020; Pellegrini et al., 2020).

In line with the literature (Akter et al., 2019; Akter and Wamba, 2016; Galvagno, 2017; Tranfield et al., 2003), we performed our bibliometric analysis and literature review through six phases. First, based on the main definitions of agility (Overby et al., 2006; Sherehiy et al., 2007; Walter, 2020) and digitalization (Legner et al., 2017; Sestino et al., 2020), the following search query was developed:

(TITLE-ABS-KEY(("digitali?at"OR"digiti?at*"OR"big data"OR"BD"OR"internet of thing*"OR"IoT"OR"digital transfor*"OR"digital technol*"OR"information technolog*"OR"ICT*"OR"Information Communication Technolog*"OR"Information and Communication Technolog*"OR"IT")AND("agil*")))*

In line with the literature (Akter et al., 2019; Akter and Wamba, 2016; Kraus et al., 2020), the terms relating to the topic of digitalization were chosen based on the most relevant contributions in the field (Kraus et al., 2020). Following Sestino et al. (2017) and considering that the IoT and BDA represent key enablers of business processes aimed at operationally exploiting the informative potential of digital technologies (Pflaum and Gölzer, 2018; Sestino et al., 2020), the terms "big data" and “internet of things” were included.

The Scopus database, which is considered an ideal scientific database for systematic literature reviews (Falagas et al., 2008; Kraus et al., 2020), was used to perform our search. The “*” and “?” operators were used as jolly characters to include as many lexical variants as possible.

Always in line with the literature (Delgado García et al., 2015; Kraus et al., 2020) and considering the managerial perspective of our review, we selected only journal articles or reviews in English, already published or in press, released by 31 December 2020 and belonging to at least one of the

following scientific areas: business, management and accounting, social science, decision science, economics, econometrics and finance.

The implementation of our search query (second step of our analysis) allowed us to select an initial dataset of 2,382 papers. For cross-validation purposes, the search query was also implemented in another scientific database, Web of Science, without finding any new relevant documents.

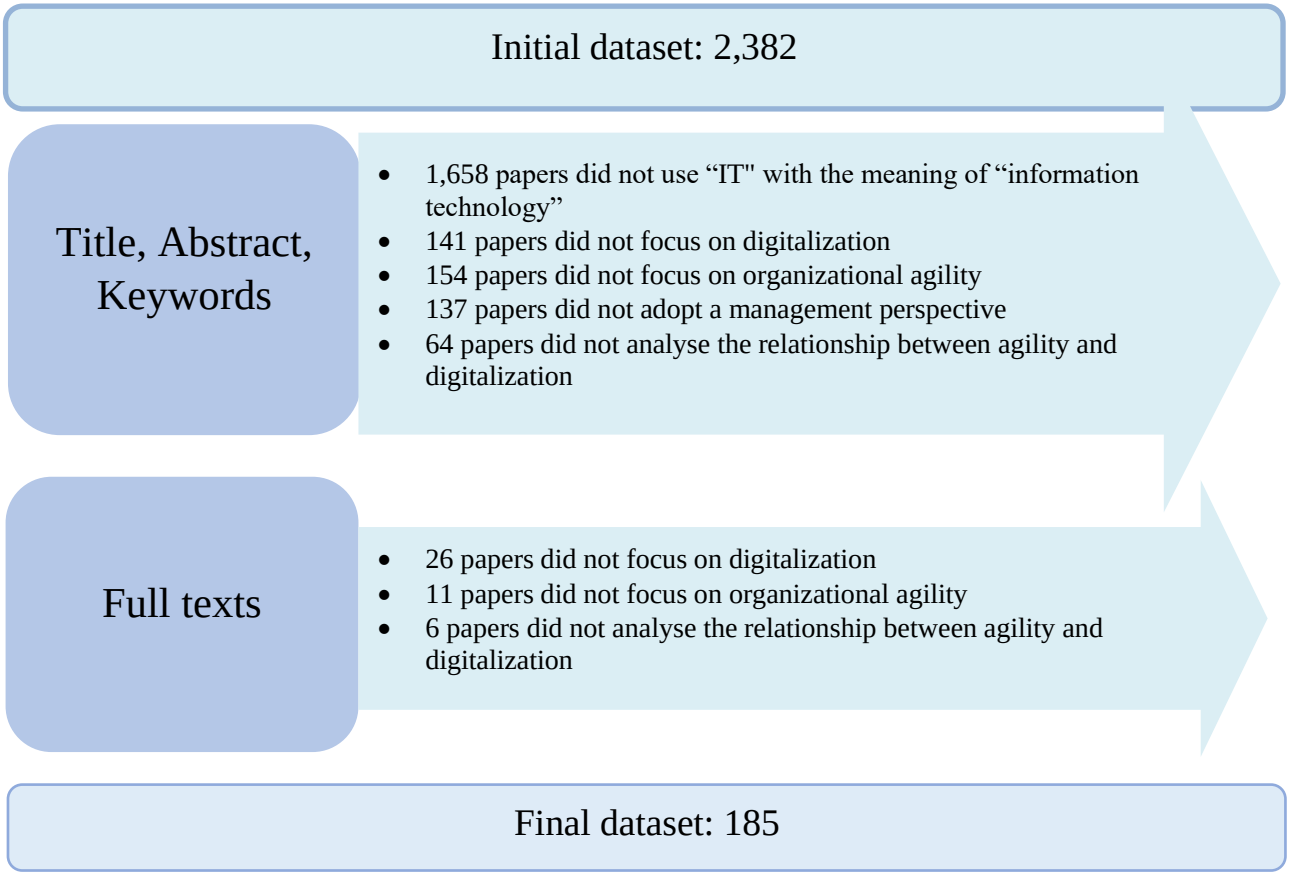

Figure 1. Paper selection process

In the following step of our analysis, three out of the four authors performed an autonomous reading of each of the 2,382 documents to independently analyse their relevance (Akter et al., 2019; Akter and Wamba, 2016; Tranfield et al., 2003). To measure the level of alignment between the results obtained through these three individual selection processes, Krippendorf’s alpha coefficient was calculated. It was greater than 0.80, thus supporting the robustness of our selection protocol. A large number of papers were excluded because they contained "IT" in their title, abstract or keywords with the meaning of third-person singular pronoun and not of information technology. Some papers were excluded because they did not delve into digitalization or organizational agility, some because they did not adopt a management point of view, and others because, although they analysed both digitalization and agility, they did not explore any significant relationship between these two

constructs. This selection process reduced our dataset to 185 papers (see Figure 1), which deeply analyse the relationship between digitalization and organizational agility from a management perspective.

A backward and forward snowballing process (Rajwani and Liedong, 2015) was finally implemented with the aim of cross-validating the reliability of our search and selection protocols. This process was conducted by manually screening the references of all 185 documents and confirmed the reliability of our selection protocols.

In the fourth step, to analyse the structure and evolution of the literature object of our review, some relevant bibliometric indicators were calculated and interpreted (Todeschini and Baccini, 2016). Subsequently, a similarity analysis was performed by using VOSviewer 1.6.10 software and the bibliographic coupling algorithm (Van Eck et al., 2006; van Eck and Waltman, 2010), based on which two contributions are considered to be coupled if they have one or more common third studies in their bibliography. This algorithm has proven to be useful and reliable to support the mapping of research fields and the recognition of research streams or trends (Boyack and Klavans, 2010). VOSviewer allowed us to build a graphical map where each sphere represents a paper, and the papers are split into clusters as a function of the similarity of their references (Van Eck et al., 2006; van Eck and Waltman, 2010). The resulting cluster structure represents a powerful instrument to interpret the literature contained in a scientific dataset and the research streams characterizing that literature (van Eck and Waltman, 2010). As a result of our similarity analysis, 159 papers were found to be connected in terms of shared references, forming a graphical structure composed of three clusters whose configurations appear quite well defined (see Section 4).

In the fifth step, always following the best methodological practices (Tranfield et al., 2003) and with the aim of focusing on the most relevant papers and making our results as significant as possible, three out of the four authors autonomously attributed a score to each of these 159 papers as a function of their importance for the main topics of each thematic cluster. Again, Krippendorf's alpha coefficient was calculated and used to obtain a statistical measure of the agreement achieved. It was also higher than 0.80 in this case, confirming the inter-reliability of the process. This final step allowed us to select a restricted dataset composed of 64 papers (40% of the total dataset).

