Tuire Hautala-Kankaanpää

Essays on digitalization among small and medium-sized firms

Complementary and contingent approaches

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Author Tuire Hautala-Kankaanpää https://orcid.org/ 0000-0003-0557-8082

Supervisor(s) Emeritus professor Jukka Vesalainen
University of Vaasa. School of Management, Strategic management.

Assistant professor Anni Rajala
University of Vaasa. School of Management, Strategic management.

Custos Emeritus professor Jukka Vesalainen
University of Vaasa. School of Management, Strategic management.

Reviewers Professor Henri Hakala
LUT University. School of Business & Management

Professor Matthias Fink
Johannes Kepler Universität Linz. Institute for Innovation Management

Opponent Professor Henri Hakala
LUT University. School of Business & Management

Tiivistelmä

Tässä väitöskirjassa selvitetään miten ja missä tilanteessa pienet ja keskisuuret (pk) yritykset pystyvät todennäköisemmin hyötymään digitalisoitumisestaan operatiivisen suorituskyvyn näkökulmasta. Aihetta tarkastellaan yhdistämällä resurssi- ja tilannetekijäteoria eli tässä työssä hyödynnetään tilanteista resurssiteoriaa, joka on nykyisessä tutkimuskentässä vielä varsin rajallisesti käytetty. Näkökulman mukaan erilaisten resurssien ja kyvykkyyksien vaikutusta voidaan tarkastella tilannetekijöiden ollessa läsnä. Väitöskirja muodostuu viidestä artikkelista, joissa käsitellään yritysten digitalisoitumista. Väitöskirjassa käytetään kahta eri kyselytutkimusta, joihin suomalaiset valmistavan teollisuuden pk-yritykset ovat osallistuneet. Ensimmäinen aineisto on poikkileikkausaineisto ja aineistot yhdessä muodostavat toisen, pitkittäisen, aineiston.

Tutkimustulokset osoittavat, että tilanteinen resurssiteoria muodostaa kattavan viitekehyksen, jonka perusteella voidaan lähestyä sitä, miten ja missä tilanteissa pk-yritykset pystyvät hyötymään digitalisoitumisesta parantuneen operatiivisen suorituskyvyn näkökulmasta. Aikaisempi pk-yrityksiin keskittynyt tutkimus on ollut vähäistä, joten tämän väitöskirjan ensimmäisenä tuloksena voidaan pitää teoreettisen viitekehyksen testaamista nimenomaan pienillä ja keskisuurilla yrityksillä niiden digitalisoitumisen kontekstissa. Tutkimustulokset osoittavat, että digitalisoitumisen hyöty operationaaliseen suoriutumiseen syntyy kahden erilaisen mekanismin kautta eli digitalisoituminen ei yksin vaikuta yrityksen menestymiseen. Ensimmäinen mekanismi muodostuu niin kutsutusta täydentävästä suhteesta, joka tarkoittaa sitä, että yrityksen digitalisoituminen vaikuttaa yrityksen muihin resursseihin ja kyvykkyyksiin vahvistavasti, ja yhdessä digitaaliset tekijät yrityksen resurssien ja kyvykkyyksien kanssa parantavat yrityksen suoriutumista. Toinen mekanismi liittyy kontingenssivaikutukseen, jossa tilannetekijät vaikuttavat yritysten digitalisoitumisesta syntyvään hyötyyn. Tulokset osoittavat, että mikäli yrityksen sisäinen ympäristö on suotuisa yrityksen digitalisoitumiseen, sillä on positiivisia vaikutuksia digitalisoitumisesta saatavaan hyötyyn. Tulosten mukaan myös ulkoinen ympäristö vaikuttaa yrityksen digitalisoitumisesta saatavaan hyötyyn. Suomalaisten pk-yritysten digitalisoituminen tuottaa yrityksille arvoa parantuneena operatiivisena suorituskykynä silloin, kun yritysten digitalisoituminen ja resurssit sekä kyvykkyydet vahvistavat toisiaan digitalisoitumiselle suotuisassa sisäisessä ja ulkoisessa ympäristössä.

Asiasanat: Digitalisoituminen, digitaalinen teknologia, pienet ja keskisuuret yritykset, operatiivinen suorituskyky, digitalisaatioperusteinen arvo

Abstract

This dissertation explains how and under what circumstances the operational performance of small and medium-sized (SME) firms is most likely to benefit from digitalization. This topic will be examined by combining the resource-based view (RBV) and contingency theory, that is, using the contingency RBV, which remains relatively rarely used in current research. The perspective permits an examination of the impact of various resources and capabilities in the presence of situational factors.

The dissertation consists of five papers dealing with digitalization in SMEs operating in various areas. The research relies on two surveys involving Finnish SMEs from manufacturing industries, the first of which provides cross-sectional data. Together the two datasets provide the longitudinal data informing the dissertation.

The research shows that the contingency RBV provides a comprehensive framework that can assist in examining how and in what circumstances SMEs can benefit from digitalization, that benefit being measured from an operational improvement perspective. Previous research on SMEs is limited, so the first result of this thesis involves testing a theoretical framework for SMEs in the context of their digitalization. The research results show that the benefits of digitalization for operational performance arise through two different mechanisms, and digitalization alone does not affect the firm's success. The effect of digitalization on SMEs' operational performance emerges from the complementarity between digitalization and firms' organizational attributes, factors, or resources that enhance performance. The second mechanism relates to environmental and situational factors and shows that both the firm's internal and external environment determine the level of the impact of digitalization. Among Finnish SMEs, digitalization produces value in the form of improved operational performance when digitalization, resources, and capabilities bolster each other in internal and external environments conducive to digitalization.

Keywords: Digitalization, digital technology, small- and medium-sized enterprises, operational performance, digitalization-based value

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In Nurmo, June 2023,

Tuire Hautala-Kankaanpää

Contents

Figures

Tables

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1 INTRODUCTION

Digitalization creates many opportunities and challenges for small and medium-sized enterprises (SMEs). Digitalization is seen as a central element in more effective (Bigliardi et al., 2022; Björkdahl, 2020; Proksch et al., 2021), competitive (Kraus et al., 2021), calculable, controllable, and predictable way to conduct business (Mandviwalla & Flanagan, 2021). However, there is a lack of consensus on how those benefits can be delivered. Therefore, to navigate an increasingly digital environment, firms require knowledge of how and when digitalization creates value for their businesses. In addition, it is necessary to know the kind of resources and strategies firms need and how an organizational structure can be modified to support successful digital transformation (Verhoef et al., 2019).

Decision-makers in firms encounter challenges related to decisions on whether to adopt or reject available technologies (Gartner et al., 2022). In the SME context, decision-makers struggle to integrate digital technologies into the business and exploit them appropriately (Bigliardi et al., 2022; Matt et al., 2015). Consequently, SMEs lag larger companies in their digitalization efforts (Eller et al., 2020). The reasons for that are diverse. An SME may lack information about the possible benefits of digitalization (Muller et al., 2021) or an appropriate strategy (Gouveia & Mamede, 2022), expertise, or resources (Drechsler et al., 2022; Fischer et al., 2020). Especially due the resource limitlessness, SMEs tend to rely on external resources, and as a result, these companies need particularly externally focused capabilities (Cragg et al., 2011) to succeed in a digitalized business ecosystem.

However, a firm's smallness can also offer advantages over larger firms. Smaller firms are usually agile (Mandviwalla & Flanagan, 2021) and flexible, which also improves the chances of instilling a positive attitude to digitalization in the firm (Eller et al., 2020). A positive attitude is essential when adopting different digital technologies (Fitzgerald et al., 2013; Hartl & Hess, 2017), and therefore considered one of the explanations behind successful digitalization. In addition, SMEs typically have a simpler organizational structure (Cragg et al., 2011) and less bureaucracy (Sirén et al., 2017). An SME is often led by its owners (Mandviwalla & Flanagan, 2021), who may dictate the firm’s strategic direction (Rajala & Tidström, 2022) resulting in effectively implemented strategic changes (Sirén et al., 2017). Therefore, effective management can foster the digitalization of an SME in the actual transformation phase transformation (Mandviwalla & Flanagan, 2021).

1.1 The need for research and purpose of the study

Academics and practitioners are increasingly aware of the value and benefits of digitalization for firms. Researchers have employed different theoretical backgrounds and frameworks while investigating the effects of digitalization. One prominent and widely used theory is the resource-based view (RBV) and its different sub-streams, such as the information technology- (IT) value research stream (Kohli & Grover, 2008; Melville et al., 2004; Schweikl & Obermaier, 2022; Zhu, 2004). An RBV perspective sees the firm as a collection of resources and capabilities that interact while creating value (Barney, 1991; Barney & Clark, 2007a; Penrose, 1959). This kind of interaction can be viewed through the notion of complementarity, which addresses *how* value is created. In the digitalized context, digital resources interact with other resources and capabilities; thus, these elements create value for firms through the complementarity mechanism (Shakina et al., 2021).

The idea of complementarity is also at the heart of the IT-value research stream, which focuses on the business value and performance impact derived from IT at the firm level and also incorporates a network perspective (Kohli & Grover, 2008; Melville et al., 2004). This research stream sees the intermediate level of improvements, such as operational effectiveness, as a suitable way to approach the impact of IT on firm performance (Chen & Tsou, 2012). Operational performance, the combined outcome of multiple organizational factors and enablers (Lu et al., 2018), is determined by manufacturing firms' assets (Schmenner & Swink, 1998). IT supports activities and processes, so the expected effects are targeted where the realization occurs (Ray et al., 2005). Hence, operational performance is a valid measure in analyzing the value of digitalization in an SME.

However, the contextual understanding, particularly as it relates to the mechanism through which firms create digitalization-based advantages, remains unclear (Ahmed et al., 2022). Hence, academics increasingly include situational factors in explaining *when* digitalization may create business value for firms. Researchers have used the contingency perspective of RBV, that is, the contingency RBV (Brandon-Jones et al., 2014; Cao et al., 2011; Gupta et al., 2018), to convey a more comprehensive theoretical understanding of digitalization-based value. That theoretical framework makes it possible to explain the complementary value of resources and capabilities through the context in which firms possess them (Brush & Artz, 1999). Hence, improvements in SMEs' operational performance are viewed through the combination of digital resources, capabilities, and other contextual factors where all are present.

In addition, there is limited research specifically focusing on digitalization-based value from the contingency RVB perspective and informing about *how* and *when* digitalization creates value for SMEs. Therefore, more detailed information about mediators and moderators is needed, alongside explanations of how SMEs can improve their performance outcomes based on digitalization (Ramdani et al., 2022). Consequently, there is a need for more detailed research that focuses on the relationship and the mechanisms between SME digitalization and improved operational performance. Moreover, there have been calls for research examining the relationship between IT and organizational factors, the effect of different types of IT resources on organizational performance, the impact of environmental factors on the value of IT, and for studies including a longitudinal perspective (Schweikl & Obermaier, 2022).

Digitalization in SMEs differs from that in larger companies as they have limited digital resources, and capabilities (Drechsler et al., 2022) and lack guidance on how to benefit from digitalization (Barann et al., 2019). These limitations mean it is unclear how apposite the findings of prior information systems (IS) research are to SME operations (Drechsler et al., 2022). It seems, for example, that cultural and organizational aspects related to digitalization are frequently overlooked when it comes to SMEs (Stich et al., 2020). It is known that SMEs need to have a certain level of resources and financial opportunities to develop their digitalization (Bouwman et al., 2019). A thorough assessment of the factors required for successful digitalization is essential to better understand how the benefits are to be actualized and the goals set achieved.

Most of the firms fall under the category of SMEs. In the EU region, 99 per cent of all companies are micro-sized or SMEs, making that specific group of companies highly influential with regard to EU competitiveness (European Parliament, 2022) and a main driver explaining national economic development (S. Wu et al., 2022). Hence, these firms are highly impactful from a societal perspective. This study uses the SME definition from Eurostat (2023), according to which companies with a turnover of less than EUR 50m, and with fewer than 250 employees are considered SMEs.

Accordingly, this study examines digitalization among firms, especially SMEs, by applying the contingent RBV framework to examine the situations in which SMEs are able to deliver value in the form of improved operational performance based on digitalization. Prior SME research has used the contingent RBV to only a limited extent, thus creating a research gap. The primary research purpose of this dissertation is shaped by the limited available research. It is:

- **How and when digitalization creates value for SMEs in the form of improved operational performance?**

1.2 Research objectives of the papers

This dissertation presents five papers to fill the research gaps and to meet its main research purpose. Each examines the question from different perspectives.

The first article examines the mediating effect of supply chain capability between digital platforms and operational performance and also the contextual role of digital culture. The article focuses on the complementarity between digitalization and supply chain capability and the contingent internal effect of digital culture. The paper therefore offers information on the effect of digital culture. Although prior research emphasizes the crucial role in firms' digitalization efforts of cultural attributes (Fitzgerald et al., 2013; Hartl & Hess, 2017), this is an underdeveloped aspect in digitalization research (Nadkarni & Prügl, 2020). This paper underlines the importance of firms' digital culture and supply chain capabilities and shows the importance of human actions to impactful digitalization

The second paper examines whether an effective digital strategy enhances the effects of digital platforms on a firm's operational performance. This paper targets the contingent effect of digital strategy in digitalization-based value creation. Prior research highlights the role of digital strategy as a guiding force in optimized ways to generate value based on digital technologies and digital resources (Bharadwaj et al., 2013; Proksch et al., 2021; Sebastian et al., 2017). However, current SME-focused digitalization research does not consider digital strategy an internal contingent element that may guide SMEs to effectively use digital platforms for digital integration. Hence, the role of digital strategy is central to the second paper. This paper highlights that firms strategizing on digitalization are more likely to benefit from it because their use of digital platforms is underpinned by planned actions.

The third paper focuses on the value creating aspects of the data. Digitalization has increased the importance of information and data (Schniederjans et al., 2020), nonetheless, firms encounter difficulties to recognize how to use data to create business value from it (Vidgen et al., 2017). Moreover, it was noticed that more research about the mechanism behind data-based value was needed (Chatterjee et al., 2022; Li, 2022). The purpose of the paper is to examine the complementary impact of SMEs' data capability and supply chain capability (SCC) on operational performance. The mediated effect of data capability is also moderated by competition. This paper examines the complementary and contingent value of SMEs' data capability. It fills the above-mentioned research gap by offering new knowledge on the complementary and contingent effect of data capability on SMEs' operational performance in various environmental (competitive) conditions. This paper shows that supply chain capabilities play a central role when examining data-related capabilities and the resulting performance in highly competitive environments.

Papers four and five introduce a new concept, platform-based digital connectivity (PDC), which relates to how SMEs are connected with their business partners through digital platforms. The two papers focus particularly on digital platforms as tools for specific tasks related to SME supply chains. These final two papers address the scarcity of research targeting inter-organizational digitalization (Lin et al., 2021; Martinelli & Tunisini, 2019). Paper four aims to analyze the extent to which PDC affects operational performance and examines the effect of environmental turbulence on the relationship between PDC and operational performance. Paper five addresses the complementary effect of PDC and SCC on operational performance. Prior research illuminates the lack of consensus on whether some capabilities act as internal contingency factors in digitalization-based value creation. Existing research on the complementary role of SCC or related concepts like organizational integration typically treats SCC as a mediator through which the effect of digitalization is channeled. This paper considers SCC as both a mediator and moderator. Both papers offer information on the circumstances in which digitalization can improve SMEs' operational performance and the effect of internal and external contingencies. Hence, these papers offer practical explanations of the impactful factors for SMEs and digitalization within them.

1.3 Scope of the articles

The articles of this study have differences in scope. The main distinction between the papers is based on the interaction mechanism between digitalization and the other organizational factors or capabilities in question. The first mechanism, the complementary effect, relates to the situation where resources and capabilities interact with firms' existing capabilities (Song et al., 2005; Wernerfelt, 1984). The second mechanism, the contingency effect, relates to contextual elements, such as environmental and internal influences (Shepard & Hougland, 1978) and factors (Sila, 2007) that, in the case examined in this dissertation, influence the relation between digitalization and operational performance.

All papers include contextual elements, which can be either internal or external. Paper 1 examines the contextual effect of digital culture, and Paper 2 tests the contextual effect of digital strategy. Papers 3 and 4 focus on external contingency effects. Paper 3 focuses on competition, whereas Paper 4 also includes changes in customer preferences and technology development as environmental factors. Papers 1, 3, and 5 address the complementary effect of digitalization. The scope of the articles is presented in Table 1.

Table 1. Scope of the articles

	Internal contingency effect included	External contingency effect included
Complementary effect included	Papers 1 & 5	Paper 3
No Complementary effect included	Paper 2	Paper 4

All five papers target the main research question from different perspectives. Together, they answer the research questions and offer new insight into when and how digitalization creates value for SMEs through improved operational performance. The results of these papers show that the value of digitalization on SMEs' operational performance can be explained through complementary and contingent effects.

1.4 Digitalization and digital technologies

Digitalization is central to this dissertation. Multiple research streams, such as those on IS, supply chain management, and strategic management examine digitalization from diverse perspectives. A broad array of research has focused on digitalization in firms, and the roots of the phenomenon date back to the 1980s (Plekhanov et al., 2022). For clarity, it is critical to determine the digitalization concept in this research.

Digitalization refers to the use of different forms of IT (Isensee et al., 2020; Ko et al., 2022) digital technologies (Fitzgerald et al., 2013; Hallikas et al., 2021; Srai & Lorentz, 2019; Warner & Wäger, 2019) and data (Björkdahl & Holmén, 2019). The term may also encompass dynamic aspects such as the innovative behaviour of a firm and thus digitalization might also refer to ongoing change without a clear beginning or end (Hagberg et al., 2016; Warner & Wäger, 2019).

In practice, the term digital transformation is often used synonymously with digitalization (Hess et al., 2016; Legner et al., 2017). Both are seen as a process where digital technologies trigger changes in a firm's environment, to which firms try to respond (Vial, 2019). Therefore, digitalization and digital transformation include changes to the premises of strategic and organizational operations, such as those relating to links in the supply chain, and the ways firms use information technology and interact with their environment (Verhoef et al., 2019). However, despite the often-synonymous use, some researchers differentiate the two terms. Digital transformation can be viewed as a more advanced phase in a firm's digital development (Ko et al., 2022; Verhoef et al., 2019) and as a socioeconomic change affecting individuals, ecosystems, and societies (Dąbrowska et al., 2022). Consequently, this study focuses on the digitalization of SMEs, that is, the use within SMEs of digital technologies and data as part of managing operations in a changing environment.

Many different technologies can support a firm's digitalization. New digital technologies share some similarities with earlier ones but also have some unique aspects. In general, digital technologies have 1) re-programmability characteristics that enable them to perform distinct functions, 2) the capacity to homogenize data, which facilitates access to data from digital devices, and 3) a self-referential nature, which binds to use the digital technology (Yoo et al., 2010). Therefore, the term digital technologies refers to the next generation of IT artifacts that are scalable, flexible, and drive growth (Tilson et al., 2010).

The term digital technology can encompass different technologies, such as IT, IS, and information and communication technologies (ITC). In addition, prior research refers to SMACIT technologies, including social media, mobile, analytics, cloud and the Internet of Things technology (Fitzgerald et al., 2013; Ritala et al., 2021; Sebastian et al., 2017; Warner & Wäger, 2019; Yoo, 2013) as digital technologies. Owing to the diverse definitions available, this study mainly uses the terms digital technology and IT, which are widely used and seen as overlapping concepts, but whose use in previous research largely depends on the field of research.

This dissertation includes three different variables to measure SME digitalization. The first relates to the digital platforms used to integrate intra-organizational and inter-organizational processes (Gartner, 2018; Kousiouris et al., 2019). The second variable is a platform-based digital connectivity construct, targeting inter-organizational processes and the use of digital technologies in those. There are two distinctive ways to measure the use of digital platforms, as they are seen especially potential to smaller firms (Bolloju & Murugesan, 2012; Ebert et al., 2017) due to their availability and easy deployment. The third variable is data capability. Digitalization has increased the availability and value of data (Schniederjans et al., 2020). From the perspective of SMEs, data capability increases knowledge within a firm of its production processes and offers information about the needs of customers and partners (Bianchini & Michalkova, 2019). It is consequently seen as essential for SMEs operating in increasingly connected business areas. These three concepts are examples of the way to approach digitalization from the perspective of digitally integrated operations; hence they do not cover digitalization as a whole.

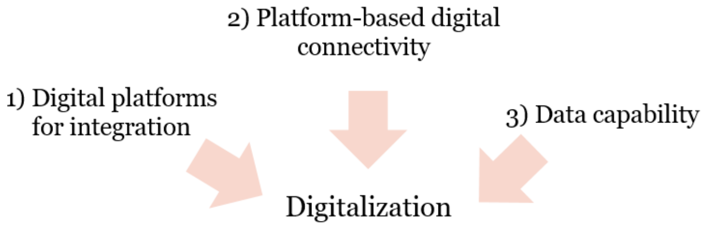

Figure 1. Digitalization-related variables in this dissertation

Regardless of which digital technology is in question, increased openness, the availability of web services, and modular technologies with rapidly developing applications make it ever more challenging to create performance advantages based on digital technologies (Grover & Kohli, 2013). Hence, firms need to make some internal organizational changes to exploit digital technologies (Boh et al., 2023). Accordingly, digital transformation has expanded the conversation about different capabilities that can support the organization's journey to becoming more digital (Dąbrowska et al., 2022).

1.5 Structure of the dissertation

This dissertation consists of a brief introduction presenting the background of the dissertation, objectives, context, and structures. In addition, digitalization and operational performance are introduced. The second section includes the theoretical framework of this dissertation, and the third section presents the methodologies applied. The fourth section reviews the results and briefly introduces the contributions of the essays and articles. The final part of this dissertation consists of five papers.

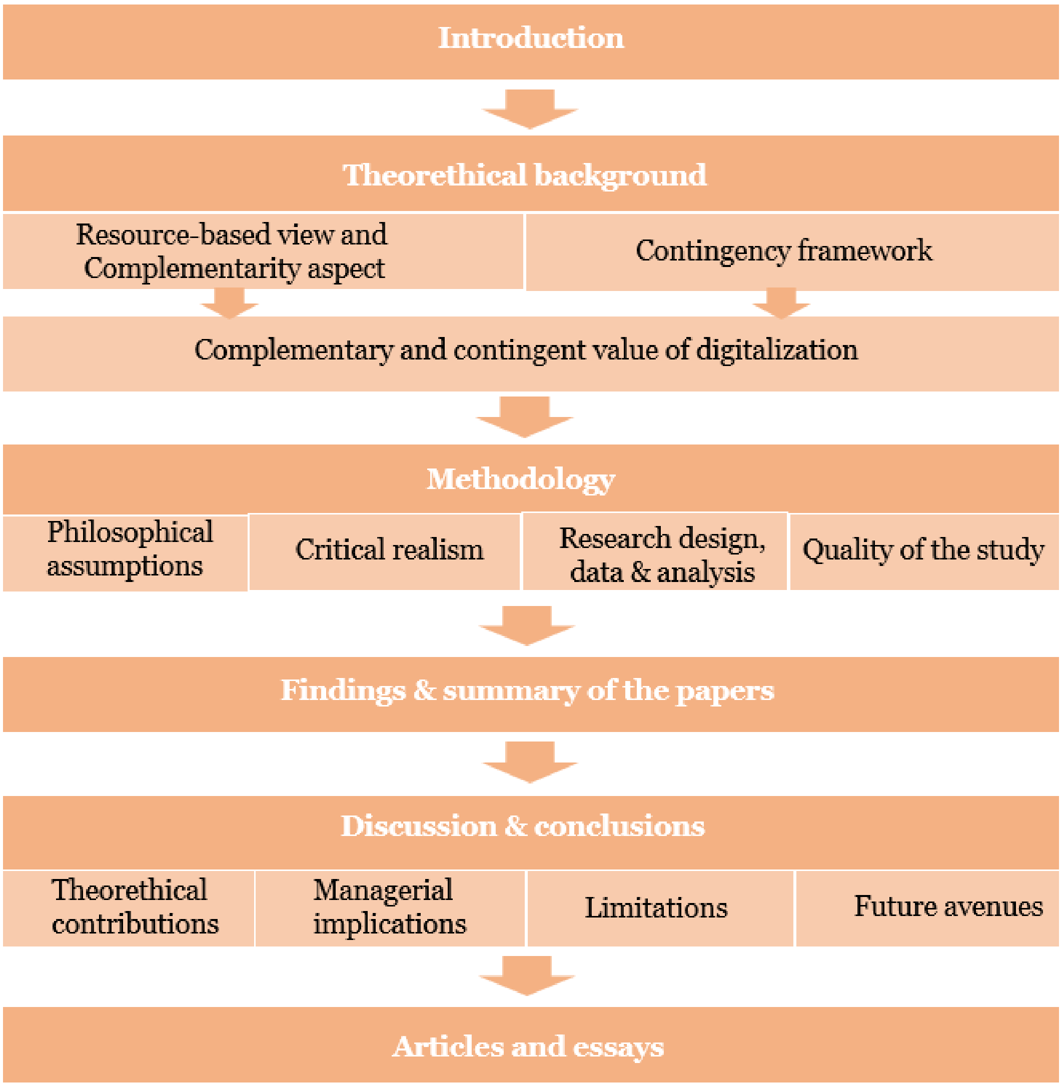

Figure 2. Structure of the dissertation

2 THE COMPLEMENTARY AND CONTINGENT VALUE OF DIGITALIZATION

This chapter introduces the dissertation's theoretical framework, which consists of the RBV that offers essential background on the complementary value of digitalization. In addition, the contextual factors that relate to the digitalization-based value creation mechanism are targeted with the help of contingency theory. The contingent RBV combines these two well-known theoretical frameworks and is presented after the summary of the original RBV. After building a proper theoretical background, this chapter reflects the theoretical framework through empirical settings.

2.1 The resource-based view and the complementarity aspect of digitalization-based value

The resource-based view is one of the most influential theories in strategic management. It addresses why some firms outperform others (Barney & Clark, 2007a) and targets firm characteristics while explaining the differences between firms (Barney, 1991). The RBV views firms as a collection of valuable resources that vary across the organization and these differences are expected to explain the disparity in performance (Penrose, 1959). Hence, resources are the basis of the RBV (Eisenhardt & Martin, 2000), and its focus is on firms' internal organizational dimensions (Cao et al., 2011).

Prior research illustrates multiple ways to define resources. Early research emphasizes resources as a firm strength or weakness (Wernerfelt, 1984). In addition, resources were divided into physical tangible (such as equipment) and intangible assets (such as skilled employees and management) (Penrose, 1959). Later, Barney (1991) included a well-known definition of the attributes (valuable, rare, imperfectly imitable, and non-substitutable (VRIN), characteristics essential to resources if they are to generate sustained competitive advantage. From the VRIN-resource perspective, prior research sees tangible resources as more easily limited and substituted than intangible assets (Barney, 1991). The VRIO analysis was developed from the VRIN and focuses on those resources and capabilities that support achieving sustainable competitive advantage (Kamboj & Rana, 2023). It includes factors that relate to the organization and its policies and procedures that use resources that are valuable, rare, and too expensive to imitate (Barney & Clark, 2007).

Prior research has offered many definitions regarding the placement of different resources within the RBV framework, not only from the perspective of VRIO characteristics but also regarding the characteristics of the resources themselves. Previous IT and IS research has distinguished between IT resources and organizational factors (Cao et al., 2011) and considered IT a tangible resource (Doherty & Terry, 2009). In contrast, IT-related skills have been considered intangible IT resources (Doherty & Terry, 2009). Drawing from IT and IS, different digital technologies, tools, and software fall under the category of digital resources or physical, tangible assets, whereas intangible assets refer to digital skills and digital capabilities. Resources and capabilities are closely connected. The term capability encapsulates a firm's "capacity to utilize resources" (Amit & Schoemaker, 1993, p. 35); nevertheless, capabilities may also be a combination of resources and activities (Vesalainen & Hakala, 2014).

Researchers have debated whether digital technology or digitalization as such creates value for firms in the form of improved firm performance. Some argue that digital technology and digitalization fulfill the VRIN criterion if other firms do not have access to such a system (Karim et al., 2022; Zhang & Hartley, 2018). A few examples are IT systems (Zhang & Hartley, 2018) enabling technologies such as e-business, ERP tools, integrated information management systems, cloud computing, big data, machine learning, and artificial intelligence (Karim et al., 2022). Nevertheless, different digital assets are usually considered imitable (Hallikas et al., 2021; Soto-Acosta et al., 2018; Wang et al., 2012) because firms can buy a wide array of digital technologies and software from the markets (Wang et al., 2012). Therefore, the well-known generic software that can be purchased lacks asset specificity (Ray et al., 2005); thus, it is likely that individual digital technology or software cannot be considered rare or inimitable (Karim et al., 2022; Wang et al., 2012), which is why it rarely directly leads to performance improvements (Wade & Hulland, 2004) that are superior compared to those of other firms. Consequently, software and technologies are essential for firms, and investing in software is likely to enhance performance more than would be the case without such software (Ray et al., 2005). Nevertheless, achieving superior performance based on generative software is difficult (Ray et al., 2005). The same applies to data. Helfat et al. (2023) highlight the role of data as a resource, which is valuable if firms have the capability to produce insights from it.

Melville et al. (2004) encapsulate the principles arguing that IT is valuable; however, internal and external factors and also complementarities determine the value of these resources. Consequently, it is more fruitful to focus on processes that technological resources affect (Chen & Tsou, 2012; Melville et al., 2004; Teng & Tsinopoulos, 2022), as complex combinations of resources and capabilities are more likely to offer long-lasting benefits for firms (Hallikas et al., 2021).

Prior research has often used the RBV to explain the value derived from digital technologies. The RBV suggests complementarity as a source of business value related to digitalization-based value (Zhu, 2004). Complementarity refers to the interplay between the factors in a system where the manifestation of one element escalates the value of others (Ennen & Richter, 2010; Milgrom & Roberts, 1995). Accordingly, complementarity is present when two factors reinforce each other (Matsuyama, 1995). Hence a resource produces a greater return in combination with other resources (Zhu, 2004). When resources have complementary characteristics and enhance each other, they are more likely to produce performance improvements (Cao et al., 2011). Competitive advantage is based on this kind of resource configuration (Eisenhardt & Martin, 2000).

Complementary resources and capabilities interact effectively with firms' existing capabilities (Song et al., 2005; Wernerfelt, 1984). Prior research, and especially that on IS views IS as complementary resources that interact with other organizational resources and capabilities (Bharadwaj et al., 2007). Similarly, digital technologies complement resources and capabilities that combine to create synergies for firms (Shakina et al., 2021). Hence VRIN conditions are achieved through the resource complementarity mechanism (Cao et al., 2011). Complementarity may also either complement and therefore enhance performance or suppress it (Brynjolfsson & Milgrom, 2012; Schweikl & Obermaier, 2022). Nevertheless, resource complementarity is more likely to focus on paired associations, although interactions of more resources are not excluded (Cao et al., 2011).

2.2 Toward the contingency perspective of RBV and digitalization-based value

The RBV has not been spared criticism. It is argued that the theory is rather static (Ling-yee, 2007) because it does not sufficiently address conditional factors (Jeble et al., 2018) and context-related issues that explain when resources are more valuable (Adetoyinbo et al., 2023). Therefore, it is argued that the RBV's basic principles apply only when firms operate in predictable environments (Kraaijenbrink et al., 2010). The current business environment is increasingly competitive (Wu et al., 2022) and marked by constant changes. To benefit from digital technologies and sustain themselves in the face of competition, firms must modify their internal processes and capabilities (Boh et al., 2023; Muller et al., 2021). The requirement influences the firms' spheres of operation and pressures SMEs to adjust their operations to fit changing environments, which again affects firms' capabilities and the way value is created (Wilden & Gudergan, 2015). However, context-related issues can also arise from a firm's internal environment. For example, when a firm develops its operations and implements new digital technologies, that move should be adjusted to fit its current operating principles.

Contingency theory identifies that organizations are subject to different environmental and internal influences (Shepard & Hougland, 1978) and factors (Sila, 2007). This contingency assumption is essential to theory building in social sciences because the research targets predicting changes related to organizations, too (Fry & Smith, 1987). The basic premise of contingency theory relates to the idea of fit and that certain strategies fit certain conditions (e.g. Lawrence and Lorsch, 1967; Hofer, 1975), and successful firms match their environment (Rumelt, 1993). For example, in an environment marked by low uncertainty, a low level of operational responsiveness is suitable, whereas a highly uncertain environment demands greater operational responsiveness from firms (Hallavo, 2015). Accordingly, firms that can match their organizational characteristics to existing contingencies, such as their environment, are more effective (Morton & Hu, 2008).

However, the knowledge of how firms modify and adapt their organization to fit their internal contingencies and situations affected by limited resources is under-investigated (Adetoyinbo et al., 2023). It is argued that the theoretical viewpoints presented in the contingency theory logic should be included in the notions of the RBV (Sirmon et al., 2007). The contingency perspective on the RBV—the contingency RBV— is used to explain the value of resources and capabilities through the context in which firms use them (Brush & Artz, 1999). In comparison with the RBV, the contingency perspective on RBV moves the focus toward the context where these variables exist and specifically to the fit between the context and resources (Cao et al., 2011). Hence, the contingency RBV combines the RBV and the basic premises of contingency theory and suggests that competitive advantage depends on a firm meeting certain conditions (Brandon-Jones et al., 2014).

The contingency RBV provides a more holistic way to determine digitalization-based business value than resource complementarity or fit as a single mechanism (Cao et al., 2011). Applying the contingency RBV framework, it is possible to seek the digitalization-based value mechanism from the level of the systems fit among digital technologies and the organizational factor synergies, that is, complementarities (Cao et al., 2011).

In this dissertation, the benefits and digitalization-based value refers to the situation where digitalization improves operational performance and is therefore valuable to a firm. Financial measures have typically been to the fore when discussing value and value creation; however, value creation can also be related to intangible drivers such as process improvements (Tonelli et al., 2016), including processes that constitute operational performance. Hence, in the context of this dissertation, digitalization-based value relates to operational performance.

Operational performance is a combined outcome of multiple organizational factors and enablers (Lu et al., 2018). It is usually a dependent measure relating to some area of effectiveness in the framework that includes contextual variables and the fit between them (Sousa & Voss, 2008).

We can conclude that the complementary and contingency approaches are used in different settings in empirical research. Those can be grouped under two basic mechanisms: 1) the combined effects of different digital and non-digital resources and organizational factors such as processes and capabilities through complementary relations and 2) contingencies relating to the business environment (Rai & Tang, 2014) or organization's internal context (Wade & Hulland, 2004). Understanding when and how digitalization improves SMEs' operational performance is greatly aided by including both mechanisms to help explain the relationship between digitalization and improved operational performance. Figure 3. shows the theoretical framework of this dissertation.

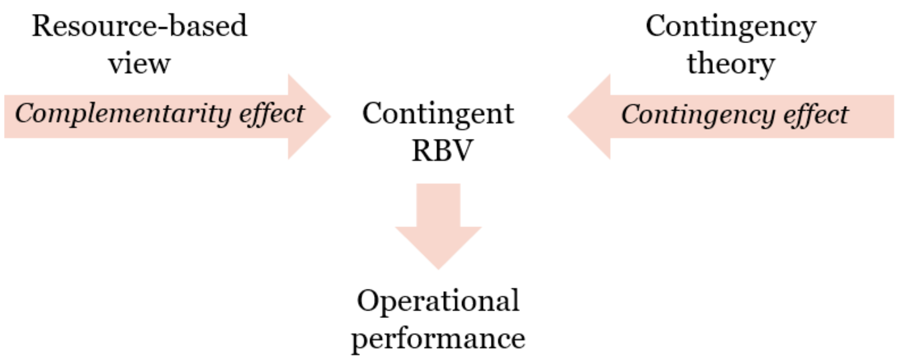

Figure 3. The theoretical framework

2.3 Digitalization-based value in empirical settings

2.3.1 From IT expenditure to a complicated chain of assets

Prior research, and especially IT research, has long examined the relationship between IT and organizational performance (Kohli & Grover, 2008; Melville et al., 2004). Early research focuses on information systems as an item of an expenditure (Brynjolfsson, 1993; Brynjolfsson & Hitt, 1996; Mahmood & Mann, 1993; Quinn & Baily, 1994). However, as the research stream evolved, researchers noticed that IT is more than just an item of expenditure; it changes the way firms conduct and organize their business (Kohli & Grover, 2008). Hence, IT is instead one part of a complicated chain of assets, capabilities (Wade & Hulland, 2004), and contextual elements (Cao et al., 2011) that determine the value resulting from using these technologies. Hence, the value of IT relates to firms' internal and external factors, complementary resources, and environment (Melville et al., 2004).

Prior research has recognized several non-IT factors (Schweikl & Obermaier, 2022), also called organizational factors (Cao et al., 2011; Wiengarten et al., 2013), that interact with digital technology in value creation. Schweikl and Obermaier (2022) divide these factors into four distinct categories, namely: 1) *organizational resources*, such as strategy, processes, structure, culture, and practices 2) relational resources, such as top management support and internal and external relations, 3) *non-IT human resources*, such as employees' skills and, 4) *financial resources*. In addition, other factors such as power and politics (Cao et al., 2011) and environmental conditions (Sirmon et al., 2007) are recognized as elements interacting with digitalization. To conclude, digitalization and digitalization-based value creation are seen as aspects of a complicated and multidimensional phenomenon that includes the interaction with organizational (Cao et al., 2011; Schweikl & Obermaier, 2022) and environmental factors (Sirmon et al., 2007).

