Mina Nasiri

PERFORMANCE MANAGEMENT IN DIGITAL TRANSFORMATION: A SUSTAINABILITY PERFORMANCE APPROACH

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LUT University

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Abstract

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In recent years, the significant potential and ubiquitous use of digital technologies has motivated firms to achieve sustainable competitive advantages and enhance their ability to fully exploit the benefits of digital transformation. However, the complexity and incomplete understanding of the approaches to digital transformation can be barriers to firms' success, rendering it impossible to tackle challenges in digital transformation without functional, operational, and strategic initiatives. It is not clear which technologies, strategies, and capabilities are required in digital transformation to achieve sustainability performance. Furthermore, there are no clear strategic approaches to the full exploitation of digital transformation with the aim of sustainability performance.

This dissertation contributes to the knowledge about the approaches to managing (sustainability) performance in digital transformation. First, in addition to determining the drivers of digital transformation, the dissertation enhances understanding of the required smart technologies, digital business strategies, and digital-related capabilities for managing (sustainability) performance in digital transformation. Second, it investigates the necessity of strategic approaches in digital transformation to achieve sustainability performance. Third, it clarifies the roles of both corporate sustainability strategies and performance measurement systems in facilitating the achievement of sustainability performance in digital transformation.

The results of this dissertation have been achieved through four publications, for which the data was gathered through survey questionnaires from SMEs in Finland. The results show that smart technologies, digital business strategies, and digital-related capabilities are necessary to achieve digital transformation. However, the sole utilization of those drivers does not provide sustainability performance; employing strategic approaches, including a corporate sustainability strategy and performance measurement systems, in tandem with those drivers creates sustainability performance in digital transformation. Moreover, this dissertation provides many new insights for both managers and practitioners regarding approaches to digital transformation with the aim of achieving sustainability performance.

Keywords: digital transformation, smart technologies, digital business strategy, digital-related capabilities, sustainability performance

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Contents

List of publications

This dissertation is based on the following papers. The rights have been granted by the publishers to include the papers in the dissertation.

I. Nasiri, M., Ukko, J., Saunila, M., Rantala, T. (2020), “Managing the digital supply chain: The role of smart technologies”, *Technovation*, 102121.

II. Saunila, M., Nasiri, M., Ukko, J., & Rantala, T. (2019), “Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy”, *Computers in Industry*, 108, 178-185.

III. Ukko, J., Nasiri, M., Saunila, M., & Rantala, T. (2019), “Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance”, *Journal of Cleaner Production*, 236, 117626.

IV. Nasiri, M., Ukko, J., Saunila, M., Rantala, T., & Rantanen, H. (2020), “Digital-related capabilities and financial performance: The mediating effect of performance measurement systems”, *Technology Analysis & Strategic Management*, 32(12), 1393-1406.

Author’s contribution

In publication I, Mina Nasiri is the principal author and investigator. She was responsible for the research design and conducting the research (literature review, empirical data collection, methodology, data analysis, and conclusions). She had a primary role in writing the paper.

In publication II, Mina Nasiri was responsible for conducting the research (literature review, empirical data collection, methodology, data analysis, and conclusions). She had a primary role in writing the paper.

In publication III, Mina Nasiri was responsible for conducting the research (literature review, empirical data collection, methodology, data analysis, and conclusions). She had a primary role in writing the paper.

In publication IV, Mina Nasiri is the principal author and investigator. She was responsible for the research design and conducting the research (literature review, empirical data collection, methodology, data analysis, and conclusions). She had a primary role in writing the paper.

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1 Introduction

1.1 Background of the study

Digital transformation has drawn significant attention from scholars and business practitioners during the last couple of decades (Besson and Rowe, 2012; Hinings et al., 2018; Li et al., 2018; Fischer et al., 2020). Previous studies on digital transformation have investigated the enablers of digital transformation (Chatterjee et al., 2002; Jarvenpaa, 1991), the capabilities and resources needed for digital transformation (Cha et al., 2015; Daniel and Wilson, 2003), process in digital transformation (Kim et al., 2007; Tan and Pan, 2003), and the advantages of digital transformation (Ash and Burn, 2003; Lucas et al., 2013). The digital transformation examined in these studies involved technologies connected with management information systems inside the companies (Boersma and Kingma, 2005), which differ from current digital technologies that cross the boundaries (Berman, 2012; Hess et al., 2016; Matt et al., 2015). Smart technologies with various characteristics, such as transferability (e.g., simplification of converting digital representations of objects), malleability (e.g., addressability and re-programmability), and homogeneity (e.g., standardized software languages), have been embedded at the core of these technologies meshing digital, which change physical artifacts to digitalized artifacts (Hinings et al., 2018; Kallinikos et al., 2013; Yoo, 2010; Yoo et al., 2010).

In 2011, smart devices with embedded sensors and cameras as well as wireless connectivity replaced with computers, which have enabled activities ranging from videoconferencing to real-time monitoring in production lines (Berman, 2012). Digital transformation has also changed the way people communicate and interact with their surroundings (Büyüközkan and Göçer, 2018; Matt et al., 2015). For instance, traditional phone calls have transformed into video calls in which people can share moments with their families and friends (Berman, 2012). Traditional ways of conducting business in local areas has turned into fully automated business in international and long-distance markets (Frank et al., 2019; Yoo et al., 2012). The emergence of digital technologies has facilitated business operations regardless of distance, time, and types of activities (Fichman et al., 2014; Yoo et al., 2012; Yoo, 2010). For example, digital transformation along with smart technologies enables adaptable systems in manufacturing to develop flexible lines in the production process to offer diverse products in widely differing conditions (Wang et al., 2016b). Thus, digital transformation has altered traditional ways of living, working, organizing companies, and the structures of entire industries (Fichman et al., 2014; Kohtamäki et al., 2020). The vast array of emerging changes has led firms to equip themselves with smart technologies (Hinings et al., 2018; Kallinikos et al., 2013; Yoo, 2010), digital business strategies (Bharadwaj et al., 2013; Hess et al., 2016; Mithas et al., 2013), and digital-related capabilities (El Sawy et al., 2016; Hess et al., 2016; Li et al., 2018; Vial, 2019) to manage issues in digital transformation.

Digital transformation is defined as the transformation precipitated by the presence of digital technologies (Hess et al., 2016; Li et al., 2018), which created fundamental changes in business operations and processes (Hess et al., 2016), operational routines (Berman, 2012), and companies' capabilities (Berman, 2012) and strategies (Li et al., 2018; Matt et al., 2015). Because of the vast number of changes in people, technology, and processes in the digital era, ways of managing performance in companies has changed (Kohtamäki et al., 2020; Li et al., 2018; Tekic and Koroteev, 2019). For instance, performance measurement tools (e.g. performance measurement systems) have been frequently recommended as a critical means of providing managers with information to manage firms' operations in the event of transitioning (Choi et al., 2013; Hall, 2008; Hitt et al., 2011; Koufteros et al., 2014; Melnyk et al., 2004), thereby facilitating the implementation of strategy (e.g., Davis and Albright, 2004) and improving organizational performance in digital transformation (Nudurupati et al., 2016). Although operating in digital ecosystems has enhanced organizational performance in recent decades, at the same time, it has created many expectations for conducting business based on sustainable values (Ruiz-Mercader et al., 2006).

Unlike in the past, when an organization's major focus was financial benefits, organizations must now compete to strike a balance between the environmental, social, and economic dimensions of their business. This is called sustainability performance (Gupta et al., 2020). Digital transformation changes traditional methods of communication and interactions into cross-border interactions between customers, competitors, and suppliers, which leads to drastic shifts in economic, social, and political perspectives (Fischer et al., 2020; Hansen and Sia, 2015; Hess et al., 2016). One far-reaching impact of digital transformation is that digital manufacturing reduces material and resource consumption because of reductions in inventory and logistic efforts, resulting in economic and environmental sustainability. Additionally, digital manufacturing enhances social sustainability by enabling equality between all stakeholders in markets and ecosystems, which contributes to narrowing educational, technological, and resource gaps between countries (Chen et al., 2015; Holmström et al., 2017). Digital transformation in societies has provided governments with high-quality, timely, and reliable data, resulting in less corruption, greater transparency, revenue growth, and cost reductions (ElMassah and Mohieldin, 2020).

1.2 Purpose of the study and research problem

In recent decades, digital transformation has emerged as a noteworthy phenomenon, changing societies and industries (Fischer et al., 2020; Li et al., 2018; Tekic and Koroteev, 2019; Vial 2019). Digital transformation can produce profits by creating business opportunities and increasing efficiency (Kohtamäki et al., 2020; Tekic and Koroteev, 2019), reducing costs and resource consumption (Chen et al., 2015; Hess et al., 2016; Kohtamäki et al., 2020), and spurring innovation (Hess et al., 2016; Hinings et al., 2018; Nambisan et al., 2017). In spite of these opportunities, it is frequently asserted that such opportunities will present major challenges under traditional business models and conventional operational routines and capabilities (Fischer et al., 2020; Li et al., 2018). Thus, digital transformation cannot create an equally fertile situation for every business and requires different approaches in different circumstances (Tekic and Koroteev, 2019). Although many researchers have observed that the opportunities for business success in the digital ecosystem can be enhanced by integrating digital technologies into the central part of the business (Bharadwaj et al., 2013; Tekic and Koroteev, 2019), it is still unclear which characteristics of digital technologies exert competitive advantages in digital transformation and how (Büyüközkan and Göçer, 2018). Furthermore, despite the strong effect of digital-related capabilities on manufacturing companies and the obvious positive impact of digitalization in business, there are still a limited number of studies concerning the relationship between digitalization and the financial performance of companies as well as the potential moderating and mediating factors of that performance (Kohtamäki et al., 2020).

Digital transformation is a multifaceted phenomenon, encompassing different dimensions and methods of implementation for different firms. Some firms aim at fostering novel technologies, namely, the internet of things and big data (Caro and Sadr, 2019), while digital transformation for another group is viewed as a substantial opportunity to enhance customer satisfaction through user involvement in social channels and the establishment of e-business (Kaplan and Haenlein, 2010). Other firms are classified according to an entirely new form of conducting business (Crittenden et al., 2019). The manifold types of firms bring other layers as well. Some firms aim at cost reduction and optimization by implementing digital transformation, while others regard digital transformation as a way of providing value through novel products and services. Although all of these perspectives may be valid, the vast number of diverse perspectives on digital transformation poses difficulties in obtaining a clear understanding of its nature and assessing strategic options and their consequences for the performance of the companies. Rooted in the important, complex, and unclear nature of this phenomenon, it remains to be determined how to make supportive strategic decisions to recognize and analyze the distinctive alternatives for digital transformation and develop a deep understanding of digital transformation (Tekic and Koroteev, 2019).

These theoretical gaps become even more interesting in small and medium-sized enterprises (SMEs) because of the substantial contribution of digital transformation to reducing educational, technological, and resource scarcity both locally and globally (Chen et al., 2015; Holmström et al., 2017), considering that SMEs are often hampered by a lack of resources and capabilities (Street et al., 2017). Before the emergence of digital transformation, founders of SMEs rarely involved themselves in the risks necessary to conduct international business. The reasons for this included cultural, language, and trade barriers as well as operational challenges, the consequence of which has been a smaller number of experiences in international environments (Li et al., 2018). However, in the current era, in which digital transformation has crossed international borders, SMEs can engage in international business. The fast pace and dynamic nature of digital transformation can also be an opportunity for SMEs because of their relative agility compared with large companies who may be less willing to try new business experiences because of the risks of losing their current competitive advantage (Chan et al., 2019).

To sum up, in today's digital era, with the rate of transitions rising on an unprecedented scale (Bititci et al., 2012; Nudurupati et al., 2016) and digitization acting as a catalyst for these changes to provide firms with new opportunities (Kohtamäki et al., 2020; Nudurupati et al., 2016), it is necessary to be equipped with smart technologies (Fichman et al., 2014; Hinings et al., 2018; Yoo et al., 2012; Yoo, 2010), digital business strategies (Bharadwaj et al., 2013; Hess et al., 2016; Matt et al., 2015), and digital-related capabilities (El Sawy et al., 2016; Hess et al., 2016; Li et al., 2018; Vial, 2019) to achieve sustainability performance in this competitive business environment (Büyüközkan and Göçer, 2018; El Sawy et al., 2016; Kohtamäki et al., 2020; Li et al., 2018; Vial 2019). Furthermore, there are still many companies without a clear vision on practical approaches to digital transformation (Fischer et al., 2020; Jackson, 2019; Li et al., 2018; Tekic and Koroteev, 2019). Thus, the aim of this dissertation was to investigate *the approaches to managing performance in digital transformation*. To reach this goal, two main research questions, with sub-questions, were posed, which are as follows.

1. What are the drivers of digital transformation influencing companies' sustainability performance?
    - 1.1. Do smart technologies support digital transformation for better sustainability performance?
    - 1.2. Do digital business strategies support digital transformation for better sustainability performance?
    - 1.3. Do digital-related capabilities support digital transformation for better sustainability performance?

2. Does a strategic approach facilitate digital transformation to achieve companies' sustainability performance?
    - 2.1. What is the role of a corporate sustainability strategy in digital transformation for better sustainability performance?
    - 2.2. What is the role of performance measurement systems in digital transformation for better sustainability performance?

1.3 Definition of the key concepts of the study

1.3.1 Scope of the study

The scope of this study was adopted and derived from two different fields of literature, performance management and strategic information management, in which research streams in the management field can be found. The integration of two different research streams results in expanding the digital transformation literature on performance management to examine more factors that impact on the performance of SMEs in digital transformation. Therefore, the present study sought to make a connection between performance management and strategic information management with an equal contribution in both fields. The scope of the research is illustrated in Figure 1.

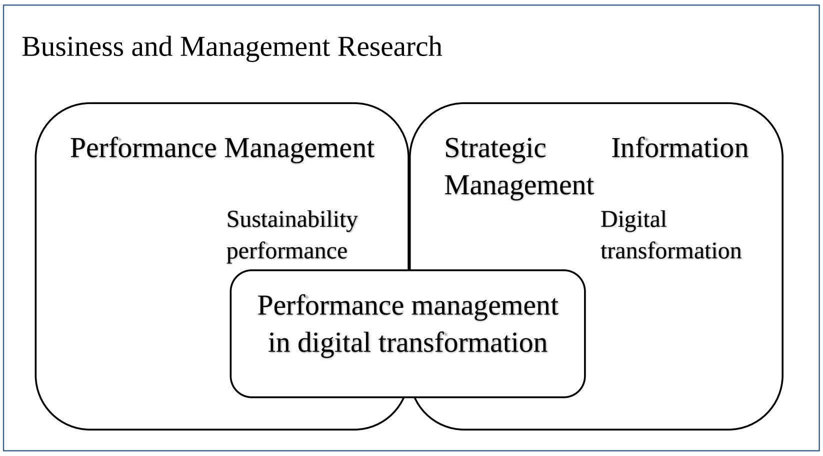

Figure 1. Scope of the research

Digital transformation as a multidisciplinary field involves multiple functional areas, including information systems management, marketing management, strategic management, innovation management, and operations management. For instance, research on digital transformation in the field of information systems management investigates the utilization of digital technologies to simplify changes (Agarwal et al., 2010; Zhu et al., 2006); roles modified among competitors, customers, and companies (Karimi and Walter, 2015; Parviainen et al., 2017); and value creation (Li et al., 2018; Matt et al., 2015). Digital transformation in marketing management involves creating new customer value regarding customers' willingness, instituting changes in relationships among companies, and the development of value propositions (Pagani and Pardo, 2017; Vendrell-Herrero et al., 2017).

Research on digital transformation has been done in strategic management with a focus on reshaping business structures utilizing digital technologies with the aim of achieving competitive advantages (Berman, 2012; Iansiti and Lakhani, 2014; Kane et al., 2015; Peppard et al., 2011; Singh and Hess, 2017), as well as on building innovative business models and opportunities (Andal-Ancion et al., 2003; Hansen et al., 2011; Liu et al., 2011; Peppard et al., 2011). Digital transformation in innovation management has been engaged in reshaping companies' value networks, competitors, and customers (Li, 2018; Schallmo et al., 2017). Digital transformation in operations management has been involved in the interplay between products and the production system to build global product networks (Gölzer and Fritzsche, 2017). The present study considered digital transformation in the field of strategic information management as the focus of this dissertation was to discover the approaches of various SMEs to digital transformation in terms of strategic decision-making, dynamic capabilities, and digital technologies.

Performance management is a multidisciplinary field that involves multiple functional areas, including accounting, operations management, and business strategy (Franco-Santos et al., 2012). For instance, performance management in operations management lies in all the processes, operational routines, and activities needed to enhance a company’s performance (De Waal et al., 2009), while performance management in a business strategy involves the structure of a company’s objectives and incorporating those objectives into an action plan (Hall, 2008). The rate of change provoked by digital technologies is dramatically increasing; consequently, these changes are affecting the way businesses are managed (Barton and Court, 2012). Additionally, performance measurement tools have been frequently recommended as an influential means of facilitating and implementing strategy and improving organizational performance (e.g., Davis and Albright, 2004). Thus, despite the importance of performance management in digital transformation (Westerman et al., 2014), studies on digital transformation in the field of performance management remain scarce (Melnyk et al., 2014; Nudurupati et al., 2016). This study contributes to managing performance during digital transformation to find the relationship between digital transformation and companies’ performance, as well as potential moderating and mediating factors concerning sustainable value, which are not adequately understood (Kohtamäki et al., 2020; Nudurupati et al., 2016).

The emergence of digital technologies has blurred the boundaries between business and research fields, in turn enhancing cross-disciplinary work. Cross-cutting research in the strategic information management field and performance management field enhance scholars’ understanding of digital transformation in various research streams, leading to research density (cf. Foss and Saebi, 2017). Furthermore, business practitioners are able to integrate digital transformation into different disciplines, particularly performance management, which results in organizational decision-making with a focus on how to react to digital transformation in companies and the implementation of changes encountered by the presence of digital technologies (Verhoef et al., 2019).

1.3.2 Concepts related to digital transformation

Digital transformation

Digital transformation can be a tremendous challenge, and no firm is protected from its effects. Those effects are not limited to changes in products or sales channels. Transformation can take place in significant business operations, organizational structures, and entire business models, as well as management perceptions (Berman, 2012; Hess et al., 2016; Li et al., 2018; Matt et al., 2015).

Berman (2012) has defined three paths leading to digital transformation: First, companies need to form and integrate digital operations and, thereafter, aim at the customer value proposition to acquire complete transformation. Second, companies must develop, broaden, or reform customer value propositions through digital contents, perspectives, and involvement and then concentrate on the integration of digital operations. Third, companies need to erect a new bundle of capabilities concerning their transformed customer value propositions and operating model in exactly the same way or at the same rate.

According to Hess et al. (2016) and Matt et al. (2015), there are four important aspects to a digital transformation framework—the use of technology, structural changes, new value creation, and financial aspects—which need to be considered in order to evaluate a company's abilities and formulate a digital transformation strategy. The use of technology addresses a company's tactics for and capabilities in exploiting and exploring the possible uses of digital technologies. Structural changes involve the fundamental alterations in a firm's structure, processes, and skill set that are necessary to cope with and exploit digital technologies. New value creation concerns changes in creating value based on the implications of digital transformation. Finally, financial aspects tackle the action plan for replying to business opportunities and developing the financial capacity to support digital transformation (Hess et al., 2016; Matt et al., 2015). El Sawy et al. (2016) and Kane et al. (2015) have emphasized the roles of strategy, culture, knowledge, and skill development, rather than technology.

Vial (2019) has proposed a framework for digital transformation that considers it as a process resulting from digital technologies, which enables strategic reactions from firms with the aim of changing value creation paths, followed by managing structural modifications and challenges that have both positive and negative consequences in this process. According to Vial's findings, leveraging digital technologies to unlock new value creation will not happen with single activities. The value creation process must be changed through transformations in value propositions, value networks, digital channels, agility, and dexterity. Before that process can begin, changes must be made in the structure and culture of an organization, its leadership, employees' skills, and roles.

Verhoef et al. (2019) have referred to organizational structure, growth strategies, digital resources, and measures and goals as the imperatives of digital transformation. According to Verhoef and his colleagues (2019), digital competition, digital customer behavior, and digital technology are the external drivers of digital transformation. They have asserted that the first stage of digital transformation is the transformation from "analogue" to "digital" (Dougherty and Dunne, 2012; Tan and Pan, 2003; Yoo et al., 2010). This is followed by continuing digitalization, meaning the incorporation of IT and digital technologies into everyday life (Li et al., 2016), and results in digital transformation, the most pervasive phase, which explains new business model development through changes in the companies (Iansiti and Lakhani, 2014; Kane at al., 2015; Pagani and Pardo, 2017).

Fischer et al. (2020) have addressed the implementation of digital transformation by utilizing business process management to build capabilities and competencies for related projects. They noted that companies should at the same time consider digital transformation in manifold dimensions, such as organizational structures, operations, strategies, and culture. These are enabled by business process management because business process management can provide comprehensive perspectives on the way activities are performed at companies, ensuring consistent results and increasing opportunities (Dumas et al., 2013). According to their findings (Fischer et al., 2020), digital transformation objectives can be organized into three categories: communication/learning, unification/optimization, and certification/automation. Firms involved with communication/learning rely on decentralization and collaboration, unlike unification/optimization, which builds on implementing a top-down management governance along with a rather authoritarian configuration. Certification/automation pursues a hybrid model.

Digital transformation in the context of this research is considered a phenomenon resulting from digital technologies, which is subject to many changes in business strategies, companies' capabilities, characteristics of digital representation, and companies' competitive advantages.