In the final step, a systematic review of these 64 papers was performed (Gaur and Kumar, 2018; Tranfield et al., 2003), to explore and connect the themes analysed, investigate the most relevant theoretical connections among the studies and the thematic clusters, discover the most relevant understudied topics and propose a future research agenda.

4. Results of the bibliometric and VOS analyses

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In Figure 2 and Table 1, we present the dynamics of some bibliometric indicators that we consider useful for analysing and interpreting the structure and evolution of the object of our review.

Starting in 2017, the number of publications per year has grown exponentially, demonstrating the recently increased scientific interest in the topic, in parallel with the increasing attention attracted by the digital revolution and the leading technologies (such as big data analytics, IoT, cloud computing) on which the digital revolution is based (Karimi and Walter, 2015; Vial, 2019).

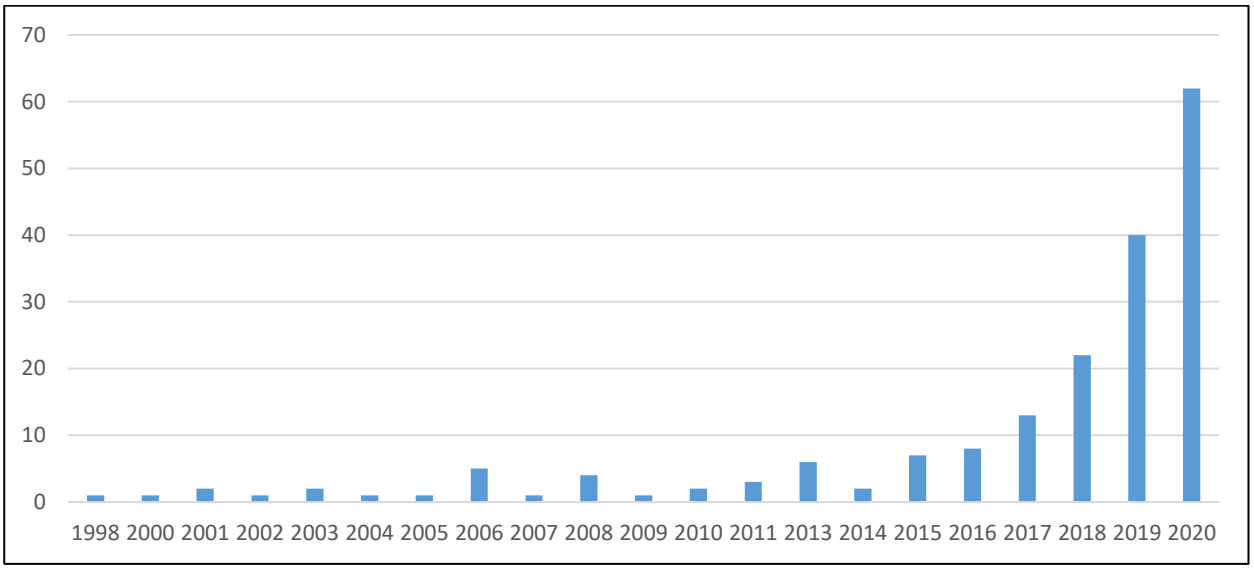

Figure 2. Papers per year

Table 2 shows that the number of authors with a significant volume of publications is relatively high, as are the number and variety of journals that published the greatest number of studies.

The main specific scientific fields covered by the most relevant journals are production, information management, supply chain management and technology management. Among the most prolific journals, the presence of marketing (Industrial Marketing Management) and general management journals (such as Management Research Review and Journal of Business Research) can be noted. The distribution of studies per author reveals a significant number of especially productive scientists (ten authors published at least three pieces and five of them produced four papers or more), while the distribution by country highlights that 42% of the scientific production comes from authors operating in the United States (48) or the United Kingdom (29), with Chinese and Indian authors also being quite prolific (20 and 24 papers, respectively).

Table 1. Papers per country, author and journal

Studies per country (top 10 countries)			
United States	48	France	9

United Kingdom	29	Indonesia	8
India	24	Italy	8
China	20	Australia	7
Finland	9	Hong Kong	6
Studies per author (top 10 authors)			
Gunasekaran, A.	8	Adeleye, E.O.	3
Sambamurthy, V.	5	Mandal, S.	3
Panda, S.	4	Yusuf, Y.Y.	3
Papadopoulos, T.	4	Zhang, J.	3
Rath, S.K.	4	Dubey R.	3
Studies per journal (top 10 journals)			
International Journal of Production Research	8	Management Research Review	4
International Journal of Information Management	7	Strategic Direction	3
International Journal of Supply Chain Management	6	MIS Quarterly: Management Information Systems	3
Journal of Business Research	6	Industrial Marketing Management	3
Technological Forecasting and Social Change	4	Decision Support Systems	3

The clustering structure resulting from the similarity analysis performed by using VOSviewer 1.6.10 software (Figure 3) reveals the presence of three thematic clusters whose configurations appear quite well outlined, as well as significant intercluster connections.

The papers belonging to the blue cluster view BDAC and the other emerging digital technologies, such as IoT, artificial intelligence (AI), blockchain and social media platforms, as crucial drivers of company agility and, through the latter, of company performance. The red cluster aggregates studies focused on the relationship between digital technologies and agility at the supply chain (SC) level. Finally, the green cluster assembles studies focused on the role of information technology capabilities (ITC) in improving organizational agility (OA) and on the impact of the ITC-OA relationship on firm competitiveness and innovation performance.

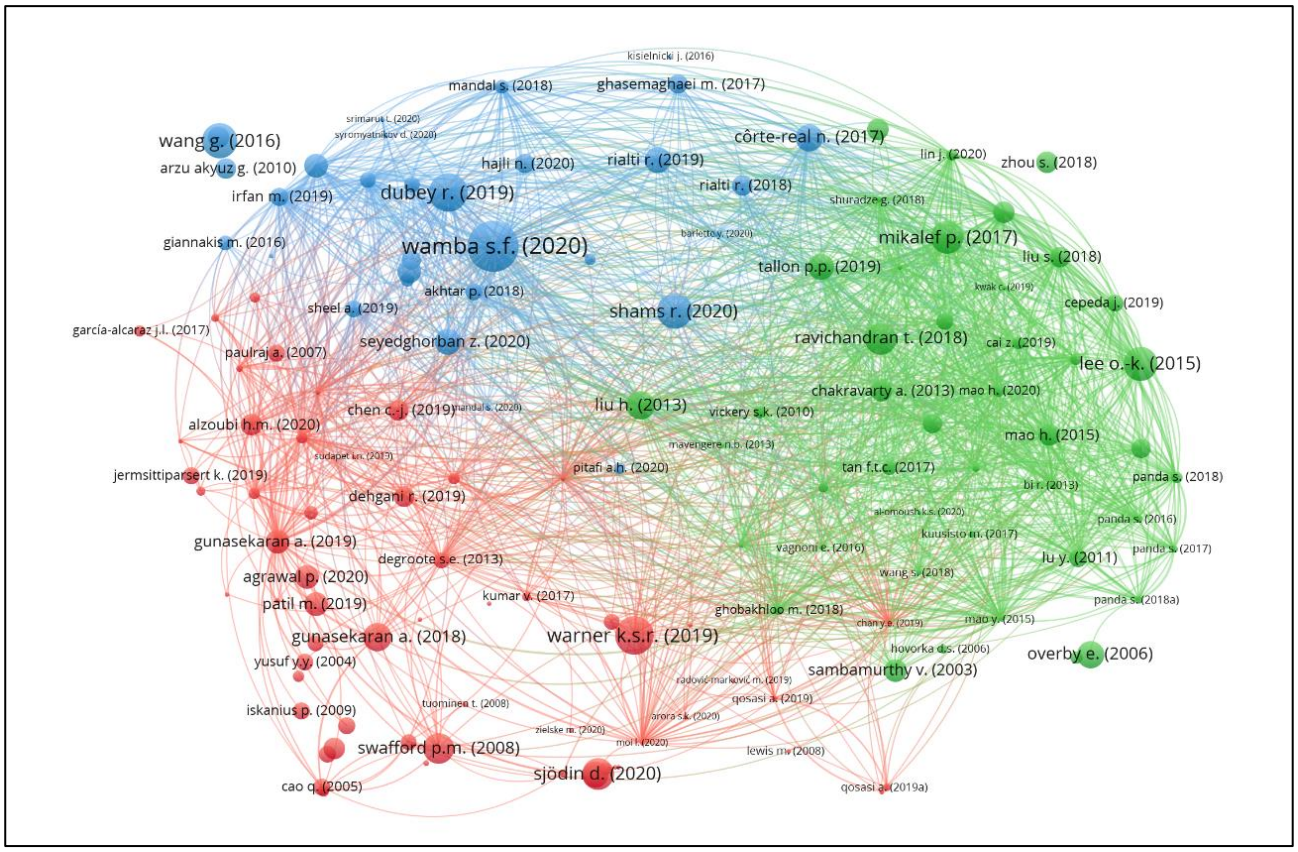

Figure 3. The clustering structure emerged from the VOS analysis

5. Results of the systematic literature review

In the following sections, we present the results of our literature review. Table 2 summarizes the main thematic areas that were the object of analysis within each cluster.