This dissertation examines factors relating specifically to the organizational factors of digital strategy, digital culture, and inter-organizational capabilities. Prior research has confirmed the crucial role of digital culture in firms' digitalization efforts (Fitzgerald et al., 2013; Hartl & Hess, 2017). Similarly, the guiding force of digital strategy in firms' digitalization is recognized (Bharadwaj et al., 2013; Proksch et al., 2021; Sebastian et al., 2017). Hence, digital culture and strategy are targeted here as internal organizational factors relevant to firms' digitalization efforts. In addition, digitalization increasingly fosters interconnectivity between firms (Plekhanov et al., 2022). That imposes new requirements for interaction between firms; thus, firms need capabilities targeted at their inter-organizational efforts. The role of inter-organizational capabilities is essential to SMEs because these firms have limited resources, which adds value to externally focused capabilities (Cragg et al., 2011). Consequently, this dissertation suggests its SCC reflects an SME's ability to coordinate inter-organizational activities. Supply chain capability can be seen as an organizational factor or relational resource.

In addition, firms operate in an increasingly turbulent environment, which is why the external environment is chosen as a factor interacting with SME digitalization. Prior research shows that the relationship between IT and other investments is stronger in turbulent environments (Havakhor et al., 2019) and the environment functions as a moderator between digitalization and improved performance

(Boon-itt & Wong, 2011; Wamba et al., 2020). In summary, the contingency view relates to both external and internal factors. To distinguish the two, internal contingencies are organizational factors modeled through moderation mechanisms in research models. Figure 4. shows the chosen factors.

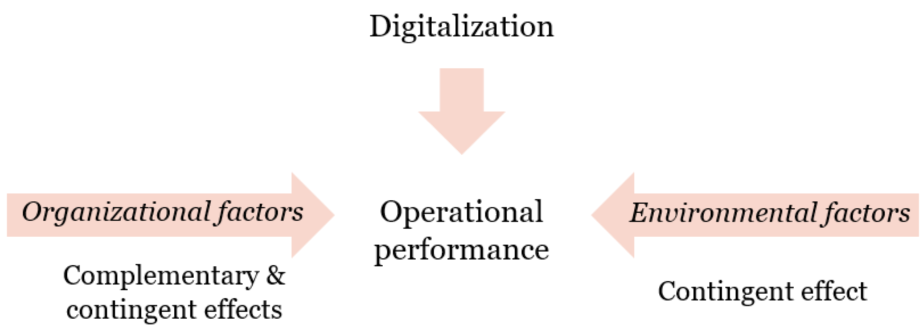

Figure 4. Empirical research settings

2.3.2 Digitalization-based value and organizational factors: Towards reasoning and empirical settings

The contingent RBV research framework is still underdeveloped in the literature (Brandon-Jones et al., 2014). This can also be seen from empirical research as a consensual understanding of the digitalization-based value mechanism is still evolving. Hence, there are diverse ways to model and justify the relationship between digital resources, organizational factors, and environmental elements in digitalization-based value creation.

In practice, prior IT-value research lacks a clear consensus on the complementarity role of organizational factors (Wiengarten et al., 2013). Researchers believe that there are no factors available that always have a complementarity relationship with IT (Schweikl & Obermaier, 2022). A similar lack of clarity exists at the level of practical modeling, as resource complementarity is argued to be achieved through mediation or moderation models (see for eg. Cao et al., 2011; Schweikl & Obermaier, 2022). Consequently, moderation may relate to both contingency and complementary approaches (Benitez-Amado & Walczuch, 2012; Schweikl & Obermaier, 2022). However, the mediation and moderation models differ in their mechanisms. Mediation models focus on the indirect effects of the predictor variable on the dependent variable. In contrast, the fit between the predictor and moderator determines the level of the dependent variable in moderation models

(Venkatraman, 1989). In practice, the same variables can be used in different settings (Venkatraman, 1989). Accordingly, it is often a case of building a proper theoretical framework and argumentation to back the use of the mediators and moderators in a research model. However, that argumentation should be based upon prior theoretical argumentation and observation, and it is important to distinguish the mediation and moderation effects from each other. The mediation effect is achieved through complementarity, whereas moderation relates to the contingency mechanism.

Organizational factors are usually treated as independent variables that serve as mediators or moderators in studies (Cao et al., 2011). They can either strengthen the relationship between digitalization and firm performance or act as a complementary organizational factor that mediates the value (Cao et al., 2011). In addition, the complementarity effect may emerge when many other elements are included in the analysis (Schweikl & Obermaier, 2022). Firms are complex entities, which is why the outcome of digitalization emerges from many factors existing in companies that include not only the technology but different resources, capabilities, and other organizational factors that form the basis of a firm’s operations in its current situation.

A good example of frequently used mediating variables is provided by those related to supply chain activities. Empirical research has confirmed the role of different supply chain capabilities in digitalization-based value creation mainly as a mediator (Brandon-Jones et al., 2014; Chatterjee et al., 2022; Ganbold et al., 2020; Liu et al., 2015; Wu et al., 2006; Yu et al., 2018; Yu et al., 2020). However, there are exceptions; for example, Dubey et al. (2019) examined the effect of big data analytics capability on competitive advantage and showed that organizational flexibility moderates the relationship.

This research targets three organizational factors: supply chain capability, digital strategy, and digital culture. It is argued that supply chain capability builds the basis for firms’ internal and inter-organizational business activities (Bi et al., 2013), and such resources may thus have a crucial role in digitalization-based value generation (Wiengarten et al., 2013). Hence, one of the mechanisms and explanations behind successful digitalization is the firm's ability to manage operations so that the fit between software and operations can be identified. Therefore, SMEs must also be able to change their current operations and processes to find a fit between digitalization and their operations, which is a two-way relationship (see, e.g., Ardolino et al., 2018; Sedera et al., 2016).

Prior research identifies inertia and more detailed routine rigidity as reasons why firms fail to change processes that use specific resources (Gilbert, 2005). In a digitalized context, routine rigidity relates to firms failing to modify their processes to fit new digital opportunities. Accordingly, to overcome inertia and routine rigidity, firms should realign their operations with their environment (Besson & Rowe, 2012), both internal and external. This last notion supports the idea of contingency mechanisms. Capabilities related to organizational processes, such as supply chain capability, may also function as moderators. The existing function depends on whether SCC is seen as something that should fit with digitalization or whether it is viewed via its complementarity aspect and as bolstering the effect of digitalization.

Similarly, recent research has emphasized the mediating role of other organizational resources and factors such as digital strategy (Eller et al., 2020). Digital strategy is the second organizational factor studied in this dissertation, as it can be both mediator and moderator. For example, if a firm invests in digital technologies and software without a clear strategy, the knowledge and readiness that emerges through the strategic planning process may be limited. Therefore, it is vital to understand the digital opportunities available, how they are suited to the organizations' activities, and what changes are required before the organization can use them. Firms are more likely to be prepared to face the challenges posed by digitalization if they have a strategy that guides the implementation and usage of digital technology. In such cases, the digital strategy may counter the effect of inertia in an organization. Hence, the failure related to change may also relate to a lack of strategy; thus, the digital strategy may function as a moderator and internal contingency factor that helps firms to find a fit between their current operations and chosen digitalization path. In addition, early IT research has shown that strategy may function as a moderator (Li & Ye, 1999).

This study targets digital culture as a third organizational factor. An organization's culture encompasses how it carries out its business (Barney, 1986) and reflects the beliefs and values shared in the organization (Miller, 1993). Prior research has referenced digital culture, which has mainly been examined as a mediator (Proksch et al., 2021) and as an antecedent of value creation (Martínez-Caro et al., 2020). Nevertheless, it is argued that as an organizational factor, organizational culture is an attribute that can only be considered a moderator. In contrast, strategy, for example, might function as either mediator or moderator (Cao et al., 2011).

Why is an organization's culture influential? Digitalization always includes some changes in organizations. Hence, an organization's cultural attributes influence the acceptance of new technologies (Hadi & Baskaran, 2021). It is reported that organizational changes will increase resistance among the organization's members and could trigger failure if the transformation does not include cultural changes

(Cooper, 1994). Cooper (1994) identifies two distinct ways, which may lead to failure in firms if IT contradicts a firm's culture. First, resistance may lead to failure if a firm undermines the analysis and decision processes or does not use implemented systems as planned, which is why implementation fails. Secondly, IT may be adapted and used to diminish the conflict between firms' culture and IT. Instead of making the necessary organizational changes, the company adapts IT to suit its own activities so that no real change can occur. Both routes can hinder necessary organizational change processes (Cooper, 1994).

Although firms can improve their culture to support successful digitalization, cultural attributes change slowly, which is why the fit between a firm's operations and its internal environment is essential. Hence, organizational culture can be regarded as a contextual element on which the effect of different variables is dependent. Nevertheless, the role of digital culture is more flexible than the more deterministic role of the environment, as firms can influence their cultural attributes and develop their organizational culture over time. Hence, organizational culture is something that firms can change by themselves. Cultural changes do, however, take time, which is why the fit between digitalization and organizational culture is essential. The use of digital culture is not limited to its role as a moderator; prior empirical research has demonstrated cultural attributes can be an antecedent (Abubakre et al., 2022) and a mediator (Hadi & Baskaran, 2021).

The environment is examined as a fourth contextual factor. Unlike organizational factors, its environment is beyond a firm's control and is therefore considered a moderator. The logic is that the environmental conditions in which firms operate influence their spheres of operation and therefore affect the firms' value generation (Wilden & Gudergan, 2015). Value creation begins when generating value for customers, specifically when firms produce more value for their customers than their competitors do (Sirmon et al., 2007). Therefore, environmental conditions also impact the type and number of resources and capabilities firms need to outperform competitors (Sirmon et al., 2007). Hence, there are external environmental factors (Brandon-Jones et al., 2014; Sirmon et al., 2007) —such as changes in customer preferences, competition and technology—that affect the way firms benefit from digital opportunities. This is especially true of SMEs with limited opportunities to impact their operational environment. The role of environmental factors as contextual, situational elements is more deterministic than that of internal factors, as confirmed by prominent empirical research, where environmental factors are modelled as contextual elements and as a moderator (Y. Li et al., 2020; Wamba et al., 2020)

Not only is it challenging to determine whether certain organizational factors function as moderators or mediators, but empirical research illustrates the disparity in how complementary mechanisms work. Some researchers hold that technology complements other resources, capabilities, or organizational factors (Arias-Pérez et al., 2022; Shakina et al., 2021) and acts as a complementary resource. A contrasting view is that other resources, capabilities, and organizational factors complement digital technology (Ashrafi & Zareravasan, 2022; Hallikas et al., 2021; Raguseo et al., 2021; Schweikl & Obermaier, 2022; Wiengarten et al., 2013). However, it is agreed that there is complementarity between digital resources and organizational and relational factors that positively interact with each other in value creation. Accordingly, in practice, complementary synergy is an essential principle of the RBV (Uwizeyemungu et al., 2018).

Nevertheless, both the complementarity and contingent effect are widely used and therefore recognized as crucial elements in digitalization-based value creation. Therefore, rather than emphasizing the importance of the independent effect of digitalization, it is suggested that the value of digitalization is most effectively explained when both complementary and contingent factors are included as a mechanism to clarify how and when digitalization creates benefits for SMEs. This is also the main premise of this dissertation, digital resources and capabilities are considered complementary elements that interact with the firm's other resources, and that effect is contingent on both an SME's internal and external operative environment.

It is important to note that the level of determinism varies depending on whether the focus is on internal or external contingency factors. Internal factors are those that SMEs can affect; however, changes may be slow, which is why at least some level of fit between internal contingency factors and firms' business is needed to overcome inertia. Regarding external contingency factors such as environmental changes, SMEs have limited opportunities to change those mainly because of their limited resources and opportunities to influence their environment. Accordingly, it is important to ensure a fit between the organization and its operational environment. Figure 5 illustrates the theoretical framework of this dissertation.

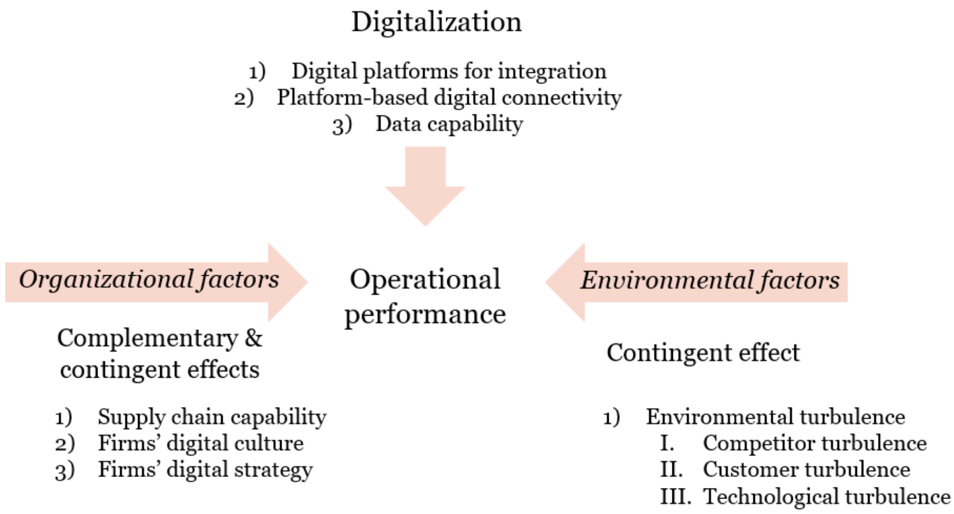

Figure 5. Digitalization and improved operational performance

3 METHODOLOGY

This chapter discusses the methodological perspectives and choices made in this study. The chapter describes the research strategy and how the research was undertaken. Researchers consistently make some implicit and explicit assumptions that determine the goals, methods of execution, and results of a study (Puusa & Juuti, 2014). This chapter focuses on those assumptions and further explains which philosophies and methods were chosen. Those choices set expectations related to the intent and motivation of research (e.g., Mackenzie and Knipe, 2006). Further, the research process and data collection are discussed.

3.1 Underlying philosophical assumptions

Philosophical assumptions focus on how we understand reality and knowledge as such. Burrel and Morgan (1979, p. 1) argue that "all theories of organization are based upon a philosophy of science and theory of society". They include assumptions of ontology, epistemology, and methodology. Ontological assumptions concern the way reality is seen. Reality might be considered objective and as a given or subjective in that the person participates in its formation (Burrell & Morgan, 1979) and what can be known about it (Guba & Lincoln, 1994). Epistemological issues concern the nature of knowledge and what can be regarded as false or true (Burrell & Morgan, 1979). Epistemology also addresses the relationship between the knower and what can be known (Guba & Lincoln, 1994). Methodological questions focus on what we believe can be found or known (Guba & Lincoln, 1994).

The above assumptions can be assessed based on the subjective-objective dimension and regulation and radical change dimensions (Burrell & Morgan, 1979). Objective assumptions hold social reality is external to the researcher, whereas subjectivism perceives social reality as based on people's perceptions and actions (Saunders, 2016). Regulation refers to the need for regulation in human behaviour and society, whereas radical change questions how things are done in society and organizations (Saunders, 2016).

3.2 Critical realism as a philosophical choice

In addition to different paradigms, management research identifies five research philosophies: positivism, critical realism, interpretivism, postmodernism, and pragmatism. Each offers the researcher an opportunity to position their research based on philosophical assumptions (Saunders, 2016). Positivism is labeled as involving law-like generalizations; critical realism focuses on explaining what is seen and experienced; interpretivism argues that humans create meanings, which differentiate from physical phenomena; postmodernism emphasizes language and power relations, whereas pragmatism focuses on organizational practices (Saunders, 2016).

The researcher's positioning in this dissertation aligns with critical realism because that philosophical choice permits explaining what is seen and experienced. Furthermore, critical realism also recognizes the structures of reality that modify the events the researcher is examining (Saunders, 2016).

This dissertation addresses structures such as organizational culture and the environment in which firms operate that modify the examined phenomenon. In addition, compared to positivism, the standard of measuring the phenomenon through respondents' perceptions in critical realism differentiates from natural sciences. Hence critical realisms is not as strict as in natural sciences, for example. Hence, this philosophical choice offers an opportunity to explain the underlying mechanism that manifests agency and the socially labeled relations that it duplicates and transforms (Rabetino et al., 2021). Furthermore, it offers a more flexible view of researching firms that each operate in an individual organizational and environmental context.

Critical realism theory informs us that new knowledge "is socially produced knowledge of a natural (man-independent) thing" (Archer et al., 1998). Critical realism relates to the outcomes and practices of research (Bhaskar, 2011; Dobson, 2001), and is argued to be "a philosophy for, not just of science" (Bhaskar, 2011, p. 141). Further, it is widely used in management (Saunders, 2016) and IT (Zachariadis et al., 2013) research because of the more flexible interpretations of reality and research.

The basis of methodology is quantitative methods and hypotheses, which is why the objective loop is chosen to analyze the world. Nevertheless, the reality and the different phenomena are not entirely natural-like and therefore difficult to measure as such. Although if reality is seen objectively rather than subjectively, it is impossible to conduct research in a vacuum and disregard the fact that researchers are always subject to some subjectivism despite their best intentions. In addition, the world as such is complex to be measured with its underlying structures. Therefore, its philosophical choices position any piece of research, and this dissertation chooses the lenses of critical realism to discover generative mechanisms (Melnikovas, 2018) in digitalization-based value.

The research onion is used to describe the chosen research strategy (Saunders et al., 2007) in Figure 1. Critical realism is chosen as a philosophical background, as discussed. This dissertation uses a deductive approach to theory development by emphasizing existing theory and formulating the hypothesis and data collection to test those hypotheses (Melnikovas, 2018). Hence, quantitative methods are used to analyze the survey data collected. Both cross-sectional and longitudinal primary data are used.

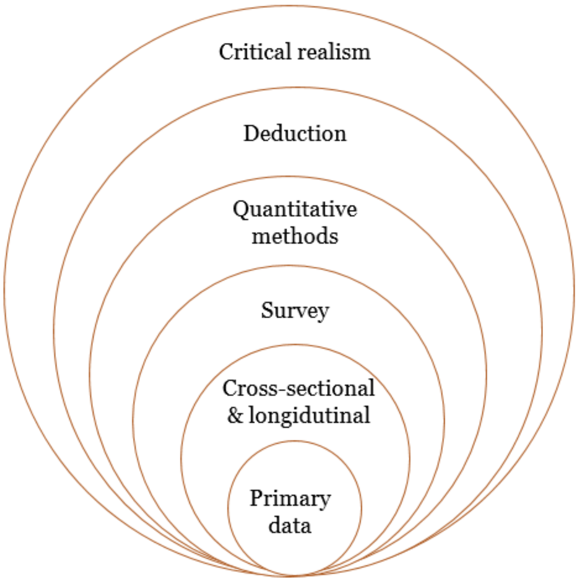

Figure 6. Research strategy. Modified based on Saunders et al. (2007)

3.3 Research design, data collection and analysis

The research design serving as a framework for the study includes the procedures necessary to obtain the relevant information to solve problems and focus on the details (Mahlohtra, 2010). It reflects the big picture of the study that aims to answer the research questions (Taylor, 2017). This dissertation tests multiple hypotheses to explore how SMEs can benefit from digitalization. Therefore, a quantitative research design and methods are used.

Two different datasets are used in this study. First, cross-sectional data were collected from Finnish firms between December 2019 and April 2020. The target respondents were chosen from the Orbis international database based on a general manufacturing category (C). As this dissertation focuses on SMEs, the turnover of the companies was limited to between EUR 1.5m and EUR 50m. E-mails were sent to 720 companies identified within the target group. A total of 21 completed the questionnaire following the e-mail invitation. The author then contacted 414 SMEs directly by telephone and invited them to participate in the study, aiming to increase the number of responses. Among those contacted, 323 agreed to take the survey, and 174 of those eventually responded, whereas 87 declined to participate when asked. A total of 194 responses were received, excluding one duplicate submission, which constitutes a response rate of 17 %. While analyzing the data, it was noticed that the turnover of one company was EUR 0.9m. However, that element of data was retained.

The second data collection operation started roughly one year after the first in spring 2021, specifically between March 2021 and June 2021. The same companies that participated in the first study data were approached; hence, the data are longitudinal. Two companies had ceased trading, and four of those that responded to the first survey did not want to respond to the second one. In addition, one firm advised that recently introduced security procedures prohibited it from responding. Ultimately 148 firms were contacted by telephone, but some others could not be reached, so e-mail invitations were also sent. The second data collection resulted in 122 responses, a response rate of 63%. Papers 1, 2, and 4 use the first data set, and paper 3 uses both data sets.

The hypotheses set out in the first three papers were tested via structural equation modelling using Amos 26 software. The fourth and fifth papers used hierarchical regression and Stata 15.1 software to test the hypotheses.

3.4 Quality of the study

The quality of the data and the measures used in the five papers were assessed by analyzing the reliability and validity of the studies to support the dissertation's reliability. Reliability refers to the extent to which scales are adhered to what it aims to measure (Hair et al., 2019). The reliability of the survey indicates the level of consistent scores that are repeatable and free from errors (Taylor, 2017), thus increasing the research's reliability. Reliability differs from validity in emphasizing the consistency of measures (Hair et al., 2019). Validity is the level at which the instrument is relevant and represents the target construct it aims to reflect for certain assessment purposes (Haynes et al., 1995). In other words, validity relates to the extent to which the study measures what it intends to measure (Taylor, 2017). Accordingly, reliability reflects the "consistency of the measures," whereas validity indicates how well those concepts are defined in accordance with the measures (Hair et al., 2019, p. 3).

Construct validity was analyzed to assess the level to which the assessment instrument is consistent with the construct (Haynes et al., 1995); thus, the items relate to the theoretical concept. An explorative factor analysis was conducted with SPSS software to confirm the validity of the scales included in the articles. In addition, confirmatory factor analysis was used to test the validity and reliability of the constructs used. The average value extracted (AVE) measure was used to test the convergent validity of each construct (Hair et al., 2011), that is, the extent to which measures are related (Taylor, 2017).

Two different measures were applied to assess discriminant validity. First, the Fornell-Larcker criterion was evaluated and the square roots of AVE values calculated (Fornell & Larcker, 1981) to measure the level at which measures designed to be unrelated are unrelated (Taylor, 2017). Second, the maximum share variance (MSV) was evaluated to analyze the discriminant validity (Hair et al., 2019). Cronbach's alpha and composite reliability (CR) were used to ensure the internal consistency of the constructs and their reliability (Hair et al., 2011; Mahlohtra, 2010; Taherdoost et al., 2016). Internal consistency reliability measures the level at which survey items measure the same idea (Taylor, 2017).

Overall, the reliability and validity of the dissertation were confirmed through diligently built theoretical frameworks that first support the building of proper theoretical argumentation and the development of hypotheses. After this process, data were carefully tested to measure the fit with the research models. This dissertation can be considered a reliable and valid work owing to testing the hypotheses developed based on a solid theoretical background.

3.5 New measurement scales

Three new scales were developed. Although there are various scales and measures in use as means of IT or integration in supply chains, there were few novel scales specifically focused on measuring digitalization in SMEs. Two of the developed scales relate to the use of digital technologies. Platform-based technologies were chosen because they can foster interaction between firms. It is also argued that these technologies offer new development opportunities, especially for smaller organizations (Bolloju & Murugesan, 2012; Ebert et al., 2017). The first, a three item-scale, measured the digital platforms used for digital integration in SMEs. The use of different digital platforms features in the dissertation because it has been recognized as an upcoming trend in supply chain management (Gartner, 2018; Kousiouris et al., 2019).

The second, the 20-item PDC scale, relates to the use of digital platforms in specific processes between firms. The scale is a more complicated construct that has four constituent dimensions: digital supply chain transparency, digital customer / supplier involvement, a digitally enabled order-delivery process and digital product data. The PDC is a higher-order organizational capability—a set that includes technology use, digitally enabled information or data sharing in supply chain-management-related processes, and the intensity of the use of digitally enabled information sharing practices with suppliers and customers. Hence, the development of PDC follows the stream of IT-resource-related research (Barua et al., 2004; Brandon-Jones et al., 2014; Rai et al., 2006) and offers an updated construct to measure current digitalized interactions between firms.

The digital strategy scale was the third developed. Strategic planning, analyzing, decision-making, and implementing digital initiatives are important elements of digital strategy (Stefanova et al., 2019) and are also generally recognized steps in the strategy development process (see e.g., Dutton & Duncan, 1987; Mintzberg, 1987; Håkansson & Snehota, 1989; Eisenhardt & Zbaracki, 1992). Accordingly, those steps were used to generate a new scale to measure a strategic approach to digitalization.

When new survey instruments are developed, researchers are recommended to assess content validity (Taherdoost et al., 2016). The author developed the survey instruments based on solid theoretical principles in collaboration with two academics to help ensure the validity of the constructs. Before the data collection started, the questionnaire was tested by an IT industry expert and by a representative of a manufacturing firm, following which some minor modifications were made before data collection.

4 FINDINGS AND SUMMARY OF THE PAPERS

4.1 Paper 1. Boosting effect of digital culture and supply chain capability

The first paper—The impact of digitalization on firm performance: Examining the role of digital culture and the effect of supply chain capability—examines the complementarity between digitalization and supply chain capability and the contingent effect of digital culture between digitalization, supply chain capability and firm performance.

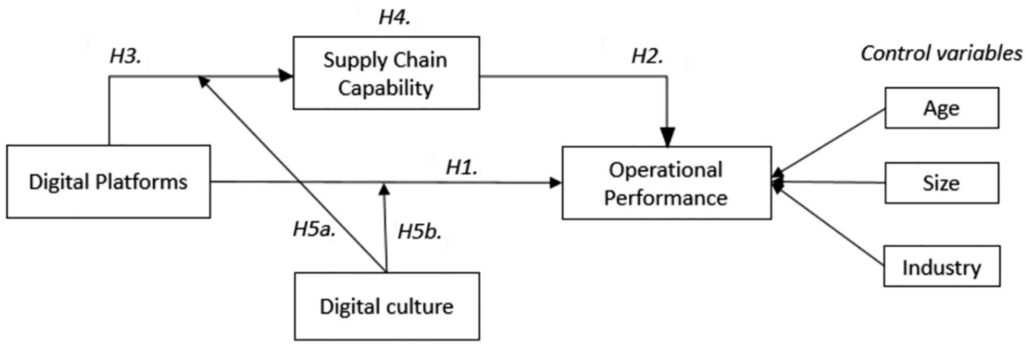

Figure 7. Research model 1.

Structural equation modelling was used to test the hypothesis. The results show that the direct effect of digitalization on firm performance is negative. However, the results confirm that digitalization complements SCC, which also mediates the positive effect of digitalization on operational performance. In addition, digital culture moderates the direct relationship between digitalization and operational performance. That effect shows that the effect of digitalization is contingent on a firm's digital culture. The results indicate that a firm acquires digitalization-based value when digitalization complements organizational factors, and that is accompanied by a fit between the firm's digital culture and digitalization. This study is one of the first to show that despite the role of a mediator, digital culture may also function as a moderator, hence showing the importance of firms' cultural attributes in digitalization-based value creation.

4.2 Paper 2. The guiding role of digital strategy

The second paper—SMEs' digital integration and operational performance - The moderating effect of digital strategy—examines the contingent effect of digital strategy between digital integration and operational performance. Cao et al. (2011) proposed that strategy either mediates or moderates digitalization-based value. However, prior research examining digitalization-based value, especially that related to SMEs, has examined digital strategy only as a mediator (Proksch et al., 2021; Eller et al., 2020) or as an antecedent (Ko et al., 2022). However, organizational changes may be slow; in such cases, some level of fit between digitalization and the firm's business is necessary. In such a situation, a digital strategy may increase an organization's readiness to pursue digitalization. Therefore, those firms that have already analyzed their need for, planned, and implemented digitalization are more prepared to make changes and overcome barriers related to digitalization.

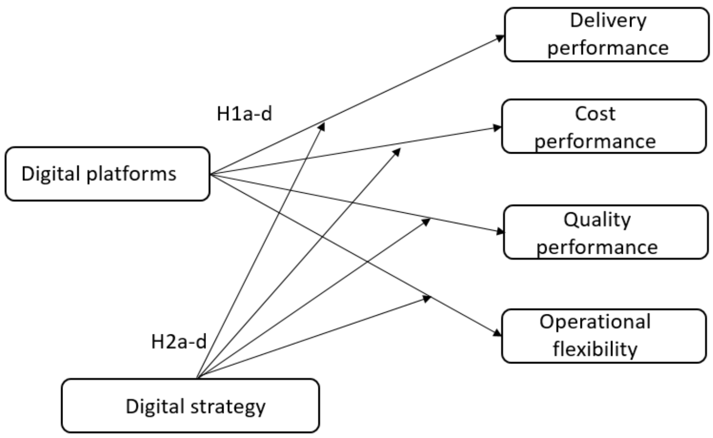

Figure 8. Research model 2.

Structural equation modelling was used to test the hypotheses. The results indicate that digital strategy can act as a moderator between a firm's digital integration and operational performance. This is one of the first research attempts to examine the contingency effect of digital strategy in the context of SME digitalization. Accordingly, it offers new and necessary information on the role of digital strategy in that context. A digital strategy may be considered an element that reduces inertia and supports firms' digitalization. Further, this study argues that well-developed strategic planning for digitalization increases the chances of a firm benefiting from digital opportunities.

4.3 Paper 3. Supply chain capability as a driver for data-based value in a competitive environment

The third paper—Complementary and contingent value of SMEs' data capability and supply chain capability in a competitive environment—examines the complementary effect of data capability on supply chain capability and the contingency effect of competition. The paper examines the deterministic role of competitor turbulence in the context of data capability, SCC and operational performance.

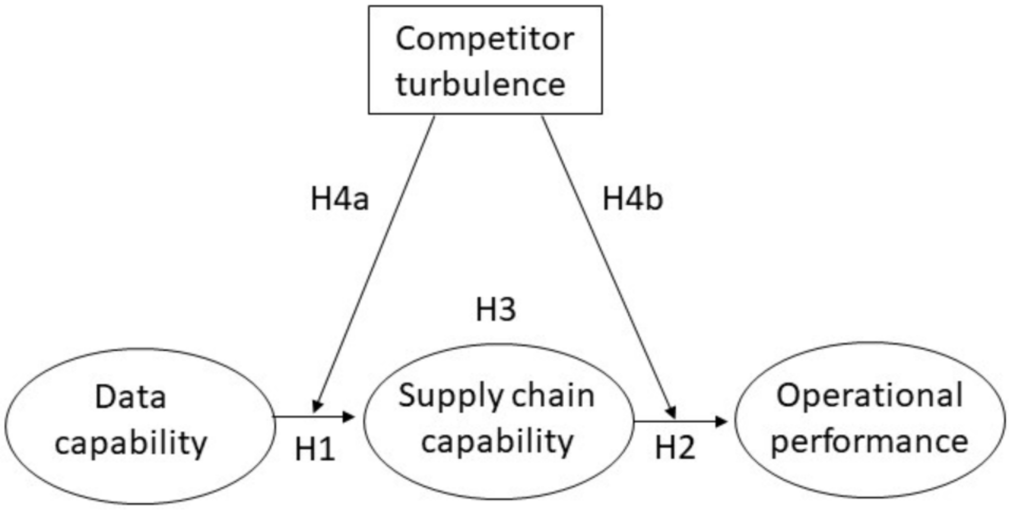

Figure 9. Research model 3.

Longitudinal data and structural equation modelling were used to test the hypothesis. Prior research argues that fully understanding the complementarity between digitalization and other organizational factors requires access to longitudinal datasets (Schweikl & Obermaier, 2022). In this dissertation, longitudinal data illuminate the complementary and contingent value of digitalization. The results indicate that SMEs' data capability indirectly complements supply chain capability, and together these capabilities positively affect operational performance. However, the results changed when a contextual element, competitor turbulence, was included in the research model. The results show that the competition moderates the effects of data capability and SCC on operational performance. When the competition is fierce, SMEs benefit from data capability and, especially from SCC, to deliver improved operational performance. Whereas in the environment labelled low-level of competition, data capability and SCC did not affect operational performance. This study underlines the deterministic role of the environment and shows that the level of the impact of digitalization among SMEs is contingent.

4.4 Paper 4. Increased value of platforms-based digital connectivity in a turbulent environment

The fourth article—Exploring the effects of SMEs' platform-based digital connectivity on firm performance – the moderating role of environmental turbulence—examines the effect of SMEs' platform-based digital connectivity on firm performance and the moderating effect of environmental turbulence. Article target contingency mechanism to explain when firms can benefit from digitalization. Digital technologies, such as digital platforms, build the basis for digital connectivity between firms.

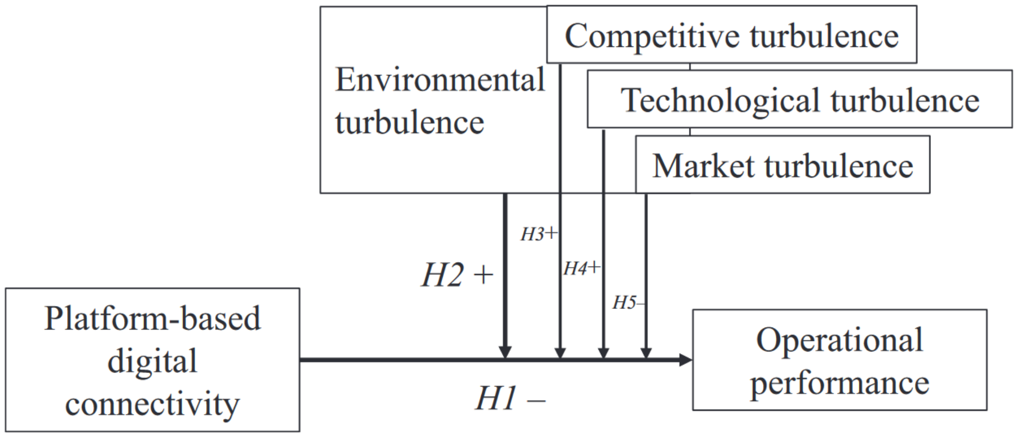

Figure 10. Research model 4.

Hierarchical regression was used to test the hypothesis. The results of this study show how different forms of environmental turbulence—competitor, market, and technological—have different moderation effects. Amid highly competitive turbulence, platform-based digital connectivity increases operational performance for SMEs. However, in a time of high market turbulence, the opposite applies as digitalization reduces operational performance among SMEs. Technological turbulence does not have a moderating effect. The results clearly show that there are deterministic factors in a firm's environment, and the effect of those contingency factors varies. Hence, the idea of there being one particular type of environment with one particular effect on digitalization-based value creation is infeasible. The finding poses several challenges to SMEs trying to manage competition and navigate changing customer preferences.

4.5 Paper 5. The complementary effect realizes when an organizational capability exceeds a certain threshold

The fifth article—The combined effect of platform-based digital connectivity and supply chain capability on SMEs' operational performance—addresses SMEs' inter-organizational digitalization from the perspective of their platform-based digital connectivity. This paper first examines the complementary effect between platform-based digital connectivity and SMEs' operational performance. It then tests the contingency effect of SCC to identify whether a certain threshold value indicates an improved opportunity to benefit from digitalization.

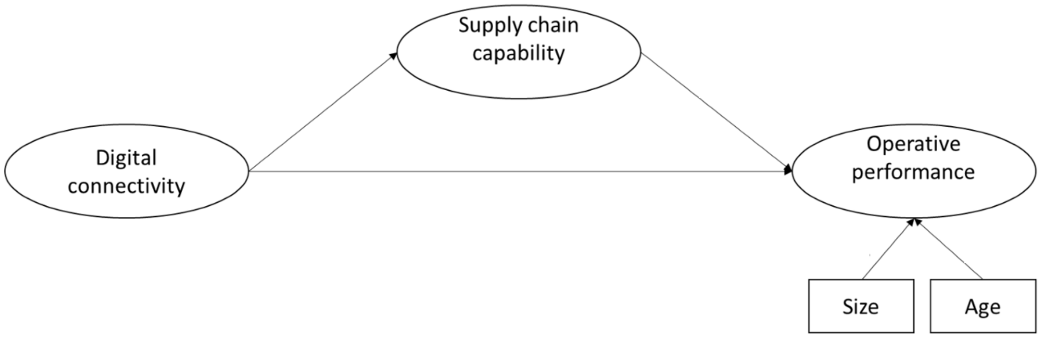

Figure 11. Research model 5.

Hierarchical regression was used to test the hypothesis. The results show a complementary relationship between platform-based digital connectivity and SCC. Further, the findings of this study show that there may be a certain level of SCC needed in successful inter-organizational digitalization, meaning that if the value of SCC is high enough, platform-based digital connectivity creates value both through the complementary and contingent mechanism. These results also support the idea of inertia and the need to tackle routine rigidity so that digitalized processes fit SMEs' operations.

5 DISCUSSION AND CONCLUSION

This dissertation aimed to examine **how and when digitalization creates value for SMEs in the form of improved operational performance**. In the process, this research addressed gaps in the prior research related to strategy research and digitalization among SMEs.

This dissertation examined the phenomenon through the lens of the contingent RBV and unveiled the complementary and contingent effect of digitalization through five different research models. The results show that SME digitalization and its effect on a firm's operational performance is a complex whole where several complementary and contingent aspects interact while creating value. Consequently, this dissertation makes several contributions.

5.1.1 Theoretical contributions

SMEs need more guidance on how to benefit from digitalization (Barann et al., 2019). This dissertation targets SMEs and therefore produces important information on when and how digitalization creates value for that specific group of companies through improved operational performance. An SME usually has a simpler organizational structure than a larger firm (Cragg et al., 2011). In addition, their smallness means SMEs have more limited resources and capabilities (Drechsler et al., 2022; Fischer et al., 2020). Despite the unique nature of SME characteristics, limited research focuses specifically on SMEs, with much of the extant work preferring to consider larger companies (Bhardwaj, 2022; Cenamor et al., 2019; Drechsler et al., 2022; Eller et al., 2020; Mandviwalla & Flanagan, 2021). Therefore, it was essential to produce knowledge that helps better understand SME digitalization and especially to explain how and in what circumstances digitalization improves SMEs' operational performance. This dissertation adds new insight to the conversation on the benefits of SME digitalization.