Smart technologies

Most of the managers and business practitioners take the view that technology has a great capacity to bring transformation to business, and firms regularly invest in technology with the expectation of obtaining routine outcomes (Fitzgerald et al., 2014; Verhoef et al., 2019). Technology in digital transformation does not promise the streamlining of automating processes; instead, these novel technologies open up substantial opportunities for conducting business in a new way (Fitzgerald et al., 2014).

For example, the widespread adoption of digital technologies has changed the nature of business processes and individual life in the current digital transformation (Fitzgerald et al., 2014). At the organizational level, devices equipped with digital sensors, networks, and processors enable intelligent management systems with the ability to track every business process remotely. On a personal level, running shoes equipped with radio-frequency identification (RFID) tags and sensors can store data about a runner's running distance, calories burned, and heart rate, which enables runners to monitor and analyze their running trends (Kallinikos et al., 2013; Yoo et al., 2012).

Digital transformation involves social media (Li et al., 2018; Oestreicher-Singer and Zalmanson, 2013), mobile devices (Pousttchi et al., 2015), analytics (Günther et al., 2017; Wang et al., 2016a), the cloud (Du et al., 2016), and the internet of things (IOT) (Vial, 2019), so that utilizing digital technologies plays an important role in successful digital transformation. All these changes demonstrate that the world is undergoing a digital transformation, in which borders have been crossed and boundaries have been blurred (Berman, 2012; Hess et al., 2016; Matt et al., 2015). Consequently, entering the digital era and the rapid expansion of digital technologies are signals for firms to equip themselves with digitalized products, services, and processes (Kallinikos et al., 2013; Yoo, 2010; Vial, 2019).

Yoo (2010) has explained digitalized artifacts and infrastructure with a variety of material characteristics, including programmability, addressability, sensibility, communicability, "memorizability," traceability, and associability. Programmability allows equipped artifacts with embedded software to accept new logic for the modification of behaviors and functions, while addressability enables artifacts through IP addresses to separately reply to messages that have been sent to a large number of similar artifacts. Sensibility enables artifacts to observe and react to modifications in the environment through embedded software and sensors, while communicability facilitates sending and receiving messages with other artifacts through a communication network along with addressability of the artifacts. Memorizability equips artifacts with internal and external memories not only to record but also to store the information that has been generated, sensed, and communicated. Traceability enables artifacts to interrelate events and entities chronologically, while associability supports the ability to be recognized with other entities in terms of place, people, and artifacts.

In another study, Yoo et al. (2012) identified re-programmability and data homogenization as the fundamental attributes of digital technology, enabling convergence and generativity in organizations. Convergence addresses the pervasive integration of organizational processes, which is achieved with smart products, tools, and the convergence of separate industries with digital technologies. Generativity refers to the flexible and dynamic nature of digital technologies to upgrade the functionality of products and services.

Digital artifacts that are editable, interactive, reprogrammable/open, and distributable have been mentioned by Kallinikos and Mariategui (2011) and Kallinikos et al. (2013). An editable artifact is one that is flexible for modification, as well as systematic and continuous updates, while interactive artifacts are highly malleable in terms of users' preferences. A reprogrammable/open artifact is one that is accessible to and modifiable by a program, while a distributable artifact allows borderless activities including the wide sharing of content on the internet.

As mentioned by Hinings et al. (2018), at the core of digital technologies, characteristics such as transferability (e.g., a simple way of converting the digital representations of any entities), homogeneity (e.g., standard software languages), and malleability (e.g., re-programmability) have been embedded to enable the integration of physical devices with human actions.

Cast in different terminology, similar viewpoints have been developed by Hinings et al. (2018), Kallinikos and Mariategui (2011), Kallinikos et al. (2013), Yoo (2010), and Yoo et al. (2012). Common among all these studies is the notion of having special properties or characteristics to turn physical artifacts into digitalized artifacts and provide digital infrastructure. Thus, in this study, smart technologies have been defined as a set of characteristics embedded in physical artifacts or business processes that complete digital technologies and bring "smartness" to physical artifacts or business processes.

Digital business strategy

A strategy can be explained as a plan of action designed to yield capability and achieve an objective or goal (Amit and Schoemaker, 1993; Barney, 1991). The alignment viewpoint of considering an information technology (IT) strategy as a functional strategy with the emphasis on aligning with a company's selected business strategy has been prevalent over the last three decades (Henderson and Venkatraman, 1999). This perspective considers IT strategy to be a supporting element of a business's overarching strategy (Chan and Reich, 2007). Mithas et al. (2013) have focused on a fusion of IT and business strategy with a consideration of the important role of IT in shaping a business strategy along with a dynamic sync between IT and business with the aim of achieving competitive advantages. In recent decades, with the introduction of digital technologies that provided the capability to conduct business across boundaries of time, place, and function (Pagani, 2013; Rai et al., 2012), the traditional business strategy has been reformed in a way that is compatible with a more connected world (Bharadwaj et al., 2013). The new concept of the business strategy has been suggested by Bharadwaj et al. (2013) and termed a digital business strategy, meaning an "organizational strategy formulated and executed by leveraging digital resource to create differential value" (p. 472). This definition underlines three important issues. First, this new definition of a digital business strategy expands beyond the alignment perspective and identifies the ubiquity of digital resources in other areas, including operations, marketing, supply chains, and purchasing. Second, the definition is not limited to technology and systems; it also takes into account a resource-based view of strategy. Third, the definition clearly relates a digital business strategy to building differential business value and, in turn, augmenting traditional performance principles, leading to competitive advantages along with strategic differentiations (Bharadwaj et al., 2013).

El Sawy et al. (2016) have addressed the necessity of including digitalization in the concept of a business strategy along with a fusion of the digital strategy and business strategy. Additionally, they have reflected on the important role of digital leadership in considering different ways of thinking about business strategy, business models, and IT functions, along with managers' mindsets, skill sets, and working environment.

Grover and Kohli (2013) have noted the importance of system visibility in a firm's digital business strategy. According to their research, there should be a balance between software, processes, and information, in which software refers to an application as a product, service, or tool for the provision of information, process is defined as the step-by-step procedures in software with the aim of creating capability, and information refers to the value provided for customers.

Pagani (2013) has referred to the implementation of a digital business strategy through reshaping value networks from static and vertically integrated networks into flexible and dynamic value networks. The cross-functional nature of digital business strategy causes static analysis to be inefficient (Grover and Kohli, 2013), raising demand for the continuous and dynamic reconfiguration of business resources across manifold organizational processes, including enhancing capabilities in operations, leadership, innovation, and customer requirements (Sia et al., 2016).

Different opinions have been posed regarding the interplay between digital strategy and business and IT strategies. In addition to the viewpoints of Bharadwaj et al. (2013), Chan and Reich (2007), and Mithas et al. (2013), Hess et al. (2016) have discussed a standalone strategy in digital transformation, in which a digital business strategy is not considered part of another organizational or functional strategy. According to Hess et al. (2016) and Vial (2019), encountering the difficulties of digital transformation and the need for survival in a fiercely competitive environment, business leaders and top managers are obliged to develop and perform strategies or strategic responses that embrace the concepts of digital transformation within a firm’s business model, processes, products, and organizational structure through digital technologies.

In this study, a digital business strategy has been defined as a comprehensive plan of action formulated to yield managerial and operational capabilities and to obtain competitive values in digital transformation.

Digital-related capabilities

Competing in highly volatile ecosystems has led to the concept of dynamic capabilities in companies to investigate solutions for sustainable prosperity amid environmental turbulence (Dixon et al., 2014; Eisenhardt and Martin, 2000; Teece, 2007). The dynamic capabilities perspective extends the resource-based view of firms with the aim of sustaining competitive advantages (Chuang and Lin, 2015; Helfat and Raubitschek, 2018; Schilke et al., 2018; Teece, 2018). Dynamic capabilities support a company’s efforts to adapt to a new business environment and also shapes companies through innovation and collaboration with other firms (Teece, 2007). As defined by Teece et al. (1997, p. 516), dynamic capabilities are “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.” In pursuit of digital transformation, extensive modifications are brought to organizational routines; thus, firms need to reassess, renew, and develop both capabilities and assets (Kohtamäki et al., 2020; Verhoef et al., 2019). Hence, dynamic capabilities are the most likely tool for providing value in digital transformation (e.g., Bharadwaj et al., 2013; Dixon et al., 2014; Karimi and Walter, 2015; Vial, 2019).

Firms aiming at digital transformation require a broad group of digital-related capabilities and resources to enable dynamic capabilities (i.e., malleability, speed, and a high degree of alignment) to enable quick reactions, including the ability to capitalize on swiftly shifting opportunities or to rapidly discard losing initiatives (Bharadwaj et al., 2013; Dixon et al., 2014; Karimi and Walter, 2015; Vial, 2019).

According to Verhoef et al. (2019), responding to digital transformation requires assets and practices along with advanced capabilities in digital networking, big data analytics, and digital agility. Digital networking creates the potential to work collaboratively through digital tools and connects firms via digital channels and based on mutual needs. Big data analytics refers to the critical role of employees' skills and abilities to analyze data for decision-making. Digital agility enables companies to both sense and seize market opportunities created by digital technologies and to provide continuous reconfiguration between digital assets and a company's other resources (Verhoef et al., 2019).

Parida et al. (2015) have referred to "global digitalization capabilities as an advanced ability to use smart and connected products to facilitate global service innovation." They have also highlighted the necessity of technical issues and skill development in advanced analysis among employees for building digitalization capabilities. According to Parida et al. (2015), digital platforms also provide opportunities for knowledge sharing and collaborative working among stakeholders through longitudinal data along with new products and service offerings.

According to Lenka et al. (2017), digitalization capabilities encompass three capabilities: intelligence capability, connect capability, and analytic capability. Intelligence capability represents the technical ability to enable integration between products and services and to conduct business with a low level of human intervention and based on borderless activities. Connect capability addresses collaborative working through network channels, while analytic capability refers to enhancing employees' abilities to analyze large amounts of data with the aim of achieving an action plan and garnering valuable insights regarding digitalization strategies.

A number of scholars have highlighted the important role of employees (Pramanik et al., 2019; Hess et al., 2016; Vial, 2019), collaboration (Amit and Han, 2017; Earley, 2014; Maedche, 2016), innovation (Pramanik et al., 2019; Yoo et al., 2012; Xue, 2014), and technical capabilities (Lenka et al., 2017; Yoo et al., 2012) in the context of digital transformation. As El Sawy et al. have observed, there is a proverb that says, "Hire for a career, not a job" (2016, p. 164). This maxim refers to the importance of hiring people who possess such characteristics as flexibility, dynamism, and adaptability to enable them to successfully handle transitions and potential problems in a rapidly changing environment (Bharadwaj, 2000; El Sawy et al., 2016). Digital transformation also needs employees with high levels of data analysis skills and the ability to tackle issues with digital tools and a digital working environment (Colbert et al., 2016; Singh and Hess, 2017).

In addition, in the current connected world, where the competition for opportunities, resources and various capabilities is fierce, organizations should be prepared to collaborate with other companies to facilitate coping with those challenges. In this way, companies, especially SMEs, can benefit from each other and minimize the risks by sharing resources, skills, and knowledge. Collaboration also provides greater opportunities for firms to enhance their chances of achieving outstanding business outcomes (Chuang and Lin, 2015; Msanjila and Afsarmanesh, 2011).

The pursuit of digital transformation will also be aided by digital solutions as well as innovative products and service offerings through digital technologies (Huang et al., 2017; Pramanik et al., 2019). In the current digital age, innovation is critical to enable firms to conduct business in a different way with novel technologies and digital solutions (Nylén and Holmström, 2015). With regard to technical capabilities, pursuing digital transformation needs technically related capabilities that enable communication between devices and the integration of products and services with embedded components. This will eventually lead to the ability to control and monitor the business process remotely. Additionally, the technical capabilities of digitalization make it feasible to offer services independent of geographic location (Lerch and Gotsch, 2015; Nylén and Holmström, 2015; Pagoropoulos et al., 2017; Ravichandran, 2018).

Because of the complexity of digital transformation, a varied group of capabilities and practices are needed to complement each other and enable businesses to prosper (Hess et al., 2016; Li et al., 2018; Pramanik et al., 2019; Vial, 2019). This study has adopted a perspective of digital transformation arising from the resource-based view and dynamic capabilities viewpoints. The study refers to digital-related capabilities as a set of capabilities including human, collaboration, innovation, and technical capabilities enabling dynamic capabilities to drive digital transformation.

1.3.3 Concepts related to performance management

Sustainability Performance

Performance is an umbrella term encompassing multiple managerial concepts (Lebas and Euske, 2002; Otley, 1999; Tangen, 2005). Since the scope of performance is related to a company’s ambitions, many scholars have noted that it is challenging to develop a single definition (Lebas and Euske, 2002; Lebas, 1995; Otley, 1999). According to Tangen (2005), performance is an umbrella term that has been widely utilized in various concepts and considered in the success of firms during their activities. Atkinson (2012) proposed a definition of performance as the “achievement of results ensuring the delivery of desirable outcomes for a firm’s stakeholders” (Atkinson, 2012, p. 48). According to Lönnqvist (2004), performance encompasses a wide range of activities, such as the exact result or outputs of specific activities, the manner of conducting activity, and an ability to achieve results. One strand of research considers performance to be the outcomes or results of a firm’s efforts, whereas the other strand refers to performance as the determinants of the outcomes or results (Neely et al., 2000). Thus, the concept of performance should be defined in companies based on the perspectives of related stakeholders (Lebas and Euske, 2002; Lönnqvist, 2004; Otley, 1999).

Similar to the concept of performance, Franco-Santos et al. (2007) have emphasized the diversity and lack of a consensus regarding the concept of performance management. As defined by Atkinson (2012), “performance management is using performance measurement information to focus on what is important, manage the organization more effectively and efficiently and promote continuous improvement and learning” (p. 48). In contrast to a concept of performance measurement that focuses on efficiency, productivity, and utilization, the main focus of this definition of performance management is on effectiveness and a comprehensive perspective of operations and the organizations. In other words, performance management is an iterative closed-loop procedure (Ates et al., 2013) that is built on performance measurements and leads to continuous progress in motivation, behavior, and processes (Radnor and Barnes, 2007). Bititci et al. (1997) defined performance management as a process whose main focus is on managing companies' performance based on their corporate and functional strategies and objectives, in which those strategies are organized into all processes, tasks, activities, and staff abilities, with the aim of making appropriate management decisions through the feedback obtained via performance measurement systems (Bititci et al., 1997). Thus, performance management is a philosophy that can take different perspectives on delivering strategic priorities (Atkinson, 2012), objectives, and operational strategies (Bititci et al., 1997; Radnor and Barnes, 2007).

Since commitment to sustainability has been added to the strategic priorities in today's competitive scenario (Goyal et al., 2013), considering sustainability initiatives in performance management is important (Artiach et al., 2010; Goyal et al., 2013; Schaltegger and Wagner, 2006), and firms continue to strive to successfully manage sustainability performance (Schaltegger and Burritt, 2014; Schaltegger and Wagner, 2017). As explained by Schaltegger and Wagner (2006), sustainability performance is "the performance of the company in all dimensions and for all drivers of corporate sustainability" (p. 2).

According to the National Institute of Standards and Technology (NIST), the aspects of sustainability can be categorized into environmental stewardship, economic development, social well-being, technical progress, and performance management (Joung et al., 2013). However, the idea of the "triple bottom line approach" asserts that the achievement of a company's long-term prosperity is highly reliant on full attention to three aspects of sustainability performance, environmental (natural societies), social (social environments), and economic (long-term economic balance) (Elkington, 1998). Environmental sustainability has been explained as a "condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity" (Morelli, 2011, p. 5). Social sustainability is based on creating social capital, such as trust, a sense of community, and social integration, through internal and external partnerships and collaboration (Dempsey et al., 2011; Elkington, 1998; Goodland and Daly, 1996). Economic sustainability is built on economic development without compromising environmental and social considerations (Goodland and Daly, 1996; Rego et al., 2017). Chen et al. (2015) noted that in the manufacturing phase, environmental sustainability involves energy sources, influences on climate change, effects on water quality through radiation and solid waste, and influences on water and soil through acidification, while social sustainability includes working conditions, the impact of the work on employees' long-term health, the percentage of permanent employees in a company's workforce, employee turnover, and employee empowerment. Finally, economic sustainability involves energy use, material consumption, waste management, profitability, and manufacturing costs.

The present research follows the definition of Schaltegger and Wagner (2006), which views a company's management performance in all dimensions, including environmental (i.e., the ability to consider and reduce the environmental impact of the business activity), social (i.e., the ability to enhance safety, health, and well-being through internal and external collaborations and partnerships), and economic (i.e., the ability to ensure long-term economic balance).

Corporate sustainability strategy

There is a consensus among scholars that companies need to proactively integrate sustainability concerns into strategic action rather than just rely on regulatory needs (Aragón-Correa and Rubio-Lopez, 2007; Bhupendra and Sangle, 2015; Christmann, 2000; Phan and Baird, 2015; Sharma and Vredenburg, 1998). Nathan (2010) developed a framework built on the research of Galbreath (2009), which addressed the necessity of embedding sustainability attitudes into strategic management processes, including structures, culture, leadership procedures, best practices, the control system, the reward system, governance and ethics, and policies. According to Lloret (2016), restrictions in three dimensions of sustainability—environmental, social, and economic dimensions—cannot be considered simply an analytical concept, but they can be represented as a driver that can be utilized by firms to effectively align a business model to a business strategy and, eventually, a sustainability strategy.

Different kinds of sustainability strategies, such as efficiency strategies, legitimating strategies, risk mitigation strategies, and holistic sustainability strategies, have been developed, but each strategy has focused on specific objective and sustainability challenges. For instance, an efficiency strategy concentrates on cleaner production and environmental efficiency, legitimating strategy concerns with external relationships and certificates to operate. A risk mitigation strategy concentrates on legal actions and standards regarding social and environmental aspects with the aim of preventing any risks for the firms, while a holistic strategy incorporates sustainability issues into all business activities (Baumgartner and Ebner, 2010).

The necessity of an interplay between strategy and sustainability initiatives raised the concept of a corporate sustainability strategy (Baumgartner and Ebner, 2010; Engert and Baumgartner, 2016; Lloret, 2016; Wijethilake, 2017), which focuses on achieving a balance between a company's environmental, social, and economic requirements and society (Baumgartner and Rauter, 2017; Baumgartner, 2014; Epstein and Roy, 2001). As proposed by Epstein and Roy (2001), the implementation of a corporate sustainability strategy consists of four steps: formulating the corporate sustainability strategy, developing plans and programs, designing suitable structures and systems, and assessing sustainability actions.

Considering that sustainability initiatives are critical to a firm's success, completely sustainable practices within a firm's strategy are likely to become a source of competitive advantages (Simas et al., 2013; Wijethilake, 2017). Additionally, a corporate sustainability strategy enhances sustainability performance through a variety of actions, such as efficient consumption of energy, growth in cost advantages, reduction of waste and discharge, increase in social reputation, and customer expectations (Wijethilake, 2017). Thus, in the present study, the concept of corporate sustainability strategies is aligned with the definition proposed by Baumgartner and Rauter (2017), Baumgartner (2014), and Epstein and Roy (2001), which addresses the integration of sustainable development principles (environmental, social, economic) into business operations with the aim of sustainability performance.

Performance measurement systems

The need to understand and measure the performance of the processes and final outcomes has raised the concepts of performance measurement, performance measures, and performance measurement systems (Neely et al., 2005; Radnor and Barnes, 2007). Performance measurement can be explained as "the process of quantifying the efficiency and effectiveness of action" (Neely et al., 1995, p. 80), while a performance measure can be defined as "a metric used to quantify the efficiency and/or effectiveness of an action" (Neely et al., 2005, p. 1229), and performance measurement systems can be described as "the set of metrics used to quantifying both the efficiency and effectiveness of action" (Neely et al., 2005, p. 1229). Atkinson (2012) has recommended a definition of performance measurement that highlights collecting and reporting data with the aim of tracking and achieving results (Atkinson, 2012). Radnor and Barnes (2007) defined performance measurements and management within operation management as "quantifying the input, output, or level of activity of an event or process" (p. 393).

Many definitions have been recommended, but, in general, a performance measurement system is considered a tool for transforming data into information in order to evaluate the effectiveness and efficiency of a business (Neely et al., 1995; Bititci et al., 1997). Performance measurement systems are critical because of their ability to provide managers with information to manage firms' operations in the event of transitioning (i.e., digital transformation) (Choi et al., 2013; Hall, 2008; Hitt et al., 2011; Koufteros et al., 2014; Melnyk et al., 2004). The measures should be integrated with the company's strategy and objectives to provide performance information in a way that enables progress on the critical dimensions of performance (Hall, 2008; Neely et al., 1995).

Various scholars have agreed on the multiple functions of a performance measurement system in facilitating the implementation of a strategy and improving a firm's performance (e.g., Bititci et al., 2012; Davis and Albright, 2004; Franco-Santos et al., 2012). According to Bititci et al. (2012), the purpose of performance measurement has shifted from rational control (e.g., integrated performance measurement, productivity management, budgetary control, and integrated performance management) into cultural control and learning (e.g., human behavior, personal interaction and socialization), in which a performance measurement system can be utilized as a social system, a learning system, and within networks. Franco-Santos et al. (2012) conducted research considering the consequences of a comprehensive performance measurement system in peoples' behavior (e.g., employees' participation, motivation, and perceptions), a firm's capabilities (e.g., strategic alignment and learning), and performance outcomes (i.e., performance of the firm, team, and management).