Table 2. Main topics per cluster

Main Topics	References
GREEN CLUSTER: INFORMATION TECHNOLOGY CAPABILITIES AND ORGANIZATIONAL AGILITY	
The role of information technology capabilities in enabling organizational agility	Gao et al., (2020); Liu et al., (2018); Lu and K. (Ram) Ramamurthy, (2011); Tallon and Pinsonneault (2011).
The enhancing factors of the relationship between information technology capabilities and organizational agility	Lin et al., (2020); Mao et al., (2015); Mao et al., (2020); Panda and Rath, (2016, 2017); Baloch et al. (2018).
Combining information technology capabilities and organizational agility to gain competitive advantages and enhance firm performance	Liu et al., (2013); Mikalef and Pateli, (2017); Vagnoni and Khoddam (2016); Martínez-Caro et al., (2020); Sambamurthy et al., (2003).
The mediating role of innovation capabilities and culture in the relationship between information technology capabilities and organizational agility	Cai et al., (2019); Cepeda and Arias-Pérez (2019); Ravichandran (2018); Nwankpa and Merhout (2020).
RED CLUSTER: DIGITALIZATION AND SUPPLY CHAIN AGILITY	

Digital transformation and supply chain agility	Agrawal et al., 2019; Bargshady et al. (2016); Brenner, (2018); Chan et al. (2019); Mak and Shen, (2020) Shiranifar et al. (2019); Warner and Wager, (2019).
Digital-based supply chain agility and firm performance	Alzoubi and Yanamandra, 2020, Chen, 2019; Degroote and Marx (2013); Garcia-Alcaraz et al. (2017); Swafford et al., (2008).
Digital organizational culture and supply chain agility	Dehgani and Jafari Navimipour, (2019); Ngai et al., (2011); Malekifar et al., (2014); Jermsittipar and Wajeetongratana (2019).
Digital-based supply chain agility: manufacturing and logistic perspectives	Gunasekaran et al., (2019); Gunasekaran et al., (2018); Zielske and Held, (2020); Paulraj and Chen, (2007).
BLUE CLUSTER: BIG DATA ANALYTICS CAPABILITIES, AGILITY AND PERFORMANCE	
Big data analytics capabilities, ambidexterity and agility	Fosso-Wamba et al., (2020); Rialti et al., (2018)**;** Rialti et al., (2019)**;** Shams et al., (2020a)**.**
Big data analytics capabilities, agility and performance	Asrini et al., (2020); Côrte-Real et al., (2017); Hajli et al., (2020); Von Alberti-Alhtaybat et al., (2019).
The role of organizational competences and learning culture	Barlette & Baillette, (2020); Fachnurrisa et al., (2020); Ghasemaghaei et al., (2017); Kisielnicki & Misiak, (2016); Kozarkiewicz (2020).
Big data analytics capabilities and supply chain agility	Christopher & Ryals, (2014); Dubey et al., (2019); Giannakis & Louis, (2016); Mandal, (2018); Meriton et al., (2020);Wang et al., (2016).
The new digital solutions as drivers of organizational agility	Ahn, (2020); Akhtar et al., (2018); Calatayud et al., (2019); Nandi et al., (2020); Pitafi et al., (2020); Rane & Narvel, (2019); Sheel & Nath, (2019).

5.1 Green cluster: information technology capabilities and organizational agility

Green cluster aggregate studies focusing on the role of information technology capabilities (ITC) in improving OA and on the impact of the ITC-OA relationship on firm competitiveness and innovation performance.

5.1.1 The role of information technology capabilities in enabling organizational agility

Superior ITC, defined as the firm's ability to leverage IT resources to support business strategies and work processes (Lu and K. (Ram) Ramamurthy, 2011), represents a significant enabler of OA (Gao et al., 2020; Liu et al., 2013; Mao et al., 2015; Martínez-Caro et al., 2020; Overby et al., 2006). Technical ITC is constituted by the combination of IT flexibility, i.e., the organization's ability to recombine IT infrastructure for business purposes, and IT integration, which is the extent to which IT infrastructure is diffused and information is shared among different company departments (Saraf et al., 2007). Since both IT flexibility and IT integration have a crucial role in improving OA (Liu et al., 2018), organizations should not only invest in modular IT components but also be able to integrate such components into the entire organizational environment (Gao et al., 2020). Liu et al. (2018) demonstrate that cloud-based IT infrastructure flexibility and integration have the potential to make firms more flexible in scheduling and deploying IT applications, responding to changes in customers' demands and connecting with new partners.

However, technical ITC can be effectively leveraged for enabling OA only if the company possesses

adequate managerial ITC, defined as the ability to align IT infrastructure to business strategy and use it to support business goals and create new opportunities (Gao et al., 2020; Lu and K. (Ram) Ramamurthy, 2011; Panda and Rath, 2017, 2016; Tallon and Pinsonneault, 2011). Gao et al. (2020) suggests that in the presence of an adequate IT business spanning capability (i.e., the capability to integrate business and IT strategic planning), IT flexibility has a stronger effect on OA than IT integration. In other words, only if organizations can continuously adapt their IT components to emerging changes can they fully leverage the OA effect of their managerial ability to boost information sharing between IT and business managers and employees. Panda and Rath (2017) find a positive impact on organizations' sensing and responding agility of "human ITC", a specific form of managerial ITC defined as the ability to effectively combine interpersonal and technology management expertise. Lu and K. (Ram) Ramamurthy (2011) conceptualizes ITC as a construct based on three dimensions, IT infrastructure capabilities, IT business spanning capabilities, and IT proactive stance, that represent a firm's ability to proactively search for ways to embrace IT innovations or exploit existing IT resources to create and leverage business opportunities.

5.1.2. The factors that enhance the relationship between information technology capabilities and organizational agility

Other studies investigate the mediating or moderating roles of the ITC-OA relationship played by information intensity and environmental uncertainty (Mao et al., 2015), environmental dynamism (Baloch et al., 2018; Chakravarty et al., 2013; Lin et al., 2020), IT spending (Panda and Rath, 2017, 2016) and organizational variables such as absorptive capacity (Mao et al., 2020) and operational dynamic capabilities (Baloch et al., 2018). When the environment is uncertain, organizations need more information processing ability to be adequately agile, effectively sense environmental changes and respond to them. As a consequence, the higher the level of environmental uncertainty and dynamism, the greater the role of ITC as an OA enabler (Baloch et al., 2018; Mao et al., 2015). In particular, high levels of product or service information intensity generate the need to catch, elaborate, and turn into knowledge a large amount of data and information. Consequently, the higher the level of information intensity, the greater the impact of IT on OA (Mao et al., 2020; Mao et al., 2015). Panda and Rath (2017, 2016) claim that firms should spend adequate amounts of money on IT assets to generate the ITC that is necessary to reach high levels of agility. However, when firms mainly invest in IT infrastructure rather than IT managerial assets, IT spending does not have a significant effect on overall agility. Baloch et al. (2018) finds that the influence of ITC on OA is significantly and positively mediated by operational dynamic capabilities, while Mao et al. (2020) shows that absorptive capacity mediates the effects of IT knowledge on both market capitalizing agility and

operational adjustment agility.