The results of this dissertation show that despite the differences in SMEs' organizational structure and available resources, there are certain organizational factors that SMEs should consider if they are to benefit from digitalization. Prior research argues that externally focused capabilities are essential for SMEs (Cragg et al., 2011). This research details how the externally focused SCC has a complementary relationship with firms' digitalization. In addition, SMEs need to be able to modify their current business to match their internal and external environment. Hence, it is not enough for SMEs to have resources and capabilities, as these resources and capabilities should fit with their existing environment. Therefore, this dissertation has several contributions, especially to SME-related research. The findings are also useful for non-SMEs and can be used by other companies while developing their ability to understand when and how digitalization is beneficial.

Prior research reveals a degree of uncertainty around the contextual understanding that is principally related to the mechanism through which firms create digitalization-based advantages (Ahmed et al., 2022). As a result, this dissertation focuses on contextual factors affecting digitalization's impact. Prior research mainly uses complementarity or contingency mechanisms to illustrate the value of digitalization. It is argued that the relationship between digitalization and its impact on performance should not be examined in isolation from other factors (Schweikl & Obermaier, 2022). Accordingly, this study used an emerging research framework, the contingent RBV (Brandon-Jones et al., 2014; Cao et al., 2011; Gupta et al., 2018), which combines both complementary and contingent aspects in the context of SMEs and produces knowledge about the complicated mechanism behind the successful digitalization of SMEs. This study is one of the first to use the framework to examine digitalization in SMEs. In doing so, this dissertation confirms that the effect of digitalization on SMEs' operational performance emerges through the complementarity and contingency mechanisms operating between digitalization and the organizational and environmental factors affecting a firm.

An important finding is to clarify the mechanism through which digitalization-based value as improved operational performance is achieved. Digitalization-based value has been approached in various ways, and it is argued that the moderation effect relates to both the complementary and contingent approaches (Benitez-Amado & Walczuch, 2012; Schweikl & Obermaier, 2022). This dissertation shows that these two approaches differ based on their mechanism. Complementarity relates to a situation where two factors, such as resources, reinforce each other (Matsuyama, 1995), and give a rise to a greater return in combination with other resources than by resource as such (Zhu, 2004). In practice, this kind of complementarity can be examined through mediation models in empirical research. In contrast, the contingency mechanism relates to an ability to create a fit between a firm and its internal and external environment (Fry & Smith, 1987; Hofer, 1975; Lawrence & Lorsch, 1967; Rumelt, 1993). Consequently, organizational effectiveness is achieved when an organization aligns with existing contingencies (Morton & Hu, 2008). The mechanism through which this form of contingencies can be targeted is moderation. Accordingly, this dissertation clearly distinguishes between these two mechanisms on a very practical level.

Prior research has identified several organizational factors that affect digitalization-based value, such as organizational resources, relational resources, non-IT human resources, and financial resources (Schweikl & Obermaier, 2022). This dissertation has identified several organizational factors whose role in the digitalization-based value creation in SMEs is less prominent. These factors are digital culture, digital strategy, and SCC. In addition, this dissertation addresses the firm environment through four different variables, namely environmental turbulence, customer turbulence, competitor turbulence, and technological turbulence.

This dissertation shows that organizational factors such as digital culture, digital strategy, and SCC are internal contingency factors that interact with digitalization while improving SMEs' operational performance. Nevertheless, such internal contingency factors are not particularly deterministic, and SMEs can react to and influence them. Prior research implies that inertia and routine rigidity are situational reasons why firms need to change their processes that use resources (Gilbert, 2005). The finding would require firms to realign with both their internal and external operating environments (Besson & Rowe, 2012) to benefit from digitalization. From an internal point of view, this dissertation shows that the digitalization of SMEs is contingent on firms' digital culture, digital strategy, and SCC. If those organizational factors do not closely align with a firm's digitalization process, it will be difficult to improve operational performance based on digitalization.

Similarly, firms must match their external environment; however, the relationship between external contingencies differs from that with internal ones. To elaborate, a firm is more likely to modify its internal contingencies to create a better fit with digitalization despite external contingencies being beyond the control of SMEs. Hence, external contingencies are more deterministic than internal ones. Nevertheless, there should also be a fit between internal contingencies and a firm's business. Therefore, the role of the environment can be considered through the contingency effect, which is modelled through a moderation model, indicating that SMEs need to fit their existing resources and capabilities to the environment in which they operate. In such a case, the value of digitalization is also dependent on environmental conditions, such as competition. With regard to internal contingency factors, they too, can affect the relationship between digitalization and improved operational performance.

In addition to organizational and environmental factors, there have been calls for research to use longitudinal data to explore the effect of various IT resources on organizational performance (Schweikl & Obermaier, 2022). This dissertation used three variables to measure SME digitalization: digital integration platforms, platform-based digital connectivity, and data capability. Consistent with the contingent RBV, the findings show that the value of digitalization emerges through the complementary and contingent effect, regardless of which variable is applied. The same also applies to longitudinal data.

To conclude, this dissertation indicates that digitalization creates value for SMEs in the form of improved operational performance through three different settings: 1) When SMEs have capabilities or organizational factors that create value in a complementarity relationship with digitalization, especially those relating to external relations and operations (e.g., supply chain capabilities). 2) The value of digitalization is improved when there is a fit between an SME's internal factors and its digitalization efforts. Specifically, an SME that encourages a digital culture that is open to and supportive of digitalization opportunities is more likely to benefit from digitalization than a firm resisting digital technologies. In addition, the guiding effect of digital strategy as a contextual element offers a favorable circumstance for digitalization to be embedded into current operations, consequently boosting the possibility of creating value. Also, a certain level of SCC supports firms in finding the fit between their current operation and digitalization. Because changes in a firm may be slow, there should be at least some level of fit between organizational factors and the firm's business to overcome inertia. 3). The value of digitalization is contingent on the environment in which an SME operates. Accordingly, to benefit from digitalization, SMEs need to fit their current businesses with the environmental conditions. However, the advent of digital technologies and the increased level of digitalization mean SMEs can now detect the changes in their environment more effectively, which supports their adjustment to that environment.

By explaining when and how digitalization improves operational performance, this dissertation combines several research streams and fragmented research areas. This dissertation also contributes to prior SME-focused research by offering several findings that will help firms leverage digitalization. As a joint contribution, this dissertation shows why it is essential to focus on broader perspectives that include firms' internal and external factors while analyzing the effect of digitalization and also to isolate the valuable resources and capabilities enhancing such effects. Figure 12 shows the results of this research.

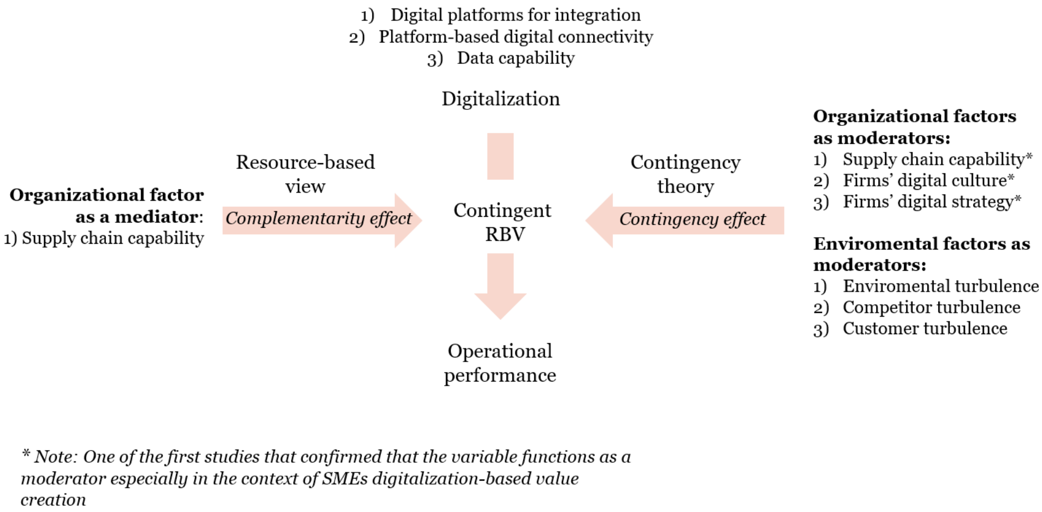

Figure 12. The results of the research

Last but not least, this dissertation is one of the first studies to test the contingent RBV framework in the context of SME digitalization. The results show that the digitalization of SMEs is a complicated phenomenon, which includes the interaction of several factors influencing SMEs' operational performance. Hence, the current study adds to our understanding of the association and mechanisms related to the connection between digitalization and SMEs' operational performance. It also explains when and why the impact of digital technology varies. This study extends existing theory on digitalization and strategic management by testing an emerging research framework, the contingent RBV (Brandon-Jones et al., 2014; Cao et al., 2011; Gupta et al., 2018), which combines two dominant theories in the management field, the RBV and contingency theory. Firms operate in an increasingly turbulent and competitive environment (Wu et al., 2022), meaning that testing the contingent RBV is a valuable action, as doing so enhances knowledge of the digitalization of SMEs from the perspective of varying external and environmental conditions and also that of internal conditions combined with the complementary ideas of digitalization and SCC.

The business environment is increasingly complicated and fragmented (Möller et al., 2020), which is why new ways to approach a real-life phenomenon from a theoretical point of view are necessary. While most of the research on SMEs and digitalization in general focuses on the complementary relation between digitalization and different capabilities, and the contingent effect of the environment, this study empirically validates SCC, digital culture, and digital strategy, which appear to be essential factors in improving SMEs' opportunities to harness the positive effect of digitalization on operational performance.

5.1.2 Managerial implications

It is important that managers understand there are several organizational and environmental factors influencing how digitalization impacts operational performance. Digitalization and digital technologies are one part of a complicated process through which firms can improve their performance.

First, it is essential to note that there is no single best solution to guarantee SMEs will benefit from digitalization. However, there are several opportunities to garner the positive effects of digitalization. First, prior research shows that digitalization impacts a firm's capabilities, resources, and organizational factors, which emerge through complementarity relations between them. This means that digital technologies strengthen the impact of firms' other resources, capabilities, and organizational factors. In practice, one crucial element of digital technologies is their ability to facilitate and enhance knowledge sharing. Firms with the capability to use that knowledge while interacting and operating with their suppliers and customers are more likely to benefit from the knowledge in question.

Second, when there is a fit between the firm and its internal and external environments, the value of digitalization is more likely to be stronger. It is essential to understand the difference between internal and external factors. The latter is rather deterministic, leading to SMEs having to adapt to their external environment. However, SMEs can also influence and build an internal environment that supports digitalization. In that case, SMEs are more likely to derive positive operational performance benefits from digitalization.

The results of this dissertation show that digitalization does not directly improve SMEs' operational performance and may even affect it negatively. The results indicate an SME investing in digitalization should carefully evaluate select digital opportunities in the context of the business and operating environment. More specifically, managers should consider the organizational factors of digital culture, digital strategy, and supply chain capabilities when planning and implementing digitalization. Ignoring those factors can make overcoming the inertia affecting the firm's current and intended digitalized operations challenging. If the issue is not addressed, investments in digitalization are unlikely to produce desired results. Accordingly, firms wishing to guarantee that these investments pay off should develop their organizational culture to support change and encourage a curious and positive approach to digital technologies. Action taken should also be aligned with the firm's strategic objectives, reinforcing the need for planned actions to nurture the digitalization of SMEs.

In conclusion, it is important to understand that there are organizational factors that can be modified and environmental factors that firms should adjust to. Nevertheless, both cases include some level of adaptation from both managers and employees.

5.1.3 Limitations and avenues for future research

As is usual, this dissertation has some limitations. This dissertation focused on the digitalization of SMEs in a specific time marked by disruptions, such as Covid-19. This unexpected crisis affected manufacturing firms around the world, including Finnish ones. Hence, examination and understanding the effects of different factors on SMEs' digitalization and digitalization-base value are needed also after times of crises.

There are a variety of ways to measure firm performance, and a more nuanced understanding of the impact of digitalization on other performance types would be welcome. In addition, as concerns about the environment grow, there is increased pressure to find more sustainable ways to conduct business. Future research could focus more acutely on how digitalization could help improve a firm's sustainable performance and achieve its sustainability goals. Such investigations might include what digital technologies could contribute to delivering the capabilities, structures, and processes that enable firms to operate more sustainably.

In addition, this dissertation focused on digitalization from a narrow perspective. It would be vital to test different kinds of constructs while examining digitalization and its impacts from the SME perspective. In addition, more research would be welcome on the factors supporting digitalization among SMEs. Digitalization always includes investment, and from the perspective of SMEs and their limited resources, it would be important to offer more information that supports beneficial digitalization for SMEs.

There are also some limitations relating to the data. Both datasets informing this study were collected from Finnish SMEs, which limits the generalizability of the results across different regions. This dissertation is based on two different sets of quantitative data, which has led to the phenomenon of digitalization being examined with a limited scope through quantitative research methods.

It is probable that some organizational factors and capabilities that could impact SME digitalization have been excluded from this study. For example, the role of employees should be examined more closely. This dissertation showed the importance of organizational capabilities and the digital culture of a firm to digitalization-based operational performance improvements. Nevertheless, knowledge of personal capabilities in the context of firm digitalization, especially with regard to non-management employees, is limited. Accordingly, future research might focus on the impact that individual-level capabilities have in the context of firms' digitalization efforts. Finally, this dissertation has highlighted the importance of SCC, emphasizing SMEs' ability to operate with suppliers and customers. However, this dissertation did not focus on the interfirm factors and roles that might explain why a certain kind of digital technology or platform was used or who decided upon that usage. Future research could focus on examining the implementation decisions around digitalization between organizations.

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The impact of digitalization on firm performance: examining the role of digital culture and the effect of supply chain capability

Tuire Hautala-Kankaanpää
School of Management, University of Vaasa, Vaasa, Finland

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Abstract

Purpose – The study examines the impact of digital platforms and supply chain capability on operational performance and tests the mediation effect of supply chain capability. Further, the purpose is to examine the moderating effect of digital culture and sharpen our knowledge of how organizational culture as a contextual factor affects the firm's digitalization.

Design/methodology/approach – The data were harvested from 194 Finnish manufacturing companies, and structural equation modeling was used to test the hypotheses.

Findings – The findings show that digital platforms positively and significantly affect supply chain capability. Moreover, supply chain capability mediates the relation between digital platforms and operational performance. Further, this study confirms that digital culture is a contextual factor that explains the differences in the effects of digital platforms on firm performance.

Originality/value – This study is one of the first attempts to examine the effect of digital culture in the context of digital platforms, supply chain capabilities, and operational performance.

Keywords Digital platforms, Digital culture, Supply chain capability, Operational performance

Paper type Research paper

1. Introduction

The fast pace of digitalization has altered the competitive logic of the industries, the value chains (Aaldering and Song, 2021; Ghobakhloo and Iranmanesh, 2021), and firms' internal and inter-organization processes (Holmström *et al.*, 2019). Firms adopt digital technologies to manage their operations, supply chain activities, and real-time visibility (ArditoPetruzzelli *et al.*, 2019); hence, businesses are increasingly connected (Seyedghorban *et al.*, 2020). This phenomenon encompasses industries globally and is sometimes also referred to as Industry 4.0 (e.g. Bazan and Estevez, 2022; Bienhaus and Haddud, 2018; Wamba and Queiroz, 2020). It emphasizes increased vertical and horizontal integration of manufacturing processes (Dalenogare *et al.*, 2018; Wagire *et al.*, 2020). Digital technologies such as digital platforms (DPs) offer information integration (Li *et al.*, 2020; Sedera *et al.*, 2016), support visibility and decision making (Yang *et al.*, 2013), and provide interoperability between different software and technologies (ArditoPetruzzelli *et al.*, 2019). Thus, they are seen as an enabler of more digitalized supply chains (Gartner, 2018). Digital platforms, as a form of integration software, offer an opportunity for seamless information flow, communication, and connectivity in firms and in supply chains (Chi *et al.*, 2018; Sedera *et al.*, 2016).

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In general, researchers have examined the relationship between digital technologies and firm performance, and it is observed that the research does not offer clear evidence about the benefits of digitalization on performance (Kohtamäki *et al.*, 2020). Some studies report a weak or nonexistent role (AlMulhim, 2021; Lee *et al.*, 2022; Liang *et al.*, 2010); some research claims that digital technology directly supports performance (Eller *et al.*, 2020; Li *et al.*, 2020); and some claims that it undermines performance (Jeffers *et al.*, 2008). Further, researchers have noticed that contextual and organizational factors complement Industry 4.0 technologies (Culot *et al.*, 2020). Hence, *how* digital technology is used in a firm's operations is more likely to explain the different performance benefits gained from the use of digital technologies than the technology itself. This advancement has highlighted the role of firm capabilities, such as supply chain capabilities that use digital technologies to support firm performance (Wu *et al.*, 2006). RBV-based digital-capability framework (Bharadwaj, 2000; Cho *et al.*, 2017; Mithas *et al.*, 2011; Rai *et al.*, 2006) argues that a firm's operations must combine a range of digital resources such as DP and firm capabilities if the firm is to derive performance benefits.

In addition, the contingency perspective of the resource-based view is adopted in this study and argued that complementary organizational aspects might explain the differential result of using digital technology (Cao *et al.*, 2011; Wiengarten *et al.*, 2013). This study also investigates the moderating role of digital culture, referring to the openness and acceptance of digitalization-related technology (Blatz *et al.*, 2018). Digital culture, like organizational culture, is identified as one of the causes preventing the change needed to become more digitalized (Fitzgerald *et al.*, 2013; Hartl and Hess, 2017).

The empirical research on digital culture is limited and has focused on the data-driven culture (Yu *et al.*, 2021), the use of IT (Leidner and Kayworth, 2006), the intention to adopt internet-enabled supply chain management systems (Liu *et al.*, 2010), big data analytics (Dubey *et al.*, 2019), and digital organizational culture (Martínez-Caro *et al.*, 2020). Nevertheless, organizational digital cultural attributes are an underdeveloped aspect of digitalization research (Nadkarni and Prügl, 2020). Further, the current digitalization research does not isolate possible moderating factors (Kohtamäki *et al.*, 2020), nor their role in the relation of DP and operational performance. Therefore, the key objective of this study is to examine the mediating effect of supply chain capability (SCC) between DP and operational performance; and the contextual role of digital culture. The present study used an empirical analysis of 194 firms to test the research hypotheses.

The remainder of this paper is organized as follows. The first section summarizes the relevant research on the digital-capability framework, DPs, SCC, and digital culture and introduces the study's hypotheses. The second presents the research methodology, data collection, measurement validation, and results. The final section incorporates a discussion of the analysis and contributions of the study and outlines its limitations.

2. Theoretical background and hypothesis development

2.1 RBV-based digital-capability framework and organizational context

RBV-based digital-capability research focuses on how digital technology creates value for firms (Barua *et al.*, 2004; Dong *et al.*, 2009; Zhu and Kraemer, 2002). It is notable that digital resources, such as digital software or digital technology, do not independently explain the performance effect of a firm (Bharadwaj, 2000; Mata *et al.*, 1995; Mishra *et al.*, 2007; Rai *et al.*, 2006; Tippins and Sohi, 2003; Wu *et al.*, 2006). That is especially the case if the resource is a common technology that competitors might mimic and adopt (Bi *et al.*, 2013; Tippins and Sohi, 2003). When they are applied independently, digital resources have little direct influence on firm performance, which might explain why the potential of the value of digital resources seems to have faded (Dong *et al.*, 2009; Wiengarten *et al.*, 2013). Nevertheless, it is clear that digital resources impact other resources, capabilities, and processes that can enhance performance (Wade and Hulland, 2004). To continue, SCC describes the firm's ability to identify, leverage, and adapt its internal and external information and resources to manage activities related to the supply chain (Amit and Schoemaker, 1993; Collis, 1994; Wu *et al.*, 2006; Yu *et al.*, 2018). The combination of SCC and resources builds the main premise of performance advantages (Morash and Lynch, 2002).

The contingency perspective of the resource-based view suggests that complementary organizational aspects might explain the differential result of using digital technology (Cao *et al.*, 2011; Wiengarten *et al.*, 2013). Organizational culture is identified as one of the causes preventing the change needed to become more digitalized (Fitzgerald *et al.*, 2013; Hartl and Hess, 2017). In general, an organization's culture influences how it conducts its business (Barney, 1986) and reflects the beliefs and values shared in the organization (Miller, 1993) and the ways we see the world (Davison and Martinsons, 2002). It is, therefore, possible to argue that a digital culture that reflects the beliefs and values connected to the use of digital technology influences how an organization conducts its business facilitated by digital technology. The common theme applied is that digital culture is more of an organizational-level critical competence that affects the use of DPs in a firm's operations.

2.2 Digital platforms

A digital platform is a form of software used to control production and logistics, manage the data, and support the integration of applications and processes between companies (Sedera *et al.*, 2016). The software considered in inter-organizational integration is the Internet of things (IoT) platforms, integration platforms, and supply chain management platforms. These enabling technologies offer an opportunity to connect different forms of software and applications seamlessly and assure interoperability (ArditoPetruzzelli *et al.*, 2019).

Although there are several possible positive outcomes of using DP, they are more likely to be accessed if firms have the capabilities to benefit from the technology and to use the information, visibility, and connectivity offered. Therefore, DPs *per se* may have limited positive performance effects as they do not offer opportunities to differentiate from competitors if competitors adopt the same general software (Bhatt *et al.*, 2010; Tippins and Sohi, 2003). In addition, DPs can guide user firms to manage their processes in similar ways (Markus and Loebbecke, 2013). If competitors use similar software, none of them should be outperforming any others on account of the DP itself. Instead, differentiation is sought through other means, such as the combination of resources, capabilities, and organizational factors.

The meta-analysis by Liang *et al.* (2010) indicated that the direct connection between organizational digital resources and firm performance is weak or nonexistent. In addition, recent empirical research has found no relationship between digitalization and firm performance (AlMulhim, 2021; Lee *et al.*, 2022). Nevertheless, empirical research also shows that digital technology can both support (Eller *et al.*, 2020; Li *et al.*, 2020; Rosenzweig, 2009) and undermine performance (Jeffers *et al.*, 2008). However, it is expected that a DP will have a positive effect on a firm's operational performance because of its integrative nature that supports the visibility and the ability to share real-time information and data (e.g. ArditoPetruzzelli *et al.*, 2019; Sedera *et al.*, 2016) Accordingly, the first hypothesis is:

H1. Digital platforms have a positive effect on operational performance

2.3 Supply chain capability

Supply chain capability forms the basis of a company's supply chain operations and is considered an explanatory factor in the success of a firm (Morash *et al.*, 1996; Morash, 2001). Further, this capability reflects a firm's ability to conduct business activities internally and within the supply chains (Bi *et al.*, 2013); and thus, it fosters business performance that is connected to the availability of products, convenience, and low level of distribution costs (Morash *et al.*, 1996).

Supply chain capability has been defined in several ways in previous research, including as an aggregate construct that combines four different dimensions (Wu *et al.*, 2006); as a construct where those dimensions are modeled independently (Yu *et al.*, 2018); and as a combination of three independent dimensions (Bi *et al.*, 2013). Moreover, independent dimension of coordination (Liao *et al.*, 2017), agility and flexibility (Yusuf *et al.*, 2004), integration (Rai *et al.*, 2006; Leuschner *et al.*, 2013; Rajaguru and Matanda, 2019; Yu *et al.*, 2020) and collaboration (Fawcett *et al.*, 2011) has been used as SCC. In this research, SCC should be read as including three different dimensions: information exchange, activity integration, and responsiveness. Those three are well-known and important activities in the supply chain process. Information exchange deals with effective and efficient knowledge sharing in supply chains (Wu *et al.*, 2006). It is a vital part of various business activities, such as forecasting, inventory, and customer management (Wei *et al.*, 2020), demand management, sales, production, and delivery processes (Rai *et al.*, 2006). *Activity Integration* describes internal channel integration based on two premises, technology integration and activity integration (Wu *et al.*, 2006). Further, *responsiveness* reflects the ability to respond to environmental transformation (Wu *et al.*, 2006), compete effectively, and react to changes in demand and supply (Yu *et al.*, 2018). *Coordination* deals with firm-internal and inter-organizational coordination that reflects the firm's ability to effectively coordinate activities relating to transactions, materials, and orders (Wu *et al.*, 2006). These dimensions reflect a firm's ability to manage and interact with supply chains and, therefore, be seen as essential drivers for firm operations.

At a general level, SCCs are expected to positively influence firm performance (Ataseven and Nair, 2017; Chang *et al.*, 2016; Leuschner *et al.*, 2013; Rajaguru and Matanda, 2019; Wong *et al.*, 2015; Yu *et al.*, 2018). They offer information-related advantages derived from multiple sources (Wu *et al.*, 2006) that support on-time delivery and help identify uncertainties (Wong *et al.*, 2015); those advantages can also drive inventory reduction and cost-saving (Hau *et al.*, 2000; Wong *et al.*, 2011). Further, SCC increases responsiveness, which can improve operational performance (Bhatt *et al.*, 2010). Digitally supported SCC is an inter-firm capability and, therefore, valuable to firms *per se* (Bi *et al.*, 2013). This finding leads to the next hypothesis:

H2. SCC has a positive effect on operational performance

2.4 The relation between DPs and SCC

Firms invest in digitalizing their supply chains and operations to achieve various effects, such as, enhanced delivery speed, flexibility, connectivity, on-time inventory, intelligence, transparency, and proactivity (Büyüközkan and Göçer, 2018). Digitally advanced supply chains differ from traditional vertical integration forms in being integrated via information flows rather than ownership (Dong *et al.*, 2009), and digital technology is recognized as a key driver of this kind of integration (Yusuf *et al.*, 2004). In addition, DPs facilitate sharing and analyzing information and deriving benefit from interactions in supply chains; therefore, they have a significant role in information exchange, especially in situations where supply chains are dispersed when they facilitate easy access to information and data. Digital platforms accelerate information exchange and can signal a need to respond to changes in the market.

Prior research indicates that using digital technologies in supply chains improves operational efficiency (Calatayud *et al.*, 2019; Singh and El-Kassar, 2019; Yang *et al.*, 2021; Zhu and Kraemer, 2002). It also positively influences differential SCCs, such as supply chain process integration (Rai *et al.*, 2006; Rajaguru and Matanda, 2019; Yu *et al.*, 2020) and collaboration capabilities (Fawcett *et al.*, 2011). DPs support a firm's SCC and enable firms to share timely, appropriate, and confidential data within supply chains. Therefore, DPs can positively influence SCC by facilitating constant information sharing, supporting integration, and offering access to real-time information and a flow of data that enables firms to operate effectively in a timely manner and respond to changes.

H3. Digital platforms have a positive effect on SCC

2.5 The mediating role of SCC

Previous research offers empirical support for SCCs' transformative role between digital resources and performance (Wu *et al.*, 2006; Yu *et al.*, 2020). Supply chain capability can be used as a mediator representing the value-creation mechanism between DPs and performance. Supply chain capability helps firms conduct business activities, in which DPs are used in organizational processes, and the use of the DPs is adapted to firm needs. In this case, the value-creation mechanism of SCC is the capacity of a firm to successfully use a DP to fit its own activities.

Previous research indicates that different digital resources and capabilities (Cámara *et al.*, 2015; Chen *et al.*, 2014; Hallikas *et al.*, 2021; Mikalef *et al.*, 2020; Yu *et al.*, 2018) require mediation support from a firm's capabilities to deliver performance gains. Hence the next hypothesis is presented:

H4. SCC positively mediates the relationship between DPs and operational performance.

2.6 Moderating effect of digital culture

Firms differ in how successfully they use digital technologies (Martínez-Caro *et al.*, 2020). It is argued that digital resources alone affect firm performance in only a minor way and that significant improvement requires the presence of organizational factors such as culture (Wiengarten *et al.*, 2013). Further, Melville *et al.* (2004) argue that organizational culture interacts with IT when value is generated. In digitalized context, digital culture relates to a firm's openness to and acceptance of digital technologies (Blatz *et al.*, 2018), and openness to new thinking is a basic requirement relating to digital technologies (Witschel *et al.*, 2019). If the organization is open and willing to use digital technologies (i.e. it has a supportive digital culture), it can more easily exploit DPs and apply them to its processes. Whereas if digital technologies are resisted by their user, it is more likely that the use of DPs remains at a lower level and will be rather ineffective. Consequently, the benefits derived are likely to be limited. In this sense, digital culture is seen as a factor that may affect the effectiveness of the DPs used in a firm's operations.

Previous research indicates that a data-driven culture moderates the effect of big data analytics on supply chain finance (Yu *et al.*, 2021). Furthermore, digital organizational culture indirectly affects operational performance (Martínez-Caro *et al.*, 2020); culture affects the use and adoption of digital technologies (Leidner and Kayworth, 2006; Liu *et al.*, 2010). This study argues that the effect of DPs is related to the digital culture in those firms. Therefore, the following hypotheses are formulated:

H5a. Digital culture moderates the relationship between DPs and SCC

H5b. Digital culture moderates the relationship between the DPs and operational performance

2.7 Dependent variable: operational performance

This article includes operational performance as an aggregate construct that describes the firm's delivery performance, cost performance, quality performance, and production flexibility (Ward and Duray, 2000). Delivery performance is a combination of reliability and delivery speed; cost performance indicates a firm's ability to reduce production and inventory costs, whereas quality performance incorporates the ability to meet customer needs; production flexibility is the ability to change product features and product mix (Ward and Duray, 2000).

2.8 Control variables

This study uses firm size, industry, and age as its control variables. Firm size is included in the research model because larger firms may have more resources available to assign (Wu *et al.*, 2006; Rueda-Manzanares *et al.*, 2008; Chen *et al.*, 2014), which may reflect on operational performance. In addition, the industry is controlled for as there may be industry-level differences between the firms (Capon *et al.*, 1990; Melville *et al.*, 2004; Jayaram *et al.*, 2010). Firm age is included because younger firms may not have the same experience-related advantages as their older counterparts (Autio *et al.*, 2000; Chen *et al.*, 2014). The research model is presented in Figure 1.

3. Research methodology

3.1 Data collection and sample

The data were collected from firms operating in the manufacturing sector between December 2019 and April 2020. Firms with a general manufacturing category (C) and a turnover of between EUR 1.5 m and EUR 50 m were randomly selected from the Orbis database. When analyzing the data, one firm's turnover was below the threshold (EUR 0.9 m), but the firm's data were retained for inclusion. A mixed-methods approach comprising both an email invitation and direct calling was used to invite the firms to participate in the study. A total of 1,136 Finnish companies were contacted, 414 by telephone. Eventually, 194 acceptable responses were received, a result considered suitable for SEM (Wolf *et al.*, 2013; Sideridis *et al.*, 2014). Responses were received mostly as a result of the telephone calls; only 21 out of the firms responded to an email. The response rate was 17%, and the respondents mainly held managerial positions such as CEO (83%) and CFO (13%). The majority of the companies operate in the metal industry (32%), others in electric or electronic machinery (22.7%), food manufacturing (9.8%), leather, stone, clay, and glass production (3.6%), wood, furniture, and paper manufacturing (9.3%), and other manufacturing sectors (8.8%). Table 1. presents the sample demographics.

3.2 Measures

The 3-item scale labeled *DP* was a novel one; the items on the DP scale relate to the use of the general commercial platforms such as IoT platforms, integrative DP, and supply chain management platforms. The IoT supports visibility, data integration, and a constant flow of information (Yang *et al.*, 2013). The typical background for these systems is that they support internal and inter-organizational integration, connectivity, and information and data

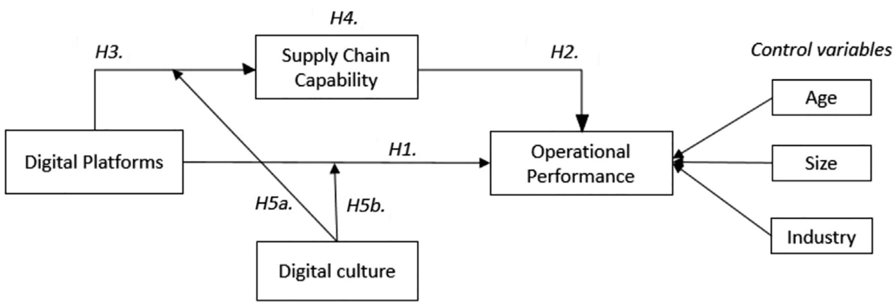


Figure 1. Research model

	n	%
Industry		
Chemicals, petroleum, rubber and plastic	27	13.9
Food manufacturing	19	9.8
Industrial, electric and electronic machinery	44	22.7
Leather, stone, clay and glass products	7	3.6
Metals and metal products	62	32
Wood, furniture and paper manufacturing	18	9.3
Other manufacturing	17	8.8
Number of employees		
<15	34	17.5
16–29	72	37.1
30–45	30	15.5
46–60	19	9.8
61–99	26	13.4
100–291	13	6.7
Turnover (thousand euros)		
<5	80	41.2
5–9.9	51	26.3
10–24.9	52	26.8
25–50	11	5.7
Firm age (years)		
<5	5	2.6
5–10	36	18.6
11–25	58	29.9
26–50		41.2
<50	15	7.7

Table 1.
Sample demographics

availability (Sedera *et al.*, 2016). Internet of Things platforms, integrative DPs, and supply chain management platforms are seen as future trends in supply chain management (Gartner, 2018; Kousiouris *et al.*, 2019) and are therefore at the heart of this study. Prior to the survey, the three academics developed the construct used to measure DPs. The survey instrument was reviewed by a representative of a manufacturing firm and by an IT industry specialist. Explorative factor analysis tested the constructs and helped assess the validity and reliability of the construct, which led to one factor emerging.

The test then continued with analyzing the measures. A confirmatory factor analysis was used to test the validity of the scales. The reliability measures average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha (α) were tested, and the results are reported in Appendix. All the scales were measured with a 7-point Likert-type scale anchored with completely disagree (1) and completely agree (7) and were estimated through the respondent's perceptual evaluation. All these scales were considered as reflective constructs.

The analysis started with the *DPs* scale, which loaded with good values (0.64–0.81), and reliability (CR = 0.78; AVE = 0.54; α = 0.77) was at an acceptable level.

The digital culture scale (a 5-item scale) was adopted from a previous study by Blatz *et al.* (2018). All items loaded above the 0.5 level (0.53–0.88) and showed good reliability (CR = 0.87; AVE = 0.57; α = 0.86).

Supply chain capability (a 15-item scale) was measured on a scale adapted from that of Wu *et al.* (2006) that included four different dimensions—information exchange (CR = 0.92, AVE = 0.75, α = 0.93), activity integration (CR = 0.89, AVE = 0.74, α = 0.89), and responsiveness (CR = 0.85, AVE = 0.60, α = 0.85) and coordination (CR = 0.66, AVE = 0.42 α = 0.69). However, one item related to a firm's ability to perform the business at less cost than its competitors was removed from the coordination dimension because of low loading (0.29) (Hair *et al.*, 2019). The reliability of the coordination dimension was then acceptable, as the AVE value exceeded the critical level of 0.4, and the CR was more than 0.6 (Fornell and Larcker, 1981; Malhotra, 2010). All dimensions of SCC loaded at acceptable levels (CR = 0.83, AVE = 0.56, α = 0.90) indicating the SCC as aggregate construct could safely be used.

The 13-item operational performance scale was adapted from prior research (Ward and Duray, 2000; Wong *et al.*, 2011) and measured delivery performance (CR = 0.86, AVE = 0.61, α = 0.85), cost performance (CR = 0.84, AVE = 0.56, α = 0.84), quality performance (CR = 0.87, AVE = 0.77, α = 0.87), and production flexibility (CR = 0.87, AVE = 0.78, α = 0.87). One item from the operational flexibility scale that measured a firm's ability to change production volumes was removed owing to a low loading (0.46). The test continued with an analysis of the operational performance construct, which established that the reliability was acceptable (CR = 0.72, AVE = 0.41, α = 0.86) (Fornell and Larcker, 1981; Malhotra, 2010). Table 2 presents the correlations, means, and standard deviations.

All control variables were measured with a single item. The largest industry sector was that of *metals and metal products* and was therefore controlled. The dummy variable was coded (Aiken and West, 1991) as 0 (other industries) and 1 (metal industry). Size is a continuous variable measured by a firm's turnover. Age is also a continuous variable.

In addition, the validity of the constructs was evaluated. Measuring the discriminant validity established that the square root of AVE-values was higher than the correlation of other constructs (Fornell and Larcker, 1981). The relevant values are shown in italicface on the diagonal in Table 2. The maximum shared squared variance (MSV) was assessed; all MSV values range from 0.193 to 0.330, indicating that the AVE value is higher on every construct measured. These results offer evidence of discriminant validity. MSV values can be found in Appendix. In addition, the heterotrait-monotrait ratio of correlations (HTMT) technique determined the discriminant validity between constructs. The results varied between 0.113 and 0.556 and stayed below the threshold value of 0.900 (e.g. Henseler *et al.*, 2015).

A confirmatory factor analysis was conducted on the measurement model using Amos 26 software. The result indicated that the data have an acceptable fit to the overall model (x^2/df; 1.78; CFI = 0.90; NFI = 0.80; IFI = 0.90; RMSEA = 0.06; TLI = 0.90). Further, skewness and kurtosis were used to estimate the multivariate normality. The skewness values ranged from −0.954 to 1.718, clearly between the −2 and +2 values that indicate acceptability (Brown, 2006; Collier, 2020). The kurtosis value ranged from −2.078 to 5.680, thus below 7.0 (Byrne, 2016) and within the higher criterion range of −10 to + 10 (Collier, 2020).