The positive effects of a performance measurement system have been recognized in different aspects of people's behavior, including strategic focus, corporation, coordination and participation, role understanding and job satisfaction, motivation, citizenship behavior, decision-making, learning, and self-motivation. In terms of a firm's capabilities, the benefits of a performance measurement system can be found in areas such as strategic process, communication, strategic capabilities, corporate control, and management practices. With regard to performance outcomes, the influential impact of performance measurement systems can be identified at all levels, including organizational and business units, managerial performance, team performance, and inter-firm performance (Franco-Santos et al., 2012).

Nudurupati et al. (2016) have addressed the necessity of refocus and reassessment of measurement efforts in the current digital era. Three steps have been proposed to shift organizational strategy and performance measurement and management in the digital era: first, weaving a sustainability agenda, creative use of advanced technology, and collaboration in organizational strategy; second, creating a balanced set of measures considering behavior, social, and environmental measures; and third, managing performance with measures evaluated in collaborative networks and social media.

In this study, a performance measurement system has been defined as a strategic approach with an influential role on people's behavior and organizational capabilities to facilitate the utilization of digital-related capabilities regarding digital transformation and manage sustainability performance.

1.4 Structure of dissertation

This dissertation is divided into two different parts with the goal of connecting research questions and research articles, as shown in Figure 2. The first part describes an overview of the study and includes an introduction with more focus on the background of the study, the purpose of the study and the research problem, definitions of the key concepts of the study, and a breakdown of the structure of the dissertation. The introduction is followed by a section on the theoretical background, which consists of relevant literature and a conceptual framework of the research. Next, the section on the research methodology outlines the research approach, data collection and analysis, and quality of the research. The section providing the results of the study includes a summary of the publications and their contributions to this dissertation, while the discussion section explains the findings of the research. Finally, the conclusion summarizes both theoretical and managerial implications along with the limitations of the research and suggestions for further research.

The second part of the dissertation presents four research articles with the aim of discussing presented research gaps in practice. This part includes empirical quantitative data gathered through survey questionnaires among SMEs in Finland. The research publications establish a separate entity that enables the author to answer all the research questions presented in the Introduction. Figure 2 illustrates the interplay between research questions and publications.

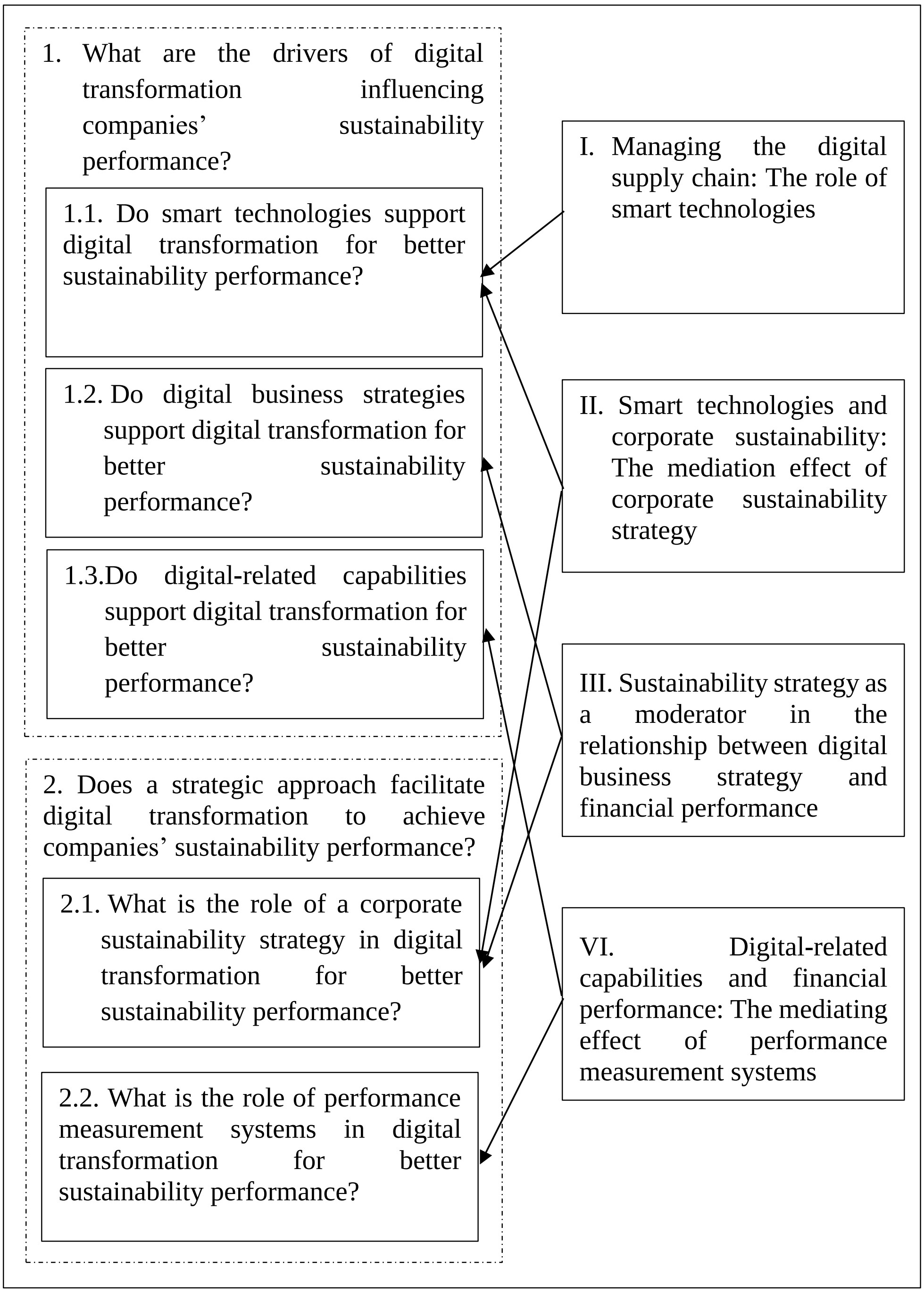

Figure 2. The interplay between research questions and publications

2 THEORETICAL BACKGROUND

2.1 Drivers of digital transformation influencing companies' sustainability performance

2.1.1 Effects of smart technologies on companies' sustainability performance

Growth in worldwide competition has forced companies to achieve sustainability performance in the environmental, social, and economic arenas. In current digital transformation, in which smart technologies have been embedded into individuals' everyday lives in the guise of smart phones, smart watches, smart TV, iPads, and laptops, smart technologies can be utilized to resolve sustainability issues. To achieve sustainability performance, companies should exploit smart technologies to respond swiftly and flexibly to the changing environment (Nižetić et al., 2019; Weichhart et al., 2016).

Moreover, in the current hyperconnected world, companies will not survive without digital competencies and sustainable initiatives. Digital competencies for companies are not limited to utilizing smart technologies. They also include the ability to utilize smart technologies with the aim of supporting and enhancing sustainable business values (Nižetić et al., 2019; Weichhart et al., 2016). Thus, on the one hand, the utility and ubiquity of smart technologies in individual lifestyles, manufacturing, services, and business (Bekaroo et al., 2016; Fichman et al., 2014; Yoo et al., 2012), and on the other hand, sustainability as a source of competitive advantages (Simas et al., 2013; Wijethilake, 2017) are among the signals to practitioners and scholars to explore the effects of smart technologies on companies' sustainability performance.

Direct digital manufacturing is an umbrella term that integrates product modeling and manufacturing technologies through the direct conversion of digital models into physical objects enabled by smart technologies (Holmström et al., 2017). In direct digital manufacturing, in addition to costs, time, quality, and flexibility, sustainability initiatives (i.e., energy and resource efficiency) have been added to the attributes' effect on the performance of the production system that are involved in costs (Chen et al., 2015). Many scholars have highlighted the potential of direct digital manufacturing for reducing waste through greater efficiency in utilizing raw materials (Chen et al., 2015; Gao et al., 2015). Smart technologies in direct digital manufacturing enable dematerialization through on-demand orders because of the close relationship with customers, leading to lower levels of environmental contaminants and less energy consumption (Chen et al., 2015). Moreover, on-demand availability of parts and spare parts in direct digital manufacturing facilitates logistics, transportation, and product lifecycle management through wide-scope access to different supply chain actors with the possibility of adopting new activities and innovative sustainable solutions (Holmström and Partanen, 2014; Mellor et al., 2014). In addition, prosumption (i.e. consumer as a prosumer) has begun to supersede consumption in direct digital manufacturing (Kohtala, 2015). Through embedded smart technologies, direct digital manufacturing allows a company to maintain less inventory through continuous monitoring, which results in lower levels of degraded products as well as energy and material savings for storage (Chen et al., 2015).

Various research has pointed to information and communications technology (ICT) as a low-carbon enabler with a positive effect on environmental sustainability through reductions in greenhouse gas emissions (Bekaroo et al., 2016; Uddin and Rahman, 2012). For example, the rate of commuting has been reduced because of the availability of video conference technologies, in turn reducing air pollution and fuel consumption. In this regard, ICT can support digital and smart solutions in a variety of sectors regardless of location, time, and types of activities, eventually increasing the efficient use of energy and reducing toxic emissions through reduced traveling.

Although ICT provides many opportunities for environmental sustainability, at the same time, the ICT industry is responsible for about two percent of carbon emissions. Since the fast-paced growth of technology is inevitable, mitigating the production of carbon emissions by ICT entails utilizing ICT technologies in a sustainable way with the help of related technology users (Bekaroo et al., 2016). In this regard, Elliot (2011) has highlighted the crucial role of technology in reducing environmental pollution, developing solutions for climate change, and creating sustainable business opportunities. Furthermore, technology (e.g., IT, smart technologies) can indirectly affect stakeholders' behavior regarding environmental issues through continuous monitoring and evaluation.

According to Tao et al. (2016), smart technologies can be applied in manufacturing to minimize and manage energy consumption during all phases of a product life cycle, including design, production, and service processes. In the design phase, the greatest share of energy consumption takes place in the design and testing of tools. Smart technologies can reduce energy consumption in the design phase through optimizing raw material procurement as well as the simulation and testing of products by real-time data.

In the production phase, a large percentage of energy is used by public facilities, transportation inside factories, and manufacturing equipment. Smart technologies can reduce energy consumption in the production phase through real-time monitoring of public facilities, efficient use of manufacturing equipment, and virtual workshops transportation scheduling.

In the service processes phase, energy is consumed during all three phases (pre-use, during use, post use). In the pre-use phase, a product with embedded RFID tags and sensors along with smart technologies can be tracked and monitored during its journey, and energy consumption can be managed through the selection of the shortest route and most efficient means of transportation. During the use phase, maintenance and inspection can be developed through continuous monitoring provided by smart technologies. All activities related to the post-use phase, including collecting, disassembling, refurbishing, recycling, reusing, reassembling, or disposal, can be efficiently conducted through smart technologies by monitoring and tracking properties.

Various scholars have considered the role of smart technologies in sustainability performance in terms of the efficient use of data and resources (Iacovidou et al. 2018; Uddin and Rahman, 2012). Iacovidou et al. (2018) have referred to the important role of smart technologies in enabling sustainable resource management in the construction industry. Smart technologies through embedded RFID tags and sensors can provide information and data regarding the amount of resources and components that can be reused, which results in a reduction in waste, the efficient use of resources, and economic and environmental sustainability.

In addition, smart technologies with characteristics such as visibility, traceability, and editability can improve information management and communication, leading to efficient human resource allocation and reducing the amount of time and the number of employees needed to recover information, as well as minimizing the potential for inefficient decision-making that may result from information shortages (Iacovidou et al. 2018). According to Uddin and Rahman (2012), green IT utilizes recent energy saving technologies, including virtualization, cloud computing, and green metrics, to enable sustainable data centers and results in the efficient use of power and energy in those data centers.

Irrespective of all its benefits, traditional information technology (IT) has contributed to environmental problems through the generation of toxic waste by useless and impractical electrical components. In turn, demands for green IT have increased. Green IT encompasses five fundamental phases for data centers considering green metrics. The first phase of green IT involves recognizing current green IT initiatives, best practices, and potential advantages, as well as establishing an efficiency team and goals. The second phase is identification and categorization, which involves classifying a data center in measurable units, determining green metrics and benchmarks, and establishing virtualization and cloud computing. The third phase is recycling and adopting low-carbon enablers, which consists of embedding sustainable policy in procurement, recycling and disposal, governance, and compliance to manage carbon emissions and to measure and reduce CO_2 emissions. The next phase is implementation, which includes updating architecture and infrastructure, employing visualization and cloud computing through outsourcing, enhancing utilization of IT tools, and applying metrics to measure efficiency. The last phase is analysis, which involves gathering real-time data, performing analysis, comparing new and old values, standardizing benchmark values, and continuously investigating more sustainable solutions (Uddin and Rahman, 2012).

In terms of the social perspectives of sustainability, through smart technologies, direct digital manufacturing enables equality of all involvements within markets and different communities. Direct digital manufacturing also enables elimination of technological, educational, and cultural limitations and gaps among different nations. In addition to the potential advantages for employees' health, creating products based on customer preferences leads to customer satisfaction and social sustainability performance (Chen et al., 2015). Bechtsis et al. (2018) has discussed intelligent autonomous vehicles, which are characterized by smart technologies with the ability to react and interact autonomously with the surrounding environment in a way that enhances sustainability performance in the supply chain. Social benefits, including the safety and accessibility of the employees, as well as the safety and health of the conveyors, have been promoted with this technology (Bechtsis et al., 2018; Duffy et al., 2003). Furthermore, this technology promotes the ongoing creation of jobs for highly skilled workers, the continual improvement of ergonomics for employees in workplaces, and the ability to recognize opportunities to employ sensors for safety and security improvement and institute digitalized objects to monitor, track, and assess probable hazards for employees in terms of accidents, noise level, and ergonomics. All of these considerations ensure the social sustainability performance of smart technologies. The concept of smart cities has been developed to enhance the social sustainability of citizens by monitoring the quality of the environment (e.g., in terms of air, noise, and water pollution) using smart technologies and sensors. Smart cities also allow the creation of decision-support systems based on collaborative working among citizens and real-time data assessment and enhance the quality and living standards of residents (Lorimer et al., 2018).

The pursuit of economic sustainability using direct digital manufacturing has been recommended by a number of scholars (Baumers et al., 2013; Chen et al., 2015). Furthermore, smart technologies play a critical role in the efficient conversion of resources and rational waste management, leading to sustainability performance (Nižetić et al., 2019). Access to the global community is possible through smart technologies in direct digital manufacturing, which enables the flow of material to digital manufacturing equipment, resulting in reductions in development time and cost (Baumers et al., 2013), as well as simpler and more efficient supply chains with fewer transportation needs and lower costs (Chen et al., 2015; Gebler et al., 2014). Furthermore, direct digital manufacturing offers a greater potential for profit because of its customer-specific solutions (Chen et al., 2015).

According to Davis et al. (2012), smart manufacturing within embedded smart technologies has been associated with resource and optimized networks, products, transition economics, and industrial innovation, in turn, enhancing economic sustainability performance. Regarding resources and optimized networks, smart manufacturing provides benefits such as reducing safety incidents and cycle times, as well as increased energy efficiency and overall operation efficiency. Through tracking and traceability properties in products, aside from dynamic product management, the rate of defense products has been reduced in the supply chain. In terms of transition economics, smart manufacturing provides incremental improvements in the time necessary to launch products into markets in the relevant industries. Smart manufacturing creates industrial innovation, leading to revenue increases in new offerings (e.g., both services and products) and the creation of sustainable careers.

2.1.2 Effect of digital business strategy on companies' sustainability performance

In line with previous research, technology is one part of the puzzle, and sustainable competitive advantages in digital transformation involve strategy, skill development, and culture (El Sawy et al., 2016; Li et al., 2018). Since digital transformation is subject to changes in business processes and strategies (Cui and Pan, 2015), companies' capabilities (Cha et al., 2015), and operational practices (Chen et al., 2014), dynamic capabilities have been recommended to adapt operational capabilities and evolve new value-added strategies (Eisenhardt and Martin, 2000; Helfat and Peteraf, 2003; Liu et al., 2013; Salvato and Rerup, 2011). Additionally, in order to put strategies into practice in digital transformation, many studies have highlighted the critical role of managerial and operational capabilities in realizing a digital business strategy (Bharadwaj et al., 2013; El Sawy et al., 2016; Grover and Kohli, 2013; Li et al., 2018; Mithas et al., 2013; Matt et al., 2015). Thus, a digital business strategy is likely to coordinate, prioritize, and implement operational practices and infrastructure (Chen et al., 2014) as well as managers' capabilities (Sia et al., 2016; Vial, 2019) in its journey to digital transformation (Matt et al., 2015) and to achieve competitive advantages (Helfat and Martin, 2015; Li et al., 2018).

Competing in digital transformation with the aim of sustainability performance has created many challenges, which emphasizes the importance of having strategies in place to be prepared for tackling those challenges (Șerban, 2017). According to Bughin et al. (2017), companies that modify their corporate strategies into digital business strategies will achieve greater revenue growth. Through planning and deploying digital linking at the core of a firm (operational capabilities), as well as managers' abilities in the consistent development and implementation of strategy, a digital business strategy is able to contribute to the efficient implementation of business activities in digital transformation and process performance, which results in lower inventory costs, quick order fulfillment, and superior relationships with stakeholders (Zhao et al., 2015). According to Vial (2019), managers with digital mindsets and skill sets can assist in implementing a digital business strategy in the group of concrete activities that impact on the organizational logic of a firm and in developing close relationships between business and IT functions, as well as stakeholders, which leads to social sustainability performance.

Digital leadership has been highlighted in the research conducted by El Sawy et al. (2016) to emphasize the important role of managers' support and digital thinking in a digital business strategy for a firm's performance. In their study, "digital leadership" has been explained as "doing the right things for the strategic success of digitalization for the enterprise and its business ecosystem" (p. 141). The term "business ecosystem" has been located in this definition to emphasize the critical role of business ecosystems in the current hyperconnected world. Since sustainability involves corporate-performance metrics for firms (Bughin et al., 2010) and has been interwoven in business ecosystems (Simas et al., 2013; Wijethilake, 2017), managers' different thinking about business strategy regarding digital mindsets and skill sets and digital operational practices can be associated with the sustainability performance of companies (El Sawy et al., 2016; Sia et al., 2016). Companies can realize a digital business strategy by preparing and developing leadership for digital transformation, building and developing agile and scalable digital operations, designing innovative digitally enabled customer experiences, and expanding and accelerating emerging digital innovation. This will enable strategic responses to the opportunities and challenges of digital transformation and help companies to achieve sustainable competitive advantages (Sia et al., 2016).

Embedding digitalization in strategies, decisions, and operations is necessary to respond quickly to digital transformation and achieve sustainability performance (Weichhart et al., 2016). Through updating the current business process, digitizing traditional industry operations, and a fully automated business process, a digital business strategy can enhance economic sustainability performance (Chae et al., 2018). Many researchers have confirmed that a digital business strategy supports firms in developing differential advantages among their competitors (Mithas et al., 2013; Mithas and Lucas, 2010). For instance, a digital business strategy can enable a company to seize the opportunity to be a digital market leader by creating unique offerings (i.e., products and services) or cost-cutting approaches that lead the strategic sustainability niche in the business ecosystem (Mithas et al., 2013). Moreover, by creating balance in a system between software, process, and information, a digital business strategy offers significant opportunities for companies to promote competitiveness (Grover and Kohli, 2013).

Managers with the capability to analyze big data are able to boost environmental, social, and economic sustainability performance in supply chains. In terms of environmental sustainability performance, knowledge of the environmental impacts of partners, the monitoring of environmental indexes (CO2 and green gas emission), resource and energy savings, and precise assessments of environmental impact can be achieved through managers' ability to analyze and interpret real-time data. In terms of social sustainability performance, the ability to utilize and analyze data efficiently provides transparency and enhances information sharing, attracts supply chain partners into ethical and sustainable behaviors, creates the potential for monitoring and tracking social concerns and issues in different universal supply chains, continues the assessment of suppliers' behavior over time, and makes predictions and suggestions about social issues along the supply chain. In terms of economic sustainability performance, managers with the ability to analyze data can predict the financial effects of the supply chain and make decisions based on those effects. Other benefits can also be achieved, such as obtaining useful information about inventory management, demand forecasting and cost savings; optimized distribution and logistics; growth in productivity levels; quick reactions to market demands; and advanced collaboration among different supply chains (Jabbour et al., 2020).

According to Dubey et al. (2018), managers need to share strategic resources and create a data-driven culture at companies to support successful information alliances in the supply chain for sustainable goals. Furthermore, companies need to enlarge digitalization and ensure that relevant technologies are interwoven into the strategic and operational architectures to achieve sustainability performance. The real-time data generated in digital transformation offers many opportunities that are relevant to businesses in dissimilar fields and results in enhanced productivity and environmental and social sustainability performance (Singh and El-Kassar, 2019).

Operational capabilities can support firms in flexibly allocating their resources with various numbers of alternatives. This creates greater potential to design more sustainable offerings such as investment in technologies that require fewer energy resources and produce lower toxic emissions (Gelhard and von Delft, 2016). Through the deployment of digital tools and digital solutions at the operational level, a digital business strategy will enhance strategic flexibility and provide superior sustainability performance for firms (Benitez et al., 2018).