5.1.3. Combining information technology capabilities and organizational agility to gain competitive advantages and enhance firm performance

While the abovementioned studies aim to measure IT-related factors directly or indirectly impacting OA, another group of contributions focuses on OA as an antecedent of firm performance and competitive advantages. Mikalef and Pateli (2017) find that OA plays a mediating role in the relationship between IT dynamic capabilities and firm competitive performance. In particular, IT dynamic capabilities enhance market capitalizing agility (thus providing first-mover advantages with regard to product customization) as well as operational adjustment agility (thus allowing a quick adaptation of production pace to customer requirements), which, in turn, leads to higher customer retention and superior competitive performance. Martìnez-Caro et al. (2020) demonstrate that IT assimilation capacity, defined as the extent to which the use of technology diffused across organizations has become routinized, has a positive and direct impact on OA and a positive indirect effect on firm performance. Liu et al. (2013) find that the effects of IT assimilation capabilities on firm performance are mediated by OA, while Vagnoni and Khoddami (2016) demonstrate that IT dynamics capabilities, expressed as IT competency, systematic insight and strategic foresight capabilities, improve the strategic agility of firms, which, in turn, leads to a superior competitive advantage.

5.1.4. The mediating role of innovation capabilities and culture in the relationship between information technology capabilities and organizational agility

Ravichandran (2018) finds that, while ITC provide an opportunity to create new business models or develop digital products and services, only the presence of an organizational culture that highly stimulates innovation, experimentation and risk taking will enable effective exploitation of IT competences that are necessary to obtain a high level of OA and a strong capability of detecting and exploiting market opportunities. Cai et al. (2019) define an “innovative climate” as an environmental factor that encourages employees to generate new ideas, thoughts and changes and finds that it enhances market agility, expressed as the ability to continuously develop new products able to satisfy the carrying needs of customers. Cepeda and Arias-Pérez, (2019) directly explore the mediating role of open innovation in the ITC-OA relationship and finds that open innovation capabilities allow the company to effectively integrate and exploit internal and external knowledge flows and, as a consequence, to accelerate innovation and gain agility when responding to context changes. Finally, Nwankpa and Merhout, (2020) suggest that digital investment and OA are key enablers of IT

innovation; only firms that are endowed with superior organizational agility can effectively leverage digital technology investments, capture insights and opportunities from a business climate dominated by digital platforms and fully exploit the conversion potential of digital investment into IT innovation.

5.2. Red cluster: digitalization and supply chain agility.

Red cluster aggregates studies focused on the relationship between digital technologies and agility at the supply chain (SC) level.

5.2.1. Digital transformation and supply chain agility

SC agility (SCA) is the ability of the SC to respond rapidly and cost effectively to unpredictable changes in markets and environmental turbulence. It requires SCs to be market sensitive (i.e., effectively connected to customer trends), virtual (i.e., able to exploit digital technologies and platforms to share information among all chain members in real time), network-based (i.e., based on the interconnected usage of members strengths) and process-aligned (i.e., characterized by a high level of process synchronization between all network players) (Bargshady et al., 2016). Agility is the core mechanism facilitating SC digital transformations by forcing companies to innovate their business models, collaborative approaches and culture (Warner and Wäger, 2019) and by permitting the introduction of a partnering, cocreating and value sharing logic (Brenner, 2018). At the same time, the development of an integrated and flexible digital IT infrastructure is fundamental to fully leverage the typical characteristics of an agile SC, such as delivery speed, data accuracy, fast new product development and introduction, flexible and collaborative planning, high process integration, low lead times and costs, high product and service quality and high levels of customer satisfaction. In this connection, digitalization offers new opportunities to further develop the SC Triple-A (agility, adaptability and alignment) approach and complete the transition from a production- to a fully demand-driven logic (Mak and Shen, 2021). Several studies (Bargshady et al., 2016) demonstrate that a positive and strong relationship exists between IT capabilities and SCA and that the latter is positively influenced by a balanced and coherent IT and knowledge capabilities coevolution (Chan et al., 2019; Shiranifar et al., 2019). However, the process of SC digital transformation can effectively occur only if some barriers are overcome, such as “no sense of urgency”, a “lack of industry-specific guidelines”, a “lack of digital skills and talent” and “high implementation and running costs” (Agrawal et al., 2019).

5.2.2. Digital-based supply chain agility and firm performance

SCA has positive effects on the performance and competitive advantage of all firms being part of the

SC (Alzoubi and Yanamandra, 2020; Chen, 2019; DeGroote and Marx, 2013; Swafford et al., 2008). Alzoubi and Yanamandra (2020) find that achieving high levels of SCA improve both the operational and competitive performance of SC actors and that digital technologies favour SCA as they facilitate the development of collaborative decision-making and the exchange and sharing of procedures, databases and applications, thus leading to greater levels of productivity and customer satisfaction. Similarly, DeGroote and Marx (2013) find that digital technologies, although having a small effect on information timeliness, meaningfully impact information quality and accuracy, thus allowing the implementation of effective, timely and well-coordinated SC planning processes that, in turn, have a positive impact on customer satisfaction and financial performance levels.

Trust between SC partners represents a fundamental enabler of SCA, as it allows high levels of coordination and collaboration to be achieved between SC members, thus permitting the reduction of costs, the improvement of product innovation processes and the creation of more value for customers (Chen, 2019). The SC's ability to effectively leverage digital technologies to promptly respond to market threats and opportunities (strategic flexibility) and timely reconfigure manufacturing resources (manufacturing flexibility) allows to reduce SC lead times and effectively adapt production volumes and variety to emerging market dynamics and customer expectations, thus leading to superior firm performance (Swafford et al., 2008). Finally, the widespread use of information and communication digital tools favours the ability of SC actors to effectively access and share information, which is key to ensuring on-time deliveries, high levels of product customization and customer satisfaction and short product development and production times. As a consequence, managers should encourage ICT implementation and provide their employees with adequate ICT training to maximize the overall SC potential of value creation and the chances that their firms will remain competitive over time (Garcia-Alcaraz et al., 2017).

5.2.3. Digital organizational culture and supply chain agility

To develop agility, SC organizations have to be endowed with adequate IT skills and knowledge. Dehgani and Jafari Navimipour (2019) demonstrate that to effectively leverage IT technologies for SCA, all SC actors must possess adequate knowledge and skills concerning, on the one hand, user need dynamics and on the other hand, software development, project management, hardware and software compatibility issues. It is fundamental that firms steadily train their managerial and operational personnel on how to use and exploit all state-of-the-art IT digital tools. Ngai et al. (2011) argue that IT competences, expressed as IT integration and flexibility knowledge, operational competences, defined as SC integration and flexibility know-how and SC learning orientation, and management competencies, expressed as the IT vision of top management, are all necessary,

interlinked and mutually supportive components of the firm competence baggage on which an effective SCA has to be based. The relationship between IT competences and SCA is positively moderated by organizational culture, expressed as a complex combination of roles, norms, values, beliefs, assumptions, and symbols characterizing the company's vision of the world (Malekifar et al., 2014). Only in the presence of a sufficiently dynamic and strong IT and agility-oriented enterprise culture is it possible to effectively leverage the IT competencies possessed by managers and employees to obtain high levels of SCA (Jermsittiparsert and Wajeetongratana, 2019).

5.2.4. Digital-based supply chain agility: manufacturing and logistics perspectives

Achieving a pronounced SC ability to quickly respond to market instability and product complexity evolution requires close supervision and active coordination of the activities of all SC actors, such as suppliers, manufacturers and logistic distributors. This is especially true for manufacturing activities. In fact, digital technologies and big data analytics capabilities (Gunasekaran et al., 2018) represent fundamental enablers of agile manufacturing, which allow to simultaneously minimize time to market and lead times and maximize production flexibility and the level of product customization (Gunasekaran et al., 2019). Furthermore, consumers' increased expectation of rapid delivery of goods and services has made the role of logistics companies much more critical for the overall agility and competitiveness of the entire SC. Paulraj and Chen (2007) find that the agility of logistics companies strongly depends on the quality of supplier-buyer relationships and the level of IT chain integration. Zielske and Held (2020) demonstrate that logistics start-ups can effectively apply agile practices in competitive contexts characterized by high levels of market insecurity and that these practices, in turn, enhance the responsiveness to changing priorities and demands, allow the acceleration of product delivery and permit the achievement of high levels of coordination between IT and business departments.