Variable	Mean	SD	1	2	3	4	5	6	7
1. Company age	27.02	16.23							
2. Company size (Turnover)	9,217	0.45	0.09						
3. Metals and metal products	0.32	0.47	−0.15*	−0.14					
4. Digital platforms	2.19	1.45	−0.06	0.12	0.06	*0.73*			
5. Digital culture	5.18	1.06	0.02	0.16*	−0.14*	0.09	*0.76*		
6. SSC	4.14	0.85	−0.02	0.16*	0.01	0.30***	0.44***	*0.75*	
7. Operational performance	4.66	0.89	−0.03	0.01	−0.12	−0.03	0.47***	0.49***	*0.64*

Note(s): $^{*}p \leq 0.05$; $^{***}p \leq 0.001$

Table 2. Correlations, means and standard deviations

3.3 Common method bias

The data were collected from a single respondent from each firm, which prompted the testing of common method variance. Harman's single-factor test was conducted to examine the unrotated factors (Podsakoff and Organ, 1986; Podsakoff *et al.*, 2003). The simple one-factor test with SPSS software was conducted, and the results indicate that the first factor explained 26.6% of the variance, well below the cut-off threshold value of 50%. The test then proceeded with Amos 26 software. The single-factor model produced an extremely poor fit to the data (x^2/df = 5.76; CFI = 0.38; NFI = 0.34, RMSEA = 0.16; TLI = 0.34), these results indicate that common method bias is not a concern.

4. Analysis and results

The analysis continued with structural equation modeling. The results of the main research model indicated an acceptable model fit to the data (x^2/df = 1.69; CFI = 0.94; NFI = 0.87; IFI = 0.94; RMSEA = 0.06; TLI = 0.89). The next step was a multicollinearity test. The variance inflation factor (VIF) was found to vary between 1.101 and 1.348, below the threshold value of >5 (Hair *et al.*, 2011). The results relieved concerns over potential multicollinearity.

4.1 Direct relations

The test started with the analysis of direct relations. The results show that DPs ($\beta = -0.148$, $p < 0.01$) directly and negatively affect performance, which means H1 is not supported. Further, SCC ($\beta = 0.397$, $p < 0.001$) has a positive and significant direct effect on the firm's operative performance, thus supporting H2. DPs ($\beta = 0.267$, $p < 0.001$) directly and positively affect SCC, which supports H3. The control variables, size ($\beta = -0.105$, $p = 0.054$), and age ($\beta = -0.046$, $p = 0.400$), did not affect operational performance, whereas industry ($\beta = -0.115$, $p < 0.05$) had a negative and significant effect on operational performance. In addition, the effect of digital culture on operational performance was controlled for, the results showing a significant direct effect of digital culture on operational performance ($\beta = 0.266$, $p < 0.001$).

4.2 Mediation analysis

Zhao *et al.*'s (2010) steps procedure was followed to analyze the possibility of mediation. The indirect effect between a DP through SCC was tested first, thus removing the direct link from a DP to operational performance. A bootstrapping approach with 5,000 iterations and 95% confidence intervals was adopted to test the mediation effects (Hayes, 2018). The results show that the indirect effect of DPs ($\beta = 0.098$, $p \leq 0.001$) on operational performance was positive and significant, which indicates a possible indirect relationship, where the mediation effect of these independent variables on performance is conveyed through SCC (James and Brett, 1984; James *et al.*, 2006). The test process continued with an analysis of the direct relationship with the mediator removed from the model. Because the direct path from DPs ($\beta = -0.047$, $p = 0.441$) on operational performance was not significant, the study findings confirm full mediation (Zhao *et al.*, 2010) between the DP and operational performance, which supports H4.

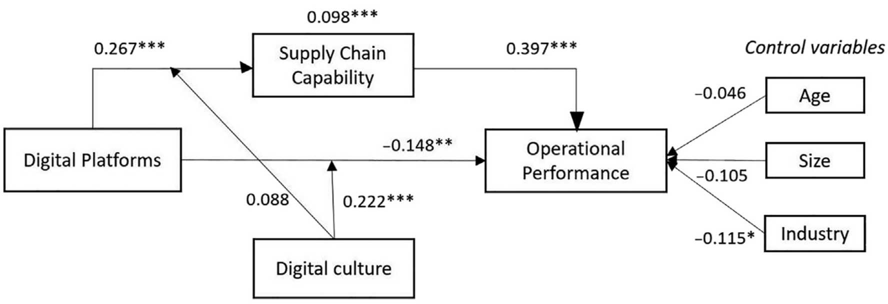
4.3 Moderation analysis

The constructs for digital culture and DP were multiplied to provide an interaction term to measure the effect of digital culture as a moderator (Bollen, 1989). The interaction term was treated as an independent variable in the model. The results show that digital culture does not moderate the relation between the DP and SCC ($\beta = 0.088$ $p = 0.162$), thus rejecting H5a. Instead, the digital culture significantly and positively moderates the relationship between a

DP and operational performance ($\beta = 0.223$, $p < 0.001$), which supports H5b. The results are presented in Figure 2.

Figure 3 shows the effect of the interaction between DPs and operational performance. The results suggest that firms with high levels of digital culture are also those in which the use of a DP is more positively associated with operational performance. In contrast, firms with a low level of digital culture tend to report a negative association between a DP and operational performance.

This study presents several findings. The results show that using DPs positively impacts SCC. Further, SCC had a positive relationship with operational performance, which shows the importance of this capability to a firm's operations. A direct and negative relationship was established between DPs and operational performance. However, the mediation analysis shows that SCC positively mediates the effect of a DP on operational performance. A moderation analysis showed that digital culture dampened the negative relationship between a DP and operational performance. Surprisingly, digital culture did not moderate the relationship between DPs and SCC. As a result, firms are more likely to benefit from a DP if they have adequate capabilities and an organizational culture that supports digitalization.



Note(s): $*p \leq 0.05$, $**p \leq 0.01$, $***p \leq 0.001$

Figure 2. The results of the SEM are presented in Table 3

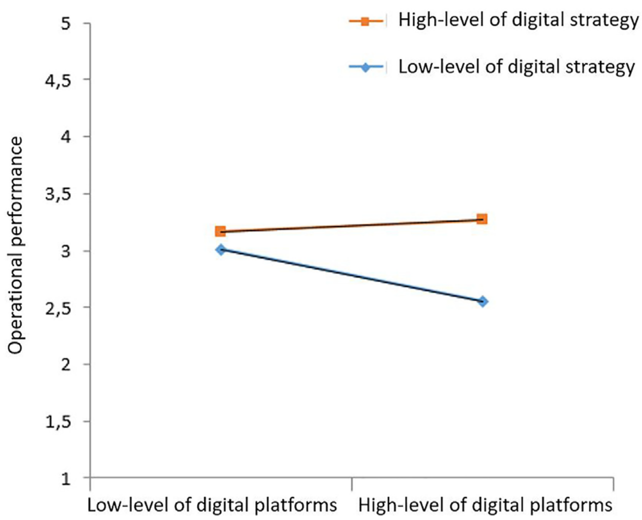


Figure 3. Moderating effect of digital culture

Table 3.
The results of the SEM

Control variables	
Company age	−0.046
Metal industry	−0.115*
Company size: turnover	−0.105
Direct effects	
Digital platforms → SCC	0.267***
Digital platforms → OP	−0.148**
SCC → OP	0.397***
Mediation effect	
Digital platforms → SCC → OP	0.098***
Moderation effects	
Digital culture * Digital platforms → SCC	0.088
Digital culture * Digital platforms → OP	0.222***
R^2	0.43**
x^2	1.69
x^2/df	25.30
Df	15
CFI	0.94
TLI	0.89
NFI	0.87
IFI	0.94
RMSEA	0.06

Note(s): *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

5. Conclusion and limitations

5.1 Discussion and theoretical implications

As digitalization continues to increase in importance for firms and their supply chains, there is a significant opportunity for organizations to improve the use of DPs and harvest the benefits of technological development. Nevertheless, understanding of the effects of DPs on performance is limited (Cenamor *et al.*, 2019), and more information would be required to explain the different performance outcomes. The purpose of this study was to examine the effect of DPs on SCC and operational performance; an additional purpose was to examine the role of SCC as a transformative mechanism through which the use of DBs creates value. This study shows that together these two concepts support firm performance.

This study confirms that DPs are basic digital resources that do not independently influence firm performance positively. A combination of DPs and SCC can, however, confer performance benefits. Further, SCC exerts a positive and significant mediation effect between DPs and operational performance. These results support the findings of Cámara *et al.* (2015), Chen *et al.* (2014), Hallikas *et al.* (2021), Mikalef *et al.* (2020) and Yu *et al.* (2018). More specifically, they offer new information about the performance effects of DPs. The results indicate that firms would benefit from having processes and capabilities designed to extract value from a DP. That suggestion supports the notion that DPs should be considered basic resources that positively influence firm performance when embedded in a firm's processes.

This study also examined the role of a digital culture that is open to and supportive of digital technologies. This study contributes by showing that digital culture moderates the relationship between a DP and operational performance. A firm lacking a supportive digital culture may be at risk in the digital era. The findings of this study extend the research of Wiengarten *et al.* (2013) and Yu *et al.* (2021) in showing that digital culture as an organizational factor plays a meaningful role in the context of a firm's digitalization and DPs.

The research of Nadkarni and Prügl (2020) showed that organizational culture is an underdeveloped topic in digitalization research. This study showed how digital culture is related to a firm's digitalization efforts and specifically to the use of DPs. This study also offers possible explanations for a recently witnessed differential performance effect of digitalization (e.g. AlMulhim, 2021; Eller *et al.*, 2020; Lee *et al.*, 2022). This study addresses the need highlighted in the research of Verhoef *et al.* (2021) to improve the understanding of digital resources and especially their role in the successful digital journey of companies. This study fills the gap by showing the effect of DPs and, more importantly, empirically demonstrates the importance of a supportive digital culture in the context of performance gains. It also shows why a digital culture is valuable to a firm's operations and performance.

To conclude, this study contributes by offering a coherent view of the effect of DPs and SCC on operational performance by including the digital culture as a contextual factor. It offers new information to inform the digitalization conversation by testing the effect of digital culture and showing that digitalization as a phenomenon is intertwined with the firm's capabilities and cultural attributes. Therefore, academics could widen their analysis related to digitalization to cover organizational aspects to increase the understanding of this complicated phenomenon.

5.2 Managerial implications

From the managerial point of view, the most important takeaway is that the cultural aspects of an organization may offer firms a productive path toward performance success when they support the use of DPs. By building a digital culture that supports different digital resources, firms are more likely to benefit from the investments associated with digitalization. While strategizing digitalization, managers could include the cultural aspects of their strategic planning to improve firms' acceptance and support for digital-related solutions. Furthermore, this study shows the importance of SCC to firm performance. That capability was highly relevant to the participating firms' operational performance in every situation measured, thus showing the importance of organizational-level capabilities using DPs to deliver performance outcomes.

5.3 Limitations and future research

There are some limitations to this research. The data informing this study were gathered from manufacturing firms, limiting its generalizability to firms outside the manufacturing field. Further, this study is limited by its Finnish context, which could complicate generalization across different countries. The data were also collected from a single managerial respondent in each firm, which may weaken the reliability of the findings.

This study focuses on digital platforms and their effect on supply chain capabilities and operational performance and the moderating role of digital culture. It seems important for future research to examine the role of digital culture more closely in the context of other digital resources and capabilities. Further, future studies might examine why the level of digital culture is higher in some firms than in others and what explains and supports the emergence of digital culture. Future research could combine case studies and surveys to offer supplemental insights into these issues.

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(The Appendix follows overleaf)

Appendix

Scale and item	Loadings	CR	AVE	α	MSV
Digital Platforms		*0.78*	*0.54*	*0.77*	*0.19*
IoT platforms for controlling production, logistics, or products and managing data (e.g. Microsoft Azure IoT Hub, IBM Watson IoT, IoT Ticket)	0.64				
Integration platforms for enterprise application integration (e.g. Mulesoft, Jakamo, Liaison)	0.81				
Supply chain management platforms for integration of processes between companies and multiplexing interactions (e.g. Pool for Tool, SAP Ariba, Jakamo, or firm SCM portal)	0.74				
Digital Culture		*0.87*	*0.57*	*0.86*	*0.33*
Adapted from Blatz *et al.* (2018)					
There is a positive attitude to digital technologies	0.81				
Employees are ready to take advantage of new digital operations models	0.83				
Employees see opportunities in digitalization	0.88				
There is a positive attitude in a firm to remote working with digital technologies	0.53				
There is a positive attitude to the training on digitalization	0.71				
Supply Chain Capability (SCC)		*0.83*	*0.56*	*0.90*	*0.28*
Adapted from Wu *et al.* (2006) and Yu *et al.* (2018)					
Information Exchange (IE)		0.92	0.75	0.93	
Our company exchanges more information with its partners than our competitors do with their partners	0.85				
Information flows more freely between our company and its partners than between our competitors and their partners	0.88				
Our company benefits more from information exchange with its partners than our competitors do from exchanges with their partners	0.90				
Our information exchange with our partners is superior to the information exchange of our competitors and their partners	0.83				
Activity Integration (AI)		0.89	0.74	0.89	
Our company develops strategic plans in collaboration with its partners	0.74				
Our company collaborates on forecasting and planning with its partners	0.93				
Our company projects and plans future demand collaboratively with its partners	0.90				
Responsiveness		0.85	0.60	0.85	
Compared to our competitors, our supply chain responds more quickly and effectively to changing customer and supplier needs	0.78				
Compared to our competitors, our supply chain develops and markets new products more quickly and effectively	0.70				
In most markets, our supply chain competes effectively	0.88				
The relationship with our partners has increased our supply chain responsiveness to market changes through collaboration	0.71				
Coordination		0.66	0.42	0.69	
Our company conducts transaction follow-up activities more efficiently with our partners than do our competitors with their own partners	0.66				
Our company spends less time coordinating transactions with our partners than our competitors with their own partners	0.60				

(*continued*)

Scale and item	Loadings	CR	AVE	α	MSV
Our company has reduced partnering costs more than our competitors	0.66				
Our company can perform the business at less cost than our competitors	*Deleted*				
Operational Performance		*0.72*	*0.41*	*0.86*	*0.33*
Adapted from Ward and Duray (2000); Wong *et al.* (2011)					
Delivery performance		0.86	0.61	0.85	
Our delivery times are shorter than industry average	0.59				
Our delivery punctuality is good or better than the industry average	0.96				
The reliability of our delivery is good or better than industry average	0.96				
We have been able to reduce the time it takes to process the order more than the industry average	0.54				
Cost performance		0.84	0.56	0.84	
Our production costs are below industry average	0.81				
The cost of storing our products is lower than industry average	0.60				
Overheads of our products are lower than industry average	0.78				
Price competitiveness of our products is better than industry average	0.80				
Quality performance		0.87	0.77	0.87	
The quality of our products has been steady and quality deviations are less common than the industry average	0.89				
Our products are reliable and match our customers' standards better than the industry average	0.87				
Production flexibility		0.87	0.78	0.87	
Our ability to change production volume is better than industry average	*Deleted*				
Our ability to customize products is better than industry average	0.79				
Our ability to make rapid changes in product offering is better than industry average	0.96				

About the author

Tuire Hautala-Kankaanpää is a grant-funded researcher in Management at the University of Vaasa and an independent researcher funded by the Foundation of Economic Education. She is a member of the Strategic Business Development research group. Her research interest includes the impacts of digitalization at the firm and supply chain levels. Tuire Hautala-Kankaanpää can be contacted at: thautala@uwasa.fi

SMEs' digital integration and operational performance - The moderating effect of digital strategy

Tuire Hautala-Kankaanpää, Jukka Vesalainen and Anni Rajala

Abstract

Purpose: Small and medium-sized enterprises (SME) are increasingly engaging digital technologies and digital integration through digital platforms. The majority of digital transformation processes fail owing to a lack of planned actions. The purpose of this study is to examine the role of digital strategy in the relationship between digital integration and the operational performance of SMEs.

Design/methodology/approach: The empirical part of the paper is based on data collected from 194 SMEs operating in the manufacturing sector.

Findings: The paper builds on the contingency perspective of resource-based theory and views digital platforms as resources that alone do not improve operational performance but that can do so when allied with a digital strategy. The paper contributes to prior research by demonstrating that a digital strategy is crucial if an enterprise is to extract operational performance advantages from digital integration. In addition, the paper demonstrates that digital strategy is an internal contingency factor that enables the successful exploitation of concurrent digital technologies.

Originality: This study is one of the first attempts to examine the moderating effect of digital strategy in the context of SMEs digital integration.

Keywords: Digital strategy, Digitalization, Digital integration, Digital platform, Operational performance, SME

1. Introduction

At times, Porter (1996) argued that firm's operational effectiveness relates to activities or functions performed in a superior manner, and that strategy is a connecting element of those activities. In today's digitalized business environment, a digital strategy fulfills the same purpose and ties the use of digital technologies to the activities, functions, and business goals of a firm (Bharadwaj et al., 2013; Proksch et al., 2021; Sebastian et al., 2017; Yeow et al., 2018). Hence, a digital strategy is regarded as a driver of digitalization in firms (Eller et al., 2020; Kane et al., 2015; Stefanova et al., 2019).

Digitalization challenges firms' strategic thinking (Li, 2020; Teubner & Stockhinger, 2020) because it alters their business environment and triggers rapid changes that require prompt decision-making (Ho et al., 2022). Further, prior research reports that many firms fail to achieve digital transformation when they attempt it (Correani et al., 2020). This is especially the challenge with SMEs (Taiminen & Karjaluoto, 2015). Too often, firms jump into digital transformation by adopting new technologies without a coherent plan (AlNuaimi et al., 2022), which can prevent them leveraging the full potential of those technologies (Stefanova et al., 2019). A recent case study by Amaral and Peças (2021) showed several obstacles facing industrial SMEs trying to digitalize their operational activity. One generally recognized challenge relates to the lack of an innovative strategy, resulting in a lack of overall clarity on the possible benefits of digital investments.

Small and medium-sized enterprises operate in highly dynamic environments (Cenamor et al., 2019) and face demands related to price, quality, delivery, and flexibility (Hilmola et al., 2015). Digital technologies can offer solutions and foster improvements in those areas (Hilmola et al., 2015). New platform-based technologies offered by platform-as-a-service (PaaS) business logic are easy-to-deploy and cost-effective to instigate inter-organizational connectivity. These technologies thus provide new development opportunities, especially for smaller organizations (Bolloju & Murugesan, 2012; Ebert et al., 2017). Nevertheless, integrating digital technologies into firms' operations and exploiting them can be challenging (Hess et al., 2016), which is why the full benefits of digitalization might remain unattainable. Accordingly, firms should develop strategies to create and capture value from digitalization (Björkdahl, 2020). The need for planned action and a strategy for digitalization is critical for SMEs because of constraints on managerial resources. In larger firms, defining the organization's digital strategy is likely to be the task of a chief digital officer or similar (AlNuaimi et al. 2022), a position that is rare in SMEs.

Prior research suggests that the value of digital technology can be influenced by organizational factors (e.g., Brush & Artz, 1999; Cao et al., 2011; Wiengarten et al., 2013, 2019; Brandon-Jones et al., 2014; Gupta et al., 2018) or the environment (Dong et al., 2009; Brandon-Jones et al., 2014; Chen et al., 2015; Syed et al., 2020), indicating the contingent nature of digitalization (e.g., Wade and Hulland, 2004). Prior information technology (IT) and IT alignment research shows that the strategic alignment of IT and business strategy moderates the relationship between IT investment and business performance (Byrd et al., 2006) and the relationship between IT impact and firm performance (Cragg et al., 2002). The topic of IT falls under the category of digital technologies (Bharadwaj et al., 2013), consequently we will use *digital technologies* to cover both terms in this paper. Recent research emphasizes the role of digital strategy as a mediator (Eller et al., 2020), or as an antecedent (Ko et al., 2022; Proksch et al., 2021) of different digitalization-related factors. Unlike others, AlNuaimi et al. (2022) examined the moderating role of digital strategy in the digital transformation of public organizations and found that digital strategy may also act as a situational factor. Nevertheless, research examining the contingent role of digital strategy in SMEs' digitalization and its effects on performance improvements is scarce.

The value of digital strategy is generally recognized. Nonetheless, existing SME-focused research offers only some empirical evidence on the effect of digital strategy on digitalization-based value creation. One of the few is the case study by Becker and Schmid (2020), which showed that the aim of SMEs' digital strategy is to optimize the use of digital technology in organizational processes. Eller et al. (2020) showed that pursuing a digital strategy boosted digitalization in SMEs; whereas the study identified no impact on financial performance. Proksch et al. (2021) examined the effect of digital strategy on the digitalization of new ventures and showed that digital strategy alone is insufficient to explain the digitalization level of SMEs. Therefore, there is a clear need for further research examining the role and importance of digitalization-related strategy-making in the adoption of new digital technologies, like digital platforms, in the SME context (Cenamor et al., 2019; Eller et al., 2020)

Consequently, this study examines the role of digital strategy as an internal contingency factor that strengthens the advantages achieved using digital platforms for digital integration in the industrial SME context. The research question is:

- Does an effective digital strategy enhance the effects of digital platforms on a firm's operational performance?

This study relies on structural equation modeling (SEM) and data gathered from 194 Finnish SMEs. The research offers a fresh perspective on SMEs' digitalization and its effect on operational performance. More precisely, the study contributes to existing SME-related knowledge by providing empirical evidence indicating the enabling role of digital strategy in adopting the use of new digital technologies. The contribution of the study also relates to the opportunities of new digital platforms, which are considered suitable means for SME digitalization.

The paper begins with a brief overview of contingent effect digitalization-based value and the literature on operational performance, digital platforms, and digital strategy. The next section focuses on the research methodology, data collection, measurement validation, and results. The last section relays the findings, conclusions, contributions, and the limitations of the research.

2. Theoretical background

2.1. Contingent effect of digitalization-based value

The contingency perspective of the resource-based view (RBV) and prior IT-based value research provides a holistic method to examine digitalization-based value (Cao et al., 2011). The framework suggests that instead of resources per se, certain internal or external conditions may explain the advantages gained from digital investments (Brandon-Jones et al., 2014; Brush & Artz, 1999). Accordingly, the value of digital technology is context dependent. One of the organization's internal contingency factors is the appearance of a strategy that aligns organizational processes and digital technologies in value-creation processes (Cao et al., 2011; Schweikl & Obermaier, 2022; Wade & Hulland, 2004 Wiengarten et al., 2013). Hence, the alignment between a firm's technologies and business strategies gives rise to a positive value derived from digitalization (Masli et al., 2011). Alignment refers to the extent to which digital technology supports existing or new organizational resources and processes (Schweikl & Obermaier, 2022). More specifically, this framework proposes that digitalization-based value relates to the level of fit or misfit between digital technology and organizational factors. (Cao et al., 2011).

2.2. Digitalization, supply chain integration, and firm performance

Digitalization supports the integration of supply chains, which improves a firm's efficiency, shortens lead times, and underpins operations control (Björkdahl, 2020). Consequently, the effect of digitalization is based on efficient operations and processes related to manufacturing (Björkdahl, 2020). Information technology plays a central role in supply chain integration (Vanpoucke et al., 2017). Digitally integrated supply chains enable real-time information flows and transparency (Childerhouse et al., 2003; Granados and Gupta, 2013), resulting in cost savings and potentially rapid problem-solving (Vanpoucke et al., 2017; Yunus & Tadisina, 2016). With the help of integrated forecasting and planning activities, firms can increase information sharing. Digital platforms offered by third-party actors are necessarily integrative tools and are based operationally on connecting intra- and inter-organizational processes, thereby reinforcing information integration, computing, and connectivity (Sedera et al., 2016; Li et al., 2020). This study particularly considers three different types of digital platforms firms use to manage their internal and inter-organizational integration within supply chains: internet of things (IoT) platforms, integration platforms, and supply chain management platforms.

Despite several potential positive outcomes of using digital technology, prior research suggests there could be complementary factors that produce positive performance outcomes when allied with digital technology. Hence, technology as such may not create performance benefits but the planned use of new digital technology alongside existing organizational resources and processes enables improved performance (Wade & Hulland, 2004; Cao et al., 2011; Wiengarten et al, 2013, 2019; Brandon-Jones et al, 2014). This argument is based on the RBV-based view, where digital technologies are seen as digital resources that are generally available for purchase, which is why these technologies rarely directly explain performance differences among firms (Hallikas et al., 2021; Karim et al., 2022; Soto-Acosta et al., 2018).

Recent studies have produced mixed results on the effects of digitalization on firm performance. For example, Li et al. (2022) found a positive relationship between digitalization and firm performance, whereas AlMulhim et al. (2021) did not find a significant direct impact. In addition, the meta-analysis by Liang et al. (2010) showed that the direct effects of IT on performance are positive for efficiency performance but found no direct effects on financial performance. Further, the recent meta-analysis by Karim et al. (2022) showed that digital technologies positively affect firm performance. Nevertheless, the value of digital technology also varies depending on how the technology-related variable is measured.

Recent research involving SMEs shows IT investments indirectly, rather than directly, affect a firm's performance (Bi et al., 2017; Eller et al., 2020; Rehman et al., 2020). Nevertheless, research has shown that for SMEs, digitalization positively affects organizational performance, directly and indirectly, including overall company performance, efficiency, productivity, employee performance, and customer performance (Yunis et al., 2018).

Overall, empirical research offers mixed results on the direct effect of digital technology adoption on organizational performance. Based on the contingent RBV theorizing on the benefits of digitalization (Brush & Artz, 1999; Cao et al., 2011; Wiengarten et al., 2013, 2019; Brandon-Jones et al., 2014; Gupta et al., 2018) and research findings indicating that the effect of digital integration may vary depending on the performance dimension measured (Ganbold et al., 2020; Dubey et al., 2019; Wong et al., 2011), we hypothesize:

> **H1.** Digital platforms do not directly affect a) delivery performance, b) cost performance, c) quality performance or d) operational flexibility

2.3. The moderating effect of digital strategy

Digital strategy refers to the cross-functional fusion of IT strategy and business strategy that aims to leverage digital resources to generate value (Bharadwaj et al., 2013; Proksch et al., 2021; Sebastian et al., 2017). A digital strategy is a business-oriented firm-level strategy that focuses on digital challenges and opportunities (Ko et al., 2022), and most importantly, seeks to improve the value of investment in digital technologies (Ross et al., 2017). This study views an SME's digital strategy as incorporating the important elements of strategic planning, analyzing, decision-making, and implementing digital initiatives, (e.g., Stefanova et al., 2019). As such, the term refers to a proactive digital strategy that includes scanning external conditions, changes, and opportunities and formulating and implementing planned actions. Hence, the digital strategy emphasizes integrating digitally supported activities and existing organizational processes.

Digital strategy has been identified as one of the key factors driving digitalization in firms (Eller et al., 2020; Kane et al., 2015). Empirical research has also shown that digital strategy supports a firm's IT capabilities, its employees' digital capabilities, and its culture (Proksch et al., 2021). It also indirectly affects digital processes (Proksch et al., 2021). Ko et al. (2022) showed that the firm's strategic goals support digital innovation. Moreover, a recent review by Hanelt et al. (2020) emphasized that digital strategy serves as a mechanism that links contextual conditions such as organizational characteristics with outcomes such as changes in organizational setups and economics. Similarly, the systematic literature review of Meier (2021) showed that the optimal course of a firm's digital journey is dependent on internal and external factors affecting a business. As such, a digital strategy provides guidelines to help navigate a digitalization journey.

Not all firms have a digital strategy, although many trying to undertake a successful digital journey would benefit from having one (Becker & Schmid, 2020). Nevertheless, digitalization and the increasing use of digital technologies may not always be the independent choice of an SME, and the investment required may be beyond the means of a single firm (Kohli & Grover, 2008). In that case, the business environment and the supply chain ecosystem rather than the organizations themselves impose strategies on firms (e.g., Mintzberg & Waters, 1985). Further, it is noticeable that the lack of an appropriate digital strategy could prevent the implementation of plans to digitalize businesses and organizations (Amaral & Peças, 2021; Peter et al., 2020).

This study assumes that SMEs are more likely to benefit from digital platforms when they are used to further the firm's overall goals, and the firm has a well-developed digital strategy to support this linkage. As such, the strategy supports the coherence of organizational actions (Rumelt, 1993) and guides how to effectively allocate digital platform use supporting the SME's operations. Consequently, it is important for SMEs to be proactive and plan activities related to digitalization rather than only reacting when environmental pressures create new demands.

Empirical research has shown that digital integration is contingent on organizational strategy (Wiengarten et al., 2019) and supply base complexity (Gupta et al., 2018). Further, organizational factors affect the relationship between digital resources and performance (Cao et al., 2011; Wade & Hulland, 2004). Strategic planning also influences the strength of the effect between digital technology and performance (Cao *et al.*, 2011), which emphasizes the value of an organization's strategic decisions that ultimately explain performance (e.g., Gatignon & Xuereb, 1997; Kindermann *et al.*, 2021).

Therefore, it seems likely that SMEs that plan, analyze, make decisions, and implement digital initiatives will be more likely to reap greater benefits from digital platforms than those who do not. Therefore, this research proposes:

> **H2:** Digital strategy positively moderates the effect of digital platforms on a) delivery performance, b) cost performance, c) quality performance, and d) operational flexibility.

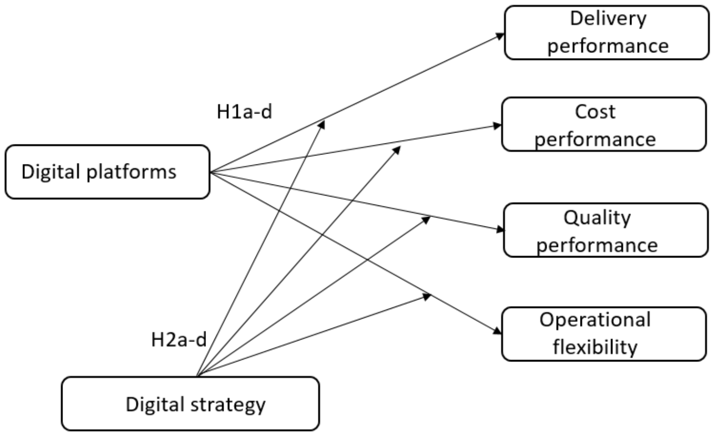

Figure 1. The research model

3. Research methodology

3.1. Data collection and sample

The data were collected between December 2019 and April 2020 using a survey instrument. The final sample consists of 194 SMEs. The firms were randomly selected from the international database *Orbis* having met the criteria of a general manufacturing industrial classification (category C) and a turnover of between EUR 1.5m and EUR 50m. Data collection began with email and phone calls to companies inviting them to participate in the study. Twenty-one firms responded to an email invitation, and 173 after a phone call. A total of 1136 companies were contacted, 414 by phone. Ultimately, 194 responses were received, equating to a response rate of 17 %.

Most of the respondents held managerial positions, such as CEO (83 %). Analyzing the data revealed one company had a turnover of EUR 0.9 m, which was below the limit of EUR 1.5m, but the firm's data were retained. The primary industries the firms operated in were metal and metal products, industrial electric and electronic machinery, chemicals, petroleum, rubber, and plastics. The demographics of the data are shown in Table I.

Table 1. Sample demographics

	n	%
Industry		
Metals & metal products	65	33.5
Industrial, electric & electronic machinery	42	21.6
Chemicals, petroleum, rubber & plastic	27	13.9
Food manufacturing	19	9.8
Wood, furniture & paper manufacturing	18	9.3
Other manufacturing	16	8.2
Leather, stone, clay & glass products	7	3.6
Number of employees		
<15	34	17.5
16-29	72	37.1
30-45	30	15.5
46-60	19	9.8
61-99	26	13.4
100-291	13	6.7
Turnover (million euros)		
< 2	12	6.2
2-4.9	68	35.1
5-9.9	51	26.3
10-14.9	27	13.9
15-19.9	17	8.8
20-50	19	9.8
	Mean	SD
Company Size (1 = over 10ME)	0.27	8835
Industry (metal)	0.32	0.47

Next, non-response bias was tested by comparing the turnover between respondents and non-respondents. The results of *t*-tests revealed no significant distribution of variance between the respondents and non-respondents, which indicates that the sample is considered representative.

3.2. Measures

The research was carried out using both novel and established measurement scales. All the items were measured on a 7-point Likert-type scale anchored with *completely agree* (7) and *completely disagree* (1). All the items and loadings are presented in Appendix 1.

The authors developed a survey instrument to measure digital strategy and digital platform use. In addition, the items were reviewed by an IT industry expert and by a representative of a manufacturing firm. Both measurement scales consist of four items. An explorative factor analysis was conducted with SPSS software to confirm the validity of the scales (Costello & Osborne, 2005). Two factors emerged, and the loadings of digital strategy variables (0.87 - 0.90) and digital platform variables (0.63 - 0.82) were acceptable without cross-loadings. In addition, the Kaiser-Mayer-Olkin (KMO) and Bartlett's tests were used to check the relevance of explorative factor analysis (Howard, 2016). The value of the KMO test is 0.770, which is greater than the threshold value of 0.5, and the value of Bartlett's Test of Sphericity is significant ($p = 0.000$). These results indicate the appropriateness of the factor analysis (Howard, 2016). The test continued by analyzing the multivariate normality. The values of skewness ranged from -0.375 to 1.317, and the values of Kurtosis ranged from -0.718 to 1.075, which can consequently be accepted (Brown, 2006; Byrne, 2016; Collier, 2020).

The *digital strategy* items are related to the firm's digital strategy process. Prior research has underlined the importance of a digital strategy in firms' digitalization efforts (Eller et al., 2020; Kane et al., 2015; Stefanova et al., 2019) and is therefore a central element in this study. Strategic planning, analyzing, decision-making, and implementing digital initiatives are considered essential dimensions in digital strategy (Stefanova et al., 2019). Consequently, these aspects are included in the digital strategy construct that was measured with four items. In addition, these aspects are well-known elements of general strategy-development processes in firms (see for e.g., Dutton & Duncan, 1987; Mintzberg, 1987; Håkansson & Snehota, 1989; Eisenhardt & Zbaracki, 1992). All the loadings were at a good level on the digital strategy scale (0.83 - 0.97), and were significant. The reliability of the measurement scale proved satisfactory ($CR = 0.78$; $AVE = 0.54$; $\alpha = 0.93$).

The 4-item *digital platform* scale is associated with the use of different forms of integration platform. Digital platforms enhance digitalized interaction between suppliers and customers (Gartner, 2018; Kousiouris et al., 2019). Such platforms are easily adopted and cost-effective solutions that support connectivity between firms. All the items loaded with acceptable values (0.65 - 0.80) and reliability ($CR = 0.93$; $AVE = 0.78$; $\alpha = 0.77$).

Operational performance was measured on a four-dimension scale adapted from Ward and Durey (2000) and Wong *et al.* (2011). The dimensions are delivery performance (a four-item scale), cost performance (a four-item scale), quality performance (a two-item scale), and operational flexibility (a three-item scale). Delivery performance reflects the firm's ability to deliver as promised with short delivery times (Krause et al., 2007). Cost performance emphasizes reducing inventory and production costs (Ward & Duray, 2000). Quality performance includes process control and process management (Flynn et al., 1994; Ward & Duray, 2000). Flexible firms can address changes to customer needs, and operational flexibility relates to cost reductions associated with changing products (Ward & Duray, 2000). The measures for delivery performance (CR=0.86, AVE=0.61, α=0.84), cost performance (CR=0.85, AVE=0.60, α=0.84), quality performance (CR=0.87, AVE=0.75, α=087), and operational flexibility (CR=0.79, AVE=0.58, α=0.76) showed acceptable reliability and validity.

Two dummy-coded *control variables* were used: size and industry. The size variable was included because larger firms may have a broader resource base that would affect operational performance (Wu et al., 2006; Rueda-Manzanares et al., 2008; Chen et al., 2014). The size variable was coded with 1 (turnover over EUR 10m) and 0 (turnover below EUR 10m). The aim was to isolate differences in digitalization between smaller and larger firms (Mulle*r et al.*, 2021). In addition, there may be some industry-level differences between the firms (Capon et al., 1990; Melville et al*.*, 2004; Jayaram et al., 2010), and the strategic role of digital software varies by industry (Joshi et al., 2022). The industry was a dummy-coded variable; the metal industry was chosen as it represented the largest number of companies surveyed. Hence, the dummy variable was coded with 1 (the metal industry) and 0 (other industries).

Confirmatory factor analysis using Amos software was conducted to test the validity of the measurement model. The measurement model shows acceptable fit (x^2/df; 1.96; CFI = 0.94; TLI: 0.92; IFI: 0.94; RMSEA = 0.07).

Maximum shared variance (MSV) was calculated to test discriminant validity. The values remained below the constructs' AVE values, providing evidence of discriminant validity (Hair et al., 2014). This result is reported in Appendix 1. Further, the square root of AVE values was calculated to verify the existence of discriminant validity. The results show that the values of the constructs remained lower than the square root of the AVE values (Fornell & Larcker, 1981), which indicates that the construct explained its variables better than it explained other constructs (Malhotra, 2010). The results are shown in Table II diagonally in boldface. In addition, the heterotrait-monotrait ratio (HTMT) was analyzed, and the values varied between 0.00 and 0.60, which is considered an acceptable range (Henseler et al., 2015).

Table 2. The descriptive statistics and the correlations with the square root of AVE shown diagonally in boldface.

Constructs	Mean	SD	1	2	3	4	5	6
1. Digital platforms	2.19	1.45	**0.73**					
2. Digital strategy	4.45	1.55	0.21*	**0.88**				
3. Delivery performance	4.96	1.14	-0.04	0.20**	**0.79**			
4. Cost performance	4.02	1.12	0.06	0.23**	0.29***	**0.77**		
3. Quality performance	5.36	1.17	-0.05	0.28***	0.62***	0.33***	**0.88**	
4. Operational flexibility	5.12	1.09	-0.18*	0.24***	0.32***	0.27**	0.46***	**0.76**

* p≤0.05; ** p≤0.01; *** p≤0.001

Note: Square root of AVE is on the diagonal

3.3. Common method bias

The data in this study were collected from a single respondent representing each firm. As no marker variable was included prior to the survey, this study used two techniques to test for possible common method variance. The first was Harman's exploratory factor analysis technique (Podsakoff et al., 2003; Podsakoff & Organ, 1986). The results of an unrotated factor test showed that one factor accounted for 29 % of variance, well below the recommended level of 50 %. A single-factor model test was conducted with Amos software to confirm the findings on unrotated factors. The results produced a poor fit to data (x^2/df; 10,874; CFI = 0.336; TLI = 0.258; RMSEA = 0.226). The two different test results suggest that common method variance is unlikely to be an issue in this study.