According to Holmström et al. (2017), enlarging digitalization in each phase of the manufacturing enhances the sustainability of products and services through changes in operational practices (e.g., digital prototyping, digital part manufacturing, digital customization) in different phases, such as product design, distribution, use, and after-sale services. Digital prototyping is one of the operational practices in the design phase, conducted by design iteration, which results in advanced designs for assessing a prototype and also minimizes costs and lead time in the product design phase. Furthermore, digital prototyping can be applied in manufacturing process changes, which facilitates engineering changes of a design in production and leads to incremental growth in the productivity of tools and equipment. Digital part manufacturing involves the manufacturing of spare parts based on demand, which results in a lower volume of spare parts during market entry, as well as a reduction in time spent on repairing and refurbishment. Digital customization enables the production of a variety of parts based on customers' specifications and interest, which results in customer satisfaction.

2.1.3 Effect of digital-related capabilities on companies' sustainability performance

Because of the vast number of changes in business processes and methods (Kohtamäki et al., 2020), digital transformation involves fundamental transitions not only in the types of technologies (Fichman et al., 2014; Yoo et al., 2012; Yoo, 2010) and strategies (Bharadwaj et al., 2013; El Sawy et al., 2016; Grover and Kohli, 2013; Li et al., 2018; Mithas et al., 2013; Matt et al., 2015) but also in companies' capabilities (Berman, 2012; Kohtamäki et al., 2020; Vial, 2019). The important roles of human capability, collaboration capability, innovation capability, and technical capabilities in digital transformation have been highlighted by many scholars (Berman, 2012; Büyüközkan and Göçer, 2018; Hess et al., 2016; Vial, 2019). The combination of these capabilities represents digital-related capabilities. Digital transformation through digital-related capabilities is associated with the sustainability performance of companies in such areas as innovativeness (Hess et al., 2016; Jackson, 2019; Svahn et al., 2017), financial performance (Karimi and Walter, 2015; Kohtamäki et al., 2020), firm growth (Berman, 2012; Setia et al., 2013), reputation (Berman, 2012), cost reductions (Hess et al., 2016) and competitive advantages (Büyüközkan and Göçer, 2018; Vial, 2019).

Digital transformation through human capabilities can support the achievement of sustainable competitive advantages, including a quick and accurate decision-making process (Bharadwaj et al., 2013; Büyüközkan and Göçer, 2018; Vial, 2019), the ability to quickly develop business solutions (Büyüközkan and Göçer, 2018; Dremel et al., 2017), profitability (Berman, 2012), and social sustainability (Vial, 2019). For instance, human capabilities through employees' support, readiness, and advanced digital skills can facilitate and accelerate the decision-making process (Bharadwaj et al., 2013; Hess et al., 2016) and enable a more rapid response to complex business challenges (Dremel et al., 2017). Furthermore, staff members who are well-trained in utilizing digital tools can easily support remote working, which enables social sustainability performance through flexible working hours and employee comfort (Pramanik et al., 2019) and environmental sustainability through reduced commuting and traveling for work (Bekaroo et al., 2016). In addition, working in an environment with employees who are ready to use and accept digital processes actualizing innovation and business growth is less challenging (Berman, 2012). In a digital supply chain, the employees' ability to utilize data in an efficient way can support companies to predict upcoming demands and develop decision-making processes, as well as find solutions for unresolved issues (Büyüközkan and Göçer, 2018). According to Fischer et al. (2020), as tasks become more complex, companies need digital expertise and motivated specialists to tackle with reformation of economic, social, and environmental benefits.

Digital transformation through collaboration capabilities (Büyüközkan and Göçer, 2018; Vial, 2019) can help sustain a firm's performance in terms of efficiency (Vial, 2019), social sustainability (Büyüközkan and Göçer, 2018; Berman, 2012), efficient resource consumption (Büyüközkan and Göçer, 2018), customer satisfaction (Berman, 2012), and relationship performance (Büyüközkan and Göçer, 2018). For instance, collaboration among stakeholders and customers in digital channels can enhance a firm's profitability through customer participation and engagement (Setia et al., 2013). Furthermore, collaboration capability through resource- and knowledge-sharing both inside and outside of the companies enhance a firm's performance (Li et al., 2018).

According to Berman (2012), collaboration through engaging customers and communities in every phase of the business process in which value is created (i.e., not only in marketing and sales but also in supply chain management, product design, human resources, finance, and IT) can differentiate companies from being customer-centric businesses. Furthermore, collaboration through digital channels and integration among customer touchpoints are vital to effectively manage digital operations. A diversity of digital and social channels enhances customer expectations, and continuously providing different user experiences through social channels is expected in order to support reputation, branding, and customer satisfaction.

According to Büyüközkan and Göçer (2018), a digital supply chain with digital cooperation from other companies as well as information-sharing and openness not only can optimize performance but also minimizes risks. A digital supply chain is also associated with social sustainability through the development of an alignment between supplies, which results in building trust and development, as well as promotion in reliability, agility, and efficiency by global information-sharing, superior collaboration, and interaction via digital platforms. Moreover, companies with a positive attitude toward collaborating with stakeholders both internally and externally can support sustainability performance through reducing failure (Fischer et al., 2020; Hess et al., 2016).

Digital transformation through innovation capabilities can help companies sustain competitive advantages, such as organizational performance and operational efficiencies (Oliveira and Roth, 2012; Vial, 2019), financial performance (Berman, 2012; Kohtamäki et al., 2020), social sustainability (Boons et al., 2013), and efficiency (Berman, 2012). According to Kohtamäki et al. (2020), through new products and services, digitalization can ensure value creation, value capture, and, ultimately, positive financial performance. Furthermore, innovative digital solutions support the enhancement of customer value and efficient solution delivery, leading to transaction cost savings and providing financial performance and sustainability (Sjödin et al., 2019).

Through the continual exploration of new solutions, firms are able to capture revenue and competitive advantages (Berman, 2012). According to Fischer et al. (2020), openness and innovation capabilities can support sustainability performance by facilitating creativity and risk-taking. Innovative activities, namely, the creation and development of new products and services, can assist firms in risk-taking activities to reap the benefits of a digital supply chain (Oliveira and Roth, 2012; Xue, 2014). Furthermore, companies seek to make sustainable differentiation through innovation and digital specialization by developing digital solutions regarding social well-being and environmentally friendly initiatives (Boons et al., 2013).

Digital transformation through technical capabilities (Hess et al., 2016; Pramanik et al., 2019; Vial, 2019) can optimize operational performance, including automation (Büyüközkan and Göçer 2018; Andriole, 2017), business process improvement (Gust et al., 2017), social sustainability (Agarwal et al., 2010; Pramanik et al., 2019), efficient resource use (Berman, 2012), cost savings (Hess et al., 2016; Pagani, 2013; Pramanik et al., 2019), and advanced productivity (Hess et al., 2016). As an example, technical capabilities through borderless activities in cloud computing enable on-demand and flexible resource allocation without human intervention (Kane, 2016). Moreover, technical capabilities can enhance the value of products and services in health care and in social life through electronic prescriptions and medical advice based on an individual's real-time data and records, which promotes an individual's quality of life (Agarwal et al., 2010). In the banking industry, cost savings and growth by streamlining banking systems and workflow optimization have been realized through technical capabilities. Technical capabilities in banks also enable operational benefits associated with business advantages, such as quicker processing, simplification, fewer errors, which results in better financial performance (Pramanik et al., 2019). In a supply chain, technical capabilities through embedded sensors and real-time data can optimize resource consumption based on supply and demand forecasting (Berman, 2012). According to Hess et al. (2016), sustaining operations in digital transformation requires an assessment of current technical capabilities and a recognition of new technical capabilities that will increase value.

2.2 Strategic approach to digital transformation influencing sustainability performance

2.2.1 Role of corporate sustainability strategy

Digital transformation has increased the demand for sustainability performance at firms because of environmental, social, and economic sustainability issues (Forcadell et al., 2020; Newell and Marabelli, 2015; Vial, 2019), and sustainability has become a strategic imperative in business ecosystems (Caputo et al., 2018; Baumgartner and Ebner, 2010; Engert and Baumgartner, 2016; Galpin and Whittington, 2012).

In digital transformation with a high reliance on digital technology, building sustainable value through advanced technology entails collaboration and cooperation within the ecosystems, including among businesses, communities, and governments (Romanelli, 2018), which have seized on the concept of sustainability performance by tying sustainability into business operations in digital transformation. This is called a corporate sustainability strategy (Epstein and Roy, 2001). According to Caputo et al. (2018), the achievement of sustainability performance in digital transformation pertains to both structural and dynamic perspectives. The former addresses technology, resources, and possible strategic approaches, and the latter refers to the management of those technologies, resources, and strategic approaches in a corporate sustainability strategy.

Irrespective of the opportunities in environmental, social, and economic sustainability offered by a cleaner production strategy, many researchers have noted various challenges that must be tackled, including lack of knowledge about cleaner production technologies, lack of equipment and information, and fragile communication schemes (Donnellan et al., 2011; Murillo-Luna et al., 2011). These challenges can be addressed with smart technologies and digital-related capabilities (Caputo et al, 2018; Stuermer et al., 2017), which can support sustainability performance when coupled with a corporate sustainability strategy (Caputo et al. 2018; Vial, 2019).

According to Baumgartner and Rauter (2017), managers' attitudes and opinions are frequently improved by economic performance. In turn, managers' capabilities in and preferences for corporate sustainability are limited and will increase after economic value is achieved. Furthermore, Salzmann et al. (2005) have noted that a corporate sustainability strategy might not be an appropriate option for all companies at all times and need to be aligned with specific firms' circumstances.

In contrast, according to Engert et al. (2016), the alignment of corporate sustainability with strategic management provides an opportunity to handle social and environmental sustainability issues with the formulation and implementation of a corporate sustainability strategy. Moreover, Harmon et al. (2009) have noted that changing managers' attitudes and convincing them to integrate corporate sustainability reduces internal errors and provides business growth. Nathan (2010) has asserted that leadership, organizational culture, best operational practices, reward systems, government policies, and ethics can assist in leveraging a corporate sustainability strategy and sustainability actions. In line with this, Engert and Baumgartner (2016) observed that successful deployment of a corporate sustainability strategy involves different factors in the structure and culture of the organization, leadership, management control, employees' qualifications and motivation, and communication. Baumgartner and Ebner (2010) argued that to achieve economic sustainability performance, managers should consider corporate sustainability aspects to acquire economic success (e.g., technology and innovation, collaboration, knowledge management, processes, and purchase) rather than aspects with a sole focus on financial outcomes.

A corporate sustainability strategy also facilitates role clarification and operational practices for staff and managers, resulting in sustainable business values. Baumgartner and Ebner (2010) also noted that in order for environmental sustainability performance to be achieved, it is necessary to concentrate on the consequences of the impacts instead of focusing on the impacts themselves. A corporate sustainability strategy can assist in this regard, for instance, by developing a high level of maturity in using renewable energy and waste management. Thus, a corporate sustainability strategy strikes a balance between a sustainability strategy and a corporate competitive strategy, in which firms can utilize differentiational values and cost leadership at the same time (Baumgartner and Ebner, 2010).

In digital transformation, it is challenging to sustain a firm's performance over time because of the complexity of the value networks (Andal-Ancion et al., 2003; Nehme et al., 2015) and the involvement of multiple actors (Gray et al., 2013). In turn, strategies with embedded ethical considerations (i.e., corporate sustainability strategy) are relevant in digital transformation. Ethical considerations direct the design and utilization of digital technologies to ensure that attaining short-term objectives does not compromise a firm's sustainability performance over time (Vial, 2019). Furthermore, the undesired consequences of security and privacy issues in digital transformation have highlighted the strategic relevance of ethics in sustaining a firm's performance in digital transformation (Vial, 2019).

According to Maher et al. (2018), digital tools can handle sustainability challenges with the help of new ways of thinking, interacting, and cooperating, which need to be coupled with a corporate sustainability strategy to acquire sustainability performance. In addition, a corporate sustainability strategy can be performed as a synergic map to make interconnections between discovering the key issues of sustainability, recognizing tools to handle these sustainability issues, and the interplay between these tools and adding smartness characteristics to attain sustainability performance. Forcadell et al. (2020) have found evidence that a synthesis of corporate sustainability and a digitalization strategy contribute to efficiency and economic values in the banking industry. In their research, they showed that a better reputation in corporate sustainability for a bank can enhance the advantages created from a digital business strategy.

To sum up, the approach to digital transformation has emerged through a reassessment of infrastructure, business strategies, and companies' capabilities (Berman, 2012; Hess et al., 2018; Li et al., 2018; Vial, 2019). It is worth mentioning that, regardless of all the different values created through this approach, there are still some unpleasant consequences in terms of security and privacy issues, because of which firms cannot reap all the benefits of sustainability performance, and companies' approaches to digital transformation with the aim of sustainability performance have been hindered (Forcadell et al., 2020; Newell and Marabelli, 2015; Vial, 2019).

According to Newell and Marabelli (2015), decision-making processes and models based on individuals' digital data and information have raised issues of privacy, security, and the safety of societies, and scholars and practitioners must study these concerns with digital transformation and the digitalization of everyday life. According to Forcadell et al. (2020), a corporate sustainability strategy can be considered a credit in digital transformation to reduce customers' fears regarding the loss and theft of their information in the banking industry.

It is accepted that a corporate sustainability strategy can help firms to translate a sustainability strategy into action (Baumgartner and Ebner, 2010; Engert and Baumgartner, 2016) and strike a balance between environmental, social, and economic sustainability in business operations (Epstein and Roy, 2001). For these reasons, the deployment of a corporate sustainability strategy can help firms to achieve sustainability performance in digital transformation (Forcadell et al., 2020; Newell and Marabelli, 2015; Vial, 2019).

2.2.2 Role of performance measurement systems

It is accepted by many scholars that performance measurement systems bring efficiency and effectiveness in firms (Franco-Santos et al., 2012; Neely et al., 1995), but the methods for creating those values and higher performance are not the same (Bititci et al., 2006; Franco-Santos et al., 2012; Saunila et al., 2014). According to Saunila et al. (2014), a performance measurement system can be utilized as an effective tool to enhance the performance of an SME through innovation capabilities. As mentioned by Koufteros et al. (2014), a performance measurement system contributes to enhanced capabilities and can improve performance. A Performance measurement system is vital for the management of firms' operational activities because of the potential to provide control and streamline operations, report annual progress, and ensure alignment with strategic goals and objectives (Johnston and Pongatichat, 2008; Franco-Santos et al., 2007). According to Franco-Santos et al. (2012), a performance measurement system can facilitate better performance through its effects on people's behaviors, organizational capabilities, and performance outcomes.

The positive impacts of performance management systems on people's behaviors can be attained through people's strategic focus (Franco-Santos et al., 2012), cooperation, coordination and participation (Cousins et al., 2008; Mahama, 2006), motivation (Malina and Selto, 2001; Papalexandris et al., 2004; Sandström and Toivanen, 2002), role understanding and job satisfaction (Burney and Widener, 2007; Hall, 2008), decision-making, learning, and self-monitoring (Tuomela, 2005; Wiersma, 2009), as well as leadership and culture (Bititci et al., 2006; Ukko et al., 2007). Performance measurement systems have an impact on people's behaviors through their strategic focus. They improve executives' debates about strategy and assist to focus the executives' attempts on an understanding and clarification of a company's objectives (Franco-Santos et al., 2012). In terms of cooperation, coordination, and participation, a performance measurement system improves communication in buyer-supplier relationships, thereby enhancing socialization and cooperation (Cousins et al., 2008; Mahama, 2006). A performance measurement system ensures a fair distribution of information performance among participants in a supply chain and thus provides opportunities for learning and problem-solving (Mahama, 2006). A Performance measurement system creates motivation to achieve strategic goals and objectives (Papalexandris et al., 2004; Sandström and Toivanen, 2002). In contrast, a performance measurement system used only as a tool for providing bonus payments reduces people's motivation (Decoene and Bruggeman, 2006; Malina and Selto, 2001).

A performance measurement system stimulates incentive and motivation under two conditions (Malina and Selto, 2001). In the first condition, a performance measurement system is considered an effective management tool for measuring a firm's performance and the targets that are within its control, as long as they are logical and achievable, as well as associated with reasonable rewards. The second condition is when a performance measurement system is designed to support efficient communication mechanisms that stimulate feedback, open discussion, and participation (Malina and Selto, 2001). A performance measurement system influences people's behavior through role understanding and job satisfaction by facilitating employees' understanding of their jobs, thereby decreasing role ambiguity and role conflict (Burney and Widener, 2007; Hall, 2008). A performance measurement system also influences people's behaviors through learning, self-monitoring, and decision-making by providing information that helps managers learn from their mistakes and study the best practices for better performance through feedback (Tuomela, 2005), as well as monitor their performance and, in turn, make effective decisions in different circumstances (Wiersma, 2009). A performance measurement system influences people's behavior through leadership and culture by forming individuals' routines and leadership styles as well as a firm's culture (Bititci et al., 2006; Ukko et al., 2007).

The positive influence of a performance measurement system on organizational capabilities can be achieved through a strategy process (e.g., alignment, development, implementation, and review) (Chenhall, 2005; Dossi and Patelli, 2010; Franco-Santos et al., 2012), communication (Franco-Santos et al., 2012; Maestrini et al., 2018; Pekkola and Ukko, 2016), strategic capabilities (Franco-Santos et al., 2012), management practices (Ukko et al., 2007), and corporate control (Choi et al., 2013; Cruz et al., 2011; Franco-Santos et al., 2012; Hitt et al., 2011; Koufteros et al., 2014). A performance measurement system can have an impact on organizational capabilities through a strategy process that enables efficient mechanisms for involving managers in the strategy formation and careful examination of the processes. This encourages interpretation of the strategy in operational practices, stimulating managers to consider organizational strategy as a persistent process rather than a single action, thus enhancing strategic alignment with the firm's activities to contribute to the strategic objectives of the firm (Chenhall, 2005; Dossi and Patelli, 2010; Franco-Santos et al., 2012).

A performance measurement system can also influence organizational capabilities through communication processes that create a mutual language, both inside and outside the companies, and provide opportunities for two-way communication to create motivation for knowledge-sharing, trust-building, and avoidance of resistance (Franco-Santos et al., 2012; Maestrini et al., 2018; Pekkola and Ukko, 2016).

Another way in which a performance measurement system can have an impact on organizational capabilities through strategic capabilities is by encouraging the acquisition of specific capabilities, processes, and operational competencies that enable a company to seize competitive advantages (Franco-Santos et al., 2012). Other factors, including a system's maturity, a company's organizational culture, the characteristics of the users, and the purpose of the use can hamper or facilitate the effects of a performance measurement system on managers' functionality and practices (Ukko et al., 2007). A performance measurement system can have an impact on corporate control by enhancing visibility, thereby enhancing control and cooperation (Cruz et al., 2011). A performance measurement system can be critical because they equip managers with information to manage a firm's operation in the event of transitioning and environmental uncertainty (Choi et al., 2013; Hitt et al., 2011; Koufteros et al., 2014).

Vial (2019) has highlighted resistance and inertia as barriers in digital transformation to enhance competitive advantages and make changes in the value creation process. The introduction of disruptive technologies (i.e., smart technologies and digital technologies) has been met with resistance from employees (Fitzgerald et al., 2014; Kane, 2016; Singh and Hess, 2017). A performance measurement system can mitigate such resistance through enhanced communication processes (Franco-Santos et al. 2012). Resistance can also be explained by a lack of understanding about the significant potential of digital technologies (Svahn et al., 2017). Through its impact on organizational capabilities, a performance measurement system can alleviate employees' resistance to digital transformation (Cruz et al., 2011; Franco-Santos et al., 2012) and thereby enhance performance in terms of both financial and non-financial aspects (Koufteros et al., 2014; Melnyk et al., 2014).

Thus, as one of the barriers in an approach to digital transformation is resistance (Vial, 2019) and performance measurement systems have been recommended as critical tools for reducing resistance and enhancing visibility (Franco-Santos et al., 2012), a performance measurement system can be utilized to avoid resistance and inertia, thereby sustaining a firm's performance in digital transformation (Nudurupati et al., 2016). The relevancy of the inertia can be found in organization where the available capabilities and resources perform as a hinderance to disruption (Svahn et al., 2017). For instance, many companies rely heavily on their current relationships with customers and suppliers through traditional channels as well as rigid and optimized production processes (Andriole, 2017) and static resources that cannot be easily reconfigured (Kohli and Johnson, 2011; Woodard et al., 2013). A performance measurement system can mitigate the hindering effects and facilitate new capabilities and resources through a strategy process and strategic capabilities in organizational capabilities (Chenhall, 2005; Dossi and Patelli, 2010; Franco-Santos et al., 2012), enabling firms to achieve sustainable competitive advantages (Franco-Santos et al., 2012).

In summary, utilizing a performance measurement system in digital transformation can provide possibilities for managers to draw comparisons between firms across sites or optimize the allocation of product manufacturing capacity with greater detail and accuracy, actions that are impossible without digital technologies and real-time data (Westerman et al., 2014). The challenging issue in digital transformation is the turbulence of the external environment, which effects a firm's strategy and, consequently, can be interconnected with a performance measurement system (Bititci et al., 2012; Melnyk et al., 2014; Nudurupati et al., 2016). Combining a performance measurement system with a sustainability agenda can help managers better understand their current environmental, social, and economic sustainability performance and the desired final outcomes (Gates and Germain, 2010; Searcy, 2012). Thus, a performance measurement system can be employed as a strategic tool in digital transformation, coupled with digital-related capabilities, a digital business strategy, and smart technologies, to create sustainability performance for firms (Büyüközkan and Göçer, 2018; Nudurupati et al., 2016).