5.3. Blue cluster: Big data analytics capabilities, agility and performance.

IT infrastructure represents a set of shared tangible IT resources enabling present and future business applications. Among these resources, platform technologies, network and telecommunications, critical data and data processing applications, play a fundamental role in firm competitiveness (Broadbent et al., 1999). Big data (BD) can be defined as a complex and large dataset that cannot be analysed with standard statistical models (Ghasemaghaei et al., 2017; Mandal, 2018). The papers belonging to the blue cluster assume that in the digitalization era, BD and the other emerging digital technologies (such as IoT, AI, blockchain and social media platform) represent primary sources for a company's competitive advantage and that big-data analytics capabilities (BDAC) have a

fundamental impact on company agility and thus on company performance.

5.3.1. Big data analytics capabilities, ambidexterity and agility

A group of contributions within the blue cluster underscore that BDAC affect company ambidexterity, which, in turn, contributes to firms' agility (Rialti et al., 2019, 2018). BDAC have a positive impact on ambidextrous capabilities, as they favour IT infrastructure flexibility (Shams et al., 2020a) as well as the company's ability to track all the relevant changes in both the internal and external environment (Fosso Wamba et al., 2020), manage supply chain disruptions (Fosso Wamba et al., 2020), and rapidly and effectively respond to customers' needs (Rialti et al., 2019). However, using complex IT infrastructures for BD gathering may also represent a limitation on company agility in adopting new IT technologies or infrastructures because the digital shift can cause data loss or unavailability (Shams et al., 2020a).

5.3.2. Big data analytics capabilities, agility and performance

Several contributions of this cluster focus on the relationship between BDAC, agility, company marketing and financial performance and competitive advantage. Big Data Analytics (BDA) tools help to effectively make marketing decisions such as those concerning new advertising campaigns, new product launches or market monitoring (Hajli et al., 2020; von Alberti-Alhtaybat et al., 2019), as in the case of the global logistics player Aramex, which has strongly leveraged BDA to understand its customers' needs and tailor the delivery experience, thus gaining a competitive advantage in the market (von Alberti-Alhtaybat et al., 2019). Hajili et al. (2020) find that BDAC are fundamental to achieving high market performance in new product launches, as they allow firms to effectively sense and respond to continuous changes in customer needs. Adopting a knowledge-based view (KBV), Côrte-Real et al. (2017) find that BDA enhance firm agility, as they provide access to critical knowledge and information in an easy and accessible way and enable managers to make and change decisions rapidly and effectively, thus permitting to achieve superior financial performance (Asrini et al., 2020).

5.3.3. The role of organizational competences and learning culture

Adequate baggage of pre-existing knowledge is also necessary to effectively leverage BDA for agility purposes. Successfully exploiting BDA to enhance company agility also requires the development of an organizational learning-oriented culture (Barlette and Baillette, 2020), effectively developed by agile leadership (Fachnurrisa et al., 2020). Ghasemaghaei et al. (2017) find that for BDA to positively affect a company, agility is essential to achieve an adequate fit between the data analysed, the data

analysis tools and their functionalities, the tasks to be accomplished, and the competencies of the employees. In particular, agility-oriented competencies are essential when implementing business intelligence projects (Kisielnicki and Misiak, 2016, Kozarkiewicz 2020).

5.3.4. Big data analytics capabilities and supply chain agility

Other contributions of this cluster focus on the role of BDAC as a driver of SCA. Indeed, rapidly and effectively addressing the SC logistics issues generated by an ever-changing and turbulent environment requires access to the precious insights generated by an appropriate usage of BDA (Giannakis and Louis, 2016; Mandal, 2018). Wang et al. (2016) and Dubey et al. (2019) go beyond the impact of BDAC on SCA and find that the latter contributes to a superior competitive advantage largely due to the high levels of demand forecast precision and inventory management effectiveness ensured by a proper usage of BDA, thus paving the way for new theories and best practices of demand chain forecasting (Christopher & Ryals, 2014; Meriton et al., 2020).

5.3.5. The new digital solutions as drivers of organizational agility

In addition to BD, other digital assets may represent valuable drivers of company agility, such as IoT (Ahn, 2020; Akhtar et al., 2018; Rane and Narvel, 2019), AI (Calatayud et al., 2019), Blockchain (Nandi et al., 2020; Sheel and Nath, 2019) and even social media (Pitafi et al., 2020). IoT solutions provide agility to innovation processes by enhancing information sharing and communication (Ahn , 2020). Furthermore, the usage of IoT installations for the real-time control of production lines increases production agility by allowing effective predictive maintenance and the quick identification and repair of mechanical failures, thus avoiding all manual checks and production stoppages that would be otherwise mandatory (Rane and Narvel, 2019). The contribution of IoT solutions to the agility of production systems is enhanced by the usage of AI self-learning algorithms (Calatayud et al., 2019) and blockchain technologies (Rane and Narvel, 2019), which allow to reach a greater degree of supply chain resilience (Nandi et al., 2020) and higher levels of communication effectiveness and trust between SC actors (Sheel and Nath, 2019). Finally, tools such as DingTalk, Slack, Microsoft Teams, Trello, and Yammer are currently widely and increasingly adopted by companies to maximize the agility of their business processes and effectively support employee communication, collaboration, and knowledge sharing (Pitafi et al., 2020).

6. Discussion and research propositions

Table 3 synthesises the most relevant understudied topics that emerged from our review. The references presented in the second column identify the papers that have directly or indirectly inspired the research gaps synthesised in the first column.

Table 3. Digitalization and agility: the main research gaps

Research gaps	References
Green Cluster: information technology capabilities and organizational agility	
Investigate the complementarity between different digital capabilities for company agility in specific competitive contexts.	Gao et al. (2020); Liu et al. (2018).
Expand the meaning of environmental uncertainty and explore more deeply its impact on digitalization-based agility.	Lin et al., (2020); Baloch et al. (2018).
Explore more deeply how an effective IT assimilation strategy can enhance the relationship between company absorptive capacity and organizational agility.	Mao et al., (2020); Martínez-Caro et al. (2020).
Investigate which and how non-IT capabilities can effectively complement IT competencies and digital platforms to optimize organizational agility.	Ravichandran (2018).
Red Cluster: digitalization and supply chain agility	
Deepen the relationship between business model innovation and supply chain digital transformation processes.	Agrawal et al., (2019); Brenner, (2018); Warner and Wager, (2019).
Investigate how digital technologies can favour trust-based relationship between supply chain partners.	Alzoubi and Yanamandra, (2020), Chen, (2019); Degroote and Marx (2013).
Learn more about which and how digital competences can be leveraged and integrated to obtain superior levels of supply chain agility.	Dehgani and Jafari Navimipour, (2019); Ngai et al., (2011).
Explore how new digital technologies can enhance the sustainability of supply chain production and logistic processes.	Gunasekara et al. (2019); Gunasekara et al. (2018).
Blue Cluster: big data analytics capabilities, agility and performance	
Learn more about how and which big data analytics capabilities mostly impact a company's ambidexterity in different competitive environments as well as the impact of the soft aspect of BDAC on organizational ambidexterity.	Fosso Wamba et al., (2020); Rialti et al., (2019); Shams et al., (2020a).
Develop specific key performance indicators to assess how BDA-agility interconnections impact the performance of different business areas and processes.	Asrini et al. (2020); Corte-Real et al. (2017).
Explore the coherences that are to be reached and maintained between a company's need and willingness of big data usage and the BDA competencies that are needed to fully exploit BDA for agility purposes	Barlette and Baillette (2020); Ghasemaghaei et al. (2017); Kisielnicki and Misiak (2016).
Investigate which and how barriers or enablers condition an effective adoption of new digital technologies for agility purposes as well as the effects on OA of using different combinations of digital technologies.	Akhtar et al., (2018); Pitafi et al. (2020); Rane and Narvel (2019); Sheel and Nath (2019).

Regarding the green cluster, some examples of addressable research gaps concern the understanding of the adequate level of complementarity between different digital capabilities that are needed to optimize company agility in different environmental contexts (Gao et al., 2020; Liu et al., 2018), how IT-based assimilation capabilities can improve organizational agility (Mao et al., 2020; Martìnez-Caro, 2020), and which and how non-IT capabilities can be leveraged to optimize the IT-OA relationship (Ravichandran, 2019). Furthermore, the ever-increasing environmental turbulence calls for a revision of the concept of uncertainty itself (Lin et al., 2020).