4. Results

Hypotheses testing began with an examination of the overall research model and conducting SEM with Amos 26 software.

We first tested Hypothesis 1 regarding the effects of digital platforms on operational performance. The results show that digital platforms do not affect delivery performance (β = -0.041, p = 0.543), cost performance (β = 0.014, p = 0.842), or quality performance (β = -0.125, p = 0.069). The findings support Hypotheses H1a–c. However, digital platforms do have a negative and significant impact on operational flexibility (β = -0.174, $p \leq 0.05$), a finding that runs counter to Hypothesis 1d.

Next, Hypotheses 2a–d were tested. Digital strategy significantly and positively moderates the relation between the digital platforms and delivery performance (β = 0.243, $p \leq 0.001$), cost performance (β = 0.162, $p \leq 0.05$), quality performance (β = 0.204, $p \leq 0.01$), and operational flexibility (β = 0.157, $p \leq 0.05$), which confirms Hypotheses 2a–d. The results are presented in Table 3.

Regarding the control variables, firm size has a negative effect on cost performance (β = -0.136, $p \leq 0.05$), and industry influences quality performance (β = -0.135, $p \leq 0.05$), and operational flexibility (β = -0.165, $p \leq 0.05$). Other relations between the control variables remained non-significant. In addition, we controlled for the effect of digital strategy on performance indicators and the results showed a significant direct effect on delivery performance (β = 0.180, $p \leq 0.001$) and cost performance (β = 0.153, $p \leq 0.01$), quality performance (β = 0.186, $p \leq 0.001$), and operational flexibility (β = 0.174, $p \leq 0.001$).

Table 3. Results of SEM

Dependent variable:	Delivery performance	Cost performance	Quality performance	Operational flexibility
Control variables				
Metal industry	-0.109	0.035	-0.135*	-0.165*
Company size	-0.087	-0.136*	0.069	-0.032
Main effects				
Digital platforms	-0.041	0.014	-0.152	-0.174*
Moderation effects				

Digital strategy * Digital platform	0.243***	0.162*	0.204**	0.157*
R^2	0.14**	0.13**	0.13**	0.10**

x^2/df; 1.57; CFI = 0.98; IFI = 0.98; TLI 0.90; RMSEA = 0.05
* $p \le 0.05$; ** $p \le 0.01$; *** $p \le 0.001$

Figures 2 show the moderating effect of digital strategy. The effect of digital platforms on operational performance varies according to the level of digital strategy implemented by the SME. When the digital strategy is effective and comprehensive, the level of digital strategy usage is high. In such cases using digital platforms improves delivery performance, cost performance, flexibility, and quality performance. When the level of digital strategy usage is low, i.e., the strategy is not proactively pursued, and the use of digital platforms is high, using digital platforms reduces an SME's delivery performance, cost performance, quality performance, and operational flexibility.

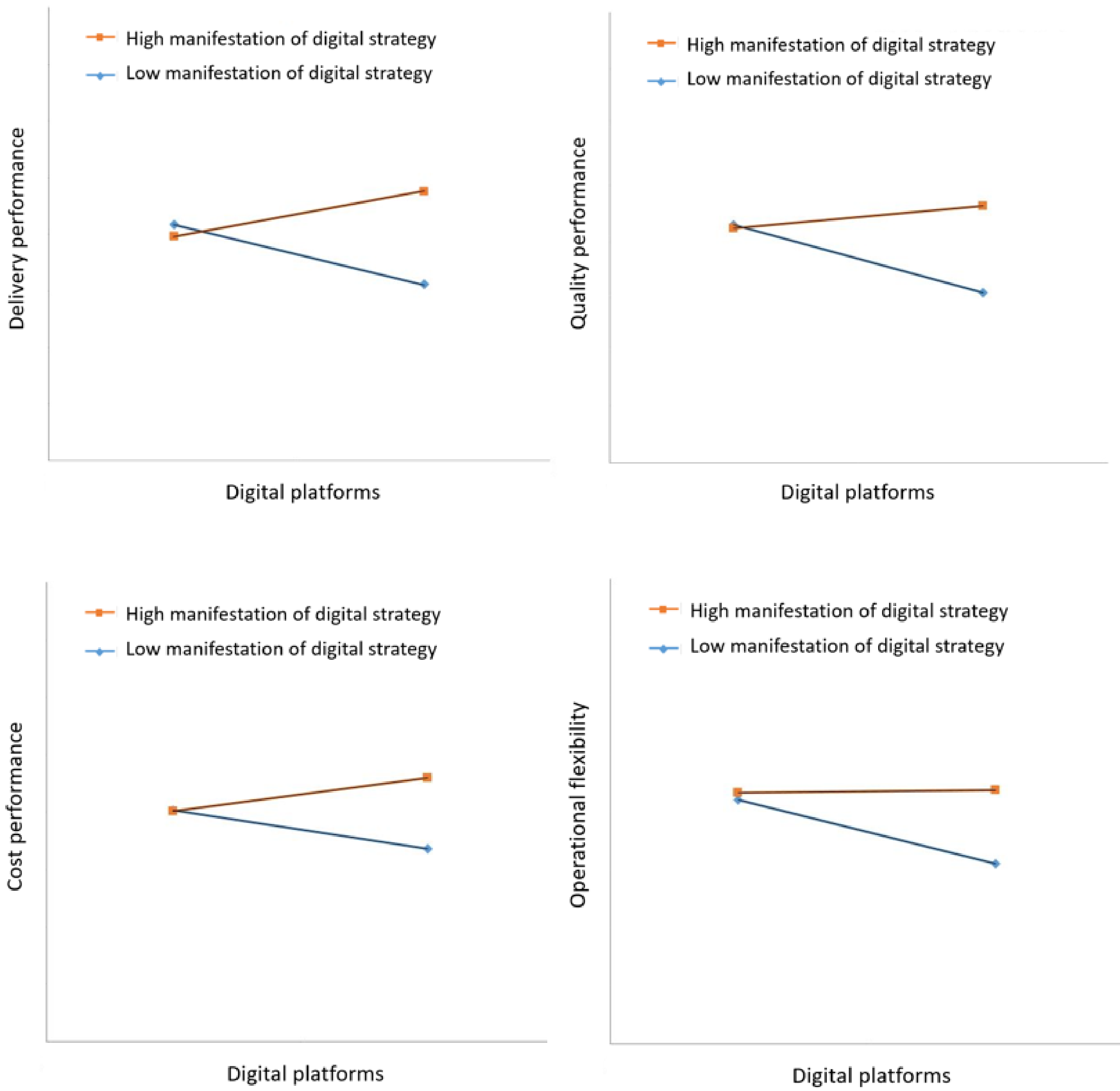

Figure 2. The moderating effect of digital strategy

5. Discussion and conclusion

This study aimed to examine whether a digital strategy strengthens the effect of digitalization on SMEs' operative performance. The need for such research was obvious because the prior knowledge on the potential roles of digital strategy in SMEs' digitalization-based value creation was limited (e.g., Eller et al., 2020; Ko et al., 2022; Proksch et al., 2021). However, existing digitalization-related research shows that a digital strategy can generally play an important role in guiding firms through digital transformation (Becker & Schmid, 2020; Eller et al., 2020; Hanelt et al., 2020; Kane et al., 2015; Ko et al., 2022; Meier, 2021; Peter et al., 2020; Proksch et al., 2021).

The findings reveal no direct effects of the use of digital platforms on delivery performance, cost performance, or quality performance, and the direct effect of digital platforms on flexibility was even negative. These results align with prior digitalization research that has demonstrated that the use of digital technology does not directly lead to performance or competitive advantages (Cenamor et al., 2019; Kim et al., 2023). The same phenomenon is well known in research concerning information technology investments, which generally reports the lack of direct effects between IT investments and performance improvements (Liang et al., 2010).

The results of the study demonstrate that digital strategy positively moderates the relationship between the use of digital platforms and operational performance in terms of delivery performance, cost performance, quality performance, and operational flexibility. The result indicates that a well-developed digital strategy enhances SMEs' opportunities to benefit from the use of digital platforms. In the case of underdeveloped digital strategies, the adoption of new digital tools may even be detrimental to a firm. Hence, SMEs are more likely to benefit from digital platforms if they explicitly plan, analyze, make strategic decisions, and implement digital initiatives. This study extends the current digitalization and digital strategy research by confirming the moderating effect of the digital strategy, thus demonstrating the importance of executing digital strategies in SMEs.

Prior research has argued that firms struggle to integrate digital technologies into their operations and then exploit them (Hess et al., 2016). According to our findings, the lack of an appropriate digital strategy may be one reason for the unsuccessful exploitation of opportunities related to these new technologies. The challenge may be pronounced in the SME sector owing to SMEs' having a limited ability to quickly and effectively change old technology to new (Khurana et al., 2022; Ritter & Pedersen, 2020).

This study offers empirical evidence of the effect of digital strategy as an internal contingency factor (e.g., Wade & Hulland, 2004; Kahli & Grover, 2008; Cao et al., 2011; Wiengarten et al., 2013), in the case of SMEs' digitalization-based value creation. As an internal contingency factor, the presence of a planned and effective digital strategy also reflects a firm's managerial competence. Having a digital strategy signals that management takes digital transformation seriously and has carefully planned a pathway toward becoming a digitalized company. However, considering the dependent position of SMEs within a supply chain, strategic awareness of both the opportunities and threats of digitalization is important. Previous studies have shown that SMEs seldom benefit from the development of digital technologies for integration, but the leading firms in the supply chain can benefit the most (e.g., in the context of EDI (Electronic data interchange) adoption). An SME that has embarked on a digitalization journey must incorporate its digitalization efforts into its business strategy (thus demonstrating its strategic will) to ensure the process remains on track.

5.1. Managerial implications

The importance of strategy-making is self-evident for managers. However, the role of new digital technologies is not always considered as comprehensively as it should be. It is important a firm includes plans for digital transformation in its business strategy in such a way that the strategy signals how new digitally enabled activities can be integrated into the existing organizational processes. Sometimes existing processes will need to be changed to derive the full benefits of digital technology. Hence, the current managerial challenge is to align business and digital strategies into a cohesive whole.

This study focused on the use of digital platforms as tools to integrate inter-organizational activity in the supply chain. These platforms, typically offered as PaaS products, are said to be SME-friendly in terms of low costs and ease of adoption. We were particularly interested in the effect of having a digital strategy on the relationship between the use of such platforms and improvements in firms' operational performance.

The results of this study support the assumption that by strategizing digitalization, SMEs are more likely to reap the value from digital platforms. Digital platforms can clearly play a strategic role for SMEs, and digital technologies should feature in their strategic decision-making. Most of the attention in the prior research has been on the value of digitalization in larger firms and in different settings. In contrast, this research reinforces the importance of digitalization in SMEs and highlights the importance of strategic planning.

The ecosystemic dependency of firms constrains their strategic freedom to independently determine their investment in digitalization. The situation applies especially to the digital integration of supply chains. Firms need to ensure that their technology choices are in line with those of their most important partners. That does not, however, mean that an SME should merely react to overall system developments. Enterprises would be better served by proactively comparing their own organizational processes against technological developments and formulating their own digital strategy to align with digitalizing business ecosystems and supply chains.

5.2. Limitations and future research

There are some limitations to this study. First, while the dataset included a broad range of SMEs representing various manufacturing industries, they were all based in Finland. That fact might limit the generalizability of the findings beyond the geographical region. Further, this study focused on digital platforms utilized by firms to increase their digital integration with suppliers and customers, and no other digital technologies were included. However, these results might spur researchers to examine the effect of SME digitalization in other settings.

Future research might include empirical studies featuring several types of digital technology and performance indicators, such as financial performance, relational performance, and innovation performance. Such studies might scrutinize operational performance dimensions in light of SMEs' digitalization. Moreover, it is important to continue to test the effect of contextual factors that may relate to digitalization, as digital technologies are integral to SMEs in the digital era, and their use cannot be divorced from their context.

Appendix 1.

Scale and item	Loadings	CR	AVE	α	MSV
Digital Platforms for digital l integration		0.78	0.54	0.77	0.05
IoT platforms for controlling production, logistics, or products and managing data (e.g., Microsoft Azure IoT Hub, IBM Watson IoT, IoT Ticket)	0.65				
Integration platforms for enterprise application integration (e.g., MuleSoft, Jakamo, Liaison)	0.80				
Supply chain management platforms for integration of processes between companies and multiplexing interactions (e.g., Pool for Tool, SAP Ariba, Jakamo, or a firm SCM portal)	0.75				
Digital Strategy		0.93	0.78	0.93	0.10
In connection with our strategic planning, we have surveyed a range of options for digitalization.	0.88				
Our strategy process analyzes the suitability of various digitalization options for our operations.	0.97				
We have taken strategic decisions to increase digitalization in our operations.	0.85				
We are currently implementing digitalization development projects in line with our strategy.	0.83				
Delivery performance		0.86	0.61	0.84	0.39
(Ward & Duray, 2000; Wong *et al.*, 2011)					
Our delivery times are shorter than the industry average	0.62				
Our delivery punctuality is good or better than the industry average	0.94				
The reliability of our delivery is good or better than the industry average	0.98				
We have been able to reduce the time it takes to process the order by more than the industry average	0.53				

Cost performance		0.85	0.60	0.84	0.12
(Ward & Duray, 2000; Wong *et al.*, 2011)					
Our production costs are below the industry average	0.78				
The cost of storing our products is lower than the industry average	0.70				
Overheads of our products are lower than the industry average	0.76				
The price competitiveness of our products is better than the industry average	0.83				
Quality performance		0.87	0.78	0.87	0.39
(Ward & Duray, 2000; Wong *et al.*, 2011)					
The quality of our products has been steady and quality deviations are less common than the industry average	0.92				
Our products are reliable and match our customers' standards better than the industry average	0.84				
Operational Flexibility		0.79	0.58	0.76	0.23
(Ward & Duray, 2000; Wong *et al.*, 2011)					
Our ability to change production volume is better than industry average	0.46				
Our ability to customize products is better than the industry average	0.83				
Our ability to make rapid changes to our product offering is better than the industry average	0.91				

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Complementary and contingent value of SMEs' data capability and supply chain capability in the competitive environment

Tuire Hautala-Kankaanpää
School of Management, University of Vaasa, Vaasa, Finland

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Abstract

Purpose – Scholars and practitioners increasingly recognize data as an important source of business opportunities, but research on the effect on small and medium-sized enterprises (SMEs) is limited. This paper empirically examines the complementary impact of SMEs' data capability and supply chain capability (SCC) and further tests the mediation effect of SCC between data capability and operational performance. The mediated effect of data capability is also moderated by competition.

Design/methodology/approach – This paper analyzes longitudinal data collected from 122 manufacturing SMEs in Finland. Hypotheses were tested by using structural equation modeling (SEM).

Findings – The results show that to benefit from the data capability, SMEs require a certain level of SCC to extract the value from the SMEs' data capability and support operational performance. Additionally, competition affects how SMEs benefit from data capability, as competitor turbulence moderates the complementary effect of data capability and SCC on operational performance.

Originality/value – This is one of the first studies examining the longitudinal effect of SMEs' data and SCC on operational performance in the current competitive environment.

Keywords Data capability, Supply chain capability, Operational performance, SME, Competition

Paper type Research paper

1. Introduction

Digitalization has fueled an era of information and data (Schniederjans *et al.*, 2020). New digital technologies facilitate data collection, processing (Lepistö *et al.*, 2022) and decision-making (Ivanov and Dolgui, 2021) by firms and along the supply chains (Schniederjans *et al.*, 2020). The ability to forecast market demand and respond to changing environmental conditions based on data also reduces the time required to fulfill orders and deliver products (Awan *et al.*, 2022). The current digitalized and competitive business environment makes data capability an essential aspect of complicated operations for all firms, including small and medium-sized enterprise (SMEs). However, changing market conditions and competition may affect the firms' spheres of operation (Wilden and Gudergan, 2015), forcing SMEs to adjust their operations to fit changing environments. The enforced changes affect firms' capabilities and the ability to create value (Wilden and Gudergan, 2015).

Digitalization enhances interconnectivity between firms (Plekhanov *et al.*, 2022), emphasizing the importance of strong supply chain capabilities. The value of a robust

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supply chain capability (SCC) stems from SMEs having limited resources (e.g. Drechsler *et al.*, 2022; Fischer *et al.*, 2020) to conduct their businesses. Hence, SMEs must understand their suppliers and customers and collaborate with them effectively. An ability to collaborate with other firms is crucial, as competition is increasingly between supply chains rather than individual firms (Kumar Jena and Singhal, 2023). Accordingly SCC is seen as a valuable capability from the operational performance perspective (Pero *et al.*, 2010; Yu *et al.*, 2020), which reflects a firm's ability to manage and optimize its supply chain (Bi *et al.*, 2013).

Data analytics impact supply chains (Ivanov and Dolgui, 2021) and how they are organized (Ivanov, 2023). Firms can utilize data for improving supply chain management through punctual activities and by applying the insights gleaned from the analysis of data that support decision-making, especially in changing environment. This study uses the concept of data capability, which encompasses SMEs' ability to collect and analyze data and offer data-based services to their customers (e.g. Blatz *et al.*, 2018). Data capability relate to firms' ability to manage and utilize data to cement an understanding of data-related opportunities to drive business outcomes. A firm's data capability and SCC boost its ability to react to environmental changes and lay the foundations for effective business with suppliers and customers. For that to happen, the data collected must serve a defined purpose (Blatz *et al.*, 2018) and provide opportunities, including operational efficiency and improved supply chain processes and performance (Hazen *et al.*, 2014; Schüritz *et al.*, 2019). Prior research shows that SMEs' data capability indirectly impacts their performance (Chatterjee *et al.*, 2022) and big data quality enhances innovation competency in SMEs (Verma *et al.*, 2020). However, the understanding of *when* and *how* data capability creates value remains limited (e.g. Chatterjee *et al.*, 2022; Li, 2022), particularly with regard to SMEs (Bhardwaj, 2022; Cappa *et al.*, 2021). This study is an attempt to redress that knowledge gap and extend the understanding of digitalization from the data capability perspective in the context of SMEs.

It is assumed that the positive impact of data capability on operational performance is channeled through its complementary relation with SCC; thus, SCC enhances the positive performance impact of data capability. Further, an SME's operating environment affects digitalization (Parviainen *et al.*, 2017) and the extent to which it can benefit from data-related capabilities (Bhardwaj, 2022). Prior research has established that contextual factors affect the evaluation of data capability's effects; hence such factors are increasingly included in research models examining data-based value (e.g. Chatterjee *et al.*, 2022; Lee, 2021; Mikalef *et al.*, 2019; Wamba *et al.*, 2020). An SME usually has limited opportunities to influence its environment, and it is usually wiser to match operations to fit the context in which it operates, an approach related to stronger performance (Gerdin and Greve, 2004). For that reason, SMEs' competitive environment is incorporated in the current research.

This study examines the complementary and contingent effect of SMEs' data capability and SCC on operational performance. It relies on the resource-based view (RBV) and the contingent approach to RBV. The contingency RBV suggests that the value of resources and capabilities depends on the contextual conditions in which these assets are used (Brandon-Jones *et al.*, 2014; Brush and Artz, 1999; Cao *et al.*, 2011; Gupta *et al.*, 2018; Wade and Hulland, 2004; Wiengarten *et al.*, 2013, 2019). This study focuses on competitor turbulence—an environmental factor beyond firms' control that can impact their operations and performance (Wiengarten *et al.*, 2013). In light of the preceding discussion, the following research questions are addressed: 1) Are data capability and SCC antecedents of improved operational performance among SMEs? 2) If so, how do those antecedents affect operational performance in a competitive context?

The aim of the current research is supported by longitudinal data from 122 Finnish SMEs over two measurement periods. Those data illuminate the effect of data usage in SMEs and why expertise related to supply chains effectively boosts the value of data capability.

This study offers several contributions as it examines the complementarity between SMEs' data capability and SCC and the mediating effect of SCC in a competitive environment.

The results show that advanced digitalization promotes the ability to manage supply chains and improve firms' performance, especially in a competitive business environment. In competitive environments, data capability and SCC generate information SMEs can use to guide their operations. Firms that understand their operational environment and can match their operations and the changing environment performs better in competitive situations.

The rest of the article is organized as follows. The theoretical framework and hypotheses are presented next. The following section addresses methodology, data collection, measures, and results, and the article ends with sections on its discussions, limitations, suggestions for future research and conclusions.

2. Theory development

2.1 Contingent and complementary effect of data capability

The RBV explains competitive advantage through resource and capability combinations (Barney, 1991). In such a setting, there is usually some degree of complementarity between resources and capabilities. Complementarity signals the interplay between factors, meaning that the presence of one factor enhances the value of others (Ennen and Richter, 2010). Researchers generally agree that there is a complementary relation between data capability and supply chain-related capabilities (Chatterjee *et al.*, 2022; Hallikas *et al.*, 2021; Jaouadi, 2022; Lee, 2021; Mikalef *et al.*, 2019; Wang *et al.*, 2012), meaning that data capability and SCC are interrelated. There are several different reasons for this. The interaction between suppliers and customers is an essential source of data and knowledge; hence links between suppliers and customers are regarded as network capabilities (Vesalainen and Hakala, 2014) supporting firms in acquiring valuable resources and benefiting from inter-organizational relations that generate knowledge (Barratt and Oke, 2007; Galunic and Rodan, 1998; Grant, 1996). Each node in these chains gathers and transmits information to different supply chain information systems (Kahi *et al.*, 2017). As such, SCC can be a source of data and a mechanism utilizing information derived from data capability. Hence, data is valuable only when providing firms with insights (Helfat *et al.*, 2023). Further, data and information acquired from collaborative work with customers can be acted on to enhance firm performance (Arias-Pérez *et al.*, 2022). However, if the level of data capability is low or the availability and quality of the data remains poor, the firm will not attain the insight from customers sufficient to support SCC, which will ultimately fail to support the firm's performance.

However, some views in current research are inconsistent concerning the connection between big data and performance (Li *et al.*, 2023). In addition, previous data capability-related research has tended to ignore SMEs and their environments, leaving gaps in the research stream. Firms today operate in increasingly turbulent environments, affecting their actions and how they conduct their business; it is therefore necessary to examine the contextual conditions under which the complementary effect of firm capabilities manifests (Lucianetti *et al.*, 2018). The RBV is argued to be rather static (Ling-yee, 2007), and the theoretical framework offers limited opportunities to address contextual and conditional factors that explain why the value of some resources or capabilities change (Adetoyinbo *et al.*, 2023; Jeble *et al.*, 2018). The contingency RBV combines the complementarity ideas from the RBV and the ideas on contextual conditions from another well-known theory—contingency theory—which states that there are environmental and organizational factors, which have an influence on firms (Shepard and Hougland, 1978) and that some strategies fit specific conditions or situations certain conditions (e.g. Lawrence and Lorsch, 1967; Hofer, 1975). From the perspective of supply chain management, the idea of fit relates to the match between uncertainty and operational responsiveness, stemming from the idea that in highly uncertain environments, firms should improve their ability to respond to changes, and in a low-uncertainty scenario, there is a reduced need for responsiveness (Hallavo, 2015).

The contingency RBV suggests that achieving competitive advantage may depend on firms' operating environments (Brandon-Jones *et al.*, 2014). This study utilizes the contingent RBV to offer a coherent explanation of the improvements that data capability and SCC can have on SME performance in a competitive environment (e.g. Brandon-Jones *et al.*, 2014; Brush and Artz, 1999; Cao *et al.*, 2011; Gupta *et al.*, 2018; Wiengarten *et al.*, 2013). More specifically, the contingent RBV is used to explain the changes in the complementary relation between data capability and SCC that a competitive environment might alter and their combined effect on operational performance in SMEs.

There is only limited research on how the external environment affects the complementarity relation between data capability and SCC. Lee (2021) showed that data analysis capability affects the ambidextrous management of supply chains, which positively impacts manufacturer performance. The effect of such management is stronger when competitive pressure is high. Wamba *et al.* (2020) confirmed that big data analytics complements supply chain agility and adaptability, which relates positively to cost and operational performance. Environmental dynamism moderates the direct relation of big data analytics to supply chain agility and adaptability and their direct relation to performance. The research of Srinivasan and Swink (2018) shows that the effect of complementary capabilities such as analytics capability and organizational flexibility is stronger in volatile markets than in stable ones. Similarly, Dubey *et al.* (2021) showed that the impact of SCC analytics powered by artificial intelligence is stronger in more dynamic environments. These findings reinforce the idea of capabilities having complementary and contingent value.

In summary, several factors determine the impact of data capability and SCC on the performance of SMEs. Those factors can be traced back to the availability of the data, level of integration, knowledge and the use of digital technologies to gather and use the data in a specific environment.

2.2 Research model and hypotheses

2.2.1 Data capability. An SME's ability to use data – its data capability – relates to its ability to collect the data on products, analyze those data and offer data-based services to its customers (Blatz *et al.* 2018). Data capability also reflects a firm's ability to utilize data to enhance understanding of data-related opportunities to progress its business. Data capability also reflects an SME's ability to process data in a way that creates new opportunities for the company in terms of services; it is thus a source of business value. However, that value is contingent on the level of digitalization in the firm's value chain (Zhu and Kraemer, 2005). Further, the benefits of data capability for an SME are wide-ranging, including helping it comprehend its own production processes and the needs of its customers and partners (Bianchini and Michalkova, 2019).

Data analytics improves the capacity to identify the patterns, relationships and interactions in the business environment, which supports the optimization of supply chains and facilitates market forecasting and accurate decision-making (Bianchini and Michalkova, 2019; Zhang *et al.*, 2020). Further, SMEs might use that high-quality information to communicate with their partners. Knowledge sharing and high-quality information spread the risks, costs and gains between supply chain members (Whitten *et al.*, 2012) as firms can benefit from detailed and timely information about their demand chains (Chen *et al.*, 2015; Holmström *et al.*, 2010). That information helps resolve issues arising in the business environment (Ghasemaghaei and Calic, 2019). In addition, using and analyzing data helps firms manage patterns related to customer preferences and supplier cost structures (Deflorin *et al.*, 2021), which can improve the ability to confront changing needs in the supply chain.

Prior research shows that data capabilities reinforce a firm's organizational capabilities (Hallikas *et al.*, 2021) and positively affect SCC because of the knowledge and information accrued from data (Ashrafi and Zareravasan, 2022; Singh and Singh, 2019; Wamba *et al.*, 2020; Yu *et al.*, 2018). Therefore, the first hypothesis is as follows:

H1. Data capability positively impacts SCC.

2.2.2 SCC as an antecedent of enhanced performance. Supply chain capability refers to a firm's ability to manage business activities related to both internal and interfirm activities (Bi *et al.*, 2013). This study views SCC as a combination of information exchange, activity integration, responsiveness and coordination: the most vital cross-functional activities in supply chain processes (Wu *et al.*, 2006). Information exchange builds on the premise that adequate knowledge sharing between firms indicates an ability to interact, share quality information and acquire knowledge (Wu *et al.*, 2006). Activity integration can be divided into technology and activity integration, marked by collaborative planning, forecasting, cooperation and evaluation (Wu *et al.*, 2006). *Responsiveness* relates to a firm's ability to adapt to environmental transformation (Wu *et al.*, 2006). It helps firms compete effectively as changes to supply and demand occur (W. Yu *et al.*, 2018). *Coordination* includes the internal and supply chain coordination related to the firm's ability to arrange transaction-related activities, materials and orders (Wu *et al.*, 2006).

Prior research argues that advanced supply chain management can enhance operational performance (Pero *et al.*, 2010), especially among manufacturing firms that link their internal processes to those of their suppliers and customers (Frohlich and Westbrook, 2001). Nevertheless, this kind of externally integrated process demands close and interactive collaboration between supply chain partners to produce an effective flow of information, goods and services (Flynn *et al.*, 2010), a capability integral to SCC. Therefore, SCC can be an enabling ability behind successful firms (Morash *et al.*, 1996; Morash, 2001). Prior research reinforces the importance of SCC, showing that supply chain-related capabilities directly impact operational performance (Y. Yu *et al.*, 2020), financial performance (Wu *et al.*, 2006; Yu *et al.*, 2018) and competitive performance (Chatterjee *et al.*, 2022; Liao *et al.*, 2017). Therefore, the expectation is summarized in the following hypothesis:

H2. SCC relates positively to operational performance

In addition to its direct value to a firm's operations, SCC can also increase the value of data capability (e.g. Wu *et al.*, 2006). Data capability helps to create knowledge about customers and SCC acts as a mechanism that integrates the data-based information with supply chain members and supports timely interactions between partners. Accordingly, SCC explains an organization's ability to exploit data (W. Yu *et al.*, 2018), so SCC functions as a mechanism to integrate data-based knowledge into firm operations. In addition, integrating data into supply chains is seen as a success factor (Plekhanov *et al.*, 2022), which explains several operational improvements, such as control over the materials and reduced inventories (Björkdahl, 2020). Therefore, SCC mediates between data capability and operational performance (Arias-Pérez *et al.*, 2022; Yu *et al.*, 2018). Hence, the next hypothesis is as follows:

H3. SCC acts as a mediator between data capability and SMEs' operational performance

2.2.3 Competitor turbulence. Competitor turbulence relates to the level and predictability of changes to a firm's business environment (Auh and Menguc, 2005). The term reflects the extent and the fierceness of competition between firms (Jaworski and Kohli, 1993; Wilden and Gudergan, 2015). In a competitive environment, firms must find new ways to produce value for their customers. Consequently, the environment affects not only how firms conduct their businesses but also the effect of different capabilities. The value of resources and capabilities may alter as the competitive situation changes (Peteraf, 1993).

Firms that analyze data can extend their knowledge of their business environment and markets and make better decisions (Chen *et al.*, 2012). Analyzing external data can help firms identify more objective perspectives that can reduce bias in their decision-making (Lee, 2021; Teece, 2007). Data capability increases the amount of relevant information based on data and therefore helps identify customers' needs in a turbulent environment, making it easier to address them. Further, the knowledge accumulated from the data and the data-driven services can enable SMEs to differentiate themselves from competitors and create value for the customers, spawning a competitive advantage (Azkan *et al.*, 2020, 2021). If resources are limited, an SME must carefully consider resource allocation. Prior research shows that data analytics capability supports firms in sensing the environment (Lee, 2021). Hence, the next hypothesis proposed is:

H4a. The direct effect of data capability on SCC is stronger when competition is intense

Moreover, firms need their suppliers and customers to adapt to changes in the competitive environment. Supply chain capability embraces the ability to leverage information sharing in coordinated and integrated business relationships to address environmental changes; thus, SCC improves an SME's ability to react to environmental changes with the help of its supply chain partners. Accordingly, the effect of inter-organizational capabilities can vary depending on the environment (Vesalainen and Hakala, 2014). In addition, data capability connects the members of supply chains more closely, which helps firms manage competition on a day-to-day basis. Data capability offers relevant information for supply chain management, and the effect of these capabilities will be stronger in the context of intense competition. Prior research shows that a firm's external environment affects its performance (Ipinnaiye *et al.*, 2017), and supply chain-related capabilities have a stronger effect when competitive pressure is intense (Lee, 2021). Hence, the next hypothesis is:

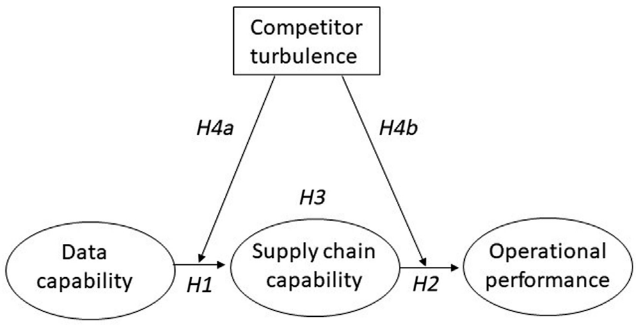
H4b. The direct effect between SCC on operational performance is stronger when the competition is intense

The research framework of this study is presented in Figure 1.

3. Research methodology

3.1 Sampling and data collection

The data were gathered from SMEs in two survey waves, the first between December 2019 and April 2020 and the second between March 2021 and June 2021. Firms in the first data set were selected from the international Orbis database by choosing SMEs that operate under a general manufacturing category (C) and whose turnover was between EUR 1.5 m and EUR 50 m. Respondents were contacted through email or telephone and invited to participate in the study. A total of 1,136 companies were contacted, 414 by phone, resulting in 194 affirmative responses.



Source(s): Author's own work

Figure 1.
Research framework

The second data set was collected from the same SMEs roughly one year after the first data collection. Most respondents were contacted by telephone and some by email. The process produced 122 answers, an acceptable number for analysis (e.g. Arias-Pérez *et al.*, 2022; Proksch *et al.*, 2021; Sideridis *et al.*, 2014; Tarifa Fernández, 2022; Wolf *et al.*, 2013). Data capability, SCC and competitor turbulence are estimated based on the first measurement point, whereas operational performance relies on the second.

The profiles of responding firms can be found in Table 1. Almost 80% of the respondents held positions such as chief executive officer (CEO) or owner. Other positions reported included chief financial officer, sales director, chair of the board of directors and others. The largest industry group was metals and metal products.

3.2 Non-response bias

Non-response bias was tested twice. The first instance compared the turnover between respondents and non-respondents (Carnahan *et al.*, 2010; Jiang *et al.*, 2020; Scheaf *et al.*, 2022) with the first tranche of data. *T*-test results indicated no significant distribution of variance between the groups, suggesting the sample was representative. The second instance compared those who answered the survey only once to those that did so twice. *T*-test results showed no significant distribution of variance between the groups, suggesting the sample is representative.

3.3 Measures

This study uses four different constructs identified in the literature, all of which use a 7-point Likert-type scale (see Appendix). Three academics were involved in developing the survey. A representative of an SME and an information technology (IT) industry expert also reviewed the survey instrument.

The four items measuring *data capability* were adapted from the questionnaire of Blatz *et al.* (2018), including questions about the firm's ability to collect and analyze the data and to produce services based on the data. The original construct measures the digitalization maturity of SMEs from the perspective of data maturity so as to focus on that specific group of companies and their use of data. Four items related to SMEs' ability to use data, that is, their data capability, were adapted for the questionnaire. The *SCC scale* was measured on a

	N	Percentage
Industry		
Metals & metal products	38	31.4%
Industrial, electric & electronic machinery	27	22.3%
Chemicals, petroleum, rubber & plastic	19	15.7%
Food manufacturing	14	11.6%
Wood, furniture & paper manufacturing	10	8.3%
Other manufacturing	13	10.4%
Number of employees		
<10	7	5.7%
10–49	81	66.9%
50–291	30	24.8%
	Mean	SD
Age	27	17
Turnover	9.4 EUR m	9.1 EUR m

Source(s): Author's own creation/work

Table 1. Profile of responding firms

four-dimension scale that included the dimensions of information exchange (a 4-item scale), responsiveness (a 4-item scale), activity integrations (a 3-item scale) and coordination (a 4-item scale) that was adapted from Wu *et al.* (2006). The 3-item *competitor turbulence* scale adapted from the scales of Jaworski and Kohli (1993) and Wilden and Gudergan (2015) was used to measure competition.

Operational performance measures the extent to which the firm achieves its operational objectives (Gu *et al.*, 2017). *The operational performance* scales were adapted from Ward and Duray (2000) and Wong *et al.* (2011). They included delivery performance (four items), quality performance (two items), operational flexibility (three items) and cost performance (four items). A previous study indicated that digitalization-based improvements can be traced back to operational effectiveness (J. S. Chen and Tsou, 2012). Operational performance is dependent on a manufacturing firm's assets (Schmenner and Swink, 1998); therefore, a primary data and operational performance construct is used as an outcome variable.

Firm size and industry were used as control variables. Firm size was measured based on turnover and was included as the size of a firm may limit its resource base and operational performance (Y. Chen *et al.*, 2014; Rueda-Manzanares *et al.*, 2008; Wu *et al.*, 2006). Size is used as a continuous variable. It is also recognized that industry may be a factor in differences between firms (Capon *et al.*, 1990; Melville *et al.*, 2004; Jayaram *et al.*, 2010; Joshi *et al.*, 2022); consequently, *industry* was included as a dummy-coded variable with 1 representing the metal industry and 0 other industries.

3.4 Reliability and validity

Amos version 26 aided confirmatory factor analysis. Cronbach's alpha (CA) and composite reliability (CR) tested the internal consistency of the constructs. Average value extracted (AVE) was used to ensure the convergent validity of the construct (Hair *et al.*, 2011). Additionally, convergent validity was assessed by confirming that the loadings of all indicators in their variables were statistically significant ($p < 0.05$).

Two items and one dimension were removed from the measurement model due to weak loadings. One of the removed items was from the data capability scale measuring the level of products equipped with information and communication technology for collecting data (loading 0.31). The other was from the SCC scale's coordination dimension measuring the firm's ability to conduct coordination activities (loading 0.10). The dimension removed was cost performance on the operational performance construct (loading 0.35). Consequently, operational performance was measured with a three-dimensional scale: delivery performance, quality performance and operational flexibility. Prior research uses various dimensions to measure operational performance, including a similar three-dimension scale (Dubey *et al.*, 2019; Eckstein *et al.*, 2015). No items were removed from the competitor turbulence scale, but one had a loading greater than one, so the unobservable variable's variance was constrained to 1, and all individual paths were constrained to be equal (Collier, 2020; Gaskin, 2021). After this procedure, the loadings and the measurement model fit were satisfactory (x^2/df = 1.53; Comparative fit index (CFI) = 0.90; Incremental fit index (IFI) = 0.90; Root means square of Approximation (RMSEA) = 0.07). In addition, the reliability of the construct was acceptable, as the AVE value was higher than 0.4, the CR value higher than 0.6 and CA exceeded 0.7, which indicates that the scale can be accepted (Fornell and Larcker, 1981; Mahlohtra, 2010) (See Table 2 for results). All these constructs are reflective.