2.3 Conceptual framework of the research

The important roles of technology, strategy, and capabilities in digital transformation has been noted by many researchers (Berman, 2012; Hinings et al., 2018; Li et al., 2018; Vial, 2019). In addition, companies' efforts to obtain competitive advantages have been transformed from achieving performance into sustaining performance in environmental, social, and economic sustainability issues (Goyal et al., 2013; Schaltegger and Burritt, 2014; Schaltegger and Wagner, 2017). There is still scant research on the approaches to digital transformation (Fischer et al., 2020; Jackson, 2019) with the aim of sustainability performance. Thus, it is necessary to determine which approach is most efficient in managing (sustainability) performance in the digital transformation.

Furthermore, corporate sustainability strategies have been frequently pointed to by many researchers as an influential factor in sustainability (Baumgartner and Ebner, 2010; Engert and Baumgartner, 2016; Galpin and Whittington, 2012), but only a limited number of studies have sought to clarify the role of corporate sustainability strategies in achieving sustainability performance in digital transformation (Forcadell et al., 2020). Thus, the present research sheds light on the role of corporate sustainability strategies in digital business strategies and smart technologies as two drivers of digital transformation for achieving sustainability performance.

Moreover, aside from the frequent use of performance measurement systems in the concept of capability and performance (Bititci et al., 2006; Franco-Santos et al. 2012; Koufteros et al. 2014; Melnyk et al., 2014; Saunila et al., 2014), performance measurement systems have been coupled with sustainability in some studies (Gates and Germain, 2010; Searcy, 2012), but there is limited research on the strategic role of performance measurement systems in achieving sustainability performance in digital transformation (Nudurupati et al., 2016). Therefore, another research gap exists in clarifying the role of performance measurement systems in digital-related capabilities as one of the drivers of digital transformation for achieving sustainability performance.

Although the above-mentioned studies have discussed to some extent the research background and the sustainability performance implications of digital transformation, previous research has not reached a consensus about managing performance in digital transformation in practice. There is a lack of research on the approach to digital transformation with the aim of attaining sustainability performance in which both drivers (smart technologies, digital business strategy, digital-related capabilities) and strategic approaches (corporate sustainability strategy, performance measurement systems) are taken into account to achieve sustainability performance and, thereby, manage performance in digital transformation.

Furthermore, while multi-disciplinary studies are common in digital transformation because digital technologies have blurred the boundaries between different fields and businesses, and digital transformation has been discussed in many research fields, including information systems management, marketing management, strategic management, innovation management, and operations management, there is limited research regarding digital transformation in the performance management research field. Since cross-disciplinary studies enhance scholars' understanding of digital transformation in various research streams, and performance management involves organizational decision-making as well as both financial and non-financial performance aspects, it is necessary to cut across digital transformation in the performance management field. To understand the approaches to managing performance in digital transformation, the conceptual framework has been built and shown in Figure 3 in order to clarify the drivers of digital transformation and the role of strategic approaches in achieving a company's sustainability performance.

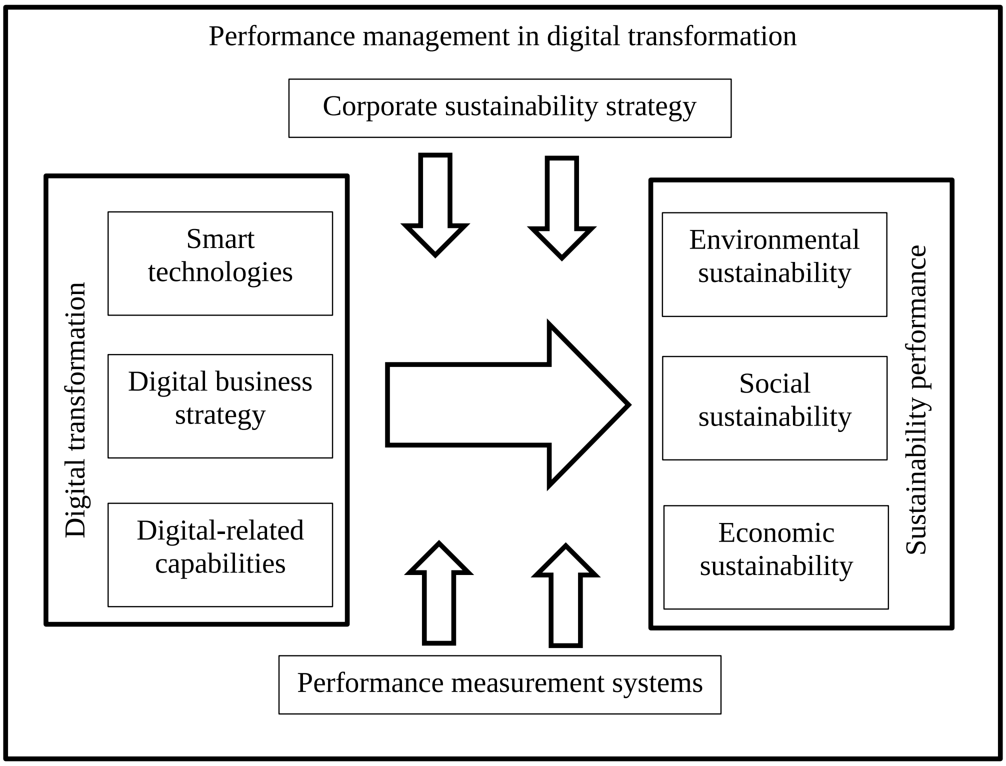

Figure 3. Conceptual framework of the research

3 Research methodology

3.1 Research approach

The research approach is defined as “the plans and procedures for the research that span the steps from broad assumption to detailed method of data collection, analysis, and interpretation” (Creswell and Creswell, 2017). In the initial phase of research, it is important to answer two questions: 1) What methodologies and methods will be utilized in order to reach the goal of the research? and 2) How can the selection of the methodologies and methods utilized in the research be justified? (Crotty, 1998). Crotty (1998) has referred to epistemology, theoretical perspective, methodology, and methods in any research, as shown in Figure 4. Epistemology asks about the theory of the knowledge interwoven with the theoretical perspective, and, in turn, the methodology. As shown in Figure 4 and proposed by Crotty (1998), the epistemological view can be categorized in three groups: objectivism, constructivism, and subjectivism. Objectivism can be included in the epistemological view that things are shaped in their meaningful entities without depending on consciousness and experiences that belongs to truth and meaning embedding in them as objects. In contrast, constructivism holds that truth or meaning will happen inside or outside of our involvement with the real world, and thus meaning is constructed rather than found. In subjectivism, the meaning does not emerge from a connection between subject and object; rather, it emerges from the interplay between the subject and the object to which it is attributed (Crotty, 1998).

Aside from epistemology, the research philosophies of scientific research can be categorized by ontology. Ontology is concerned with the nature of reality (Saunders et al., 2011) and the study of being (Crotty, 1998). Ontology can be placed at the same level as epistemology in Figure 4 with the aim of informing the theoretical perspective, in that each theoretical perspective has a specific method for understanding what ontology is and what epistemology means. Thus, ontological and epistemological concerns have mainly appeared together (Crotty, 1998). In addition to epistemology and ontology, axiology associates in research and concerns the influential role of values in conducting research (Saunders et al., 2011).

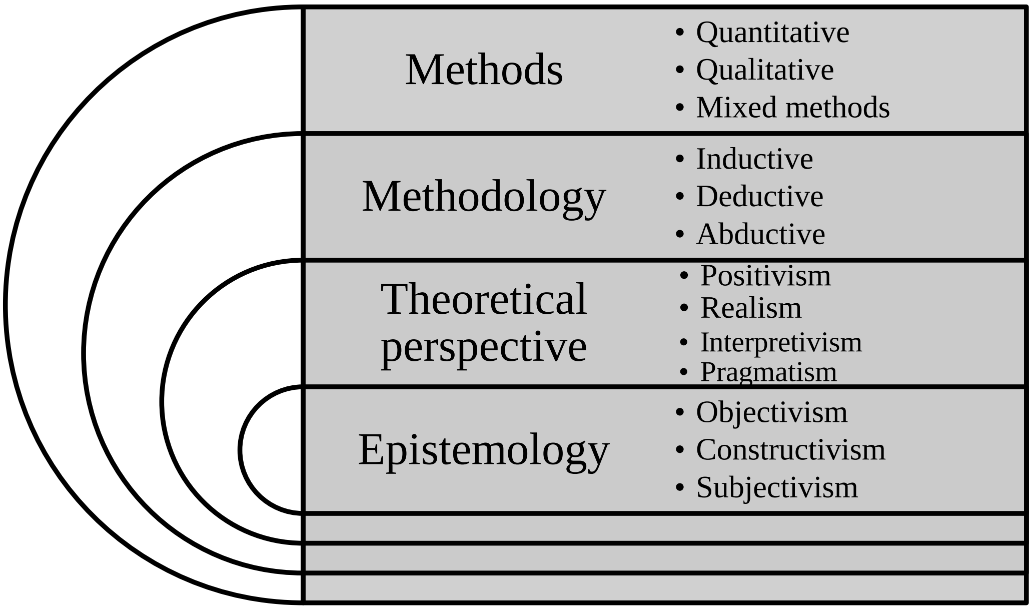

Figure 4: Four elements of research (modified by Crotty, 1998)

Theoretical perspective can be described as a philosophical viewpoint providing knowledge about methodology and, consequently, creating a context for the process and grounding its logic and criteria (Crotty, 1998). According to Saunders et al. (2011), research philosophies in management research involve ways of seeing the world and can be categorized into four different groups: positivism, realism, interpretivism, and pragmatism.

Positivism is “the epistemological position that advocates working with an observable social reality. The emphasis is on highly structured methodology to facilitate replication, and the final product can be law-like generalizations similar to those produced by the physical and natural scientists” (Saunders et al., 2011, p. 598). Realism is very similar to positivism and is defined as “the epistemological position that objects exist independently of our knowledge of their existence” (Saunders et al., 2011, p. 599). Interpretivism is “the epistemological position that advocates the necessity to understand differences between humans in their role as social actors” (Saunders et al., 2011, p. 593). Pragmatism is “a position that argues that the most important determinant of the research philosophy adopted is the research question, arguing that it is possible to work within both positivist and interpretivist positions. It applies a practical approach, integrating different perspectives to help collect and interpret data” (Saunders et al., 2011, p. 598). Furthermore, research approaches in managerial research include both deductive (testing theory through hypotheses) and inductive (building theory) methods. Table 1 summarizes the four theoretical perspectives in management research, which are adopted from Saunders et al. (2011).

Table 1. Summary of four theoretical perspectives in management research (Saunders et al., 2011)

	Positivism	Realism	Interpretivism	Pragmatism
Ontology: the researcher's view of the nature of reality or being	External, objective, and independent of social actors	Objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist) but is interpreted through social conditioning (critical realist).	Socially constructed, subjective, may change, multiple.	External, multiple, view chosen to best enable answering the research question
Epistemology: the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law-like generalizations, reducing phenomena to simplest elements	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations that are open to misinterpretation (critical realism). Focus on explaining within a context or contexts.	Subjective meanings and social phenomena. Focus on the details of situation, a reality behind those details, subjective meanings motivating actions.	Either or both observable phenomena and subjective meanings can provide acceptable knowledge depending on the research question. Focus on practical applied research, integrating different perspectives to help interpret the data.
Axiology: the researcher's view of the role of values in research	Research is undertaken in a value-free way. The researcher is independent of the data and maintains an objective stance.	Research is value laden; the researcher is biased by world views, cultural experiences and upbringing. These will impact on the research.	Research is value bound; the researcher is part of what is being researched, cannot be separated, and so will be subjective.	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view.
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative.	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

The methodology is the strategy or action plan, the processes related to the selected methods, and the connection between the selected method and desired outcomes (Crotty, 1998). Methodology is associated with research strategy as "a general plan of how the researcher will go about answering the research question(s)" (Saunders et al., 2011, p. 600) and make a connection between theory and research (Bryman, 2016). Inductive, deductive, and abductive are among the research strategies and methodologies that can be used in studies. An inductive strategy is a "research strategy involving the development of a theory as a result of the observation of empirical data" (Saunders et al., 2011, p. 593). By the same token, in an inductive strategy, the researchers determine whether the theory is the outcome of the research (Bryman, 2016). Deductive refers to "research strategies involving the testing of a theoretical proposition by the employment of a research strategy specifically designed for the purpose of its testing" (Saunders et al., 2011, p. 590). In a deductive strategy, theory leads research (Bryman, 2016). Further, a deductive strategy entails the development of propositions from available theory and tests them in the real world (Dubois and Gadde, 2002). The combination of inductive and deductive creates the definition of abductive (Dubois and Gadde, 2002). According to Walton (2014), the best definition of an abductive strategy refers to "reasoning for given data to a hypothesis that explains the data" (p. 217). An abductive strategy is appropriate for the researcher whose final objectives are finding new things—other relationships and other variables (Dubois and Gadde, 2002).

Various methods have been involved with the techniques and procedures utilized to collect data and analyze data on research questions or hypotheses (Crotty, 1998). Research methods encompass questions, data collection, data analysis, interpretation, and validation (Creswell and Creswell, 2017). Quantitative research methods include experimental designs (Keppel, 1991) and non-experimental designs (i.e., survey questionnaires) (Fowler, 2013). Qualitative research methods include narrative research (Clandinin and Connelly, 2000), phenomenology (Moustakas, 1994), grounded theory (Charmaz, 2006; Corbin and Strauss, 2007), ethnographies, and case studies (Yin, 2017). Mixed methods involve different methods, such as convergent, explanatory sequential, exploratory sequential, and transformative, embedded, or multiphase (Creswell and Creswell, 2017).

The present research follows the positivism perspective, which involves elements such as determination, reductionism, empirical observation and measurement, and theory verification (Creswell and Creswell, 2017). Positivism includes two different assumptions, ontology and epistemology. The former concentrates on the idea that reality is external and objective, and the latter focuses on the notion that knowledge is important and achieved with observations of the external reality (Easterby-Smith et al., 2002). This research also employs the axiology assumption because the research was conducted in a value-free way, which means that the researcher is independent of the data and sustains an objective stance (Saunders et al., 2011).

In terms of the research methodology in the present research, the deductive strategy has been employed for the following reasons: First, the goal of this research is to find a causal relationship between different variables. Second, this research has used a highly structured methodology (i.e., reliability, validity) to facilitate reputation. Third, this research has been operationalized in a way that enables facts to be quantitatively assessed. Fourth, it assumes the stance of reductionism, which holds that problems are best understood when they are reduced to their simplest possible elements. The last reason involves generalization, which means that a sample of sufficient numerical size has been selected in this study (Saunders et al., 2011). In this research, all the publications utilized a deductive strategy via surveys along with quantitative methods.

3.2 Data collection and analysis

Quantitative research methods

Sampling frame

The research for all the publications was conducted using quantitative data, which was collected through the use of a structured survey questionnaire from the SMEs. The SMEs operated businesses in the service and manufacturing industries in Finland. In the first phase, the contact information of 6,816 Finnish SMEs was obtained from the database company that maintains the register of SMEs in Finland. These companies were selected randomly from approximately 20,000 SMEs in Finland. The low response rate is not a significant issue in this study because of the random sampling selection. Among the random sampling of 6,816 SMEs, 986 had invalid contact information; hence, the survey was undertaken with 5,830 SMEs. Thus, the sample is representative of approximately 30 percent of the entire population of SMEs that satisfied the criteria.

In the next phase, a letter of invitation that included information about the main goal of the study, the importance of the study, and the contact name of the researcher was mailed to the respondents to solicit their participation in the survey. Then, in early November 2017, the survey questionnaire along with a direct link was sent by e-mail to the respondents, all of whom are in managerial positions. After one week, the first reminder was sent, and further reminders were sent once a week for the next three weeks. The final survey response was completed after a total of four reminders. From the total number of 5,830 respondents, 282 responses were received. After the data was received, a data screening process was conducted and invalid responses were excluded based on the following criteria: first, incompleteness, which means that more than half of the values in a response were missing; second, validity, which means that responses contained the same answers for all survey items; and third, inconsistencies, which means that there were inconsistent responses from the same company. Two responses were excluded as a result of the specified criteria, and 280 valid responses were achieved.

Respondent demographics

The respondents' characteristics were analyzed in terms of five elements: revenue, number of employees, years since established, industry, and type of business. As shown in Table 2, approximately 70 percent of the respondents had revenue of €2 million to €10 million, while the rest had revenue of €10 million to €50 million. About 70 percent of the respondents were small with fewer than 49 employees, while 28% were medium-sized with between 50 and 249 employees, and 2% gave no responses regarding the number of employees. The ages of the companies ranged from 2 years old to 123 years old with an average of 35.85 years of experience in their field. It can be calculated from the data presented in Table 2 that most of the respondents were experienced because about 82 percent of the respondents indicated that it had been more than 15 years since the business was established. About 42 percent of the respondents were from the manufacturing sector, while 57% were from the service sector and less than one percent did not answer the question regarding the type of industry. The majority of respondents (84%) concentrated on business-to-business (B2B) trade, whereas about 16 percent focused on business-to-customer (B2C) trade.

Table 2. Respondents' characteristics

Characteristics	Category	No.	Percent
Revenue (Million €)	2–10	195	69.6
	10–50	85	30.4
Number of employees	Fewer than 49 employees	197	70.3
	50–249 employees	78	27.9
	No response	5	1.8
Years since established	Less than 15 years	51	18.2
	15–29 years	87	31.1
	30–44 years	61	21.8
	Over 45 years	81	28.9
Industry	Manufacturing	118	42.1
	Service	160	57.1
	No response	2	0.8
Type of Business	Business to Business	235	84
	Business to Customer	44	15.7
	No response	1	0.3

Bias

An analysis of variance (ANOVA) test was conducted to determine the non-response bias (Armstrong and Overton, 1977). The respondents were split into two groups, early respondents and late respondents. Early respondents are those who answered the survey questionnaire completely after the first email, and late respondents are those who completed the survey questionnaire after the last reminder. The early respondents and late respondents are likely to be similar to non-respondents based on the constructs. Making comparisons between early and late respondents through ANOVA confirmed that there were no significant differences between the two groups. Therefore, non-response bias is not a problem in this case, and the respondents are representative of the entire population.

Because there was a single respondent from each company, it was necessary to check common method bias. Various statistical and non-statistical approaches can be used to minimize the likelihood of common method bias (Podsakoff et al., 2003). Conducting the survey anonymously encouraged the respondents to respond as honestly as possible and minimized any inclination to answer in a socially desirable way, thereby reducing the probability of common method bias. Moreover, an iterative approach was conducted through different sessions with expert researchers to create items that were direct and easy for the respondents to understand. The survey was conducted with two different scales for the variables, *weak/excellent* and *strongly disagree/strongly agree*, which alleviated the possibility of common method bias. Furthermore, it is possible to reduce the probability of common method bias through methodological separations (Craighead et al., 2011). The items were constructed in such a way that the respondents could not recognize the cause-and-effect relationship between the dependent and independent variables.

In addition to the approaches discussed above, Harman’s single factor test was applied to inspect the influence of bias (Podsakoff et al., 2003). Built on the results of the principal component analysis (PCA), more than one factor loaded for 70% of the total variance, and no single factor loaded for more than 50% of the variance. Thus, this study does not suffer from common method bias based on the exploratory factor analysis and unrotated factor solutions (Podsakoff et al., 2003). As a result, based on the above-mentioned approaches and applied tests, the validity of the results is not threatened by common method bias or the risk of common method bias in the research.

Variable measurement

Since there is no comprehensive scale for managing sustainability performance in digital transformation, the scales used in previous research have been reviewed and developed through different sessions with experienced researchers. The unit of analysis in this research relies on the managers’ perceptions of the sustainability performance (including environmental, social, and economic), the drivers of digital transformation (including smart technologies, digital business strategy, and digital-related capabilities), and strategic approaches (such as corporate sustainability strategy and performance measurement systems).

It has been demonstrated in previous research that there is a high rate of correlation and concurrent validity between objective and subjective measurements (e.g., Venkatraman and Ramanujam, 1987). Although objective measurements are more reliable and valid, they are not appropriate in this research for a variety of reasons, including the time necessary to employ them and the fact that they are unable to measure intensity, frequency, and type of activity. Thus, in this study, self-reported subjective measurements were adopted and a variety of approaches (i.e., pre- and post-tests) were used to enhance the validity and reliability of the research.

Furthermore, many arguments exist about using single-item measures in surveys. Some researchers assert that there is a lack of reliability and validity in single-item measures (Diamantopoulos et al., 2012; Sarstedt and Wilczynski, 2009). Other researchers claim that there are no differences in the validity of single-item and multiple-item measures (Bergkvist and Rossiter, 2009, 2007). In previous research, using single-item measures has been confirmed in certain specific circumstances, namely, whether the research setting includes concrete singular objects and attributes (Bergkvist and Rossiter, 2009,

2007) that include items both homogeneous (Loo, 2002) and unambiguous to the respondents (Sackett and Larson Jr., 1990). These can be validated by high internal consistency or unidimensionality through factor analysis (Loo, 2002). In this study, measuring sustainability performance with a single item is acceptable and does not pose any problems regarding the reliability and validity of the research.

Sustainability performance includes three subjective items: 1) environmental sustainability, which concerns the ability to consider and reduce the environmental impact of the business activity; 2) social sustainability, which concerns the ability to enhance safety, health, and well-being through internal and external collaboration and partnerships; and 3) economic sustainability, which concerns the ability to ensure long-term economic balance and financial performance. As shown in the Appendix, the respondents were polled to assess their sustainability performance over the last three years based on their perceptions on a scale of [1] *weak* to [4] *excellent*.