With regard to the red cluster, some interesting future research areas concern the drivers of the SC digital transformation, with particular attention to business model innovation processes (Alzoubi and Yanamandra, 2020; Chen, 2019; DeGroote and Marx, 2013). Little attention in the literature has been devoted to the role of digital technologies and competencies in favouring trust-based relationships among SC members processes (Alzoubi and Yanamandra, 2020; Chen, 2019; DeGroote and Marx, 2013) and, as a consequence, enhancing organizational agility (Dehgani and Jafari Navimipour, 2019; Ngai et al., 2011). Finally, there is a need for a deeper analysis of the impact of the effective use of digital technologies in operation processes on supply chain sustainability and agility (Gunasekaran et al., 2019, 2018).

In the blue cluster, further research could investigate the drivers affecting the relationship between BDAC, ambidexterity and agility (Fosso Wamba et al., 2020; Rialti et al., 2019), the specific key performance indicators used to assess how the BDA-agility interconnections impact the performance of different business areas (Asrini et al., 2020; Corte-Real et al., 2017), and consequently, how firms should adapt their organizational learning processes to fully exploit BDAC (Barlette and Baillette, 2020; Ghasemaghaei et al., 2017). Finally, research on new digital technologies such as blockchain, IoT, AI or social media is still at an early stage, and researchers should embrace the mission to deepen the barriers and enablers characterizing the adoption of these technologies and what could be the best match between them to enhance firms' agility (Akhtar et al., 2018; Pitafi et al., 2020; Rane and Narvel, 2019; Sheel and Nath, 2019),

To inspire future research directions, we now present a number of research propositions based on these research gaps. The propositions are not industry- or case-specific but may have relevance in different industrial or economic contexts.

6.1 Research propositions

Based on the review of the literature presented in Section 5, following the best practices (Hughes et al., 2019) and aiming to inspire further research concerning the relationships between digitalization and agility, twelve unique research propositions are presented in the next sections, each of which relates to one or more of the research gaps summarized in Table 3.

6.1.1. The complementarity between different digital capabilities

Scholars have largely investigated the direct and indirect effects of different technical and managerial digital capabilities on company agility and performance (Gao et al., 2020; Lu and K. (Ram) Ramamurthy, 2011; Overby et al., 2006; Sambamurthy et al., 2003). Nevertheless, the importance and role of each capability depend on the characteristics of the different environmental and

organizational contexts. For example, in the case of companies endowed with a high level of absorptive capacity, digital flexibility is more important than infrastructure integration capability (Gao et al., 2020). Furthermore, in times of economic recession (such as the one we are experiencing due to the current global health crisis), it could be appropriate to prioritize IT proactiveness compared to IT flexibility or integration. As a consequence, a deeper understanding of the complementary and interaction mechanisms between the different digital capabilities in the diverse competitive and organizational contexts could provide insights on how to effectively leverage these mechanisms.

Propositions 1. *Researchers should deepen the understanding of the complementary and interaction mechanisms between the different digital capabilities that impact organizational agility in diverse competitive contexts.*

6.1.2 Environmental uncertainty

Environmental dynamism and complexity (Lin et al., 2020) represent key moderating variables of the relationship between digital capabilities and organizational agility. Scholars have interpreted environmental uncertainty as mainly related to market and industry factors. However, the strategic growth of firms is also affected by other environmental factors, such as those related to institutional pressures, the level of government support, and the rise of global emergencies (such as the global health crisis we are currently experiencing). As a consequence, future research should deepen the effects of these types of uncertainty on the relationship between digital capabilities and agility.

Proposition n. 2. *There is a need to expand the meaning of environmental uncertainty to better understand all its possible causes and impacts on organizational agility capabilities.*

6.1.3. Digital technology assimilation strategy as an amplifier of the absorptive capacity–agility relationship

According to the knowledge-based view, organizational agility has to be based on a superior absorptive capacity, which enables effective knowledge acquisition and exploitation processes. In turn, the positive effect of absorptive capacity on agility depends on the presence of an adequate digital technology assimilation attitude, i.e., the degree to which digital technologies are known and used within organizational processes (Mao et al., 2020; Martínez-Caro et al., 2020). Currently, a relevant digital infrastructure investment can become a significant amplifier of the absorptive capacity-agility relationship only if guided by an effective digital assimilation strategy.

Proposition 3. *Currently, investment in digital technology can represent an effective answer to the need for ever-higher levels of agility brought on by an ever more rapidly changing environment. Further studies are therefore needed to investigate which IT assimilation strategies allow to maximize*

the impact of absorptive capacity on organizational agility.

6.1.4. The role of the non–IT complementary capabilities

Digital capabilities have declined in countless types, such as technical, managerial, and relational capabilities, and have been found to have relevant and positive effects on organizational agility (Gao et al., 2020; Liu et al., 2018). Ravichandran (2019) finds that innovation capacity, i.e., a firm's propensity to innovate, represents a crucial non-IT complementary capability positively affecting organizational agility. Innovation capacity, however, is a very broad concept that can be declined in many different ways.

Proposition 4. *Scholars should deepen the role played by non-IT complementary capabilities within the IT capabilities-agility relationship and the possible types of these complementary capabilities and analyse whether and how they can allow firms to leverage their digital platforms more effectively.*

6.1.5. Business model innovation and supply chain digital transformation processes

New digital technologies such as the IoT, blockchain, cloud computing and big data allow firms to constantly evolve and reconfigure their value propositions (Brenner, 2018). Nevertheless, the digital transformation journey asks for a strategic renewal of the firm's business model, collaborative approach and culture (Brenner, 2018; Warner and Wäger, 2019) to effectively overcome the barriers that hinder this journey (Agrawal et al., 2019). While several studies on business model innovations based on digitalization have been carried out at the firm level (Brenner, 2018), a similar investigation at the supply chain level is still missing.

Proposition n. 5. *Digital transformation allows the implementation of significant renewal processes of the supply chain configuration and strategy. In this connection, researchers should more deeply investigate the best practices through which digitalization can effectively impact business model innovation at the supply chain level as well as the barriers to be overcome for effectively developing and implementing these practices.*

6.1.6. The role of digital technologies in improving trust-based relationships between SC partners

Trust is a fundamental enabler of information sharing processes throughout the entire SC and is therefore crucial to achieve coordinated responses to market changes and high levels of innovativeness (Alzoubi and Yanamandra, 2020; Chen, 2019; DeGroote and Marx, 2013). While it has been demonstrated that trust-based relationships positively impact SC agility and competitive advantage (Chen, 2019), further research is needed to investigate how and to what extent digital technologies may enhance trust between SC partners and, as a consequence, SCA.

Proposition n. 6. *SCA depends on the effectiveness of the knowledge sharing processes activated between SC partners. Trust represents a fundamental enabler of these processes. In this connection, researchers should deepen how and which SC digital integration strategies, processes and practices should be projected and implemented to fully leverage the agility effect of trust mechanisms at the SC level.*

6.1.7. Integrating different digital competences for SC agility

Being part of a supply chain entails the opportunity to collaborate with business partners and allows the development and integration of internal and external digital skills. Different types of digital competences, i.e., technical, operational and managerial (Dehgani and Jafari Navimipour, 2019), have been identified as crucial for the effective development of SC agility (Ngai et al., 2011). In this connection, managers and researchers should more deeply understand how each type of digital competence impacts SCA differently, as well as how these different types of competences can be effectively integrated at the SC level.

Proposition n. 7. *Researchers and practitioners should investigate the impact of the different types of digital competences (technical, operational and managerial) on SCA, as well as explore which best practices for integrating internal and external digital knowledge and skills should be adopted at the SC level.*

6.1.8. The impact of the new digital technologies on SC sustainability

Manufacturing and logistics have a key role in reducing environmental impact and promoting a better quality of life. Many benefits and challenges related to the deployment of new digital technologies, such as big data, blockchain and IoT within manufacturing and logistic processes (Gunasekaran et al., 2018), as well as the role of these technologies in empowering SCA (Gunasekaran et al., 2019), have already been investigated. Nevertheless, further studies are needed to investigate whether and how these technologies may enhance the level of SC sustainability.

Proposition n. 8. *Currently, sustainability is a new imperative to which SCs must effectively respond to remain competitive. Digital technologies may help effectively face this challenge. To help firms better orient their IT investments, researchers should investigate how and which digital technologies and infrastructures could be leveraged to optimize the level of SC sustainability.*

6.1.9. Delving into the BDAC effect on ambidexterity

Studies demonstrating the existence of a significant impact of BDAC on company ambidexterity and agility (Shams et al., 2020a) have mainly adopted the dynamic capability view (DCV) and considered

BDAC as a particular category of dynamic capabilities (Fosso Wamba et al., 2020; Rialti et al., 2019). Nevertheless, they have not delved into how this impact varies in different market contexts and competitive environments and the role of the soft character of BDAC, which is represented by soft competencies such as communication and interactional and creative skills.