The Fornell-Larcker criterion was used to test discriminant validity following an evaluation of the square roots of AVE values (Fornell and Larcker, 1981). The results show good values and the square root of the AVE was higher than the values of the constructs (Fornell and Larcker, 1981). The values are bolded diagonally in the correlation matrix

SMEs' data and supply chain capabilities

(see Table 3). In addition, the maximum share variance (MSV) was calculated for discriminant validity. The values remained below the constructs' AVE values (Hair *et al.*, 2019). Finally, the heterotrait-monotrait ratio (HTMT) was calculated and the values ranged between 0.10 and 0.45, so they were below the threshold value of 0.9 (Henseler *et al.*, 2015). Together these findings provide evidence of discriminant validity. The correlations, means and standard deviations of the constructs can be found in Table 3.

The current research included certain procedures to mitigate common method bias. Respondents were informed about the academic purpose of the study and assured of confidentiality. In addition, the survey content was pre-tested with a representative of a manufacturing firm and the IT industry (M. Chen *et al.*, 2021). Common method variance was tested using Harman's single-factor test and the single-factor model test. These tests are widely used and adapted, but using them does require diligence (see, e.g. Hulland *et al.*, 2018; Podsakoff *et al.*, 2003; Podsakoff and Organ, 1986). Harman's single-factor test indicated that the first factor explained 29% of the variance. Further, the single-factor model shows a poor fit to the data (x^2/df; 4.10; CFI = 0.40; IFI = 0.40; RMSEA = 0.16), mitigating concerns about common method bias.

4. Analysis and results

4.1 Hypotheses testing

The covariance-based SEM method was used to test the hypotheses. The direct effect of data capability on SCC is strong ($\beta = 0.309$) and significant ($p \leq 0.01$), therefore supporting H1. The effect of SCC ($\beta = 0.512, p \leq 0.001$) on operational performance is also strong and significant; hence H2 is supported. Further, the mediation effect was analyzed and a bootstrapping approach considered 5,000 bootstrapping resamples with 95% confidence intervals (Hayes, 2018) to test the significance of the mediating effect of SCC between data capability and operational performance. The results showed that the indirect effect of data capability on operational performance is significant and positive ($\beta = 0.158, p \leq 0.01$); hence SCC mediates the effect of data capability on operational performance, which supports H3. The mediation model explains 27% of SMEs' operational performance variance. Table 4 presents the results of the SEM.

Construct	CR	AVE	CA
1. Data capability	0.83	0.63	0.84
2. SCC	0.82	0.53	0.90
3. Competitive turbulence	0.81	0.59	0.73
4. Operational performance	0.73	0.48	0.88

Source(s): Author's own creation/work

Table 2. Reliability and validity of the constructs

Variable	Mean	SD	MSV	1	2	3	4
1. Data capability	3.37	1.71	0.10	*0.80*			
2. SCC	4.12	0.84	0.23	0.32**	*0.73*		
3. Competitive turbulence	4.66	1.17	0.01	−0.02	0.06	*0.76*	
4. Operational performance	5.14	0.81	0.23	0.24*	0.47**	0.12	*0.69*

Note(s): Significant at $*p \leq 0.05$; $***p \leq 0.01$
Figures in diagonal in italic are values of the square root of AVE
Source(s): Author's own creation/work

Table 3. Correlations, mean standard deviations, and discriminant validity

IMDS

Hypothesis	Full research model	Low competitive turbulence	Highly competitive turbulence
Direct effect			
H1. Data capability → SCC	0.31**	0.167	0.431*
H2. SCC → OP	0.52***	0.240	0.856**
Indirect effect			
H3. Data capability →>OP	0.16**	0.040	0.374*
Control variables			
Metal industry → OP	−0.08	−0.071	0.139
Company size → OP	−0.05	−0.002	0.034
Metal industry → SCC	−0.06	0.057	0.297
Company size → SCC	0.08	0.173	−0.158
R^2	0.28***	0.06*	0.67***
x^2/df	1.424	1.234	1.234
CFI	0.937	0.942	0.942
IFI	0.939	0.947	0.947
RMSEA	0.062	0.044	0.044

Table 4.
The results of SEM

Note(s): *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$
Source(s): Author's own creation/work

The control variables seemed to have no significant effect on operational performance or SCC. The direct relation between data capability and operational performance was tested and no direct relationship between the two constructs was identified. These results mitigate concerns about the other factors explaining the causal mechanism behind data capability's effect on SCC and operational performance (Collier, 2020; Hill *et al.*, 2021).

4.2 Moderation analysis

Multi-group analysis was used to examine the effect of competitor turbulence between the paths, and it was decided to divide the data into two diverse groups based on the median split (Collier, 2020). The groups encapsulate those firms facing a low level of competition ($n = 66$) and those facing a high level of competition ($n = 56$). The number of firms in the groups is uneven because a few firms shared the same median. Dividing the firms into two groups made it possible to analyze the measurement model invariance (Collier, 2020). The measurement model indicated an acceptable fit to the data (x^2/df = 1.43; CFI = 0.85; IFI = 0.85; RMSEA = 0.06). In particular, the RMSEA value was excellent, which offers support for invariant data across groups from a configurational perspective (Collier, 2020). Furthermore, the metric invariance was tested between the constrained and unconstrained measurement models. The results support the existence of measurement invariance because of the non-significant metric invariance test ($p = 0.148$) (Collier, 2020). Therefore, the analysis with two distinct groups continued with a structural model.

The structural model showed a good fit to the data (x^2/df = 1.23; CFI = 0.94; IFI = 0.95; RMSEA = 0.04). After confirming the fit of the research model, the paths were constrained to be equal in both groups to analyze the equality between them. The results show that the overall effects of the paths in a model differed significantly ($p \leq 0.001$), which indicates the moderating effect of competitor turbulence. In the environment marked by low-level competition, data capability does not affect SCC ($\beta = 0.167$, $p = 0.148$), whereas, under conditions of intense competition ($\beta = 0.431$, $p \leq 0.05$), data capability has a significant and positive effect on SCC. Further, SCC does not influence operational performance in an environment labeled by low competition ($\beta = 0.240$, $p = 0.130$), whereas it does in a highly competitive environment to a significant extent ($\beta = 0.856$, $p \leq 0.01$). The results also show that there was no indirect effect of data capability on operational performance in firms facing a low level of competition ($\beta = 0.040$, $p = 0.248$), whereas, in a highly competitive environment, SCC mediates the indirect effect of data capability ($\beta = 0.369$, $p \leq 0.05$) on operational performance. The results show that data capability and SCC together explain 68% of SMEs' operational performance variance when the competition is intense, whereas, under conditions of weaker competition, it explains only 6%. This result strongly affirms the crucial role of SCC when SMEs face intense competition.

5. Discussion and implications

This study centered on how data capability can contribute to developing SCC and operational performance in a competitive environment. No prior study examines the moderating effect of competitor turbulence on the relation between SMEs' data capability, SCC and operational performance. The findings of this study extend the current research, especially from the SME perspective.

In line with prior research on larger firms (Arias-Pérez *et al.*, 2022; Yu *et al.*, 2018), this study suggests that an SME's SCC significantly mediates the relationship between data capability and operational performance. The results are interpreted in relation to SMEs, as prior research notes that smaller firms' scarce resources hinder their benefiting from data (Cappa *et al.*, 2021; Surbakti *et al.*, 2020). The results show that SMEs need a certain level of SCC to benefit from their data capability.

Changes such as increasing competition in business spheres have altered firms' capability to create value (Wilden and Gudergan, 2015). An SME has limited opportunities to change its environment and must adapt to find new means to cope with competition. It is essential we understand the conditions that foster an SME's ability to establish a competitive advantage based on its data-related capabilities (Bhardwaj, 2022). The results of this study show that those SMEs that are able to manage their supply chains in a competitive environment have greater potential to operate effectively. Data capability as a source of information and the increased ability to react to changes does support SMEs' SCC and ability to manage in the face of competition.

5.1 Theoretical implications

Numerous academic studies have focused on data capability from varying perspectives. What is not yet fully understood is when and how data capability creates value for SMEs in the form of improved operational performance. Most research on data capability and digitalization has focused on larger firms (Bhardwaj, 2022; Chatterjee *et al.*, 2022; Eller *et al.*, 2020) and excluded the effect of competition, which is regarded as an external and determinant contingency factor. Accordingly, the current research applied principles from an emerging research framework, the contingent RBV (Brandon-Jones *et al.*, 2014; Brush and Artz, 1999; Cao *et al.*, 2011; Gupta *et al.*, 2018; Jeble *et al.*, 2018; Wiengarten *et al.*, 2013) to understand and evaluate both the complementary and contingent effects of data capability and SCC on SMEs' operational performance in a competitive environment.

The basic principles from RBV were used to evaluate the complementarity effect of data capability and SCC on operational performance. The first research question was: Are data capability and SCC antecedents of improved operational performance among SMEs? This study provides empirical evidence that data capability as such does not benefit SMEs' operational performance. However, it is in line with prior research in showing there is a complementary relationship between data capability and SCC, and together those variables lay the foundation for improved operational performance (Chatterjee *et al.*, 2022; Hallikas *et al.*, 2021; Jaouadi, 2022; Lee, 2021; Mikalef *et al.*, 2019; Wang *et al.*, 2012). The results of this study show that data capability is instrumental in producing data-based knowledge, which complements a firm's SCC and offers insights that can be used in decision-making and in dealing with suppliers and customers. Similarly to the research of Arias-Pérez *et al.* (2022) on technology companies, this study confirms that data capability should be aligned with key processes, especially those focusing on collaborative work with customers to produce the greatest possibility of impacting firm performance.

Further, the findings of this study empirically confirm SCC as a factor that underpins firms' improved performance (Morash, 2001; Morash *et al.*, 1996; Wu *et al.*, 2006; Yu *et al.*, 2018), including that of SMEs. Supply chain capability exerts its influence through information exchange, activity integration, responsiveness and coordination to act as a mediator between data capability and operational performance and to directly support SME operations. These findings align with prior studies (e.g. Yu *et al.*, 2018), and the results also confirm the value of SCC for SMEs.

Prior research indicates that the environment impacts firms' digitalization (Parviainen *et al.*, 2017) and SMEs' ability to benefit from their data capability (Bhardwaj, 2022). Those findings prompted the inclusion of the contingency perspective of RBV in the second research question: "How do those antecedents affect operational performance in a competitive context?" This research question moved the focus on to the environment in which data capability and SCC are used. Including the context in which those capabilities are used made it possible to extend the understanding of the complex mechanism of data-related value creation, particularly that flowing from improved operational performance in SMEs. The findings of this study show that certain fundamental functions between firms, such as SCC, produce greater benefits than data capability when the competition is intense.

Without a diverse range of organizational capabilities for working with customers and suppliers, achieving the potential benefits of digitalization and data can be challenging for SMEs. Accordingly, this study contributes new insight into how SMEs' data capability complements SCC and when the contingent effect of those variables is stronger from the perspective of SMEs' operational performance. This study is in line with Vesalainen and Hakala (2014) and empirically shows that the effect of inter-organizational capabilities such as SCC can vary depending on environmental conditions such as competition.

The results provide an interesting insight into the changing impact and value of the capabilities being studied. In an environment marked by fierce competition, the complementarity between the data capability and the SCC was stronger, which significantly impacted operational performance. Together these capabilities produced information needed to manage operations in a turbulent environment. However, data capability and SCC did not improve performance in a weak-competition environment. Hence, this article also contributes to the literature on contingent RBV, showing that when examining the effect of SME digitalization on operational performance, a framework targeting and combining internal factors and external conditions is suitable to explain a complex phenomenon.

5.2 Managerial implications

This study offers SME managers in the manufacturing sector some practical insights. In response to findings that data-related investments do not always pay off (Cappa *et al.*, 2021; Surbakti *et al.*, 2020), this study applies the contingent RBV to explain how and when SMEs are likely to benefit from data use. The study focuses on the relationship between SMEs' data capability, that is, the ability to use acquired data and SCC, which refers to firms' ability to manage supply chain operations in a competitive environment.

The results show that the value related to data capability emerges based on two mechanisms. First, data capability complements the firm's other capabilities. In this case, it boosts SCC and these capabilities improve firms' operational performance. The rationale is that the data capability produces information and knowledge to be utilized when managing operations with suppliers and customers, which offers advantages to firms. In such a case, SCC both produces and applies the data; hence, firms must be able to manage their supply chains and possess a certain level of SCC to benefit from acquired data.

Second, the firm's environment affects the magnitude of its capabilities. That is because when competition is fierce, firms need new ways to conduct their business and match their operations to the changing environment. In an environment marked by low competition, firms do not need to detect and react to changes that occur in their environment so quickly. Hence, the value of information derived based on data capability becomes less relevant. However, when the competition is fierce, firms need data-based knowledge about their supply to react proactively to changes in demand and avoid risks. Accordingly, the ability to manage inter-organizational operations helps firms compete, and the value of data capability and SCC increase in competitive situations. Accordingly, policymakers should not focus merely on digitalization and expect it to generate positive outcomes detached from SME operations or the environment in which the firms operate.

Finally, the results show that SMEs' SCC is a critical factor in improved performance. Managers developing their ability to use data should pay attention to network capabilities, such as SCC. The approach can unlock opportunities based on increased data availability, which are especially important in a competitive environment.

5.3 Limitations of the study and future research directions

Inevitably this study has some limitations. The sample comprises Finnish SMEs and the results might differ in other locations, which future research might test. Further, the first tranche of data used in this study was collected at the beginning of the coronavirus disease 2019 (COVID-19) crisis, and the second wave of data a year after. That particular period may have affected the generalizability of the results. In addition, the data informing this study were gathered from a diverse group of SMEs operating in various fields. Research and information on industry-specific data capabilities would illuminate possible differences related to SMEs operating in different fields. A case study approach could provide such information.

6. Conclusion

This study examined SMEs' data capability and SCC as antecedents of improved operational performance in a turbulent environment. Reference to the contingent RBV and diverse research streams enabled formulating research hypotheses and a conceptual framework that could be empirically tested on Finnish manufacturing SMEs. The results show that data capability significantly and positively impacts SCC and SCC similarly affects operational performance. The influence of these variables is stronger in a competitive environment. These findings offer the latest information on complex data-based value generation. They show that SMEs' ability to manage their supply chains is critical when competition is intense and companies seek to exploit the potential of data. The study provides topical information on the value of data and shows that an SME's business environment determines the value of data capability and SCC.

While the value of data has long been recognized, there was limited research from a longitudinal perspective, especially on SMEs. The insight into the complementary and contingent effect of capabilities highlights the importance of a framework that produces more coherent information about the complex combination of capabilities and the environment in which SMEs operate. While there is still some way short of a complete explanation of the relationship between data capability SCC and improved operational performance, the contingent RBV offered a framework to advance that quest.

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Appendix

Scale and item	Loadings
Data Capability	
Almost all of the products we sell accumulate data in our systems	0.80
We can analyze the data accumulated from the products	0.97
We offer productized data-driven services to our customers	0.57
All our products are equipped with information and communication technology (e.g. sensors) for collecting data	*deleted*
Supply Chain Capability (SCC)	
Adapted from Wu *et al.* (2006), Yu *et al.* (2018)	
Information Exchange (IE)	
Our company exchanges more information with its partners than our competitors do with their partners	0.89
Information flows more freely between our company and its partners than between our competitors and their partners	0.88
Our company benefits more from information exchange with its partners than our competitors do from exchanges with their partners	0.91
Our information exchange with our partners is superior to the information exchange of our competitors and their partners	0.85
Activity Integration (AI)	
Our company develops strategic plans in collaboration with its partners	0.74
Our company collaborates on forecasting and planning with its partners	0.91
Our company projects and plans future demand in collaboration with its partners	0.88
Responsiveness	
Compared to our competitors, our supply chain responds more quickly and effectively to changing customer and supplier needs	0.67
Compared to our competitors, our supply chain develops and markets new products more quickly and effectively	0.88
In most markets, our supply chain competes effectively	0.71
The relationship with our partners has increased our supply chain responsiveness to market changes through collaboration	0.80
Coordination	
Our company conducts transaction follow-up activities more efficiently with our partners than do our competitors with their own partners	0.79
Our company spends less time coordinating transactions with our partners than our competitors with their own partners	0.53
Our company has reduced partnering costs more than our competitors	0.56

(*continued*)

Table A1. Measurement scales

IMDS

Scale and item	Loadings
Our company can perform the business at less cost than our competitors	*deleted*
Operational Performance	
Adapted from Ward and Duray (2000), Wong *et al.* (2011)	
Delivery performance	
Our delivery times are shorter than the industry average	0.60
Our delivery punctuality is good or better than the industry average	0.95
The reliability of our delivery is good or better than the industry average	0.93
We have been able to reduce the time it takes to process the order more than the industry average	0.52
Quality performance	
The quality of our products has been steady, and quality deviations are less common than the industry average	0.84
Our products are reliable and match our customers' standards better than the industry average	0.75
Production flexibility	
Our ability to change production volume is better than the industry average	0.55
Our ability to customize products is better than the industry average	0.72
Our ability to make rapid changes in product offering is better than the industry average	0.95
Cost performance	*deleted*
Our production costs are below the industry average	*deleted*
The cost of storing our products is lower than the industry average	*deleted*
Overheads of our products are lower than the industry average	*deleted*
The price competitiveness of our products is better than the industry average	*deleted*
Competitor turbulence	
Competition in our industry is cutthroat	0.83
Price competition is a hallmark of our industry	0.83
One hears of a new competitive move almost every day	0.61

Table A1.

Source(s): Author's own creation/work

Corresponding author
Tuire Hautala-Kankaanpää can be contacted at: thautala@uwasa.fi

Exploring the effects of SMEs' platform-based digital connectivity on firm performance – the moderating role of environmental turbulence

Anni Rajala and Tuire Hautala-Kankaanpää
School of Management, University of Vaasa, Vaasa, Finland

Abstract

Purpose – Small- and medium-sized enterprises (SMEs) often operate in environments marked by high levels of turbulence. Such firms adopt digital technologies and platforms that provide access to external real-time information and establish digital connectivity between firms to remain competitive. This study aims to focus on SMEs' downstream and upstream platform-based digital connectivity (PDC).

Design/methodology/approach – This study examines the effects of PDC on SMEs' operational performance under conditions of environmental turbulence. The data was gathered from 192 SMEs operating in the manufacturing arena.

Findings – The results show that the adoption of PDC does not directly affect an SME's operational performance. However, in highly turbulent environments, PDC can improve operational performance. The results indicate that the performance effects of PDC vary according to the level and type of environmental turbulence.

Research limitations/implications – This research offers insights into the relationship between PDC among SMEs and operational performance and encourages future research examining other possible conditional effects that could explain the contradictory results found in previous research.

Originality/value – This study contributes to the knowledge of supply-chain digitalization among SMEs and its performance effects in varying environmental conditions. Further, this study contributes to the prior research by focusing on the interorganizational aspects of digitalization in SMEs.

Keywords Platform-based digital connectivity, Digitalization, Environmental turbulence, Small- and medium-sized enterprises

Paper type Research paper

1. Introduction

The digitalization of small- and medium-sized enterprises (SMEs) has recently attracted scholarly attention (Eller *et al.*, 2020; Matarazzo *et al.*, 2021; Scuotto *et al.*, 2021). The majority of the research exploring digital transformation has focused on large corporations (Cenamor *et al.*, 2019; Matarazzo *et al.*, 2021), and it is argued that SMEs lag behind larger companies in terms of the extent of digitalization (Eller *et al.*, 2020). Nevertheless, SMEs compete in highly dynamic environments and continuously search for ways to survive, grow and be competitive (Cenamor *et al.*, 2019; Lin and Lin, 2016; Martinelli and Tunisini, 2019). Digital technologies are developing and providing access to new ways to create value (de Gooyert, 2020). The emergence of new digital technologies signals that firms should seek to transform their business digitally (Verhoef *et al.*, 2021). Many SMEs are making more use of digital platforms to implement their business strategies in response to the pressures of competition (Li *et al.*, 2016).

Prior research has reviewed the advantages of information technology for company performance (Eller *et al.*, 2020; Suoniemi *et al.*, 2022; Yunis *et al.*, 2018), but there remains little research on the impact of digitalization on firm performance (Eller *et al.*, 2020; Ferreira *et al.*, 2018). Results on the impact of digital technologies on firm performance are conflicting. Some studies report that using digital technologies alone does not benefit performance (Cenamor *et al.*, 2019; Irani, 2010), and that a majority of projects adopting digital technology fail (Irani, 2010; Yunis *et al.*, 2018),). However, some studies report positive effects on firm performance (Eller *et al.*, 2020; Li *et al.*, 2020). Moreover, it is feasible that the relationship between digitalization and firm performance is nonlinear (Kohtamäki *et al.*, 2020). These contradictory results demonstrate the existence of the productivity paradox of information technology (IT) (Brynjolfsson and Hitt, 1998;

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King *et al.*, 2020), which refers to the fact that massive investments in information systems (IT) do not always spur productivity improvements.

Digital technologies facilitate interactions between organizations, and digital platforms are an important source of competitive advantage in networked economies (Cenamor *et al.*, 2019; Kazan *et al.*, 2018). Digitalization enhances effective interaction between firms and has made organizational boundaries more flexible and permeable (Corsaro and D'Amico, 2022). Moreover, digital technologies facilitate processes that connect people and companies and enable monitoring, communication, exchange and feedback (Cherbib *et al.*, 2021). Digital platforms and digital technologies are forms of digital connectivity available to firms. Digital connectivity, which includes information sharing, is considered one of the most important contributors to expediting the flow of goods, mitigating risks and minimizing uncertainty in supply chains. The forms of digital connectivity available to firms include digital platforms and other digital technologies (Engelseth and Wang, 2018; Lin *et al.*, 2021b). This study focuses on platform-based digital connectivity (PDC), which refers to using digital technologies and processes in upstream and downstream supply chains to share information and convey knowledge. Prior research has argued that digital platforms are increasingly being created and implemented in various functions within supply chains (Lin *et al.*, 2021a).

There is a call for research on how digitalization affects firm performance from the interorganizational perspective (Lin *et al.*, 2021b; Martinelli and Tunisini, 2019), especially in varying environmental conditions (Li, 2022). We respond to this call by studying the PDC of firms in various environmental conditions. The results of the study demonstrate that PDC is not directly associated with operational performance; however, in a turbulent environment PDC produces operational benefits (Wang *et al.*, 2020).

This paper aims to study the effects of PDC on firm performance under various conditions of environmental turbulence. Prior research has addressed environmental turbulence as an aggregate construct (Liao and Tu, 2008; Turulja and Bajgoric, 2019) or distinguished competitive, market and technological forms of turbulence (Jaworski and Kohli, 1993; Kohli and Jaworski, 1990; Wilden and Gudergan, 2015). Research on the moderating effect of environmental turbulence on the relationship between digitalization and performance is relatively scarce and mainly focused on the performance impact of digital technologies (Li *et al.*, 2020), IT capabilities (Chen *et al.*, 2014; Dubey *et al.*, 2020; Rai and Tang, 2010), big data analytics (Wamba *et al.*, 2020) and the integration of supply-chain information (Iyer *et al.*, 2009). Extant knowledge of the moderating effect of environmental turbulence is somewhat contradictory and is influenced by the form of turbulence studied. We focus on the moderating effects of environmental turbulence between PDC and the operational performance of SMEs. Environmental turbulence is used as an aggregated construct, and the competitive, technological and market forms of turbulence are also addressed. This paper aims to study the effects of PDC on firm performance under different conditions of environmental turbulence.

Prior research has addressed environmental turbulence as an aggregate construct (Liao and Tu, 2008; Turulja and Bajgoric, 2019) or distinguished competitive, market and technological forms of turbulence (Jaworski and Kohli, 1993; Kohli and Jaworski, 1990; Wilden and Gudergan, 2015). Research on the moderating effect of environmental turbulence on the relationship between digitalization and performance is relatively scarce and mainly focused on the performance impact of digital technologies (Li *et al.*, 2020), IT capabilities (Chen *et al.*, 2014; Dubey *et al.*, 2020; Rai and Tang, 2010) big data analytics (Wamba *et al.*, 2020) and supply-chain information integration (Iyer *et al.*, 2009). Extant knowledge of the moderating effect of environmental turbulence is somewhat contradictory depending on the type of turbulence studied. We focus on the moderating effects of environmental turbulence between PDC and the operational performance of SMEs. Environmental turbulence is used as an aggregated construct, and the competitive, technological and market forms of turbulence are also addressed.

The study draws on supply chain digitalization literature to examine the moderating effect of environmental turbulence on PDC and SME performance. Research on the benefits of digitalization applicable to SMEs is relatively scarce (Cenamor *et al.*, 2019; Matarazzo *et al.*, 2021), which reinforces the need to extend the knowledge on the use of digital technologies and platforms in SMEs and the associated benefits. Accordingly, the research questions are as follows:

RQ1. To what extent does PDC affect operational performance?

RQ2. What is the effect of environmental turbulence on the relationship between PDC and operational performance?

The empirical part of the paper is based on a sample of 192 Finnish SMEs, and hierarchical regression analysis is conducted to address the research questions. The results of the study demonstrate that PDC is not directly associated with operational performance; however, under some environmental conditions, PDC produces operational benefits. This study contributes to the supply chain digitalization literature by showing that PDC does not in itself improve operational performance in SMEs. Further, we contribute to the literature by expanding knowledge on the effects of PDC and operational performance among SMEs. We also demonstrate that depending on the level of environmental turbulence and the type of turbulence, PDC can either improve or diminish operational performance. An additional contribution is therefore to demonstrate that the performance effects of PDC can vary markedly depending on the conditions.

The paper is structured as follows. Section 2 presents the theoretical background of the study and its research hypotheses. Then, the data and empirical methods are presented, and then the results are outlined in Section 3. We then discuss the findings and theoretical contributions in Section 4. Finally, managerial implications are discussed, and suggestions for future research are made in Section 5.

2. Theoretical background and hypotheses

Digital transformation has prompted several recent literature reviews (Hanelt *et al.*, 2021; Nadkarni and Prügl, 2020;

Verhoef *et al.*, 2021), with the topic being defined as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication and connectivity technologies (Vial, 2019). Verhoef *et al.* (2021) distinguished three phases of digital transformation: digitization, digitalization and digital transformation. Digitization refers to the action of converting analog information into digital information (Verhoef *et al.*, 2021); digitalization is defined as the use of digital technologies (Srai and Lorentz, 2019), and digital transformation is seen as a larger change (Verhoef *et al.*, 2021), similar to the definition of Vial (2019). In this paper, we focus on the digitalization of interorganizational relationships, and thus, we build on digitalization literature.

Cross-boundary digital technologies drive changes that extend beyond internal process optimization as such technologies potentially trigger changes to business models, strategy, corporate culture and entire industry structures (Nadkarni and Prügl, 2020). Digitalization is changing how companies in a value chain interact with firms upstream or downstream in the supply chain, improving interorganizational interactions and improving data acquisition, warehousing and big data analytics (Porter and Heppelmann, 2014). Value creation is shifting from the value chain to value networks. Networks and ecosystems are, in turn, becoming more interconnected because of the growth of digital platforms (Nadkarni and Prügl, 2020). Digitalization fosters a greater number of network parties and process integration that again enables collaboration, information sharing and joint goals (Shashi *et al.*, 2020). Consequently, firms develop digital connectivity to access and share information with supply chain partners (Wong *et al.*, 2011a, 2011b).

This study defines PDC as the adoption of platform-based digital technologies and processes that enable firms to access, acquire and share knowledge and real-time information in the upstream and downstream supply chain. This view has some similarities with the so-called *self-thinking supply chain.* The notion holds supply chains are digitally connected through the cloud-based Internet of Things (IoT) architecture that enables real-time connectivity and deploying artificial intelligence to monitor supply chain performance (Calatayud *et al.*, 2019; Hallikas *et al.*, 2021). However, while self-thinking supply chains remain merely a vision, PDC among firms is already quite commonplace. Further, many digital technologies cannot be restricted to the boundaries of specific firms, instead involving a wider ecosystem or digital infrastructures that may be open (Hanelt *et al.*, 2021).

Implementing new digital technologies is always risky for SMEs (Moeuf *et al.*, 2018). Digitalization solely through the implementation of enterprise resource planning (ERP) systems has very high costs in relation to benefits and is not seen as a very productive digitalization strategy for SMEs (Koh and Saad, 2006). Accordingly, companies are increasingly investing in and introducing digital platforms to increase operational efficiency, establish interorganizational collaboration and improve customer satisfaction (Cenamor *et al.*, 2019; Hong *et al.*, 2021). Digital platforms are crucial in connected and data-rich businesses that utilize information sharing, collaboration and collective action (Costa *et al.*, 2020). Digital platforms provide SMEs with an affordable way to digitalize business compared to investing in complex IT systems (Cenamor *et al.*, 2019). Further, digital platforms are sources of external knowledge, which may be crucial for achieving competitive advantage via digital technologies (Ricci *et al.*, 2021).

2.1 Platform-based digital connectivity and small- and medium-sized enterprises performance

A major objective of digitalization in supply chains is to gather information about changes in the business environment, market customer behavior and the competitive situation (Hallikas *et al.*, 2021). Meeting that objective requires organizations identify, access and collect relevant data. Those data must then be combined, refined, analyzed and transformed into an actionable form to benefit from the digitalization of the supply chain (Hallikas *et al.*, 2021). In addition, firms adopting PDC should weigh the benefits of information sharing against the vulnerability to information leakage (Ried *et al.*, 2021).

Prior research identifies some positive effects of digitalization and firm performance. For instance, Barua *et al.* (2004) found that customer-side digitization is positively related to financial performance. Similarly, Eller *et al.* (2020) found that digitalization positively affects an SME's financial performance. Other research, in contrast, indicates that digitalization *per se* does not enhance a firm's performance. For example, Hallikas *et al.* (2021) found that using external market-related data did not directly affect supply chain performance but that external data could nurture digital procurement capability and thus indirectly affect supply chain performance. Similarly, Cenamor *et al.* (2019) demonstrated that the effect of platform capability on SME performance is indirect via network capability, meaning that acquiring a digital platform is not in itself sufficient to boost an SME's performance. In addition, Kohtamäki *et al.* (2020) argued that digitalization alone is insufficient to generate positive financial performance effects for manufacturing companies. Other studies show that information systems do not necessarily lead to improved operational efficiency and effectiveness (Irani, 2010). The implication is that PDC itself may not enhance SMEs' operational performance but can do so in combination with some other mechanism.

Research also suggests that digital technologies *per se* provide little value to an organization, but the application of digital technologies within a specific context can reveal new ways to create value (Vial, 2019). Moreover, implementing complex IT systems often involves costly investment in system integration and lengthy projects (Kohtamäki *et al.*, 2020). Cappa *et al.* (2021) found that cultivating big data can negatively affect firm performance, as the cost of data storage, management and analysis can outweigh the benefits. Similarly, for SMEs, the cost of implementing PDC may be greater than the monetary benefits of operational efficiency. That is because the early phases of digitalization projects can suffer from poor system integration that spurs overlapping processes and inefficiency. In addition, Wong *et al.* (2011a, 2011b) argued that connectivity via information integration might even be detrimental to the efficiency of interorganizational coordination and supply chain cost reduction.

Further, it is stated that SMEs still do not consider data a source of added value and lack the resources to invest in and manage complex digital systems (Moeuf *et al.*, 2018). The productivity paradox suggests that IT initiatives can reduce productivity (King *et al.*, 2020). Cousins and Menguc (2006) also state that supply chain integration incurs costs and might not improve operational performance, sometimes even reducing it. Further, Barua *et al.* (2004) found that supplier-side digitization negatively affected financial performance. Das *et al.* (2006) report that collaboration with external partners can increase the cost of coordination and encourage inflexibility.

In conclusion, prior studies report contradictory results on the effect of different digitalization-related variables on firm performance. Digital platforms are viewed as a complex form of digitalization because they facilitate interactions between companies (Cenamor *et al.*, 2019). We, therefore, assume that digital platforms have similar effects on SMEs' performance to those reported for digitalization overall. We expect that PDC will have a negative direct effect on SME performance. We therefore hypothesize.

H1. Platform-based digital connectivity has a negative effect on operational performance in SMEs.

2.2 The moderating role of environmental turbulence

Environmental turbulence refers to the unpredictability or uncertainty firms face when predicting rapid changes in customer needs or technology development. The term encompasses competitive, market and technology turbulence (Jaworski and Kohli, 1993; Wang *et al.*, 2020). Environmental uncertainty encompasses changing customer demand, unpredictable competitor action and fluctuating sales volumes (Wong *et al.*, 2011a, 2011b). Competitive turbulence encompasses the competition in an industry (Huang and Tsai, 2014; Jaworski and Kohli, 1993). Market turbulence encompasses the rate and predictability of change in customer segments and customer preferences (Jaworski and Kohli, 1993; Wilden and Gudergan, 2015). Technological turbulence encompasses the rate of technological change in the industry (Huang and Tsai, 2014; Jaworski and Kohli, 1993; Wilden and Gudergan, 2015). Environmental turbulence is a key variable that affects a firm's competitive performance, strategies and capabilities (Rai and Tang, 2010). While prior studies have confirmed it moderates firm performance, the results are inconsistent.

Firms cannot rely solely on intra-organizational data in a dynamic business environment and must also access external information to predict changes and reduce uncertainty (Cherbib *et al.*, 2021; Li *et al.*, 2020; Wilden and Gudergan, 2015). Such external information can be valuable when combating environmental uncertainty (Wong *et al.*, 2011a, 2011b). Childerhouse *et al.* (2003) state that information flows should be transparent both upstream and downstream along the supply chain to counter environmental dynamism. The effects of digital-related variables on firm performance have been found to be strong in both stable and turbulent environments. Vijayasarathy (2010) found the use of technology has a strong effect on supply chain performance in a stable environment.

Further, Wong *et al.* (2011a, 2011b) found that the positive effect of information integration on supply chain cost performance strengthens when there is a low level of environmental uncertainty. Iyer *et al.* (2009) found that the relationships between IT-based business-to-business (B2B) integration and operational, financial and market performance are stronger in stable environments than in turbulent ones. In contrast, Li *et al.* (2020) found that digital technologies have a stronger effect on economic performance in highly dynamic environments than in more stable ones. Further, Wamba *et al.* (2020) demonstrate that environmental dynamism positively moderates the relationship between big data analytics and a firm's operational performance. In addition, Srinivasan and Swink (2018) find that the association between analytics capability and operational performance is stronger in high-volatility markets.

In summary, prior research has shown that the strength of the relationship between digital-related variables and firm performance varies depending on the extent of environmental turbulence. The need to identify opportunities in a turbulent environment often makes SMEs reliant on external partners to provide information on market changes (Alexiev *et al.*, 2016). Moreover, external pressure may force SMEs to adopt digital technologies to maintain their competitive position (Iacovou *et al.*, 1995; Li *et al.*, 2020). Therefore, the more turbulent the environment, the stronger the pressure on SMEs to leverage digital technologies to establish connectivity in their supply chain (Li *et al.*, 2020). Following this logic, we argue that SMEs can use PDC in turbulent environments to predict changes in the environment and, therefore, assume that the effect of PDC on operational performance will be stronger in situations of high environmental turbulence. As prior research has demonstrated that in turbulent environments, the use of digital technologies has a stronger effect on firm performance, and as we argue that SMEs operating in dynamic environments are more motivated to adopt digital technologies to remain competitive, we hypothesize:

H2. Environmental turbulence positively moderates the relationship between platform-based digital connectivity and a firm's operational performance.

We also acknowledge that the effect of environmental turbulence can differ depending on the type of turbulence (Wilden and Gudergan, 2015). First, with regard to *competitive turbulence*, a turbulent and uncertain environment challenges the identification of future probabilities and encourages a focus on real-time situation-specific new knowledge (Eisenhardt and Martin, 2000). That focus can cause issues with imitating competitors' strategies and encourage senior management to rely on their own decisions (Noda and Collis, 2001). In a more stable environment, firms' have more time to benchmark and identify the resources and capabilities that create value for the firm (Song *et al.*, 2005).

Business relationships often involve technological investments that unite partners (Easton and Araujo, 2003), and interorganizational investments in digitalization can benefit supply chain members. That is because PDC between firms can reduce the effect of competition and limit the willingness to switch partners and the opportunities to do so. If firms collaborate in highly competitive environments, they might

Journal of Business & Industrial Marketing
Volume 38 · Number 13 · 2023 · 15–30

choose between sharing information to gain access to the other firm's information and acquiring knowledge to mitigate competition (Alexiev *et al.*, 2016). In highly competitive environments, firms benefit from bold and proactive activity (Auh and Menguc, 2005). A competitive environment drives firms, and especially SMEs, to seek competitive advantage by adopting new technologies (Chan *et al.*, 2012; Daniel and Grimshaw, 2002).

Accordingly, we argue that when competitive turbulence is high, SMEs are more willing to adopt digital technologies and foster interorganizational integration to remain competitive. Presumably, the PDC built upstream and downstream is used more efficiently than in a stable environment, which enhances operational performance. Dong *et al.* (2009) confirmed that IT integration had a stronger effect on process improvement in more competitive environments than in stable ones. Further, in highly competitive environments, the potential knowledge gains from interorganizational collaboration can spur some level of information sharing but also information protection (Alexiev *et al.*, 2016). We assume that upstream and downstream PDC will be positively associated with operational performance. That hypothesis is based on the integrative effect of PDC that binds parties and operations, supports transparency and the use of data to analyze the current situation and formulate new knowledge and contributes new insights, which can be invaluable when rivalry is fierce.

H3. Competitive turbulence positively moderates the relationship between platform-based digital connectivity and a firm's operational performance.

Technological turbulence encompasses the level of technological change in production, process and service technologies (Iyer, 2011; Kohli *et al.*, 1993). The assumption is that technological uncertainty will prompt frequent changes in product design and innovation (Mishra *et al.*, 2007), and firms will acquire a competitive advantage through technological innovation (Jaworski and Kohli, 1993). Further, an environment marked by high levels of technological turbulence drives partners to deploy IT in support of collaborative efforts to make supply chain operations more predictable (Iyer, 2011). The role of fast information sharing grows in a highly turbulent environment (Trkman and McCormack, 2009), and PDC can be viewed as an avenue that enables information sharing in response to the requirements imposed by rapid changes.