The drivers of digital transformation, including smart technologies, digital business strategy, and digital-related capabilities, were assessed based on multiple items, and the respondents were asked to assess the items on a scale of [1] to [7], with [1] meaning *strongly disagree* and [7] meaning *strongly agree*. The strategic approach included performance measurement systems with multiple items in a 7-point Likert-type scale ranging from [1] *strongly disagree* to [7] *strongly agree*, and the corporate sustainability strategy was assessed based on a single item in a 4-point Likert-type scale ranging from [1] *weak* to [4] *excellent*.

Various control variables, namely, company size based on the number of employees and revenue, company age (evaluated by the years since the establishment of the company), and the type of business and industry, were utilized to reduce the probability of confounded results. The size of the company can have an impact on firm performance (Zhou et al., 2005) because of the huge amounts of resources, technology, and budget needs, which contribute to variations in firm performance. In this study, company size was controlled by the number of employees and revenue. Firm age might also have an impact on performance; for example, start-ups might encounter opportunities by cooperating with other parties for learning, information-sharing, and the acquisition of capabilities with less cost (Baum et al., 2000), while older companies might have a great deal of experience in dealing with challenges. Firm age was assessed by the number of years since the company was established. The type of business and industry can also have an impact on performance (Reinartz et al., 2004). This was controlled by asking respondents of the type of business if they earned their revenue from B2B or B2C trades and the type of industry if they operate in service-oriented companies or manufacturing companies. The exact items are presented in the Appendix.

The construct validity of the scales was checked by evaluating content validity, criterion validity, and discriminant and convergent validity in order to ensure that the survey measured what it was intended to measure (Field, 2013; Hair et al., 2010). For content validity, various approaches were used to check if the measurement items were relevant and representative of the target construct. First, an exhaustive literature review was conducted to extract the appropriate items. Second, each item was measured using a scale with more than three points. Third, the final survey was evaluated by a research expert in the field. For criterion validity, correlation analysis was conducted to check whether or to what extent a measure was related to the outcomes (Taherdoost, 2016). For discriminant validity, various methods were employed to test if the constructs that were intended to be unrelated were actually unrelated. Confirmatory factor analysis (CFA) and various indices including average variance extracted (AVE) and maximum shared variance (MSV) were used to test discriminant validity. The discriminant validity was tested by collating the value of the AVE and MSV. Since the values of the MSV were lower than the value of the AVE and the value of the square root of AVE was greater than the value of the correlation between constructs, the discriminant validity was supported (Fornell and Larcker, 1981).

Multicollinearity was tested using the variance inflation factors (VIF) and the tolerance value. Although a correlation coefficient between the independent variables greater than 0.7 might threaten the research in terms of multicollinearity, as suggested by Kleinbaum et al. (1988), multicollinearity is not problematic if the recommended value for VIF is 5 with a tolerance greater than 0.2. The recommended values were met in this study.

In terms of convergent validity, different approaches were used to test if the constructs that should be related were actually related. The unidimensionality of the scales was tested with exploratory factor analysis, and a lack of significant cross-loadings confirmed the convergent validity. Moreover, the AVE was greater than the suggested threshold of 0.5 and each factor loading had a value greater than 0.4 with eigenvalues of one, which confirmed the convergent validity (Carmines and Zeller, 1979). As suggested by Fornell and Larcker (1981), an AVE value lower than 0.5 is also acceptable if the value of the composite reliability (CR) is greater than 0.6. In this study, all the tests conducted confirmed the convergent validity of the constructs. All the above-mentioned remedies confirmed the construct validity of the scales in terms of content validity, criterion validity, and discriminant and convergent validity.

The construct reliability of the scale was evaluated using Cronbach’s alpha and CR to ensure stable and consistent results (Nunnally, 1978). Although an accepted cut-off value of 0.6 has been proposed for Cronbach’s alpha in exploratory research (Boyer and Pagell, 2000) and new constructs (Flynn et al., 1990), Nunnally (1978) argued that a smaller value is permissible if the scales are new and have fewer items. The validity and reliability of the constructs are discussed in more detail in the publications associated with this dissertation.

Analysis

In publication I, the survey data was analyzed by confirmatory factor analysis (CFA), regression analysis, and structural equation modeling (SEM). CFA was conducted to check the reliability and validity of the constructs along with regression analysis using structural equation modeling to test the hypotheses. In this study, the mediating effect of smart technologies on the connection between digital transformation and relationship performance was investigated. Additionally, smart technologies as one of the drivers of digital transformation have been presented.

In publication II, the survey data was analyzed by regression analysis to test the relationship between smart technologies, corporate sustainability, and sustainability performance. In addition to presenting smart technologies as one of the drivers of digital transformation, this study investigated the role of corporate sustainability strategies in digital transformation to influence sustainability performance.

In publication III, the survey data was analyzed by confirmatory factor analysis (CFA) and regression analysis, in which CFA was used to check the reliability and validity of the constructs and regression analysis was used to test the hypotheses. In addition to presenting digital business strategies as one of the drivers of digital transformation, this study examined the moderating effect of corporate sustainability strategies in the relationship between digital business strategies and economic sustainability performance.

In publication IV, the survey data was analyzed by regression analysis to find the relationship between digital-related capabilities, performance measurement systems, and economic sustainability performance. In addition to presenting digital-related capabilities as one of the drivers of digital transformation, this study examined the role of performance measurement systems in digital transformation to achieve better economic sustainability performance. A summary of the measures and analyses applied is presented in Table 3.

Table 3. Summary of the measures and analyses applied

	Independent variables	**Dependent variables**	**Moderator variables**	**Mediator variables**	**Control variables**	**Analyses**
Publication I	Digital transformation	Social sustainability performance	-	Smart technologies	Size, age, type of business	Confirmatory factor analysis, regression analysis, structural equation modeling
Publication II	Smart technologies	Sustainability performance	-	Corporate sustainability strategy	Size, age, industry	Regression analysis
Publication III	Digital business strategy	Economic sustainability performance	Corporate sustainability strategy	-	Size, age, industry	Confirmatory factor analysis, regression analysis
Publication IV	Digital-related capabilities	Economic sustainability performance	-	Performance measurement systems	Size, age, industry	Regression analysis

3.3 Quality of the research

The quality of the research was measured according to validity, generalizability, and reliability in a positivism approach. In general, validity is defined as whether the measures correspond closely to reality (Easterby-Smith et al., 2002). Validity can be categorized in three different groups: construct validity, internal validity, and external validity. Construct validity is defined as the extent to which operationalization measures the intended concept (Ghauri et al., 2020). To confirm the construct validity of the quantitative research, the content validity, criterion validity, and discriminant and convergent validity were measured as proposed by Field (2013) and Hair et al. (2010).

Various measures were applied in this research to check the construct validity. These included an exhaustive literature review before preparing survey items, an evaluation of the survey items with research experts in several sessions, correlation analysis and exploratory factor analysis, and the utilization of different indices, including AVE, MSV, VIF, and tolerance value.

Internal validity addresses the extent to which the research design has the capability of eradicating bias and the impact of extraneous variables (Easterby-Smith et al., 2002). Various approaches were used (both statistical tests and non-statistical tests) before, during, and after each phase to minimize the risk of non-respondent bias and common method bias. Furthermore, the effect of control variables on the research was checked in all four publications.

External validity addresses the extent to which the results of a particular study can be generalized to all relevant contexts (Saunders et al., 2011), whereas generalizability explains the extent to which the findings of the research are relevant and applicable in other situations or settings (Easterby-Smith et al., 2002; Saunders et al., 2011). External validity and generalizability are associated with each other, and both were confirmed in this study because the sample was selected in a way that can be considered as representative of the target group.

Reliability means the extent to which the data collection methods and analysis procedures result in consistent findings (Saunders et al., 2011). Aside from validity and generalizability, the study reliability was checked and assessed with different remedies from the beginning of the data collection phase to the end of the interpretation phase. In addition to reliability analysis (i.e., Cronbach's alpha and CR), other remedies were deployed to enhance the reliability of the research. These included an extensive literature review of the available research and a development of the perceptions of respondents over time and within path dependence.

4 Results of the study

This chapter presents summaries of the four publications and provides answers to the proposed research questions regarding those four publications. As shown in Figure 5, each of the publications has been placed in its relevant location to make explicit guideline about the interplay between the publications and research framework of the study. In addition, the objectives, findings, and main contributions of each publication are explained in the summary.

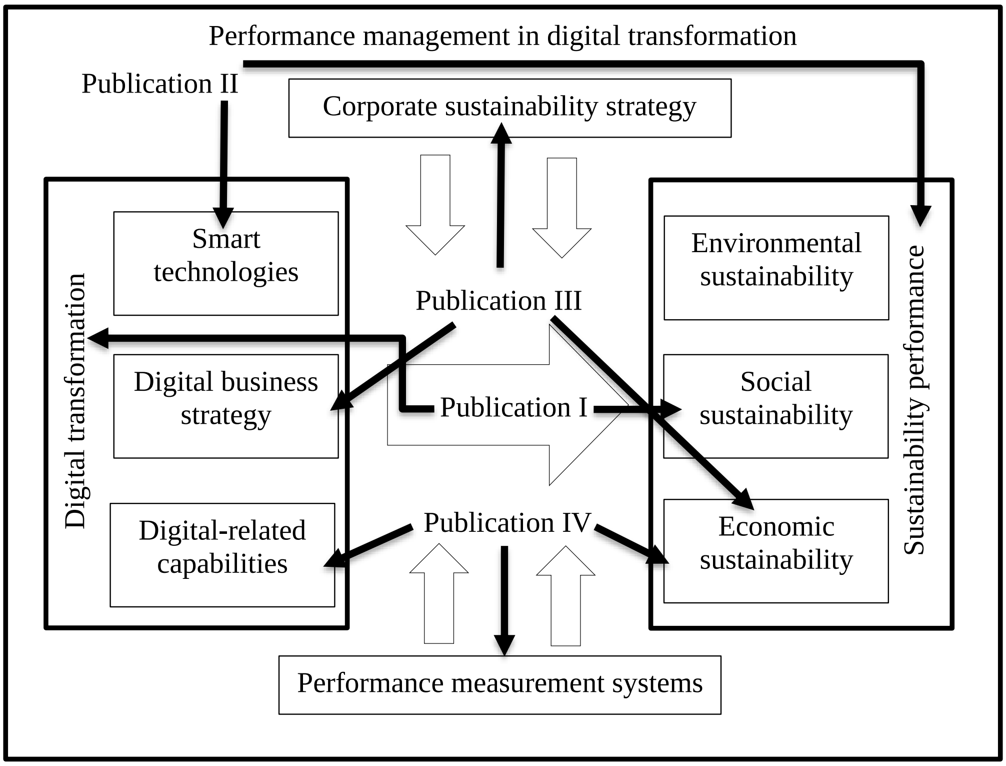

Figure 5. Interplay between publications and conceptual framework of the study

4.1 Summary of the publications

All four publications are connected to the first main research question, which is: *What are the drivers of digital transformation influencing sustainability performance?* Publications II, III, and VI focus on answering the second main research question: *Does a strategic approach facilitate digital transformation to achieve companies' sustainability performance?* Publication I introduced one of the drivers of digital transformation and determined the effect of related drivers in achieving sustainability performance in terms of the social dimension. Publication II introduced one of the drivers of digital transformation and its effect on sustainability performance. Publication II also introduced one strategic approach to achieve sustainability performance in all three dimensions (environmental, social, and economic). Publication III, aside from concentrating on the other drivers of digital transformation and related capabilities to realize those drivers, examined one strategic approach to achieve sustainability performance in terms of economic sustainability. Publication IV addresses the last driver of digital transformation and its effect on economic sustainability. In addition, another strategic approach, along with the method of utilizing it to achieve sustainability performance in terms of economic sustainability, is examined in Publication IV. The results of the publications are summarized in Table 4.

Table 4. Summary of the results of the publications

	Publication I	**Publication II**	**Publication III**	**Publication IV**
Title	"Managing the digital supply chain: The role of smart technologies"	"Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy"	"Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance"	"Digital-related capabilities and financial performance: The mediating effect of performance measurement systems"
Main objective	The study investigates how digital transformation in companies can fuel smart technologies, thereby improving relationship performance.	The purpose of this paper was to empirically examine the mediating role of corporate sustainability strategies between smart technologies and corporate sustainability.	This paper empirically examines the role of a sustainability strategy in the relationship between a digital business strategy and financial performance.	This research examines how different types of digital-related capabilities can fuel performance measurement systems, leading to improved financial performance.
Research question	1.1	1.1 + 2.1	1.2 + 2.1	1.3 + 2.2
Main findings	The sole digital transformation of the companies cannot improve relationship performance, and digital transformation needs to be coupled with smart technologies to achieve better relationship performance. This means that smart technologies fully mediate the relationship between digital transformation and relationship performance.	A corporate sustainability strategy fully mediates the relationships between smart technologies and environmental sustainability and smart technologies and social sustainability. Moreover, smart technologies have a direct and significant influence on economic sustainability, but the relationship is also partly mediated by a	The findings show that a sustainability strategy promotes the relationship between managerial capabilities and financial performance but inhibits the relationship between operational capability and financial performance.	The findings reveal that performance measurement systems significantly mediate the relationship between human and collaboration capabilities and financial performance. However, a significant mediating effect of performance measurement

		corporate sustainability strategy.		systems was not found between digital, technical, and innovation capabilities and financial performance.
Main contribution to the dissertation	Determining the drivers of digital transformation and the effect of digital transformation and smart technologies on improving social sustainability performance.	Determining the role of smart technologies as a driver of digital transformation and the effect of smart technologies and the strategic role of corporate sustainability strategy on better sustainability performance.	Determining the role of a digital business strategy as a driver of digital transformation and the effect of a digital business strategy and the strategic role of a corporate sustainability strategy on better economic sustainability performance.	Determining the role of digital-related capabilities as a driver of digital transformation and the effect of digital-related capabilities and the strategic role of performance measurement systems on improving economic sustainability performance.

4.2 Determining drivers of digital transformation and their effects on sustainability performance

4.2.1 Smart technologies as drivers of digital transformation for better sustainability performance

Sub-question 1.1, *Do smart technologies support digital transformation for better sustainability performance?* was examined in two publications: Publication I, entitled “Managing the digital supply chain: The role of smart technologies” and Publication II, entitled “Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy.”

Objective

The objective of Publication I was to investigate the approaches needed to achieve competitive advantages in the digital transformation. Aside from determining one of the drivers of digital transformation and its critical role in digital transformation to achieve social sustainability performance in terms of relationship value, Publication I examined how digital transformation in firms can encourage smart technologies, leading to better relationship performance in terms of both internal and external collaborations, which is called social sustainability performance. The goal of Publication II was to introduce one of the drivers of digital transformation in achieving sustainability performance and investigate the effect of that driver on performance in environmental sustainability, social sustainability, and economic sustainability.

Main findings

The findings of both publications reveal that digital transformation as a sole action does not improve a company's sustainability performance and needs to be coupled with smart technologies and a strategic approach to achieve sustainability performance. Smart technologies have been defined as a set of characteristics embedded in physical artifacts or business processes that complete digital technologies and bring smartness to physical artifacts or business processes. Smart technologies have a direct and significant impact on economic sustainability performance, but the relationship is also partly mediated by a corporate sustainability strategy. Although smart technologies do not have a direct impact on environmental or social sustainability performance, a corporate sustainability strategy fully mediates the relationship between smart technologies and environmental and social sustainability performance.

Answer to research question

An approach to digital transformation with the aim of improving sustainability performance requires multiple disciplines. Digital transformation cannot provide social sustainability alone, but digital transformation coupled with smart technologies can create social sustainability performance. Furthermore, smart technologies as one of the drivers of digital transformation can support sustainability performance only in terms of economic values; however, smart technologies coupled with a corporate sustainability strategy can fully support sustainability performance in terms of environmental, social, and economic sustainability.

4.2.2 Digital business strategy as a driver of digital transformation for better sustainability performance

Sub-question 1.2, *Do digital business strategies support digital transformation for better sustainability performance?* was examined in Publication III, entitled "Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance."

Objectives

The objectives of Publication III were to investigate ways to actualize digital business strategies and find the relationship between digital business strategies, corporate sustainability strategies, and economic sustainability performance. Aside from determining the driver of digital transformation, Publication III investigated ways to actualize digital business strategies and the required strategy for attaining economic sustainability performance.

Main findings

The findings of Publication III reveal that digital business strategies can be actualized with managerial capabilities and operational capabilities, but those capabilities do not have direct effects on economic sustainability performance. Furthermore, the results demonstrate that a corporate sustainability strategy supports the relationship between managerial capability and economic sustainability performance but inhibits the relationship between operational capability and economic sustainability performance.

Answer to research question

Digital business strategies do not support economic sustainability alone and should be incorporated into a corporate sustainability strategy to facilitate the links between a digital business strategy and economic sustainability performance. Furthermore, two different capabilities, managerial and operational capabilities, are required to actualize a digital business strategy in the digital transformation. Thus, a digital business strategy alone does not support economic sustainability performance, but when coupled with a corporate sustainability strategy, it can support economic sustainability performance through managerial capabilities and inhibit it through operational capabilities.

4.2.3 Digital-related capabilities as drivers of digital transformation for better sustainability performance

Sub-question 1.3, *Do digital-related capabilities support digital transformation for better sustainability performance?* was examined in Publication IV, entitled “Digital-related capabilities and financial performance: The mediating effect of performance measurement systems.”

Objectives

The objectives of Publication IV were to investigate the capabilities required in digital transformation and the ways in which those capabilities can provide economic sustainability performance. Aside from determining the drivers of digital transformation and its relevant capabilities, Publication IV examined ways to actualize digital-related capabilities as well as the required strategic approach for attaining economic sustainability performance.

Main findings

The findings of Publication IV show that companies need digital-related capabilities in terms of human capabilities, collaboration capabilities, innovation capabilities, and technical capabilities in digital transformation, but those capabilities do not have a direct effect on economic sustainability performance. Moreover, the results demonstrate that performance measurement systems can mediate the relationship between two of the digital-related capabilities (human and collaboration) and economic sustainability performance.

Answer to research question

Digital-related capabilities do not support economic sustainability performance alone and should be coupled with a performance measurement system as a strategic tool to facilitate the relationship between digital-related capabilities and economic sustainability performance and thus better economic sustainability performance. Furthermore, four types of digital-related capabilities—human, collaboration, technical, and innovation—are required in digital transformation.

4.3 Role of strategic approach to digital transformation in influencing sustainability performance

4.3.1 Role of corporate sustainability strategy in digital transformation for better sustainability performance

Sub-question 2.1, *What is the role of a corporate sustainability strategy in digital transformation for better sustainability performance?* was examined in two publications: Publication II, entitled “Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy,” and Publication III, entitled “Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance.”

Objectives

The objectives of Publications II and III were to investigate the role of a corporate sustainability strategy in the relationship between smart technologies and sustainability performance (including environmental, social, and economic) and in the relationship between a digital business strategy and economic sustainability performance, respectively.

Main findings

The findings of Publications II and III reveal the critical role of a corporate sustainability strategy in achieving sustainability performance. The findings of the Publication II demonstrate that a corporate sustainability strategy mediates the relationship between smart technologies and sustainability performance. In this regard, the results show that a corporate sustainability strategy partially mediates the relationship between smart technologies and economic sustainability, whereas it fully mediates the relationship between two dimensions of sustainability performance (environmental sustainability and social sustainability). The findings of Publication III demonstrate that a corporate sustainability strategy moderates the relationship between a digital business strategy and economic sustainability performance. In this regard, the results show that a corporate sustainability strategy positively moderates the relationship between digital business strategy in terms of managerial capabilities and economic sustainability performance, whereas the relationship is negative between digital business strategy in terms of operational capabilities and economic sustainability performance.

Answer to research question

A corporate sustainability strategy can act as both a mediator and a moderator in different circumstances. When a corporate sustainability strategy is accompanied by smart technologies and sustainability performance (environmental, social, and economic), it acts as a mediator between smart technologies and sustainability performance (environmental, social, and economic). When it is accompanied by a digital business strategy and economic sustainability performance, it acts as a moderator between a digital business strategy and economic sustainability performance. Additionally, in the role of a moderator, a corporate sustainability strategy promotes the relationship between managerial capability and economic sustainability performance, but it inhibits the relationship between operational capability and economic sustainability performance.

4.3.2 Role of performance measurement systems in digital transformation for better sustainability performance

Sub-question 2.2, *What is the role of performance measurement systems in digital transformation for better sustainability performance?* was examined in Publication IV, entitled “Digital-related capabilities and financial performance: The mediating effect of performance measurements systems.”

Objective

The objective of Publication IV was to examine the mediating effect of performance measurement systems on the connection between digital-related capabilities and economic sustainability performance. Furthermore, the publication examined how different kinds of capabilities in digital transformation can fuel a performance measurement system, thereby achieving better economic sustainability performance.

Main findings

The findings of Publication IV show that digital-related capabilities, such as human, collaboration, innovation, and technical capabilities, refer to the capabilities required by companies to approach digital transformation. The results also show that performance measurement systems significantly mediate the relationship between both digital-related human capabilities and collaboration capabilities and economic sustainability performance. By contrast, no significant mediating effect of performance measurement systems was found between digital-related innovation and technical capabilities and economic sustainability performance. Moreover, the empirical evidence validates that the number of employees has a significant negative effect on the mediating model, while the type of industry has a significant positive effect on the mediating model.