Proposition n. 9. *Researchers and firms should deepen their understandings of how and which BDAC impact company ambidexterity in different competitive environments. In addition, more research is needed to better understand the impact of the soft aspect of BDAC on organizational ambidexterity.*

6.1.10. Using specific key performance indicators to assess how the BDA-agility interconnections impact the performance of different firm departments and processes

Studies investigating the relationship between BDA, agility, and company performance use overall performance indicators such as market share or return on investment (Asrini et al., 2020; Côrte-Real et al., 2017). However, to maximize the positive effects arising from the optimization of the BDAC-agility interconnections, it would be necessary to design and use specific process-level key performance indicators (KPIs) suitable to understand how these effects emerge in the different firm's departments and processes (Côrte-Real et al., 2017).

Proposition n. 10. *Future research should aim to design and test specific KPIs suitable to assess the impact of the BDAC-agility relationship on the performance of different company areas and processes.*

6.1.11. Exploring the BDA-organizational learning fit issue

Fully exploiting BDA for agility purposes requires firms to evolve their organizational competencies and learning culture (Barlette and Baillette, 2020; Kisielnicki and Misiak, 2016) to reach and maintain an adequate fit between their needs and willingness to use BD and the necessary competencies and knowledge possessed by their employees (Ghasemaghaei et al., 2017). Nevertheless, more research is needed to investigate how this fit can be reached and maintained over time (Barlette and Baillette, 2020).

Proposition n. 11. *Researchers should more deeply explore the qualitative and quantitative characteristics of the system of coherences that are to be reached and maintained between a company's needs and willingness of BD usage and the BDA competencies of its employees that are needed to fully exploit BDA for agility purposes.*

6.1.12. Barriers and enablers in the adoption of new digital technologies

The literature analysing new digital technologies (such as IoT, AI or social media) as valuable company agility drivers is still in an early stage. First, it mainly focuses on single firm case studies (Rane and Narvel, 2019) and industries and concerns IT-oriented environments and countries (Akhtar et al., 2018; Pitafi et al., 2020; Sheel and Nath, 2019). Second, it does not focus on the cultural and technical barriers or enablers in the adoption of these technologies, as it has instead already been done for BDA (Ghasemaghaei et al., 2017). Finally, it does not explore the effects of the possible combinations of different technologies at one time, such as the effects of integrating blockchain technologies in IoT, AI or BD solutions (Sheel and Nath, 2019).

Proposition n. 12. *Researchers should investigate which barriers or enablers limit or facilitate the effective adoption of new digital technologies for agility purposes. In addition, they should control if and how the impact of these technologies on OA is affected by the industry context. Finally, further research should be carried out to better understand the effects of using different combinations of digital technologies on firm agility.*

6.2. Theoretical contributions

The theoretical contributions of this study are fourfold. First, it discovers and analyses three different, although interrelated, thematic clusters concerning the interconnections between digitalization and organizational agility, focusing on the relation between IT capabilities and OA and the impact of the ITC-OA relationship on firm competitiveness and innovation performance, the relationship between IT and digital technologies and agility at a supply chain level, and BDAC and other emerging digital technologies as crucial drivers of company agility.

Second, this study proposes twelve original research propositions regarding new research pathways to be followed and new managerial solutions to be designed and implemented in the field of digital technology-driven organizational agility.

Third, our review unveils the existence of a two-way connection between digital capabilities and agility, i.e., not only digital technology has a relevant and positive impact on OA, but also agility itself represents a crucial driver of company digital transformation. This development allows to overcome and enlarge the traditional view, according to which IT and digital capabilities represent key enablers of organizational agility (Barlette and Baillette, 2020; Panda and Rath, 2017, 2016). In fact, based on our findings, we claim that OA itself is fundamental for the effective implementation of digital transformation processes and that several barriers to digital transformation are mostly related to the absence of an agile organization, as demonstrated by studies included in the green (Liu et al., 2013), red (Brenner, 2018; Warner and Wäger, 2019), and blue (Barlette and Baillette, 2020; Kisielnicki and Misiak, 2016) clusters. Furthermore, an adequate digital culture enabling firms to

predict how new digital tools will affect current business processes, models and products (Jagtap and Duong, 2019; Scuotto et al., 2017) and a strong risk- and learning-oriented culture (Kane et al., 2015) represent key enablers of an effective digital transformation.

Fourth, with regard to the impact of digitalization on OA, our findings provide new insights into the different agility capabilities that are required to accompany, facilitate and drive the different phases of digital transformation. According to the digital transformation lifecycle framework (von Rosing and Etzel, 2020), digital transformation evolves through diverse evolutionary phases (initial analysis, execution, ongoing improvement). Furthermore, the portfolio of capabilities possessed by a firm must progressively evolve so that a dynamic appropriate balance between the different sets of capabilities can be maintained in the diverse phases of a firm's development (Vokurka and Fliedner, 1998). Based on these considerations and the findings of our study, Table 4 summarizes which agility capabilities can be considered critical in the different phases of the digital transformation lifecycle.

Table 4. Agility capabilities and the digital transformation lifecycle

DT phase	Critical agility capabilities	Research propositions
Early Phase	- Pre-existent digital capabilities, skills and talent (Jagtap and Duong, 2019; Scuotto et al., 2017). - Strategic agility to reconfigure the business models (Warner and Wagner, 2020; Brenner, 2018). - Operational agility to introduce new digital tools at the organizational and supply chain level (Agrawal et al., 2019).	P.5 Business model innovation and supply chain digital transformation processes P.12 Barriers and enablers in the adoption of new digital technologies
Execution Phase	- Managerial agility to integrate and complement existing capabilities with new digital technology capabilities (Gao et al., 2020) and - Managerial agility to integrate and complement existing capabilities with non–IT capabilities such as innovative capacity (Ravichandran, 2019).	P.1 The complementarity between different digital capabilities P.4 The role of the non–IT complementary capabilities P.7 Integrating different digital competences for SC agility
Ongoing phase	- Presence of an adequate digital technology assimilation attitude (Mao et al., 2020; Martinez-Caro et al, 2020); - Managerial capabilities to improve and maintain trust-based relationships between value chain partners (Chen, 2019); - Managerial capabilities to evolve the learning culture and find a fit between digital technologies usage and employers' knowledge (Barlette and Baillette, 2020).	P.3 Digital technology assimilation strategy as an amplifier of the absorptive capacity–agility relationship P.6 The role of digital technologies in improving trust-based relationships between SC partners P.11 Exploring the BDA-organizational learning fit issue

We hope this research will boost further studies aimed at more deeply exploring the value creation potential of an effective co-development of digital transformation and OA. In our opinion, meta-analysis (Jeyaraj and Dwivedi, 2020) could favour a deeper understanding of the overall value creation potential that can be generated through the integration of the two constructs analyzed in our review.

6.3. Implications for practice

Our results have managerial implications for designing and implementing business practices aimed at optimizing the mutual relationships between digitalization and OA. First, the process of digital transformation leading to superior levels of OA is long, complex and articulated and must passes through several stages of an evolutionary pathway. The relationships between digital capabilities and agility are also complex and bidirectional. This bidirectionality is becoming increasingly pronounced due to the exponential increase in the use of new digital tools and technologies such as big data, cloud computing, blockchain, and IoT. In fact, while these technologies represent important enablers of OA (Ahn, 2020; Akhtar et al., 2019), OA, in turn, is a crucial enabler of an effective deployment of these technologies (Vial, 2019). However, to date, there is no readymade roadmap for the effective management of the mutual relationships and coevolutionary interconnections between digitalization and OA. That is why an effective design of a balanced development of both digital and agility capabilities, as well as the two-way relationships between these two categories of capabilities, will be fundamental to allow firms to gain and maintain their competitive advantage in a globalised and digitalised world.