Previous research has demonstrated both a decline in performance when technological turbulence is high (Segarra and Callejón, 2002) and technological turbulence facilitating better performance (Efrat and Shoham, 2012). Technological turbulence forces firms to keep up with and adapt to technological trends (Martin *et al.*, 2020). In addition, technological turbulence fosters collaboration with downstream partners (Iyer, 2011). We expect that a technologically turbulent environment would encourage SMEs to familiarize themselves with PDC and be willing to incorporate it into their operations. We therefore expect SMEs operating in environments with a high level of technological turbulence to be more engaged with PDC and more capable of using it; thus, the relationship between PDC and operational performance should be stronger.

H4. Technological turbulence positively moderates the relationship between PDC and a firm's operational performance.

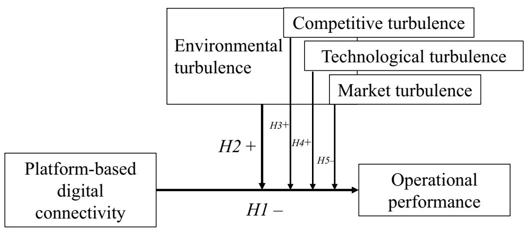
2.2.1 Market turbulence

Organizations operating in less turbulent markets are less likely to modify their products or services (Jaworski and Kohli, 1993; Kohli and Jaworski, 1990). In contrast, firms operating in highly turbulent markets may have long-standing customers with frequently changing preferences alongside new customers with different requirements (Hanvanich *et al.*, 2006). A broad customer base may also require an SME to install a range of IT systems to interact with the customers in real time. The systems or platforms may vary, creating an issue with system compatibility and hindering information exchange, which would reduce operational efficiency (Bayraktar *et al.*, 2009). An IT-enabled integration can ensure information flows across organizational boundaries in real time, which could thus extend a firm's capability to respond to fluctuations in the volume and type of products the market demands (Rai and Tang, 2010). A case study by Welker *et al.* (2008) showed that complex business conditions encourage partners to share information through direct contacts such as phone calls and meetings, limiting the role of information and communication technology. That finding suggests that companies may be reluctant to invest in building PDC in turbulent markets.

A turbulent market environment may also lead to firms struggling to accommodate diverse customer demands, which weakens operational performance despite the interaction and information offered by PDC. Although SMEs firms may be able to obtain individualized customer data (Schniederjans *et al.*, 2020), their usually limited resources present challenges around exploiting those data. Further, if companies focus only on the needs of customers, the performance effect would be negative because market demands and customer preferences are constantly changing in dynamic environments (Oh *et al.*, 2012). In addition, SMEs may be powerless in the face of large customers' changing needs because they are forced to accept the buyers' norms instead of securing their own interests (Quayle, 2003). This imbalance can lead to SMEs focusing on activities that do not improve performance.

Moreover, Arora *et al.* (2016) argued that turbulent markets reduce interfirm collaboration because firms fear information and knowledge sharing. Most SMEs tend guard information on their supply chains (Chan *et al.*, 2012), so we anticipate that in uncertain market conditions, SMEs may defer building and fully using PDC (Figure 1). Accordingly, we hypothesize:

Figure 1 The hypothesized model



Journal of Business & Industrial Marketing
Volume 38 · Number 13 · 2023 · 15–30

H5. Market turbulence negatively moderates the relationship between PDC and operational performance.

The hypothesized model of the study is illustrated in Figure 1.

3. Method

3.1 Data collection and sample

The data were collected from SMEs operating in the manufacturing sector. In total, 1,136 manufacturing companies meeting a criterion of an annual turnover of €1.5–50m were selected from the Orbis database at the end of 2019. Their CEOs were then invited to participate in the study via an internet-based survey constructed using the Webropol survey tool. In total, 21 of 720 companies completed the survey following an e-mail invitation. We sought to increase the response level by contacting 414 companies by telephone, and 323 then agreed to accept the survey, of which 172 eventually completed it, and 87 declined to participate. A total of 193 responses were received, including one duplicate submission. Therefore, the final sample comprises 192 SMEs, equating to a response rate of 17%, which can be considered adequate (Malhotra, 2010). The non-response bias was tested by comparing the turnover between non-respondents and respondents using a *t*-test. There were no differences between the groups t (1109) = −0.477, p = 0.634; hence, the sample appears representative of the selected population.

Of the key respondents, 83% were CEOs, 4% were CFOs and 13% were in other management positions. The companies in the final sample are mainly small firms, in that 73% have fewer than 50 employees and 69% have a turnover of less than €10m. Among the sample, 59% of the companies operate in the metal manufacturing industry. The remaining 41% operate mostly in electric or electronic machinery, chemicals, petroleum, rubber, plastic, food or transport manufacturing industries.

3.2 Measures

PDC was measured through a novel instrument based on 20 items that interrogated the firms' digital connectivity. The measurement instrument was developed by three academics based on prior research on platform-based connectivity and tested by two practitioners – an IT professional and consultant and a CEO of a manufacturing SME. The items measure the PDC of a firm in both directions: upstream (suppliers) and downstream (customers) along the supply chain. All the PDC items were measured on a seven-point scale anchored with *not at all* (1) and *very much* (7). As the PDC measurement instrument is a novel one, we conducted several tests to assess the validity and reliability of the scale. First, we conducted an exploratory factor analysis that identified four factors. We named the dimensions of PDC to reflect the factors and thus categorized PDC into *digital supply chain transparency* (6 items), *digital product data* (2 items), *digitally enabled order-delivery process* (4 items) and *digital customer/supplier involvement* (6 items). The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.85, which exceeds the threshold value of 0.5. Further, the results of Bartlett's test of sphericity (2171,17, p = 0.000) also indicated that the data were suitable for factor analysis.

Factor analysis was conducted with Oblimin rotation, and the four-factor solution explained 68% of the variance. Two items were dropped owing to low loadings. Next, the validity and reliability of those dimensions were assessed. Although the digital supply chain transparency dimension showed quite poor average variance extracted (AVE) values (<0.5), the composite reliability (CR) and Cronbach's alpha values exceed the threshold values of 0.7. Research has accepted AVE values greater than 0.4 as adequate (Fornell and Larcker, 1981; Malhotra, 2010). We also assessed the discriminant validity of the measures through maximum shared variance (MSV) and average shared variance (ASV) values. The key criteria for assessing discriminant validity were that MSV was less than AVE and ASV was less than AVE (Hair *et al.*, 2014). We concluded that the PDC constructs did not suggest any issues with discriminant validity (Table 1). We also concluded that all the dimensions of PDC showed satisfactory validity and reliability. The relevant results are digital supply chain transparency (AVE = 0.43, CR = 0.82, α = 0.82), digital product data (AVE = 0.59, CR = 0.74, α = 0.74), digitally enabled order-delivery process (AVE = 0.58, CR = 0.85, α = 0.84) and digital customer/supplier involvement (AVE = 0.64, CR = 0.91, α = 0.92).

The environmental turbulence scale featured three dimensions: market turbulence, competitive turbulence and technological turbulence. The measurement scale is one validated in prior studies (Jaworski and Kohli, 1993; Wilden and Gudergan, 2015). Technological turbulence measures the speed and frequency of technological change, market turbulence is based on assessing the changes in customer preferences, and competitive turbulence measures the general degree of competition (Wilden and Gudergan, 2015). Each of the three dimensions was measured by three items with a seven-point scale anchored with *totally disagree* (1) and *totally agree* (7). The assessment of the validity and reliability of the market turbulence scale revealed some issues relating to one item loading poorly, which adversely affected the AVE and CR values (AVE = 0.29, CR = 0.50, α = 0.48). Therefore, we

Table 1 Reliability and validity

Construct	CA	CR	AVE	MSV	ASV
Platform-based digital connectivity					
Digital supply chain transparency	0.82	0.82	0.43	0.42	0.31
Digital product data	0.74	0.74	0.59	0.27	0.27
Digitally enabled order-delivery process	0.84	0.85	0.58	0.41	0.27
Digital customer/supplier involvement	0.92	0.91	0.64	0.53	0.30
Turbulence					
Competitive turbulence	0.7	0.75	0.52	0.01	0.26
Market turbulence	0.5	0.48	0.29	0.50	0.26
Technological turbulence	0.84	0.85	0.65	0.50	0.26
Operational performance					
Delivery performance	0.84	0.82	0.53	0.02	0.17
Production costs	0.84	0.85	0.58	0.21	0.11
Product quality	0.87	0.88	0.78	0.48	0.14

Notes: CA = Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted; MSV = Maximum shared variance; ASV = Average shared variance decided the market turbulence construct should be dropped as its inclusion could jeopardize the interpretation of the results. The market turbulence construct also had some issues with discriminant validity (Table 1), whereas technological and competitive turbulence did not. The technological turbulence (AVE = 0.65, CR = 0.85, α = 0.84) and competitive turbulence scales (AVE = 0.52, CR = 0.75, α = 0.70) showed satisfactory reliability and validity.

The operational performance measurement instrument was adapted from prior research (Ward and Duray, 2000; Wong *et al.*, 2011a, 2011b). Operational performance was measured through three dimensions: delivery performance (4 items), production costs (4 items) and product quality (2 items). Each of these dimensions was measured on a seven-point scale anchored with *totally disagree* (1) and *totally agree* (7). Delivery performance (AVE = 0.53, CR = 0.82, α = 0.84), production costs (AVE = 0.58, CR = 0.85, α = 0.84) and product quality (AVE = 0.78, CR = 0.88, α = 0.87) demonstrated acceptable levels of validity and reliability. The operational performance constructs did not have any discriminant validity issues (Table 1). To ensure the validity of the operational performance measurement, we tested the relationship between the three-dimensional operational performance measure and objective performance indicators derived from the financial database. We found that our three-dimensional operational performance measure positively correlated with the EBIDTA margin of each company (0.15, $p < 0.05$), indicating the reliability of the subjective performance measure used.

We also used company age, size and industry as *control variables*. Company age is a continuous variable. Company size was measured through turnover and dummy coded as 0 (turnover less than EUR 10 m) or 1 (turnover over EUR 10 m). The industry was dummy coded such that the metal industry was coded as 1 and other manufacturing as 0.

3.3 Test of measures

A confirmatory factor analysis was conducted using Stata 15.1 software to ensure the measurement model demonstrated sufficient validity. All items loaded significantly on their latent variables ($p < 0.000$), and the loadings ranged from 0.25 to 0.95. Although one item had a low loading (0.25), we decided to retain it in the measurement model, as it was part of a previously validated scale. All other loadings were acceptable. Although the loadings of two items fell below the 0.5 minimum loading recommended by Hair *et al.* (2014), they met the minimum criterion of 0.4 applied in other research (Kohtamäki and Partanen, 2016). The loadings and items are presented in Appendix. The fit indices indicate that the data fit the model well (χ^2/df = 1.69; CFI = 0.91; TLI = 0.90; SRMR = 0.08; RMSEA = 0.06). These tests indicate that the measurement model is acceptable.

We used various tests to control for common method variance (Podsakoff *et al.*, 2003). First, we compared the research model to a single-factor model (Podsakoff *et al.*, 2003). The research model exhibits a significantly better model fit (χ^2/df = 1.69; CFI = 0.91; TLI = 0.90; SRMR = 0.08; RMSEA = 0.06) than the single-factor model (χ^2/df = 4.71; CFI = 0.41; TLI = 0.37; SRMR = 0.14; RMSEA = 0.14). The results suggest that common method variance is low. Second, we used the marker variable approach, which is suggested as an appropriate method for controlling the effects of common method variance (Podsakoff *et al.*, 2003). The technique incorporates a theoretically unrelated *marker variable* in the analysis; however, researchers rarely include unrelated constructs in their surveys and tend to use a variable with a weak correlation with the main study variables (Richardson *et al.*, 2009). We chose a marker variable that was measured on a similar scale as the main study variables and thus was more likely to reflect the same method variance. We chose flexibility (consisting of three items) as our marker variable. It has a weak correlation with the turbulence and connectivity variables and is measurable on the same scale. It can therefore be assumed to have the same method variance effect as the other study variables. The common method variance analysis results show that the inclusion of the marker variable did not seriously affect the results because the relationships remained steady with and without the marker. Therefore, the tests indicate that common method variance is controlled for in the analysis and poses no threat to the interpretation of the study's results.

4. Analysis and results

The hypotheses were tested using moderated regression analysis employing Stata 15.1 software. Table 2 shows the correlations between constructs, means and standard deviations.

The highest correlation between independent variables is 0.32 (Table 2), and the variance inflation factor (VIF) analysis shows that values for all constructs remain well below the threshold value of 10 (Hair *et al.*, 2014), as the highest VIF value is 1.12. The results indicate that multicollinearity is not an issue in the research model.

We tested the research hypotheses through hierarchical regression analysis, the results are presented in Table 3. First, we tested the relationships between PDC and operational performance and the moderating effects of environmental turbulence. We ran a model including only the company age and industry control variables (Model 1), which were not found to have any effect on operational performance. Next, we added the direct effects of PDC and environmental turbulence to the model (Model 2). Environmental turbulence was found to have a positive relationship with operational performance (β = 0.22, $p < 0.001$). The moderation effect of environmental turbulence was added to the third model (Model 3), which is our main research model. The model shows that PDC is not directly associated with operational performance (β = –0.03, n.s.): *H1* is therefore unsupported. The model also provides evidence of the moderating role of environmental turbulence on the relationship between PDC and operational performance (β = 0.21, $p < 0.001$), which indicates that the relationship between PDC and operational performance varies according to the environmental conditions. The results demonstrate that in highly turbulent environments, PDC improves operational performance, while in the case of low turbulence, PDC reduces a firm's operational performance. Therefore, *H2* is supported.

The moderation model explains 15% of the variance in the SMEs' operational performance, which is realistic, as operational performance comprises multiple effectual factors. We examined only the effects of PDC and environmental turbulence on performance. Figure 2 demonstrates the

Table 2 Correlations, means and standard deviations

Variable	Mean	SD	1	2	3	4	4a	4b	4c	4d	5	6
1. Company age	26.94	16.05										
2. Company size (1 = over 10 m€)	0.32	0.47	0.09									
3. Industry (1 = metal industry)	0.59	0.49	−0.17*	−0.03								
4. Platform-based digital connectivity	2.62	1.09	0.00	0.07	−0.03							
4a. Digital supply chain transparency	2.44	1.18	0.00	0.10	−0.04							
4b. Digital product data	2.27	1.44	0.02	0.05	−0.02		0.47***					
4c. Digitally enabled order-delivery process	3.60	1.60	−0.02	0.13	−0.06		0.55***	0.37***				
4d. Digital customer/supplier involvement	2.86	1.40	−0.00	−0.07	0.03		0.61***	0.48***	0.56***			
5. Competitive turbulence	4.60	1.15	0.01	0.07	−0.18*	0.06	−0.01	0.02	0.16*	0.09		
6. Technological turbulence	3.54	1.32	−0.10	−0.01	0.07	0.32***	0.24***	0.26***	0.24***	0.24***	0.09	
7. Operational performance	4.78	0.89	−0.05	0.05	−0.07	−0.00	0.2	−0.04	0.01	0.04	0.25***	0.16*

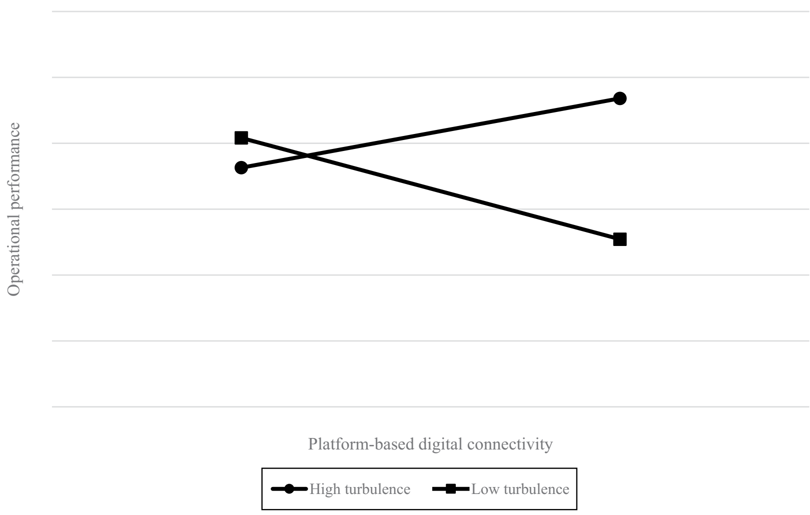
Notes: $^{*}p \leq 0.05$, $^{**}p \leq 0.01$, $^{***}p \leq 0.001$

Table 3 Results of the hierarchical regression analyses

Dependent variable: Operational performance	Model 1	Model 2	Model 3
Control variables			
Company age	−0.00	−0.00	−0.00
Industry: metal manufacturing	−0.15	−0.12	−0.12
Company size: over 10 m€	0.11	0.11	0.07
Main effects			
Platform-based digital connectivity (PDC)		−0.07	−0.03
Environmental turbulence		0.22***	0.21**
Moderation effects			
PDC × environmental turbulence			0.21***
ΔR^2	0.01	0.04	0.06
R^2	0.01	0.05	0.15
Adjusted R^2	0.00	0.04	0.12
F	0.78	5.44	5.51

Notes: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Figure 2 The moderating effect of environmental turbulence on the relationship between PDC and operational performance



Journal of Business & Industrial Marketing
Volume 38 · Number 13 · 2023 · 15–30

moderating effect of environmental turbulence on the relationship between PDC and operational performance.

To extend our understanding of the moderating effects of environmental turbulence on the relationship between PDC and operational performance, we tested the different turbulence types separately (Table 4).

The analysis indicates that the effects of competitive turbulence on operational performance were positively associated with operational performance ($\beta = 0.17$, $p < 0.01$) and to positively moderate the relationship between PDC and operational performance ($\beta = 0.23$, $p < 0.001$). Accordingly, *H3* is supported. These results (Figure 3) show that PDC improves an SME's operational performance when competitive turbulence is high, while in environments where competitive turbulence is low, PDC reduces that operational performance.

Technological turbulence proves to be positively associated with operational performance ($\beta = 0.16$, $p < 0.05$), but it does not moderate the relationship between PDC and operational performance; thus, *H4* is not supported. Market turbulence could not be tested because of the measure's reliability issues; therefore, *H5* could not be tested.

5. Discussion

This study builds on the supply chain digitalization literature to examine the moderating role of environmental turbulence in the relationship between PDC and operational performance in SMEs. Both scholars and practitioners recognize the importance of PDC to SMEs.

Our results demonstrate that the relationship between PDC and SMEs' operational performance is moderated by environmental turbulence. This study contributes to the literature on supply chain digitalization in several ways. First, we found that PDC alone does not directly affect operational performance, which demonstrates that the implementation of digital technology is no guarantee of operational efficiency. This finding confirms the existence of the IT productivity paradox, where manufacturing companies struggle to capture value flowing from digitalization (Kohtamäki *et al.*, 2020). Previous studies have recognized that electronic supply chain processes influence operational performance (Chae *et al.*, 2014; Hallikas *et al.*, 2021); however, it has also been argued that the relationship between digitalization and performance is nonlinear (Kohtamäki *et al.*, 2020) or that the relationship may be mediated by a number of intermediate variables (Wamba *et al.*, 2017). Our study shows that the relationship between PDC and performance varies depending on the prevailing environmental conditions. Prior studies have demonstrated that digitalization may have a positive effect (Barua *et al.*, 2004; Eller *et al.*, 2020), a negative effect (Cappa *et al.*, 2021) or no direct effect (Hallikas *et al.*, 2021) on performance. Our results show that PDC in and of itself does not affect operational performance; however, when the moderating effect of environmental turbulence is factored in, PDC may benefit firms in various ways. Hence, this study offers valuable information about the impact of digitalization on firm performance from the interorganizational perspective (Lin *et al.*, 2021b; Martinelli and Tunisini, 2019). In addition, this study contributes to the prior research by offering one possible explanation for the diverse results of studies of digitalization on firm performance. Environmental turbulence positively moderates the relationship between PDC and SMEs' operational performance, meaning that in a turbulent environment, the effects of PDC on operational performance are positive.

In contrast, increasing PDC undermines operational performance in stable environments, which signals that the costs of digitalization may outweigh the gains; a finding in line with that of Cousins and Menguc (2006). This outcome is logical, as an SME operating in a turbulent environment must acquire and assimilate external information to maintain competitiveness. Deploying PDC provides access to tools to enhance information sharing, often in real time, which results in improved operational performance. Similarly, Corsaro and D'Amico (2022) acknowledge that digitalization can foster interaction between firms.

The current study, therefore, contributes to the literature by demonstrating that the performance effects of PDC can be

Figure 3 The moderating effect of competitive turbulence on the relationship between PDC and operational performance

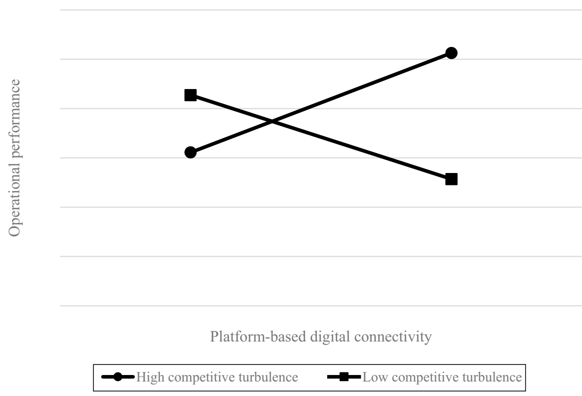


Table 4 Results of the moderation effects of different types of environmental turbulence on the relationship between PDC and operational performance

Dependent variable: Operational performance	Model 1	Model 2
Control variables		
Company age	−0.00	−0.00
Industry: metal manufacturing	−0.19	−0.04
Company size: over 10 m€	0.12	0.02
Main effects		
PDC	−0.06	0.04
Technological turbulence	0.16*	
Competitor turbulence		0.17**
Moderation effects		
PDC × technological turbulence	0.10	
PDC × competitor turbulence		0.23***
R^2	0.05	0.16
Adjusted R^2	0.02	0.13
F	1.76	5.96

Notes: $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

divergent under differing conditions. Moreover, the results suggest that the conflicting results of prior studies on the effects of digitalization on performance might relate to conditional effects. The current research offers empirically tested insights into the effect of the environmental conditions affecting a firm, as has been called for in prior research (Li, 2022).

Second, we demonstrate how different forms of environmental turbulence have different moderation effects. In environments marked by high competitive turbulence, PDC strongly enhances operational performance, a finding aligned with that in a recent theoretical paper by Knudsen *et al.* (2021). That study states that in velocity environments, hyper-competition will be normal, and therefore digitalization makes data and networks sources of competitive advantage. Prior studies report technological turbulence exerts positive moderation effects on the relationship between digital-related variables and performance (Efrat and Shoham, 2012; Iyer, 2011). Our results indicate that technological turbulence does not affect the relationship between PDC and operational performance. That may be because SMEs collaborate with larger companies, which may determine the technologies and platforms used, and therefore SMEs may only have to adapt to those requirements.

Third, we focus on digitalization and digital transformation among SMEs because prior research indicates a research gap (Cenamor *et al.*, 2019; Matarazzo *et al.*, 2021; Tortora *et al.*, 2021). The liability of smallness may discourage SMEs from investing in and using digital connectivity (Cenamor *et al.*, 2019) because they may not have the necessary resources, skills, commitment and proper understanding of digital opportunities (Matarazzo *et al.*, 2021). Our results demonstrate that some SMEs that have built PDC downstream and upstream along the supply chain can enhance their operational performance; however, the turbulence of the operating environment can mean others experience reduced operational performance. Previous studies of digitalization among SMEs mainly focused on digital platforms (Cenamor *et al.*, 2019; Li *et al.*, 2020) or the adoption of digital technology (Yunis *et al.*, 2018). We studied PDC among SMEs, which includes both the use of digital technologies and platforms. Therefore, we extend the knowledge of SME digitalization and its performance effects.

5.1 Managerial implications

The results highlight that adopting digital technologies, platforms or tools is not a guaranteed route to competitive advantage, operational efficiency or success. Digitalization-related capabilities must be developed to use the opportunities presented by various tools and techniques. When adopting digital platforms and building digital connectivity between firms, managers should consider the skills required to use those tools.

In addition, while some level of information sharing allied with supply chain transparency can provide external information that might be a source of competitive advantage, clear rules on information sharing with external partners must be in place. Nevertheless, PDC can enhance SMEs' operational performance, especially in turbulent business environments.

Further, it is important that SMEs investing in digitalization to build PDC between firms do not lose sight of their strategies and goals and establish an organizational culture capable of identifying and exploiting opportunities presented by digitalization. Moreover, building a positive attitude to digital tools is a necessary component of the digital transformation process. When competition is fierce in the SME business environment, strategies incorporating PDC may be beneficial.

Overall, managers should carefully examine the business environment in which they operate and be aware that if it is one of high environmental turbulence, access to external knowledge and information may accelerate performance enhancements. In addition, the type of environmental turbulence present should be identified because that can affect the impact of PDC. In environments with a high level of competitive turbulence, PDC may enhance operational performance. In that case, establishing and maintaining PDC upstream and downstream along the supply chain can be a source of competitive advantage and boost operational performance.

Furthermore, PDC can benefit SMEs in the long term. Therefore, managers should be aware that even if PDC is not currently an attractive option for the firm, it could become one in the future. Moreover, SMEs operating in turbulent environments may benefit from proactively seeking opportunities to maintain and improve the firm's competitiveness. Those opportunities can be presented by nurturing PDC. As the changes in the business environment can also affect business models and processes, it is important that managers acknowledge the level of digitalization and direction of their business environment and aim to match and preferably exceed, competitor efforts.

5.2 Limitations and future research

This study is affected by several limitations. The data were collected between the end of 2019 and the beginning of 2020 and therefore do not reflect the effects of the COVID-19 pandemic on SME digitalization. The COVID-19 pandemic may have forced many SMEs to make a digitalization stripe, which would offer avenues for future research. In addition, SMEs may have started developing digitalization-related capabilities that will foster PDC and positively affect performance. Therefore, future research could examine the capabilities that mediate between digitalization and performance. Moreover, we studied only the conditional effects of environmental turbulence. Future research might investigate other conditional effects that explain the contradictory results of prior studies on the relationship between digitalization and performance.

Another limitation of the study is that its sample was drawn only from manufacturing SMEs. Future studies might extend the purview to the service sector or other industries. In addition, our empirical context is Finland, which limits the generalizability of the results. Accordingly, future research might benefit from analyzing cross-country differences and similarities related to digital connectivity in SMEs.

In addition, the market turbulence measure was affected by poor reliability, and therefore the effects of market turbulence could not be empirically studied. Future research should also be aware that the market turbulence measure may need some modifications if it is to be reliable.

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Journal of Business & Industrial Marketing
Volume 38 · Number 13 · 2023 · 15–30

Appendix

Table A1 Measurement constructs and items

Constructs and items	Mean	SD	Loading
Platform-based digital connectivity			
Digital supply chain transparency (α: 0.82; CR: 0.82; AVE:0.43)			
Assess the following statements about the transparency of information from your company's perspective			
To what extent do your customers share digitally (through portal or collaboration platform) information on demand forecasting?	2.93	1.85	0.52
To what extent do you share information on demand forecasting digitally with your suppliers (through a portal or collaboration platform)?	2.40	1.62	0.78
To what extent do you have a view of the capacity or warehouse situation of your suppliers (through portal or collaboration platform)	2.21	1.37	0.59
To what extent do you open your capacity or warehouse situation to your customers (through portal or collaboration platform?)	2.16	1.58	0.61
To what extent do you let your customer follow the progress of their order-delivery process digitally?	2.50	1.76	0.69
To what extent do your suppliers let you digitally follow the progress of your order-delivery process?	2.43	1.52	0.71
Digital customer/supplier involvement (α: 0.92; CR: 0.91; AVE:0.64)			
To what extent do you use digital collaboration platforms to interact in the following business processes			
With customers on issues related to the development of your own product	3.01	1.76	0.74
With suppliers on issues related to the development of your own product	2.76	1.57	0.74
With customers on issues related to the development of activities	3.02	1.71	0.82
With suppliers on issues related to the development of activities	2.65	1.55	0.85
With suppliers on training or advice related to their products	2.83	1.64	0.84
In training or advising customers	2.92	1.72	0.80
Digitally enabled order-delivery process (α: 0.84; CR: 0.85; AVE:0.58)			
To what extent does your firm automatically exchange information on enterprise resource planning?			
Regarding order information from customers	3.65	2.16	0.79
Regarding order information to be sent to suppliers	3.17	1.91	0.75
To what extent do you use digital collaboration platforms to interact with the following business processes?			
With customers on issues related to the order-delivery process	4.13	1.95	0.74
With suppliers on issues related to the order-delivery process	3.44	1.76	0.77
Digital product data (α: 0.74; CR: 0.74; AVE:0.59)			
To what extent does your company take advantage of the (big) data from the products?			
In your customer relationships (our products produce a continuous stream of data operated by the customer, which is utilized in service performance to the customer)	2.30	1.67	0.78
In your supplier relations (machine and equipment suppliers receive a continuous data flow from the devices we operate, and they perform data-based service activities for us).	2.24	1.54	0.76
Environmental turbulence			
Technological turbulence (α: 0.84; CR: 0.85; AVE:0.65)			
The technology in our industry is changing rapidly	3.52	1.55	0.76
A large number of new product ideas have been made possible through technological breakthroughs in our industry	3.44	1.51	0.86
The technological changes in this industry are frequent	3.65	1.46	0.79

(*continued*)

Table A1

Constructs and items	Mean	SD	Loading
vMarket turbulence (α: 0.48; CR: 0.50; AVE:0.29)			
In our kind of business, customers' product preferences change quite a bit over time	3.40	1.30	0.78
We are witnessing demand for our products and services from customers who have never bought them before	2.40	1.35	0.43
It is very difficult to predict any changes in this marketplace	3.99	1.38	0.25
Competitor turbulence (α: 0.70; CR: 0.75; AVE:0.52)			
Competition in our industry is cutthroat	4.86	1.46	0.91
Price competition is a hallmark of our industry	5.38	1.34	0.75
One hears of a new competitive move almost every day	3.55	1.54	0.40
Operational performance			
Delivery performance (α:0.84; CR: 0.82; AVE:0.53)			
Delivery products quickly or on short lead-times	4.90	1.44	0.65
Provide on-time delivery to our customers	5.22	1.37	0.78
Provide reliable delivery to our customers	5.28	1.36	0.79
Reduce customer order taking time	4.46	1.35	0.68
Production costs (α:0.84; CR: 0.85; AVE:0.58)			
Produce products with low costs	4.03	1.45	0.80
Produce products with low inventory costs	3.99	1.38	0.66
Produce products with low overhead costs	3.94	1.36	0.78
Offer price as low or lower than our competitors	4.14	1.28	0.80
Product quality (α:0.87; CR: 0.88; AVE:0.78)			
High-performance products that meet customer needs	5.26	1.31	0.95
Produce consistent quality products with low defects	5.46	1.18	0.81

Corresponding author
Anni Rajala can be contacted at: arajala@uwasa.fi

The combined effect of platform-based digital connectivity and supply chain capability on SMEs' operational performance

Jukka Vesalainen, Anni Rajala, Tuire Hautala-Kankaanpää*

*corresponding author

Abstract

This study addresses the platform-based digital connectivity (PDC) of firms and focuses on the combined effect of such connectivity and supply chain capability (SCC) on operational performance (OP). We accessed the current stream of research drawing on the resource-based view to investigate if SCC mediates the effect of PDC on OP. We found a partial mediation model best fits the data. A post-hoc analysis showed that the mediation effect of SCC is stronger for the higher levels of SCC. The result is in line with the earlier studies on the complementary effect of digital and non-digital organizational resources but adds that there may be a certain threshold on organizational resources (here SCC) before the complementary effect between digital and non-digital resources activates. The managerial implication of that finding is that there is a need to ensure a strategic fit between existing organizational practices and new digital tools.

Introduction

Digital transformation is a driver of strategic change that all organizations should consider. The availability of digital technologies such as social media, mobile technologies, effective data analytics, the internet of things, and digital platforms enable changes in value-creation practices in intra-organizational and inter-organizational contexts. In the context of digital transformation, digital technology is thus an important enabler of value creation and enhanced performance (Vial, 2019). However, digital technologies alone do not benefit organizations; their use in a specific context makes them valuable (Vial, 2019).

One of the most important functionalities of digitalization relates to inter-organizational connectivity achieved using digital platforms. Platforms enable close collaboration between and coordination of value chain members (Klötzer & Pflaum, 2017). Digital platforms are considered one of the most important innovations to emerge since the mid-2000s because they offer "…a technology architecture that allows the development of its computing functionalities and allows the integration of information, computing, and connectivity technology platforms available to an organization" (Sedera et al., 2016, p. 367). Because these technologies are easy-to-deploy and provide cost-effective inter-organizational connectivity, they offer better development opportunities for smaller organizations than, for example, electronic data interchange (EDI) applications (Bolloju & Murugesan, 2012; Ebert et al., 2017; Sedera et al., 2016). This study addresses the advantages stemming from the use of digital platforms in the supply chain relationships of small and medium-sized enterprises (SMEs) operating in the manufacturing sector. It does so by focusing on the combined effect of platform-based digital connectivity (PDC) and supply chain capability (SCC) on firms' operational performance (OP).

Scholars of supply chain management and information systems research seeking to illustrate the advantages of digital technologies in concert with organizational value-creation processes (Wernerfelt, 1984) have adopted the resource-based view (RBV) on digitalization as a performance driver (Barua, Konana, Whinston, & Yin, 2004; Brandon-Jones, Squire, Autry, & Petersen, 2014; Havakhor, Sabherwal, Steelman, & Sabherwal, 2019; Rai, Patnayakuni, & Seth, 2006). The perspective highlights that digital technologies should be integrated into organizational processes to achieve strategic or operational benefits. Digital technologies and organizational processes thus act as complementary resources for a high-performing organizational configuration (Wade & Hulland, 2004). It has even been argued that organizational processes or the entire strategic profile of the firm should be changed to optimally exploit digital technologies (Ardolino et al., 2018).

Prior research on the effects of digital technologies has also adopted a contingency view that, when combined with a complementarity perspective, comprises the contingent RBV (Brandon et al., 2014). Three distinct research settings can be identified: 1) the complementary effects of various IT-related factors (such as skills and tools), 2) the complementary effects of IT-related factors and organizational processes, and 3) the contingencies of the business environment (Rai & Tang, 2014) or organizational factors (Wade & Hulland, 2004). Studies investigating the combined effect have treated digital platforms as the key resources and other organizational resources as complementary resources interacting with IT-related resources, thus increasing their value (Sedera et al., 2016).

The meta-analysis by Liang, You and Liu (2010) shows the power of the combined effect of digital resources and organizational processes/capabilities as drivers of organizational performance. Several scholars verify the same result concerning SCC as a specific organizational capability (Cámara, Fuentes, & Marín, 2015; Devaraj, Krajewski, & Wei, 2007; Ganbold, Matsui, & Rotaru, 2020; Irfan, Wang, & Akhtar, 2019; Rai et al., 2006; F. Wu, Yeniyurt, Kim, & Cavusgil, 2006). Typically, these studies investigate the mediation effect of supply chain-related factors between IT resources and performance and indicate that IT resources do not directly affect performance but that the effect is channeled through supply chain-related capabilities.

The current research specifically addresses the digitalization of SMEs in the manufacturing sector. This choice makes it possible to focus on the special character of small manufacturing businesses by developing knowledge of the effects of digital transformation specific to SMEs. Research on SME digitalization is scarce, and the results on the benefits are mixed (Bi et al., 2019). Research has established, for example, that the adoption of EDI does not necessarily improve channel partners' performance but can benefit the effectiveness of large corporations (Bolloju & Murugesan, 2012; Ebert et al., 2017; Sedera et al., 2016). Premkumar and Ramamurthy (1995) suggest that smaller firms might start using digital technologies due to external pressures only. One of the few studies addressing SME digitalization is that of Cenamor et al. (Cenamor et al., 2019), which studied the role of new types of digital platform technology in SMEs (Cenamor et al., 2019) and, specifically, the role of network capability as a mediator between digital platform capability and SME performance. In addition, Bi, Davison, and Smyrnios (2019) addressed the combined effect of IT and supply chain-related capabilities and found the latter fully mediate the effect of IT capability on performance. Despite the contributions of those few studies, work on the benefits of digitalization to SMEs is relatively scarce.

This study particularly examines the use of cloud-based digital platforms (e.g., an integration platform as a service, IPaaS) to integrate supply chain activities with upstream and downstream partners (Ebert et al., 2017). These new types of digital resources are supposed to combine with supply chain capabilities to affect a firm's OP. However, we do not treat the platforms as bare IT resources but measure them as *tools in use* for specific supply chain-related tasks (digital supply chain transparency, digitally enabled customer and supplier involvement, digitally automated order/delivery processes, and digital product data).