Answer to research question

A performance measurement system acts as a mediator between digital-related capabilities and economic sustainability performance. A performance measurement system significantly facilitates the relationship between digital-related human capabilities and collaboration capabilities and economic sustainability performance, but no significant effect was found of a performance measurement system as a mediator between digital-related innovation and technical capabilities and economic sustainability performance.

5 Discussion

In today's digital transformation, when the rate of transformation has been exponentially increasing and the emergence of digital technologies has acted as a catalyst for these changes in everyday life, it is vital for companies to be equipped with smart technologies, a digital business strategy, and digital-related capabilities. However, to achieve sustainability performance, these drivers (smart technologies, digital business strategy, and digital-related capabilities) alone are not enough, and these drivers need to be coupled with strategic approaches (corporate sustainability strategy and performance measurement systems) in order to maximize sustainability performance. Thus, the findings of the present study provide new insights about the approach to digital transformation with the aim of achieving sustainability performance.

In terms of the first research questions regarding the direct effects of drivers of digital transformation on sustainability performance, the results revealed that smart technologies, digital business strategies, and digital-related capabilities are drivers of digital transformation and that they complement each other but cannot achieve sustainability performance on their own. Regarding the significant role of smart technologies in digital transformation, the findings of this study are in line with research conducted by Hess et al. (2016) and Matt et al. (2015), which emphasized the utilization of novel technologies and structural changes involving fundamental alterations in a firm's structure, processes, and the skill sets required to cope with and exploit digital transformation. Furthermore, smart technologies with specific characteristics are required beforehand to provide smartness for products, services, and processes at firms (Kallinikos et al., 2013; Yoo, 2010; Vial, 2019) and to be prepared for digitization (convert physical artifacts to digitalized artifacts) (Verhoef et al., 2019; Yoo, 2010) in advance for the execution of digital transformation.

In this study, a significant positive impact of smart technologies on sustainability performance has been found only in economic sustainability performance. No significant direct effect has been found in social and environmental sustainability performance. This result supports the perspective of previous scholars (Baumers et al., 2013, Chen et al., 2015), who indicated that smart technologies reduce costs and consumption as well as create economic value through the opportunities that smart technologies provide to enable tracking and remote monitoring with the aim of reducing unnecessary functions, thereby optimizing and reducing resource consumption and, ultimately, achieving economic sustainability performance and values.

The results are also in line with previous research by scholars such as El Sawy et al. (2016) and Kane et al. (2015), who have highlighted the roles of strategy, culture, knowledge, and skill development rather than technology. In addition, the results support the research conducted by Vial (2019), who observed that leveraging digital technologies to unlock new value creation requires more than a single activity. Vial argued that value creation requires changes in organizational structure, organizational culture, leadership, and employee roles and skills in advance and then transformations in value propositions, value networks, digital channels, agility, and dexterity.

Although no significant direct effect of smart technologies on social sustainability performance was found, the results of this study confirmed that smart technologies facilitate the achievement of social sustainability in the digital transformation. This is because of the supportive role of technology (Berman, 2012), which should be coupled with other entities (Vial, 2019) to provide social sustainability performance. A significant direct impact of smart technologies on environmental sustainability performance is not supported, which might be because of the environmental issues posed by the toxic waste of smart technologies (i.e., RFID tags, chips, smart devices); thus, no direct effect was found. This result can be associated with the research conducted by Bekaroo et al. (2016), who observed that the IT industry is responsible for 25% of environmental issues and that these issues can be addressed by utilizing smart technologies in a sustainable way and having the full support of users.

Regarding the vital role of digital business strategies in digital transformation, the findings of this study are aligned with Bharadwaj et al. (2013), El Sawy et al. (2016), Kane et al. (2015), Li et al. (2018), and Sia et al. (2016), who have highlighted the important role of managers' capabilities and operational capabilities in the actualization of digital business strategies. One explanation for this might be that digital business strategies can harness opportunities through managers' skill sets and operational routines, which simplifies conducting business in digital transformation within complex domains.

The findings of this study did not support a direct significant effect of digital business strategies, in terms of managerial and operational capabilities, on economic sustainability performance. In other words, a digital business strategy in terms of managerial and operational capabilities is not sufficient to achieve economic sustainability performance. This might be because of the idea that the impacts of a digital business strategy can be improved only at the business process level, such as productivity and efficiency (Li et al., 2018), and cannot provide economic sustainability performance. Furthermore, a firm's perception of economic sustainability performance is associated with other firms' success as well as other factors. Thus, a digital business strategy alone cannot provide economic sustainability performance and needs to be coupled with sustainability initiatives to improve economic sustainability performance.

Regarding the essential role of digital-related capabilities in digital transformation, the findings of this study are aligned with those of other researchers who have highlighted the important role of digital-related capabilities in terms of human capabilities (Hess et al., 2016; Pramanik et al., 2019; Vial, 2019), collaboration capabilities (Amit and Han, 2017; Earley, 2014; Maedche, 2016), innovation capabilities (Pramanik et al., 2019 ; Yoo et al., 2012; Xue, 2014), and technical capabilities (Berman, 2012; Lenka et al., 2017: Yoo et al., 2012) in digital transformation. No significant direct effect of digital-related capabilities on economic sustainability performance was found, which might demonstrate that digital-related capabilities are not enough to enhance economic sustainability performance. One explanation for this might be that digital transformation to obtain value creation and competitive advantages cannot be achieved with a single action (Li et al., 2018; Vial, 2019). Thus, economic sustainability performance cannot be achieved with digital-related capabilities alone, and other factors and strategic reactions are needed to improve economic sustainability performance.

Referring to the second research question to discuss the mediating and moderating effects of strategic approaches, the results showed that different strategic approaches, such as corporate sustainability strategies and performance measurement systems, can facilitate the relationship between digital transformation and sustainability performance. Regarding the essential role of a corporate sustainability strategy in smart technologies, the findings of this study show that a corporate sustainability strategy mediates the relationship between smart technologies and sustainability performance (environmental, social, and economic). These findings are in line with previous research by Forcadell et al. (2020) and Vial (2019), who noted the important role of corporate sustainability strategy as a facilitator and complimentary action in digital transformation for the achievement of sustainability performance. The supportive role of corporate sustainability strategy in obtaining sustainability performance has been verified by other scholars (Caputo et al., 2018; Engert and Baumgartner, 2016; Epstein and Roy, 2001; Maher et al., 2018). One explanation for this might be the necessity of a corporate structure for the exploitation of advanced technology (Romanelli, 2018). In this setting (smart technologies and sustainability performance), a corporate sustainability strategy can simplify and facilitate the achievement of sustainability performance in digital transformation.

Regarding the critical role of corporate sustainability strategy in digital business strategy, the findings of the study show that a corporate sustainability strategy moderates the relationship between a digital business strategy and economic sustainability performance. The evidence in this study verified the two-edged role of a corporate sustainability strategy when it is located next to a digital business strategy and achieving economic sustainability performance. The results show that a digital business strategy in terms of managerial capabilities is positively moderated by a corporate sustainability strategy to achieve economic sustainability performance, but a digital business strategy in terms of operational capabilities is negatively moderated by a corporate sustainability strategy to achieve economic sustainability performance. In other words, a corporate sustainability strategy can promote the relationship between a digital business strategy in terms of managerial capabilities and economic sustainability performance, while a corporate sustainability strategy can hinder the relationship between a digital business strategy in terms of operational capabilities and economic sustainability performance.

These results are in line with the findings of previous studies, including Helfat and Martin (2015) and Li et al. (2018), who have referred to the importance of superior managerial cognitions (e.g. clear vision about digital transformation) in encouraging strategic changes, thereby improving business performance. Additionally, as proposed by Harmon et al. (2009), changing managers' attitudes and behavior toward corporate sustainability strategies can reduce the number of organizational faults and enhance business performance. The presented literature supports the idea in this study that managers' recognitions should be focused on the digital business strategy and the corporate sustainability strategy at the same time to improve economic sustainability performance. In contrast to previous research about the role of a corporate sustainability strategy as a facilitator of efficiency in the process (Baumgartner and Rauter, 2017), the results of the present study support the contention of Salzmann et al. (2005) that a corporate sustainability strategy is not applicable in all cases. With considering this notion that corporate sustainability strategy integrates environmental, social, and economic sustainability simultaneously in business operations (Epstein and Roy, 2001), the reason for the deterrent role of a corporate sustainability strategy between a digital business strategy in terms of operational capabilities and economic sustainability performance can explain why companies who attempt to achieve economic value when coupled with a corporate sustainability strategy, the focus cannot be on only one dimension (economic sustainability performance) as this would hamper the links between operational capabilities and economic sustainability performance.

Regarding the important role of performance measurement systems in digital-related capabilities, the findings of the study show that performance measurement systems significantly mediate the relationship between digital-related capabilities in terms of human and collaboration capabilities and economic sustainability. However, no link was found between digital-related capabilities in terms of innovation and technical capabilities and economic sustainability performance. The findings of this study support the idea proposed by Koufteros et al. (2014) and Melnyk et al. (2014) that the use of performance measurement systems has been increasing in the last couple of decades on the premise that they bring better financial and non-financial performance.

Furthermore, inertia has been referred to as a barrier in the approach to digital transformation with the aim of achieving competitive advantages. This inertia can be associated with a lack of willingness to make changes in capabilities (Vial, 2019). Meanwhile, performance measurement systems have been found to have an influential role in mitigating the hindering effects of capabilities and resources through strategies and strategic capabilities (Chenhall, 2005; Dossi and Patelli, 2010; Franco-Santos et al., 2012). Thus, a performance measurement system can be useful when coupled with digital-related capabilities to achieve digital transformation with competitive advantages.

To be more specific about the consequences of performance measurement systems on all dimensions of digital-related capabilities, the following understandings have been developed in this study. First, the findings reveal that digital-related human capabilities contribute to economic sustainability performance through the utilization of a performance measurement system. Relying on the influential role of performance measurement systems in reducing resistance (Franco-Santos et al., 2012) and the resistance of employees as the barrier to achieving digital transformation with competitive advantages (Vial, 2019), this research supports the role of performance measurement systems as mediators between digital-related capabilities and economic sustainability performance. This is because performance measurement systems, through their influence on people's behavior and organizational capabilities, can enhance employees' motivation and mitigate their resistance to digital proficiency and skill sets, resulting in better economic sustainability performance.

Second, the evidence of this study demonstrates that digital-related collaboration capabilities contribute to economic sustainability performance using a performance measurement system. Since working with advanced technologies requires collaboration (Chuang and Lin, 2015; Lenka et al., 2017; Msanjila and Afsarmanesh, 2011; Parida et al., 2015) and performance measurement systems through their effects on people's behavior and companies' capabilities can enhance the potential for knowledge-sharing and building trust (Franco-Santos et al., 2012; Maestrini et al., 2018; Pekkola and Ukko, 2016), thus it can be applicable in digital transformation as well and provide better economic sustainability performance.

Third, the results of the study demonstrate that performance measurement systems do not assist digital-related innovation capabilities to achieve better economic sustainability performance. In contrast to previous research conducted by Melnyk et al. (2014), who highlighted the important role of innovation as a driving force to form performance measurement systems, the evidence of this study shows that performance measurement systems are not sufficiently developed to promote digital-related innovation capabilities in a way that can actualize economic sustainability performance. Moreover, another explanation could be that the utilization of digital-related innovation capabilities may be associated with digital-related human capabilities, which were the least developed among the studied capabilities. A higher level of digital-related human capabilities may facilitate a culture that embraces the use of performance measurement systems, leading to effective management and better economic sustainability performance (Bititci et al., 2012). The results may also indicate that other types of management systems are needed to make innovation capabilities fully exploitable. This refers to innovation systems in which ideas are evaluated instead of measured, thus progressing the best ideas for innovation.

Finally, the findings of the study do not support the mediating effect of performance measurement systems between digital-related technical capabilities and economic sustainability performance. One explanation for this result is that the swiftness of technological advancements (Nudurupati et al., 2016) sets high standards for technical capabilities to handle the vast number of technologies and data volume. Thus, sophisticated, creative ways of sourcing data are required along with professional analytics to exploit the full potential of performance measurement systems as proposed by Barton and Court (2012). Furthermore, this may explain why the utilization of digital-related technical capabilities may also be associated with digital-related human capabilities. In particular, employees' mindsets, skill sets, and digital expertise (El Sawy et al., 2016) may be crucial for the full exploitation of digital-related technical capabilities in the development of performance measurement systems and the improvement of economic sustainability performance.

6 Conclusion

The main goal of this dissertation was to understand the approaches to managing (sustainability) performance in digital transformation. Encompassing the results of the publications and the synthesized understanding obtained over the course of the research process, the study argues that smart technologies, digital business strategies, and digital-related capabilities are drivers in the approach to digital transformation. Furthermore, the research suggests the important role of a strategic approach in supporting those drivers in order to achieve sustainability performance in the digital transformation.

This study makes three contributions to the literature. First, it provides empirical evidence to identify the drivers of digital transformation and the recognized strategic approaches to utilizing those drivers in a way that produces sustainability performance in SMEs. Second, the study explains the effects of each driver on sustainability performance. Third, the study clarifies the role of strategic approaches (corporate sustainability strategy and performance measurement systems) in the process of digital transformation with the aim of achieving sustainability performance.

6.1 Theoretical implications

This research has made a link between the strategic information management field and performance management research. The theoretical grounding of the dissertation was built on the literature related to digital transformation (including smart technologies, digital business strategies, and digital-related capabilities) and sustainability performance, as well as performance measurement systems and corporate sustainability strategies. This combination forms the innovative contribution of the dissertation as most studies in this field have neglected the critical role of obtaining comprehensive information on both the required drivers and the strategic approaches to sustainability performance in digital transformation and of then utilizing that information to reshape the approach to digital transformation with the aim of sustainability performance.

In addition, this research has identified the required technologies, strategies, and capabilities needed in digital transformation to achieve sustainability performance. Furthermore, the research raises awareness and understanding of the limited research on the utilization of strategic approaches such as corporate sustainability strategies and performance measurement systems to manage (sustainability) performance in digital transformation. In addition to clarifying the role of corporate sustainability strategies and performance measurement systems, this study has clarified the relationship between smart technologies and corporate sustainability strategies, digital business strategies, and corporate sustainability strategies, as well as digital-related capabilities and performance measurement systems. Moreover, this study has suggested ways of utilizing strategic approaches (including corporate sustainability strategy and performance measurement systems) with the final aim of enhanced sustainability performance.

6.2 Managerial implications

This study provides new insights and guidance for managers of SMEs about ways to approach digital transformation with the aim of achieving sustainability performance. The findings of this study provide evidence that the existence of smart technologies, digital business strategies, and digital-related capabilities in firms can drive digital transformation. The study argues that managers should also consider other strategic approaches such as corporate sustainability strategies and performance measurement systems to fully exploit digital transformation with the aim of sustainability performance. To be more specific, the study provides the following managerial implications.

Regarding smart technologies as drivers of digital transformation with the aim of sustainability performance, the findings of this research can guide managers as follows. First, managers can achieve better social sustainability performance in digital transformation through the advanced utilization of smart technologies. Second, while many companies might be capable of implementing digitalization in their business operations, leveraging digital transformation to uncover opportunities to promote social sustainability, especially in terms of internal and external relationship values, will likely necessitate investment in smart technologies to support and complement companies' strategies. Third, smart technologies can provide economic sustainability performance, but the sole utilization of smart technologies cannot provide environmental and social sustainability performance on its own. Instead, with the presence of a corporate sustainability strategy to integrate sustainable development principles into business operations, the effects of smart technologies can be harnessed to provide sustainability performance in terms of social and environmental sustainability performance. Thus, it is vital for the managers of SMEs to recognize the significance of this strategy for integrating smart technologies and firm-level sustainable development in digital transformation and to ensure that they have adequate resources in place to support corporate sustainability strategy in their companies.

Regarding digital business strategy as a driver of digital transformation with the aim of sustainability performance, the results of this study can guide managers as follows. First, a digital business strategy is not enough on its own to provide economic sustainability performance. It must be coupled with a corporate sustainability strategy to generate economic sustainability performance. Second, managers' recognition of digital transformation at firms plays a key role in achieving better economic sustainability performance through the facilitating role of a corporate sustainability strategy. Therefore, managers should have the relevant competencies and positive attitudes regarding both their digital business strategy and their corporate sustainability strategy in order to obtain sustainability economic values. Furthermore, managers should have the ability to prioritize tasks based on a firm's goals and to consider sustainability principles during the design of the firm's strategy. Third, the willingness of managers to seize opportunities in digital transformation are important. If a manager considers a corporate sustainability strategy to be the main concern of the business to enhance sustainability at the heart of business operations, that corporate sustainability strategy will enhance the company's economic sustainability performance; conversely, operational capabilities with the aim of digitizing business processes do not work even by the utilization of a corporate sustainability strategy. Fourth, managers of SMEs should be aware of the balance between their corporate sustainability strategy and the pursuit of economic sustainability performance. It is worth mentioning that a corporate sustainability strategy does not always provide economic value. For example, a corporate sustainability strategy that focuses on environmental and social sustainability instead of economic sustainability can decentralize the economic benefits and hamper the potential benefits of a corporate sustainability strategy.

Regarding digital-related capabilities as drivers of digital transformation with the aim of sustainability performance, the findings of this research can guide managers as follows. First, digital-related capabilities alone cannot provide economic sustainability performance. A performance measurement system is needed to centralize those digital-related capabilities in digital transformation to achieve economic sustainability performance. Second, not all digital-related capabilities in digital transformation are equal; thus, their effects on economic sustainability performance differ. As an example, digital-related human capabilities at the lowest level have a significant effect, whereas digital-related innovation capabilities at the highest level do not have significant effect. Third, managers with developing digital-related human capabilities can achieve better economic sustainability performance through performance measurement systems. Since a lack of resources and capabilities often creates significant problems for SMEs, by considering this point, managers of SMEs can make effective decisions regarding resource acquisition.

6.3 Limitations of the research

This research has a number of limitations, all of which offer opportunities for future research. First, the data was collected from SMEs in Finland, which might result in a lack of generalizability because the data gathering was restricted to a single country. In future studies, researchers should gather data in other countries and from other company sizes to determine whether this will produce different results. The next limitation stems from the cross-sectional nature of the data, which might conceal issues raised during the process and interfere with a comprehensive understanding of the drivers of digital transformation on sustainability performance over time. Future research should be conducted using longitudinal data. Additionally, sustainability performance in terms of economic sustainability performance and environmental sustainability performance were measured with a single item through the self-reporting of managers at firms. This might have created the potential for bias. Although the potential for bias was addressed using both statistical and non-statistical methods, utilizing multiple items from multiple respondents in future research could enhance understanding of this topic and reduce the potential for biased answers or results.

6.4 Suggestions for further research

This research includes some fascinating insights that serve as a useful starting point for further research. First, as this research was conducted using quantitative methods, further research using qualitative methods could complement the understanding of the approaches to managing (sustainability) performance in digital transformation and provide new insights about the phenomenon of digital transformation.

Next, as the type of industry (manufacturing and service firms) has been used only as a control variable to reduce the probability of confounded results and has not been considered as a distinctive variable in the study, it is worth considering the differences between manufacturing and service firms to understand whether these differences are significant depending on the age of the company and the generational shift.

Furthermore, in-depth research is required to investigate whether other types of technologies, strategies, and capabilities are required to manage sustainability performance in digital transformation. Research should also be conducted to discover whether other capabilities besides digital-related capabilities are necessary in order to exploit performance measurement systems in digital transformation. In addition, deep analysis can improve the understanding of the inhibiting role of a corporate sustainability strategy on a digital business strategy in terms of operational capabilities and economic sustainability performance.

Since this dissertation investigated the role of corporate sustainability strategies in exploiting smart technologies and digital business strategy, it would be beneficial to further research the role of corporate sustainability strategies in exploiting digital-related capabilities. Likewise, as the present research only examined the role of performance measurement systems in exploiting digital-related capabilities, further research could be conducted on the role of performance measurement systems in exploiting smart technologies and digital business strategies.

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Appendix: Survey items

Part 1: Background information

1. Revenue (Million €) (2-5, 5-20, 20-50)
2. Number of employees (10-49, 49-250)
3. Years since established
4. Organizational position (Manager, Employee)
5. Industry (Service, Manufacturing)
6. Type of business (B2B, B2C)

Part 2: Drivers of digital transformation

1. Digital transformation
   We aim to digitalize everything that can be digitalized.
   We collect large amounts of data from different sources.
   We aim to create stronger networking between the different business processes with digital technologies.
   We aim to enhance an efficient customer interface with digitality.
   We aim at achieving information exchange with digitality.

2. Smart technologies
   All the devices are programmable.
   All the devices are able to be uniquely identified.
   All the devices are aware of and respond to changes in their environment.
   All the devices can send and receive messages.
   All the devices can record and store all information.
   All the devices can identify with other devices, places, or people.

3. Digital business strategy
   3.1.Managerial capabilities
   Our company's management is familiar with digital tools.
   Our company's management has a clear vision for utilizing digitality in the future.
   Our company's management supports the utilization of digitality in our company.

   3.2.Operational capabilities
   Utilizing digitality in internal processes has become an important part of our business.

Digitality is a natural part of our business.
Digitality enhances our business.

4. Digital-related capabilities
   4.1. Human capabilities
   Digital skills development is supported and promoted in our company
   Our employees are well trained in digital tools usage.
   Digitalisation of the operating environment is easily accepted by our employees.

   4.2. Collaboration capabilities
   Digital cooperation is made with other companies.
   Digital channels are used to share information with other companies.
   Digitality transforms the shape of social relationships in our business.