Second, achieving and maintaining high levels of OA requires the development of an organizational culture highly oriented to innovation, experimentation and exploitation of cutting-edge digital approaches and technologies (such as those relating to digital security, blockchain, social media, IoT and cloud computing). Managerial priorities must therefore be focused on attracting, training, and retaining employees capable of mastering the most advanced digital technologies available, as well as continuously developing their digital skills. Our findings strongly support the fact that an effective implementation of the different phases of the digital transformation process requires an adequate digital and learning-oriented attitude by all managers and corporate staff. A suitable organisational climate and appropriate incentive mechanisms and policies must be designed and implemented to allow these digitally oriented and open-mind cultural and learning approaches to develop and take root.

Third, effectively leveraging digital technologies to enhance OA requires digitalization processes to be themselves agile and flexible to allow the continuous acquisition of new digital capabilities and an

effective integration of the latter with the existing ones. Therefore, managers should not only invest in dedicated training and recruitment programmes aimed at developing and renewing their personnel's digital skills but also be continuously engaged in designing appropriate solutions and processes for effective integration and the adequate valorisation of the complementarities between the existing IT infrastructural and cultural baggage and the new technologies that are necessary to acquire and incorporate on an ongoing basis. IT flexibility is essential precisely when a digital transition process is ongoing. For example, cloud-based technologies can represent an excellent solution to make the IT infrastructure properly flexible; just think how much more easily a company would be able to change its providers if it had all its servers in the cloud compared to adopting a no cloud solution. AI can also increase the flexibility of the very digital capabilities of a company by allowing the activation of autonomous self-learning processes of new digital skills.

Fourth, our findings suggest that trust represents a critical element for the effective implementation of knowledge sharing and co-innovation processes that are necessary to effectively leverage digital technologies to boost agility at the SC level, which requires the effective coordination of many different internal and external actors and partners. In this connection, new digital technologies such as blockchain solutions seem particularly appropriate for ensuring significant and scalable processing power and high levels of accuracy and security. These latter, in turn, represent crucial enablers of monitoring and trust-building processes and collaborative innovation activities and, as a consequence, are crucial levers for solving the problem of a lack of trust in all SC phases and for all SC partners. Furthermore, in a globalised and digitalised world, many actors, seemly external to the SC context, may in fact significantly affect SC value creation processes in many different ways. For example, a negative review posted by a social network user who is not a customer and does not have direct relations with the company or the SC can have a negative effect on brand reputation. It follows that managers should enlarge their value chain view; leveraging digital tools and technologies represents an unavoidable step to effectively sense the global environments in which they are embedded.

Finally, achieving high levels of OA requires a revisitation and evolution of business model formulas following digitalization evolutionary patterns, which can also be radical. With regard to business model value propositions, for example, the real-time big data collection and analysis processes allowed by the use of BDA may allow the shift from business models based on products (goods-dominant logic) to much more agile business models based on services (service-dominant logic), in which the value is continuously cocreated by firms and their clients, as opposed to being created by firms and then used by clients. Furthermore, with regard to business model channels, leveraging digital interfaces and tools may allow to bypass one or more intermediaries. Finally, adopting a digital service-dominant logic can permit to transform the business model revenue structure from one based

on rigid purchase-based payments to one based on recurrent lease-based payments, thus allowing to satisfy the needs of a much larger number of clients.

6.4. Limitations and future studies

This study has some limitations. First, the activity of selecting papers may have been biased by the subjectivity characterizing the interpretations and evaluations of the authors. We addressed this aspect by implementing a multiple human subject reading and screening of the papers (Tranfield et al., 2003). The fact that Krippendorf's alpha coefficient was greater than 0.80 supports the robustness of our selection protocol.

A second limitation is that the Scopus database was used only to perform the search phase of this research. However, we cross-validated our findings on another prestigious scientific database, Web of Science, without finding any new relevant documents.

Third, our analysis exclusively focuses on the relationship between digitalization and OA without investigating either the interconnections with other key company capabilities and correlated research fields or the scientific patterns emerging across these interconnections (Shams et al., 2020b). For example, our study does not delve into the processes and strategies to integrate digital capability-based decision-making within risk and knowledge management, which is a relevant emerging topic in the management literature (Battisti et al., 2019; Dellermann et al., 2017).

Fourth, this study adopts a managerial viewpoint and does not explore the different technical benefits and restrictions characterizing several digital and ICT technologies, tools, and approaches (such as BDA, IOT, cloud computing, machine learning, and AI). Our analysis could thus stimulate further research aimed at exploring which are the ideal usage conditions and environments for these diverse technologies to provide increasing levels of agility responsiveness to firms of different sizes and different industries.

Finally, our review has not investigated the different critical issues characterizing digitalization-OA interconnections in B2B compared to B2C contexts. We hope our research will stimulate further analyses to address this gap.

7. Conclusions

There is an ever-growing demand for studies aimed at exploring the consequences of the digital revolution we are witnessing (Karimi and Walter, 2015; Vial, 2019), effectively contributing to the scientific debate and concretely supporting managers in successfully addressing the coevolutionary relationship between OA and digitalization. This research meets this need by offering a systematic review of the literature concerning digitalization-OA interconnections for the first time.

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Table 5. A summary of research propositions

IT capabilities as OA enablers	Digitalization as SC agility driver	BDAC and digital technologies as OA drivers
1 Proposition 1. Researchers should deepen the understanding of the complementary and interaction mechanisms between the different digital capabilities that impact organizational agility in diverse competitive contexts.	6 Proposition 6. SCA depends on the effectiveness of the knowledge sharing processes activated between SC partners. Trust represents a fundamental enabler of these processes. In this connection, researchers should deepen how and which SC digital integration strategies, processes and practices should be projected and implemented to fully leverage the agility effect of trust mechanisms at the SC level.	10 Proposition 10. Future research should aim to design and test specific KPIs suitable to assess the impact of the BDAC-agility relationship on the performance of different company areas and processes.
2 Proposition 2. There is a need to expand the meaning of environmental uncertainty to better understand all its possible causes and impacts on organizational agility capabilities.	7 Proposition 7. Researchers and practitioners should investigate the impact of the different types of digital competences (technical, operational and managerial) on SCA, as well as explore which best practices for integrating internal and external digital knowledge and skills should be adopted at the SC level.	11 Proposition 11. Researchers should more deeply explore the qualitative and quantitative characteristics of the system of coherences that are to be reached and maintained between a company's needs and willingness of BD usage and the BDA competencies of its employees that are needed to fully exploit BDA for agility purposes.
3 Proposition 3 Currently, investment in digital technology can represent an effective answer to the need for ever-higher levels of agility brought on by an ever more rapidly changing environment. Further studies are therefore needed to investigate which IT assimilation strategies allow to maximize the impact of absorptive capacity on organizational agility.	8 Proposition 8. Currently, sustainability is a new imperative to which SCs must effectively respond to remain competitive. Digital technologies may help effectively face this challenge. To help firms better orient their IT investments, researchers should investigate how and which digital technologies and infrastructures could be leveraged to optimize the level of SC sustainability.	12 Proposition 12. Researchers should investigate which barriers or enablers limit or facilitate the effective adoption of new digital technologies for agility purposes. In addition, they should control if and how the impact of these technologies on OA is affected by the industry context. Finally, further research should be carried out to better understand the effects of using different combinations of digital technologies on firm agility.
4 Proposition 4. Scholars should deepen the role played by non-IT complementary capabilities within the IT capabilities-agility relationship and the possible types of these complementary capabilities and analyse whether and how they can allow firms to leverage their digital platforms more effectively.	9 Proposition 9. Researchers and firms should deepen their understandings of how and which BDAC impact company ambidexterity in different competitive environments. In addition, more research is needed to better understand the impact of the soft aspect of BDAC on organizational ambidexterity.	
5 Proposition 5. Digital transformation allows the implementation of significant renewal processes of the supply chain configuration and strategy. In this connection, researchers should more deeply investigate the best practices through which digitalization can effectively impact business model innovation at the supply chain level as well as the barriers to be overcome for effectively developing and implementing these practices.		

Twelve unique research propositions concerning relevant theoretical and practical issues are proposed for scientists and managers (Table 5). The first group of propositions regards IT capabilities as OA enablers, the second group concerns digitalization as an SC agility driver, and the last group concerns BDAC and digital technologies as OA drivers. Although focused on the potential of digital technologies, capabilities, approaches and culture for obtaining high levels of OA, most of the propositions may also stimulate further research regarding the potential of digitalization for corporate strategy and innovation (Ciampi et al., 2020).

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