Theory Development

Theoretical background

Organizational capabilities, in general, have been positively linked to organizational performance (Chahal et al., 2020; Liang et al., 2010). One specific group of organizational capabilities relates to capabilities of an inter-organizational nature, such as supply chain capabilities (F. Wu et al., 2006; W. Yu et al., 2018), collaborative capabilities (Levi-Bliech et al., 2018), and network capabilities (Cenamor et al., 2019). These supply chain-related capabilities encompass the organizational processes and practices a firm uses to share strategic information, integrate activities, and coordinate cooperation with its external partners. Research on supply chain management also categorizes these practices as supply chain integration and confirms that both upstream and downstream integration are important performance drivers for a firm (Ataseven & Nair, 2017; Y. Yu et al., 2020). The basic notion is that firms need their inter-organizational partners if they are to compete successfully (Rai & Tang, 2010; Uzzi, 1997). That is because competition arises between supply chains rather than individual firms (Narasimhan & Kim, 2001; I. L. Wu et al., 2014), and collaborative advantage (Dyer & Singh, 1998) is an important success factor for all organizations. Firms seeking relationship-specific advantages must be willing to be transparent and share strategic and operative information. That willingness fosters effective information sharing between network partners and can be regarded as an additional dimension in the RBV-based reasoning where digital technologies play an important role. In this study, we define PDC as an organizational higher-order capability consisting of three dimensions: 1) technological (the digital tools and platforms in use), 2) meaningful digitally enabled information or data sharing in supply chain-management-related processes, and 3) the intensity of the use of digitally enabled information sharing practices with upstream and downstream partners. This study thus follows the stream of IT-resource-related research that has adopted a wider resource-based perspective on firms' digital competencies (Barua et al., 2004; Brandon-Jones et al., 2014; Rai, Patnayakuni & Seth, 2006).

Digital connectivity refers to the extent to which firms establish digital connections via integrated information systems to share and use strategically valuable information (Bensaou & Venkatraman, 1996; Chang, Kim, Wong, & Park, 2015; Rai et al., 2006) . The aim is to enhance decision making and coordination (Brandon-Jones et al., 2014). The foundation of digital connectivity is exposed in the integration literature and discussed in different research streams, such as those on supply chain management (Malhotra et al., 2005; Smith et al., 2007), organizational research (Premkumar & Ramamurthy, 1995), logistics (Sanders et al., 2011), and information systems (Hsin Chang et al., 2019; Liu et al., 2013; Zhu & Kraemer, 2005). In general, integration research seeks to define the dimensions of, and the extent to which, individual firms form an integrated entity (Barki & Pinsonneault, 2005). Within the supply chain context, connectivity refers to electronic linkages, technological infrastructure, or IT infrastructure as valuable resources related to information sharing (Brandon-Jones et al., 2014; Dubey et al., 2019; Zhu & Kraemer, 2002). In this respect, digital connectivity aligns closely with the information capability presented by Mithas et al. (2011) and Wang et al. (2015), reflecting the firm's ability to deploy technologies as part of its operations.

Platform-based digital connectivity as a first-order resource

According to the RBV logic, firms cannot achieve sustainable competitive advantage by relying on single resources; instead, they must develop higher-order resources. These are created as configurations where a resource and its meaningful use play an important role. These two dimensions are often called *component competence* and *architectural competence* (Henderson & Cockburn, 1994). A firm's competitive advantage is thus based on a multi-layer architecture of resources and processes that deploy those competences effectively (Mills et al., 2003; Vesalainen & Hakala, 2014; Wang & Ahmed, 2007). Wang and Ahmed (2007) differentiate between zero-, first- and second-order elements in a firm's strategic capability architecture. *Resources* represent the zero-order level and are seldom a source of competitive advantage. *Capabilities* are resource/process combinations representing the first-order level, and are more likely to sit within the VRIN framework, in that they are valuable, rare, inimitable and non-substitutable" (Barney, 1991) and thus, create sustainable competitive advantage. *Core capabilities* are defined as a bundle of strategically important capabilities and represent the second-order level in the strategic capability architecture. Viewed from the above perspective, PDC can be defined as a configuration of technological resources combined with meaningful processes and practices that deploy technology in cooperation with partners (Brandon-Jones et al., 2014; Rai et al., 2006).

Furthermore, according to that principle, IT investments are zero-order elements and, as such, are not expected to have an important effect on a firm's competitive advantage. Accordingly, it is understandable that research addressing IT investments and firm performance has generally not identified positive connections (Brynjolfsson & Hitt, 1996). Moreover, IT resources combined with certain relevant purposes represent the first-order level of organizational capabilities. Barua et al. (2004) developed a three-component RBV model of IT-related strategic capability. The study defined OIC as a configuration comprising technology (IT resources), organizational elements (processes and practices that deploy technology), and environmental aspects (the willingness of partners to use digital technology to share information). From the RBV perspective, OIC would be a first-order capability because it connects an IT resource with inter-organizational processes. Similarly, PDC is treated here as a first-order capability. In this study, we link PDC to four central digitally enabled purposes of supply chain management: digital supply chain transparency, digital customer and supplier involvement, digital order/delivery process, and digital product data (Bolloju & Murugesan, 2012).

Digital supply chain transparency. Supply chain transparency is one form of organizational transparency (Hultman & Axelsson, 2007). The term refers to the information and physical flows in the supply chain and is often used synonymously with supply chain visibility, a term widely used in logistics and supply chain management (Barratt & Oke, 2007). Supply chain visibility has been regarded as an organizational capability (Brandon-Jones et al., 2014). We define digital supply chain transparency as the practice of making available relevant supply chain information—such as demand forecasts, inventory levels, or logistic goods flow information—to the partner through a digital platform.

Digitally enabled customer and supplier involvement. Firms can manage competitive challenges by communicating openly along their supply chains (Chen et al., 2004). Previous research has identified several advantages stemming from supplier involvement, including shorter time to market, lower development costs, improved manufacturability, fewer engineering changes, higher product quality, greater product reliability, and innovativeness (Bonaccorsi & Lipparini, 1994; Feng et al., 2010; Ragatz et al., 2002). Modern digital collaboration platforms enable cross-border interaction by combining several important features for successful co-creation (Sedera et al., 2016).

Digitally automated order-delivery processes. The automation of standard information flows over organizational borders has been topical since the 1990s (Sohel & Shroeder, 2001). Various technological solutions have been applied, ranging from point-to-point integration and enterprise middleware integration to the newest cloud-based solutions (e.g., integration platforms-as-a-service, IPaaS) (Ebert et al., 2017). EDI technology has been quite widely adopted to build automatic data transfer between organizations, albeit that is a solution preferred by bigger enterprises. For smaller firms, the adoption of EDI tends to have been mandated by bigger firms in the supply chain. However, new cloud-based technologies have improved the ease of adoption to make digitalization more relevant for smaller firms (Ebert et al., 2017).

Digital product data. The internet of things (IoT) encompasses smart products that continuously generate data to monitor product status and condition, user profiling and tracking behaviors, self-diagnostics, mapping product and user locations and movement, and control and automation (Ardolino et al., 2018; Porter & Heppelmann, 2014). The IoT has led to an increased volume of data, and it has been argued that the ability to share, analyze, and use data form the basis of digitalization competence (Parida et al., 2015; Ritter et al., 2020). The meaningfulness of connectivity comes from the increased volume of information, generating new data from product use, thus improving the product and service offering.

Various multifunctional information and collaboration platforms are available on the market. For example, the Gartner consultancy continuously follows the commercial offerings of various platforms and recognizes the following platform types, among others: platforms for multi-enterprise supply chain business networks, IoT platforms, integration platforms, content service platforms, and collaboration platforms. Each platform type is represented by several commercial applications offered as platform-as-service (PaaS) business logics.

Platform-based digital connectivity, supply chain capability, and operative performance

The meta-analysis of IS research literature by Liang, You, and Liu (2010) showed the mediated models explain the effect of IT resources on firm performance better than direct IT performance models. The study addressed organizational capabilities at a general level, including both intra- and inter-organizational capabilities. Scholars usually refer to supply chain capabilities or inter-organizational integration when writing on inter-organizational capabilities. The concept of supply chain capability (SCC) as a four-dimensional construct consisting of *information exchange, coordination, activity integration, and* *supply chain responsiveness* was originally defined by Wu et al. (2006). It is typically defined as an organizational capability formed as a configuration of several organizational attributes excluding IT-related features. The latest research on the connection between digital resources and firm performance reveals the connection is generally mediated through organizational capabilities. Only Wu et al. (2006) use SCC as a specific type of four-dimensional concept of organizational capability. Yu et al. (2018) used the same SCC variables but modeled them separately. Scholars have more often approached supply chain-related organizational capabilities through *supply chain integration* (Cámara et al., 2015; Devaraj et al., 2007; Ganbold et al., 2021; Irfan et al., 2019; Rai et al., 2006). Rai et al. (2018) studied supply chain process integration as a single dimension of supply chain capability. In addition, Ganbold et al. (2020) focused on supply chain integration dividing the concept into supplier, customer, and internal integration. Irfan et al. (2019) treated SCC as a combination of information integration and operational coordination. In contrast, Brandon-Jones (2014) used supply chain visibility as an organizational capability mediating IT-related attributes and firm performance. Bi et al. (2019) investigated the combined effect of IT capabilities, inter-organizational process alignment, and process flexibility among SMEs. The study found a full mediation through supply chain-related capabilities. In all the studies mentioned above, supply chain-related capabilities are seen as a digitally enabled organizational capability, where digitalization is a catalyst for the improvement of general supply chain-related capabilities. Theoretically, these approaches derive from the RBV and the idea of organizational capabilities as resource/activity configurations that are difficult to imitate, thus creating a sustainable competitive advantage for the firm.

The so-called catalytic effect of digitalization is recognized in prior research (Wu et al. 2006). The effect means that IT resources or digital tools improve the quality of organizational processes and capabilities. On a general level, the meta-analysis by Liang et al. 2010 reports a positive relationship between IT resources and capabilities for inter-organizational integration. More specifically, the positive relation between IT resources and organizational capabilities refers, for example, to the connection of IT advancement and IT alignment to the dimensions of SCC (Wu et al. 2010), the positive relation between supply chain-wide use of big data and SCC (Yu et al. 2018), and the connection between digital connectivity and supply chain visibility (Brandon-Jones et al. 2014). The inter-organizational integration research stream has demonstrated the catalytic effect of IT resources and capabilities. That effect advances positive connections between cloud computing or the use of Web 2.0 technologies and supply chain integration (Cámara et al., 2014), e-business capability and customer/supplier integration

(Ganbold, 2020), and inter-firm IT assimilation and information integration/operational coordination (Irfan et al., 2019). We thus hypothesize:

> *H1: Platform-based digital connectivity is positively linked to supply chain capability*

Several meta-analyses have established that capabilities related to the supply chain influence organizational performance. More specifically, Wu et al. (2006) found a positive relationship between SCC and operational and financial performance. Yu et al. (2018) found a positive relationship between SCC-dimensions *coordination* and *responsiveness* and financial performance. Among integration studies, Ataseven and Nair (Ataseven & Nair, 2017) found both customer and supplier integration positively correlate with performance factors relating to cost, delivery, and flexibility. Chahal et al. (2020) found supply chain integration and organizational capabilities are positively linked with business, financial, and competitive performance measures. Leuscher et al. (Leuschner et al., 2013) found a positive connection between both information integration and relational integration and firm performance. Accordingly, we hypothesize:

> *H2: Supply chain capability is positively linked to operative performance*

The logic derived from the RBV suggesting an indirect effect of PDC is based on IT investments being a zero-order resource (Wang & Ahmed, 2007), indicating that digital platforms available on the market are not a source of competitive advantage. The main idea of the indirect, mediated effect is that IT resources should be bundled with organizational value-creating processes to deliver operational benefits. Most of the studies referred to above found an indirect effect (fully or partially mediated) between IT or digital resources and organizational performance. The mediated effect also seems to outperform the direct effects on performance in research settings using organizational capabilities not related to the supply chain (Liang et al., 2010). Some studies using supply chain capability-related factors as mediators have demonstrated full mediation between IT-related variables and performance, indicating that IT does not have a direct effect on performance; instead, the effect is channeled through an organizational capability (Bi et al., 2019; Cámara et al., 2015; Devaraj et al., 2007; Rai et al., 2006; F. Wu et al., 2006). Other studies found either a partial mediation (Brandon-Jones et al. 2014; Irfan et al. 2017; Cenamor et al. 2019) or did not test the mediation effect, but the modeled effect of IT-related factors was expected to be channeled through SCC (Yu et al.2018; Levi-Bliech, 2018; Ganbold et al. 2020). Given the overall results of research on the connections between IT and performance indicating the strong mediating effect of organizational capabilities as a catalyst (Liang et al., 2010), we hypothesize:

H3: Platform-based digital connectivity has an indirect effect on operative performance, and the effect is mediated by SCC

Method

Data collection and sample

The data were collected from SMEs operating in the manufacturing sector. We used the Orbis database to identify 1136 companies categorized with the manufacturing code C based on the standard industrial classification and with an annual turnover of between EUR 1.5 million and EUR 50 million. Twenty-one of the 720 companies completed the survey following an e-mail invitation. Seeking to improve the response rate, we contacted another 414 companies by telephone, of which 87 declined the invitation to participate in the study. We sent a web-based survey to the firms' chief executive officers (CEOs) in line with the key respondent approach. We received 173 completed surveys back, which we pooled with the original 21 responses. Therefore, the final sample consists of 194 SMEs, providing a survey response rate of 17 %.

The eventual key respondent sample comprised CEOs (83 %), chief financial officers (4 %), and other management positions (13 %). The firm sample mainly consists of very small firms; 73 % have fewer than 50 employees, and 69 % have a turnover of less than EUR 10 million. Most of the companies operate in the metal industry (32 %), others are in electric or electronic machinery (22.7 %), food manufacturing (9.8 %), leather, stone, clay, and glass production (3.6 %), wood, furniture, and paper manufacturing (9.3 %), and other manufacturing sectors (8.8 %).

Measures

Digital connectivity was measured with 20 items addressing the digital connectivity of the firm upstream and downstream. All the digital connectivity items were measured with a 7-point scale anchored with *not at all* (1) and *very much* (7). Because the digital connectivity measurement instrument is novel, we conducted several tests to assess the validity and reliability of the scale.

Initially, an exploratory factor analysis was carried out, and the resulting dimensions of PDC aligned with the theoretical expectations outlined in the theory development. The analysis yielded four dimensions, namely, *digital supply chain transparency* (consisting of 6 items), *digital product data* (consisting of 2 items), *digitally enabled order-delivery process* (consisting of 4 items), and *digital* *customer/supplier involvement* (consisting of 6 items). During the measurement testing, two items were excluded due to low loadings. Subsequently, the validity and reliability of the digital connectivity dimensions were evaluated. Despite the digital supply chain transparency dimension displaying a below-par average variance extracted (AVE) value (less than 0.5), both the composite reliability (CR) and Cronbach's alpha values surpassed the 0.7 threshold values. Thus, it was concluded that all the dimensions of digital connectivity exhibited satisfactory validity and reliability. The recorded measures were digital information sharing (AVE=0.43, CR=0.82, α=0.82), use of digital data (AVE=0.59, CR=0.74, α=0.74), digitally enabled order-delivery process (AVE=0.58, CR=0.85, α=0.84), and digital customer/supplier involvement (AVE=0.64, CR=0.91, α=0.92).

Supply chain capability was measured through three dimensions: *responsiveness* (4 items), *information exchange* (4 items), and *activity integration* (3 items). The measurement instrument was adopted from the study by Wu et al. (2006). All these dimensions were measured on a 7-point scale anchored with *totally disagree* (1) and *totally agree* (7). The measures of responsiveness (AVE=0.59, CR=0.85, α=0.84), information exchange (AVE=0.76, CR=0.93, α=0.93), and activity integration (AVE=0.74, CR=0.89, α=0.89) showed satisfactory reliability.

The instrument used to measure *operational performance* was borrowed from prior studies (Ward & Duray, 2000; C. Y. Wong, Boon-Itt, & Wong, 2011b). This measurement evaluated operational performance through three dimensions: *delivery performance* (consisting of 4 items), *production costs* (consisting of 4 items), and *product quality* (consisting of 2 items). A 7-point scale ranging from totally disagree (1) to totally agree (7) was used to measure all these dimensions. Delivery performance (AVE=0.53, CR=0.82, α=0.84), production costs (AVE=0.58, CR=0.85, α=0.84), and product quality (AVE=0.78, CR=0.87, α=0.87) exhibited acceptable levels of reliability and validity. To ensure the validity of the operational performance measurement, the study analyzed the connection between the three-dimensional operational performance measures and objective performance indicators derived from a financial database (Orbis). The analysis showed a positive correlation between the three-dimensional operational performance measure and the earnings before interest, taxes, depreciation, and amortization margin of the companies (0.15, $p<0.05$), implying the reliability of the subjective performance measure employed in the study.

We also used company age and size as *control variables*. Company age is a continuous variable. Company size was measured in terms of turnover and was dummy coded as 0 (turnover less than EUR 10m) and 1 (turnover over EUR 10m).

Test of the measurement model

A confirmatory factor analysis conducted using Stata 15.1 software ensured the validity of the measurement model. All items loaded significantly on their latent variables ($p<0.000$), and the loadings ranged from 0.52 to 0.93. All loadings were acceptable according to the recommendation of Hair et al. (2014), as each exceeded the threshold of 0.5. The loadings and items are presented in Appendix 2. The fit indices indicate that the data fit the model well ($x^2/df=1.77$; CFI=0.90; TLI=0.89; SRMR=0.08; RMSEA=0.06). Based on these tests, we can conclude that the measurement model is acceptable.

To minimize and assess the influence of common method variance (Podsakoff et al., 2003), we initially compared the research model to a single-factor model (Podsakoff et al., 2003). The research model presented a considerably better model fit ($x^2/df=1.77$; CFI=0.90; TLI=0.89; SRMR=0.08; RMSEA=0.06) than the single-factor model ($x^2/df=5.74$; CFI=0.33; TLI=0.29; SRMR=0.17; RMSEA=0.16), indicating that common method variance is low. Secondly, we used the marker variable approach, which is suggested to be a suitable method for managing the effects of common method variance (Podsakoff et al., 2003). This method involves incorporating a theoretically unrelated marker variable in the analysis, but it is commonly challenging to incorporate unrelated constructs in surveys. Therefore, it is permissible to employ a construct that has a low correlation with the main study variables (Richardson et al., 2009). We did not include any wholly unrelated constructs in our survey; therefore, we chose a marker variable that was measured in a similar way as the main study variables and was more likely to reflect the same method variance, and that also had quite a low correlation with the research variables. The chosen marker variable is communication, which was measured through three items adopted from the study by Cheung et al. (2010). During the analysis, the inclusion of the marker variable did not seriously affect the results as all the same relationships remained as had been observed without the marker variable, and its inclusion weakened the fit indices. The results of the above tests indicate that common method variance is effectively controlled in the analysis and therefore poses no threat to the interpretation of the results of the study.

Results

The hypotheses were tested using structural equation modeling with Stata 17.0 software. Appendix 1 reports correlations between constructs, means, and standard deviations. In order to examine the mediating role of SCC, we adopted the recommendations of James et al. (2006). Rather than the Baron and Kenny

(1986) method, we utilized the SEM approach, which is deemed more appropriate as it permits testing for both complete and partial mediation (James et al., 2006). Additionally, the Baron and Kenny method (1986) is considered excessively cautious since the SEM approach for mediation does not necessitate a significant relationship between the antecedent and outcome or significant total effects in mediation (see, e.g., James et al., 2006; Zhao et al., 2010). Zhao et al. (2010) argue that instead of full, partial, and no mediations (as in Baron & Kenny, 1986), there are five types of mediation: complementary mediation, competitive mediation, indirect-only mediation, direct-only nonmediation, and no-effect nonmediation. As we follow the SEM approach, we will test our model both without a direct effect between PDC and OP (model 1) and with a direct effect between PDC and OP (model 2).

Model 1: Full mediation

The measures of the overall fit of the structural model were acceptable ($x^2/df=1.73$; CFI=0.89; TLI=0.88; SRMR=0.08; RMSEA=0.06). The structural paths are summarized in Figure 1. Control variables of company age and size were not found to influence OP. The results of Model 1 show that Hypothesis 1 is supported, as the direct path from PDC to SCC was positive ($\beta=0.49$, $p\leq0.001$). Further, SCC has a significant positive effect on OP ($\beta=0.46$, $p\leq0.001$), thus supporting Hypothesis 2. These results thus indicate that SCC can function as a mediator between PDC and OP.

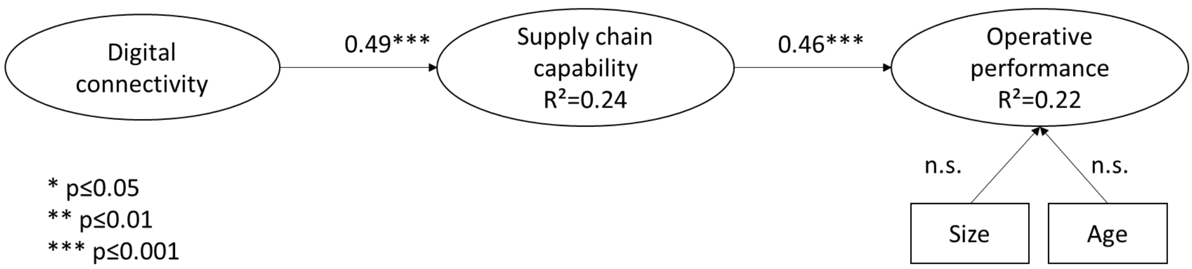

Figure 1. Summary of the structural paths of full mediation (Model 1)

To test Hypothesis 3, we analyzed the indirect effect of PDC on OP through SCC. A significant parameter estimate was found for the indirect effect of PDC on OP ($\beta=0.17$, $p\leq0.001$), which indicates that Hypothesis 3 is supported.

Model 2: Partial mediation

Next, we tested the model with a direct path from PDC to OP to detect whether the mediation is full or partial (James et al. 2006). The measures of the overall fit of the structural model are acceptable (x^2/df=1.72; CFI=0.89; TLI=0.88; SRMR=0.08; RMSEA=0.06). The results show that the paths from PDC to SCC (β=0.52, p≤0.001) and from SCC to OP (β=0.69, p≤0.001) are positive and statistically significant. These results again indicate that Hypotheses 1 and 2 are supported. The direct path from PDC to OP is negative (β=-0.33, p≤0.01). The indirect effect of PDC on OP was found to be positive and statistically significant (β=0.27, p≤0.001), providing evidence supporting Hypothesis 3. These results demonstrate that SCC works as a mechanism that turns the negative direct effect of PDC on OP positive. According to Zhao et al. (2010), the model is a competitive mediation model, as both the mediated and the direct effects exist and point in opposite directions. This type of mediation is also called inconsistent mediation (e.g., MacKinnon, Fairchild, & Fritz, 2007).

In assessing the significance of the indirect effect of PDC on OP, we used a bootstrapping procedure that created a 95 % confidence interval around the indirect effect estimate (see, e.g., Lau & Cheung, 2012; Zhao et al., 2010). This procedure also indicated the statistical significance of the indirect effect, the Monte Carlo test was significant (z=4.55, p=0.000), as was the Sobel test (z=4.59, p=0.000), and in accordance with the 95 % confidence intervals, the indirect effect was statistically significant.

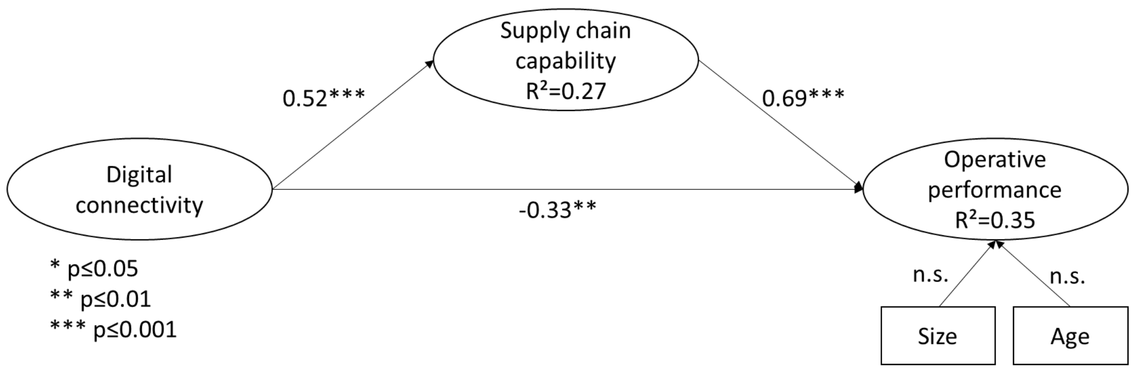

Figure 2. Summary of the structural paths of partial mediation (model 2)

Model comparison

Further, we compared the partial mediation model (Model 2) with the full mediation model (Model 1) to examine whether SCC fully or partially mediates the hypothesized relationship (Table 1). Based on (1) overall model fit as measured by x^2/df, CFI, TLI, and RMSEA; and (2) Akaike's Information Criterion (AIC), the partial mediation model seems to offer a better fit with the data than the full mediation model.

Table 2. Results of structural equation modeling of full and partial mediation models.

	Model 1: Full mediation	**Model 2: Partial mediation**
Direct effects		
Digital connectivity → supply chain capability	0.49***	0.52***
Digital connectivity → operational performance		-0.33**
Supply chain capability → operational performance	0.46***	0.69***
Company size → operational performance	0.04	0.05
Company age → operational performance	-0.05	-0.06
Indirect effects		
Digital connectivity → operational performance	0.17***	0.27***
x^2/df	1.73	1.72
CFI	0.89	0.89
TLI	0.88	0.88
RMSEA	0.06	0.06
AIC	24792.10	24785.15
R^2	0.22	0.35

*p<0.05, **p<0.01, ***p<0.001

In conclusion, after testing both full and partial mediation models, we have demonstrated that (1) PDC has a positive effect on SCC, (2) SCC has a positive effect on OP, and (3) the positive effect of PDC on OP is mediated by SCC. This means that our research hypotheses—H1, H2, and H3—are all supported.

Given the somewhat surprising inconsistent mediation effect found in the above analysis, we continued the analysis with an additional explorative phase by further examining the combined effect of PDC and SCC on OP, following a post-hoc research strategy suggested by Ludlow and Klein (2014). We conducted a post-hoc analysis to explore the mediation model as a group SEM. The data were divided into high SCC (n=119) and low SCC groups (n=73) to unveil if the level of SCC makes a difference in the mediation model shown above. The results (Table 3) indicate that in both the low ($\beta=0.23$, $p<0.05$) and high SCC groups ($\beta=0.25$, $p<0.01$), PDC positively affected SCC. Further, the results indicate that in the low SCC group, PDC negatively affected OP ($\beta=-0.44$, $p<0.001$), while in the high SCC group, PDC had no direct effect on OP. The effects of SCC on OP were found to be positive in the high SCC group ($\beta=0.43$, $p<0.001$), whereas such an effect was not found in the low SCC group. The indirect effect of PDC on OP via SCC was found to be significant in the high SCC group ($\beta=0.08$, $p<0.05$) and insignificant in the low SCC group. The results indicate that a relatively high level of SCC is needed before the combined effect of PDC and SCC triggers improved OP. The post-hoc analysis shows SCC acts as both a mediator and moderator. The moderator role of SCC was also tested in a separate analysis by modeling it as a moderator for PDC and OP. The analysis showed SCC significantly moderates the relationship between PDC and OP.

Table 3. The results based on split sample analysis

	Low SCC	**High SCC**
Direct effects		
Digital connectivity → supply chain capability	0.23*	0.25**
Digital connectivity → operational performance	-0.44***	0.02
Supply chain capability → operational performance	0.15	0.43***
Company size → operational performance	0.14	-0.07
Company age → operational performance	-0.13	0.04
Indirect effects		
Digital connectivity → operational performance	0.03	0.08*
x^2/df	1.54	
CFI	0.96	
TLI	0.84	
RMSEA	0.075	
R^2	0.33	

*p<0.05, **p<0.01, ***p<0.001

Discussion

The current research studies the combined effect of PDC and SCC on OP by applying an RBV lens treating the joint effect of digital and organizational capabilities as a higher-order resource. Moreover, the study focuses on SMEs in the manufacturing sector and the platform-based digital tools offering them a means to progress digital supply chain connectivity. The choice was justified because new cloud-based digital platforms offer smaller firms a realistic means of digitalization (Ebert et al. 2017). The review of previous research led to the hypothesis that PDC would not directly affect OP, but the effect would be channeled through SCC; the hypothesized effects were supported by the data obtained. Given that inconsistent partial mediation appeared to be the strongest model, the study was extended with an explorative exercise examining the role of high/low SCC for the hypothesized mediation models. That approach revealed that the mediation works only in the high SCC group, indicating that SCC acts as both a mediator and moderator for the relationship between PDC and OP.

This study found the benefits of digitalization for SMEs follow the same basic logic as revealed in corresponding studies based on more general datasets. Digital capabilities do not have a positive direct effect on organizational performance. On the contrary, we found a significant negative direct effect on digital connectivity and OP. Further investigation revealed that a firm with well-developed supply chain capabilities seems to benefit from adopting digitally enabled supply chain practices. Conversely, the benefit is likely negligible for firms with weak supply chain capabilities, and the implementation costs might even mean the adoption detracts from performance. The combined effect of PDC and SCC examined here signals a role for both the complementary and conditional effects of PDC and SCC on firms' OP. According to the complementary logic, PDC and SCC form a second-order resource—a core capability—to function as a source of improved organizational performance. Conditional logic posits that the impact of digitalization depends on internal organizational contingencies. Extant supply chain research following the conditional logic has used factors linked to the business environment as moderators specifying the advantages of digitalization. These external contingency factors are typically exchange- or partner-related (Bensaou & Venkatraman, 1995) or competition-related (Havakhor et al., 2019). This study treated SCC as an internal contingency factor in the post-hoc analysis. According to the classical contingency studies (Lawrence & Lorsch, 1967), two types of fit are linked to organizational performance: the organization–environment fit and the strategy–structure fit. The notion of strategy–structure fit highlights the importance of internal coherence in intra-organizational conditions (Tushman & Nadler, 1978). In IS studies, the prevalent internal organizational conditions have been used as a moderator; for example, Sedera et al. (2016) modeled existing IS infrastructure as an organizational capability that determines the advantages of digital platforms. Our result on the contingency effect of SCC on the relationship between PDC and OP relates to the intra-organizational conditions of fit. Based on that logic, we propose that the performance related to digitalization is conditional on organizational characteristics.

The results of this study indicate SMEs with well-developed supply chain capabilities benefit from digitalization, but those with underdeveloped supply chain capabilities do not. The benefits that can be derived from digitalization are thus dependent on the intra-organizational fit between supply chain-related capabilities and digital tools introduced. It seems that adopting new digital platforms cannot enhance underdeveloped supply chain practices sufficiently to boost information sharing, activity integration, and supply chain responsiveness. In other words, if these practices are not already present at a certain level, firm performance will not improve; at least in the short term. Alternatively, if a firm is used to sharing information, integrating activities, and responding to environmental changes in collaboration with its partners, then the introduction of new digital platforms to enhance integration can boost SCC and improve organizational performance.

The empirical results of this study indicate that both complementary and conditional logics play a role in the combined effect of IT-related and supply chain capabilities on organizational performance. The complementary logic originates from the RBV and highlights the layered and combined nature of resources and capabilities. Bare IT resources represent the zero-order level in capability architectures, and it is thus not surprising that IT investments as such have not been found to positively affect organizational performance. According to the same logic, it is understandable that the combined effects of digital capabilities and organizational processes are positively connected to organizational performance. The conditional logic, originating from contingency theory, assumes that the fit between conditions and organizational characteristics defines the level of performance. In this study, we refer to the congruence view (Tushman & Nadler, 1978) that highlights the fit between intra-organizational elements. Based on that logic, digitalization is beneficial for SMEs if the firms' supply chain capabilities are well-developed when new digitally enabled practices are introduced. This thinking corresponds with ideas emphasizing the need to change or develop organizational processes as a result of digitalization (Ardolino et al., 2018). Digitalization both enables organizations to change their value-creating processes and practices and impels them to do so.

As a result of the empirical analysis, it is possible to propose that the intra-organizational conditional logic triggers the complementary benefits of digitalization and organizational resources. This finding supports the argument that organizations must change the existing processes, structures and strategies to fully exploit the opportunities of digitalization (Ardolino et al., 2018). We thus propose the following:

The advantages of digitalization flow from both the complementary and conditional logics. As a configuration, digital and organizational capabilities form a second-order capability that improves a firm's competitive position more than would a zero-order resource or first-order capability. The configuration is, however, contingent on the fit between digital and organizational capabilities.

Managerial implications

Many businesses are undergoing an accelerated digital transformation. Their development seems to be a somewhat trial-and-error process rather than a planned path to new modes of action that bring success. The results of the current study indicate that managers and experts responsible for the digitalization of a firm's business processes should be aware of the current status of those processes to ensure congruence between the new digital applications and firms' value-generating processes. If, for example, a firm lacks organizational capabilities in supply chain management, digitalization will not offer a solution capable of improving performance. Management may be inspired by the opportunities promised by digitalization, which thus functions as an important opportunity-driven driver of development that can direct managerial attention to technological enablers. As this inspiration is a positive catalyst for development, management should also pay attention to the firm's value-generating processes to ensure that digitalization fits within the current processes and practices. If not, there is a need to develop the processes first or at least alongside the digitalization efforts.

Limitations and future research

This study used a novel research instrument to measure PDC. Developing another new research construct may not advance the consistency of research in this field but adds variation to the conceptual means of research. Digitalization is a multifaceted field where a range of research constructs can be justified. This study addresses a new area of digitalization (digital platforms). Because we wanted to measure that aspect of digitalization as a first-order capability, we could not find an existing research construct to use. Our contribution is therefore partly general and partly contextualized to SMEs. Regarding the more general propositions formulated, it should be noted that this study specifically addressed SMEs in the manufacturing sector.

We hope the results of the current study will encourage scholars to delve deeper into the logical mechanisms explaining the combined effects of digital and organizational capabilities. As the dominant research setting seems to be mediation modeling, with the idea of digitalization as a catalyst for organizational processes, there might be room for an intra-organizational conditional logic highlighting the internal congruence. The results of this study indicate these approaches should not be mutually exclusive but complementary.

Appendix 1.

Constructs and items	Mean	SD	Loading
Digital connectivity			
Digital supply chain transparency (α: 0.82; CR: 0.82; AVE:0.43)			
Assess the following statements about the transparency of information from your company's perspective			
To what extent do your customers share information on demand forecasting digitally (through a portal or collaboration platform)?	2.93	1.85	0.52
To what extent do you share information on demand forecasting with your suppliers digitally (through a portal or collaboration platform)?	2.40	1.62	0.78
To what extent do you have a view of the capacity or warehouse situation of your suppliers (through a portal or collaboration platform)	2.21	1.37	0.58
To what extent do you make your capacity or warehouse situation available to your customers (through a portal or collaboration platform?)	2.16	1.58	0.61
To what extent do you let your customers follow their order/delivery progress digitally?	2.50	1.76	0.70
To what extent do your suppliers let you follow order/delivery progress digitally?	2.43	1.52	0.71
Digital customer/supplier involvement (α: 0.92; CR: 0.91; AVE:0.64)			
To what extent do you use digital collaboration platforms to interact in the following business processes			
With customers on issues related to the development of your product	3.01	1.76	0.75
With suppliers on issues related to the development of your product	2.76	1.57	0.75
With customers on issues related to the development of activities	3.02	1.71	0.82
With suppliers on issues related to the development of activities	2.65	1.55	0.85
With suppliers on training or advice related to their products	2.83	1.64	0.84
In training or advising customers	2.92	1.72	0.80
Digitally enabled order-delivery process (α: 0.84; CR: 0.85; AVE:0.58)			
To what extent have you integrated firms' IT systems with your partners?			
In order to get information from customers	3.65	2.16	0.79

In order to send information suppliers	3.17	1.91	0.75
To what extent do you use digital collaboration platforms to interact with the following business processes?			
With customers on issues related to the order/delivery process	4.13	1.95	0.74
With suppliers on issues related to the order/delivery process	3.44	1.76	0.77
Digital product data (α: 0.74; CR: 0.74; AVE:0.59)			
To what extent does your company generate and use product data?			
With regard to customer relationships: our products produce a continuous stream of data when operated by the customer	2.30	1.67	0.78
With regard to supplier relationships: machine and equipment suppliers receive a continuous data flow from the devices we operate, and they perform data-based service activities for us	2.24	1.54	0.76
Supply chain capability			
Activity integration (α: 0.; CR: 0.89; AVE:0.74)			
Our company develops strategic plans in collaboration with our partners	4.06	1.48	0.74
Our company collaborates actively in forecasting and planning with our partners	4.09	1.54	0.92
Our company projects and plans future demand collaboratively with our partners	4.29	1.43	0.90
Responsiveness (α: 0.; CR: 0.85; AVE:0.59)			
Our company always forecasts and plans activities collaboratively with our partners	4.83	1.39	0.79
Compared to our competitors, our supply chain develops and markets new products more quickly and effectively	4.10	1.41	0.68
In most markets, our supply chain competes effectively	4.75	1.27	0.88
The relationship with our partner has increased our supply chain responsiveness to market changes through collaboration	4.69	1.26	0.72
Information exchange (α: 0.; CR: 0.93; AVE:0.76)			
Our company exchanges more information with our partners than our competitors do with their partners	4.12	1.28	0.85
Information flows more freely between our company and our partners than between our competitors and their partners	4.11	1.23	0.88

Our company benefits more from information exchange with our partners than do our competitors from their partners	4.03	1.16	0.90
Our information exchange with our partners is superior to the information exchanged by our competitors with their partners	3.88	1.13	0.85
Operational performance			
Delivery performance (α:0.84; CR: 0.82; AVE:0.53)			
Delivery of products quickly or short lead-time	4.90	1.44	0.66
Provide on-time delivery to our customers	5.22	1.37	0.78
Provide reliable delivery to our customers	5.28	1.36	0.79
Reduce customer order taking time	4.46	1.35	0.68
Production costs (α:0.84; CR: 0.85; AVE:0.58)			
Produce products with low costs	4.03	1.45	0.80
Produce products with low inventory costs	3.99	1.38	0.66
Produce products with low overhead costs	3.94	1.36	0.78
Offer prices as low or lower than our competitors	4.14	1.28	0.80
Product quality (α:0.87; CR: 0.87; AVE:0.76)			
High-performance products that meet customer needs	5.26	1.31	0.93
Produce consistent quality products with low defects	5.46	1.18	0.83

Data availability statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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