   4.3. Innovation capabilities
   Digitality enables innovations and new ideas in our company
   Digitality forces us to develop new solutions.
   Digitality helps to produce new products and services.

   4.4. Technical capabilities
   Digitality increases the value of our products or services.
   Digitality enables the integration of products and services into our company.
   Digitality enables up-to-date, location-independent services for our customer.
   Digitality allows us to work across boundaries of time, place or activities.

Part 3: Strategic approach

1. Corporate sustainability strategy
   1.1. What is your company´s ability to integrate sustainable development principles into business operations over the last three years?

2. Performance measurement systems
   2.1. The performance measurement provides a broad range of performance information about different areas of the business.
   2.2. The performance measurement is produced in a documented form.
   2.3. The performance measurement enables the formation of links between the current operating performance and the long-term strategies.

Part 4: Sustainability Performance

1. How do you assess your company in terms of environmental sustainability (ability to take into account and reduce the environmental impact of the activity) over the last three years?
2. How do you assess your company in terms of social sustainability (ability to promote health, safety, and well-being) over the last three years?
3. How do you assess your company in terms of economic sustainability (ability to ensure the long-term economic balance of the company) over the last three years?
4. How do you assess your company in terms of financial performance over the last three years?
5. How do you assess your company in terms of internal collaboration over the last three years?
6. How do you assess your company in terms of external collaboration over the last three years?

Publication I

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Managing the digital supply chain: The role of smart technologies

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ABSTRACT

This study investigates the approach required to achieve competitive advantages in the digital supply chain. Moreover, the study examines how digital transformation of companies can fuel smart technologies, leading to improved relationship performance. The results of the survey given to 280 Finnish small and medium-sized enterprises (SMEs) show that digital transformation of the companies alone cannot enhance relationship performance, and that it needs to be coupled with smart technologies to achieve this goal. This means that smart technologies fully mediate the relationship between digital transformation and relationship performance.

1. Introduction

Digitalization has changed the ways in which people communicate and interact with their surroundings. Novel technologies and gadgets—including smartphones, computers, driverless cars, and smart wearable devices—have all transformed how we access and disseminate information. These novelties and digital transformations affect every industry, and supply chains are no exception. Digitalization in supply chains has come to encompass digital products and services as well as the handling of supply chain processes within companies undergoing these rapid changes (Büyüközkan and Göçer, 2018). In order to benefit from the digital supply chain, it is necessary to leverage novel approaches, including digital transformation with technologies. This study defines the digital supply chain as a bundle of interconnected activities, handled with novel technologies, involved in supply chain processes between suppliers and customers (Büyüközkan and Göçer, 2018). In other words, the digital supply chain is an intelligent, value-added, novel process that utilizes new approaches, specifically digital transformation with technologies, to create competitive value and network effects (Büyüközkan and Göçer, 2018). Companies' digital transformations allow them to benefit from extra features, including barcode scanning, services offered based on location, and near-field communication (Ström et al., 2014). These activities are made possible by smart technologies, a group of characteristics embedded in devices that enable intelligence. These characteristics allow devices to be programmable, addressable, sensible, communicable, memorizable and associable (Yoo, 2010). Therefore, this study considers the digital supply chain built on both digital transformation and smart technologies, a context in which digitalization will change the way firms collaborate and interact (Akter et al., 2016; Büyüközkan and Göçer, 2018; Matt et al., 2015; Weichhart et al., 2016; Zhu et al., 2015).

Many researchers have highlighted the importance of both internal and external relationship performance in managing the entire supply chain (Stank et al., 2001; Holweg et al., 2005). For example, Stank et al. (2001) observed that increased collaboration among supply chain participants reduces total costs and augments service performance. They also found that, ideally, collaboration begins with customers and extends throughout the firm—from the distribution of finished goods to the manufacturing and procurement of raw materials to work with material and service suppliers. Studies also have indicated that increased digital transformation has given rise to increased collaboration within supply chains (Kiel et al., 2017; Klein and Rai, 2009; Nordman and Tolstoy, 2016; Zhao et al., 2015). Although many firms have mentioned and validated the great potential of digitalization in supply chains, there remains a substantial untapped possibility when it comes to companies seeking to move toward a digital supply chain (Büyüközkan and Göçer, 2018). Because there is a lack of evidence regarding how digital transformation increases collaboration (Scuotto et al., 2017), further investigation is needed into the role of smart technologies in the digital supply chain (Büyüközkan and Göçer, 2018). In this study, relationship performance includes both internal and external relationships, where the former refers to success in internal production, processes, communication, while the latter addresses the success of operations with other participants in a supply chain (Klein and Rai, 2009; Trainor et al., 2014).

Based on the abovementioned gaps, this study will shed light on the required approach to attain value-driven benefits in the digital supply chain. Specifically, the study investigates the mediating role of smart technologies between digital transformation of companies and relationship performance (in the digital supply chain). This study was

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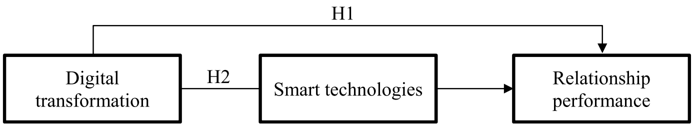

Fig. 1. Conceptual model.

conducted through a structured survey of 280 small and medium-sized enterprises (SMEs) in Finland. This study contributes to research on the digital supply chain by clarifying the relationship between digital transformation of companies, smart technologies, and relationship performance in practice.

This research proceeds as follows: First, the research starts with an introduction to briefly explain and highlight the significance of this research in the digital supply chain context. Second, the theoretical framework and research model will be presented, which deal with the development of hypotheses and a conceptual model of the digital supply chain, digital transformation of the companies, and smart technologies. The third section includes the research methodology, including sample and data gathering and construct operationalization as well as data analysis, validity, and reliability. Then, the results of the study will be described. Finally, the study will finish with the discussion and conclusions, which include theoretical and managerial implications as well as limitations and further research.

2. Theoretical framework and research model

2.1. The digital supply chain

For decades, firms have considered collaborative relationships as opportunities to make sure that their supply chain is effective and responsive to market transitions. Many companies, such as IBM, Dell, Hewlett-Packard, and Procter & Gamble, were able to achieve competitive advantages and lower transaction costs through strong long-term relationships with their partners (Cao and Zhang, 2011; Sheu et al., 2006). Based on previous research, collaborative relationships enable risk sharing (Kogut, 1988), complementary resources accessibility (Dwyer et al., 1987; Klein and Rai, 2009), productivity enhancement (Klein and Rai, 2009), and profitability (O'Toole and Donaldson, 2002) during the time. In this study, we define relationship performance as the appropriate level of collaboration, both internally and externally, between companies and their suppliers, built for conducting business (Akter et al., 2016; Büyüközkan and Göçer, 2018). Internal collaboration includes activities such as internal production, processes, and communication among employees inside the companies, while external collaboration encompasses the abovementioned operations with other participants outside the firms, in the supply chain (Klein and Rai, 2009; Trainor et al., 2014).

Organizations around the world have turned their attentions to digitality because of the considerable benefits it brings for firms. A huge number of benefits of utilizing digitalization in supply chains exists, many of which are still largely untapped. The reason could be the disruptive nature of organizational transformations, which might cause managers to neglect them and delay the processes (Büyüközkan and Göçer, 2018). Digitality has changed the way that both companies and individuals interact and communicate with each other in an extreme way (Berman, 2012; Büyüközkan and Göçer, 2018; Matt et al., 2015). Therefore, in order to exploit digitalization in business, companies should consider all the necessary procedures, strategies, and tools needed to move toward the digital supply chain (Akter et al., 2016; Büyüközkan and Göçer, 2018; Matt et al., 2015; Weichhart et al., 2016; Zhu et al., 2015). In this study, the digital supply chain is defined as a bundle of interconnected activities that are involved in supply chain processes between suppliers and customers, which are handled with novel technologies (Büyüközkan and Göçer, 2018). The digital supply chain enables wider availability of information and infinitely superior interactions, communication, and collaboration, which lead to improved trust, agility, and productiveness (Büyüközkan and Göçer, 2018; Liu et al., 2013). The digital supply chain needs a combination of digital tools, strategies, and approaches, which support interactions between customers and suppliers externally, as well as employees internally. In order to reap the benefits of the digital supply chain, there is a need to leverage novel approaches, including digital transformation with technologies. Therefore, the digital supply chain built on both digital transformation and smart technologies (Akter et al., 2016; Büyüközkan and Göçer, 2018; Matt et al., 2015; Weichhart et al., 2016; Zhu et al., 2015).

Digital transformation is defined as the transformation of business process, culture, and organizational aspects to meet market requirements, owing to digital technologies. In other words, it is the rethinking, reimagining, and redesigning of business in the digital age (Hinings et al., 2018; Li, 2018; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019). Digital transformation of companies involves fundamental changes in business process, including digitalizing everything that can be digitalized (Hagberg et al., 2016), collecting massive volumes of data from different sources (Leviäkangas, 2016; Frank et al., 2019), stronger networking among business processes using digital technologies (Berman, 2012; Matt et al., 2015), creating an efficient customer interface (Berman, 2012; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019), and information exchange based on digitality (Berman, 2012; Frank et al., 2019). Because of the key role of digital technologies in digital transformation, companies need to improve the level of technical adaptability and implement digital technologies appropriately (Frank et al., 2019; Pramanik et al., 2019).

Smart technologies refer to entities where physical devices or processes are complemented with the smart properties of digital technologies. Yoo (2010) has used the term "digitalized artifacts" to describe the necessary and desirable properties of artifacts to be digitalized for such smart technologies. In this sense, smart technologies are defined by certain key characteristics, including programmability, addressability, sensibility, communicability, memorizability, and associability in devices that make interconnectivity and intelligence of companies possible. Programmability enables devices to perform many different functions with more flexibility. Addressability enables devices to be identified and recognized uniquely. Sensibility makes devices able to react and be aware of changing circumstances. The communicability characteristic of devices enables them to interact with each other in a way that allows them to send and receive messages. Regarding memorizability characteristics, the devices have a type of memory chip, which collects and stores all the information. Finally, associability makes it possible for devices to be associated with other entities including devices, locations, and people (Yoo, 2010). Smart grids provide one example of these smart technologies; these modern power grids integrate multiple ICTs and services with the existing power delivery infrastructure (e.g., Featherston et al., 2016).

2.2. Importance of digital transformation in the digital supply chain

Collaboration, both internal and external, makes up an important part of companies' relationship performance in the digital supply chain. Digital transformation driven, for example, by increased automatization, data collection, information exchange, and networking, has created opportunities and challenges for company collaboration activities

Table 1
Results of the validity and reliability tests.

Latent variable	Measured variable	Standardized weight	Alpha	AVE	CR
Digital transformation (Berman, 2012; Frank et al., 2019; Hagberg et al., 2016; Leviäkangas, 2016; Li, 2018; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019)	We aim to digitalize everything that can be digitalized.	.570	.808	.471	.814
	We collect large amounts of data from different sources.	.644			
	We aim to create stronger networking between the different business processes with digital technologies.	.843			
	We aim to enhance an efficient customer interface with digitality.	.727			
	We aim at achieving information exchange with digitality.	.615			
Smart technologies (Yoo, 2010)	All the devices are programmable.	.837	.945	.742	.945
	All the devices are able to be uniquely identified.	.712			
	All the devices are aware of and respond to changes in their environment.	.805			
	All the devices can send and receive messages.	.942			
	All the devices can record and store all information.	.929			
	All the devices can identify with other devices, places, or people	.920			
Relationship Performance	Assesses internal collaboration over the last three years.	.780	.597	.462	.627
	Assesses external collaboration over the last three years.	.562			

(Riemer and Schellhammer, 2019; Singh et al., 2018). According to Riemer and Schellhammer (2019), the ability to collaborate and exchange information has provided new forms of working and also new types of virtual organizations, which have given companies the need to adjust their operations.

Digital transformation has revolutionized the possibilities and solutions for companies to handle and execute their external collaboration activities in the digital supply chain (Crittenden et al., 2019). Even though different types of social media solutions have changed the way people communicate, contemporary devices can also be identified and contacted by other devices or people. As such, digital transformation can enable the acquisition of external collaboration, and reduce engagement costs (Crittenden et al., 2019). In relation to external collaboration activities in the digital supply chain, digital transformation can also improve customer service as it enables the collection of large amounts of data from different sources and their utilization in building strong networks between different partners. Digital transformation also makes it possible for consumers and end-users to become experts on product and service offerings (Berman, 2012).

In addition to possibilities for external collaboration in the digital supply chain, digital transformation provides possibilities for internal collaboration within companies. Digital transformation can, for example, support collaborative work for planning and executing business processes (González-Rojas et al., 2016), as there is a possibility to exchange information and make everything digitalized. Even though the internal collaboration activities are difficult to handle without face-to-face communication, and companies require new types of capabilities to utilize the possibilities provided by digital transformation (Riemer and Schellhammer, 2019), the provided options can, for example, ease the establishment of a collaborative work environment (Boudreau et al., 2014; Merschbrock and Mundvold, 2015), where different people can operate. Based on the argumentation presented above, the following hypothesis is presented:

H1. Digital transformation of companies has a positive effect on relationship performance

2.3. *Importance of smart technologies as a mediator in the digital supply chain*

Digital transformation refers to fundamental changes in business processes, including digitalizing everything that can be digitalized (Hagberg et al., 2016). One key goal for digital transformation is stronger collaboration among business processes using smart technologies (Berman, 2012; Matt et al., 2015). The benefits of smart technologies are clearly indicated by the growing prospects of combining software and software components and mixing content across platforms, infrastructures, and production systems (Langlois, 2003; Merrifield et al., 2008; Yoo et al., 2010; Kallinikos et al., 2013). This indicates that smart technologies may be needed to fully exploit the possibilities of digital transformation. Smart technologies extend internet-based services by incorporating technologies, such as mobile operating systems (Nylén and Holmström, 2015), which support several service functions, including organizational service management, collaboration management, customer service support, as well as service research and planning (Chen et al., 2006; Loukis et al., 2012; Chuang and Lin, 2015). An example of the use of smart technology is a digital platform that integrates back-end enterprise resource planning (ERP) systems with front-end web-based systems and across different partners, in order to support e-business initiatives (Hsu, 2013; Zhu et al., 2015). By effectively managing interactions with partners and gaining shared key knowledge across organizational boundaries, smart technologies (in terms of an integrated digital platform) affect the development of procurement, channel management, and customer service (Devaraj et al., 2007; Zhu et al., 2015). Based on the above considerations, it can be assumed that in order to facilitate digital

Table 2
Correlation matrix.

	Mean	St. Dev.	Digital transformation	Smart technologies	Relationship performance
Digital transformation	5.11	0.975	.687[a]		
Smart technologies	3.76	1.641	.519***	.861[a]	
Relationship performance	2.86	0.501	-.008	.248**	.680[a]

[a] Square root of AVE, Sign. *** ≤0.001, ** 0.001 < p ≤ 0.01.

Table 3
Unstandardized maximum likelihood estimates (N = 280).

Structural path	Estimate	S.E.	C.R.	P
Relationship performance < — Firm size	-.001	.001	-.930	.352
Relationship performance < — Firm age	.000	.001	.099	.921
Relationship performance < — Type of business	.036	.100	.363	.717
Relationship performance < — Digital transformation	-.093	.048	-1.952	.051
Relationship performance < — Smart technologies	.095	.026	3.616	***
Smart technologies < — Digital transformation	.920	.113	8.130	***

Sign. *** ≤0.001, ** 0.001 < p ≤ 0.01, * 0.01 < p ≤ 0.05.

transformation of companies, smart technologies are needed for better relationship performance. Thus, the second hypothesis is as follows:

H2. Smart technologies mediate the relationship between digital transformation of the companies and relationship performance

2.4. Conceptual model

This study investigates the smart technologies through which digital transformation of companies influences relationship performance in SMEs. Fig. 1 shows the conceptual model. To sum up, prior literature suggests that digital transformation can lead to improved relationship performance (Crittenden et al., 2019; Riemer and Schellhammer, 2019). Digital transformation is about companies' capability to use digitality for the benefit of their operation, and this depends on the characteristics of the digital tools adopted. Consequently, this study proposes smart technologies as an important tool to turn digital transformation of a company into increased relationship performance. This is because it is widely accepted that relationships are strongly affected by digitization (Jonsson et al., 2018), but certain properties need to be instantiated (Yoo, 2010) to gain relationship performance. Thus, the presence of smart technologies acts as a prompt for SMEs to gain relationship performance by means of digital transformation.

3. Research methodology

3.1. Sample and data gathering

Data collection was conducted as cross-sectional random sampling of SMEs located in Finland. The companies operate in a variety of service and manufacturing sectors, such as engineering, information technology, real estate, consulting, construction, accounting, and health services. From a sample of 5830 companies, 280 responses were obtained. The respondents were all in a managerial position, which provided them with good knowledge to respond to items related to digital transformation, smart technologies, and relationship performance at a company level.

The majority of companies (around 71%) were small with fewer than 50 employees, and the rest (around 29%) were medium-sized. Reported company ages indicated that about 37% of the companies were established fewer than 25 years ago. The remaining 63% of the companies were more mature (with more than 25 years since their establishment). The majority of the companies concentrated on business to business (B2B) trade (84%), whereas 16% of firms earned their revenue from business to customer (B2C) trade.

We tested the potential for nonresponse bias by building on Armstrong and Overton's (1977) suggested uniformity between nonrespondents and late respondents. The tests showed no significant divergence between early and late respondents, which demonstrates the nonexistence of nonresponse bias.

3.2. Construct operationalization

All items were adopted from previously utilized scales. Digital transformation was measured by five items that rated the companies' ability to use digitality in their operation. Digital transformation was identified by the following items: "In our company, we aim to digitalize everything that can be digitized," "In our company, we collect massive volumes of data from different sources," "In our company, we aim to create stronger networking between the different business processes with digital technologies," "In our company, we aim to enhance an efficient customer interface with digitality," and "In our company, we aim at achieving information exchange with digitality." This construct was built based on prior literature (Berman, 2012; Frank et al., 2019; Hagberg et al., 2016; Leviäkangas, 2016; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019). The construct for smart technologies included the following items: "In our company, all the devices are programmable," "In our company, all the devices are able to be uniquely identified," "In our company, all the devices are able to respond to changes in their environment," "In our company, all the devices can send and receive messages," "In our company, all the devices can record and store all information," and "In our company, all the devices can identify with other entities (e.g., other devices, places, or people)." This construct was based on the work of Yoo (2010). The response scale for the items of digital transformation (independent variable) and smart technologies (mediating variable) ranged from 1 to 7 (1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = agree, and 7 = strongly agree). The dependent variable, relationship performance, was assessed by the state of collaboration both internally and externally. The response scale included managers' perceptions in the range of 1–4 (1 = weak, 2 = satisfactory, 3 = good, and 4 = excellent). In terms of control variables, well-established companies probably have sophisticated practices in terms of both internal and external collaboration, and such companies are also probably larger and older. Thus, the influence of firm size (assessed by the amount of employees) and firm age (assessed by the number of years since the company's establishment) on relationship performance was controlled. The third control variable was the type of business, which was assessed with a dummy variable divided into B2B and B2C companies.

The potential for common method variance was addressed as the data for each item were collected from the same source. Both ex ante and ex post remedies were employed (Podsakoff et al., 2003). Items of different variables were placed in a way that reduced the possibility of the respondent anticipating causalities. The introductory letter explained that the survey was anonymous which was likely to prevent the respondent from providing socially acceptable responses instead of the corporate reality. Also, Harman's one-factor test was employed. More than one factor emerged and the prior factor accounted for less than half of the variance, which provides the evidence for the lack of common method variance.

3.3. Data analysis, validity, and reliability

Confirmatory factor analysis (CFA) was utilized to check the reliability and validity of the constructs. Table 1 demonstrates standardized loadings, Cronbach's alpha (α), average variance extracted (AVE), and composite reliability (CR) values for each construct. The reliability of the scales was validated through Cronbach's alpha. The alpha values for digital transformation and smart technologies suggest the admissible level of reliability. The alpha value for relationship performance is lower (0.597), but according to Hair et al. (2006), values near 0.60 are acceptable, especially if the factor only has a few items. Convergent validity was estimated via factor loadings, CR, and AVE. Each loading was significant. CR values were significantly higher than the cutoff of 0.60 (Fornell and Larcker, 1981). The AVE value for smart technologies was more than the cutoff of 0.50, but the AVE values for the digital transformation scale and relationship performance were 0.471 and 0.462, respectively, which are slightly below the cutoff. However, we consider the AVE value to be at an acceptable level as the CR was above the threshold (Fornell and Larcker, 1981). Discriminant validity was estimated by collating the AVE and maximum shared variance (MSV) values. All MSV values were smaller than the AVEs, which supports discriminant validity. Thus, the validities of the study constructs are supported.

Moreover, Table 2 presents the means, standard deviations, and variable correlations. The high mean for digital transformation substantiates a wide adoption of digitality in SMEs. However, the mean for smart technologies is significantly lower. The correlations between the variable pairs were at an acceptable level.

4. Results

Fit indices of the model are calculated using multiple criteria, including ($\chi 2/\mathrm{DF} = 2.286$), the comparative fit index (CFI = 0.943), the incremental fit index (IFI = 0.944), the normed fit index (NFI = 0.904), and the root mean square error of approximation (RMSEA = 0.068). Based on a rule of thumb for a model with a high degree of freedom (DF), the acceptable threshold to ensure a well-fitting model for the $\chi 2/\mathrm{DF}$ ratio is in the range of 2–5 (Kelloway, 1998). A value greater than 0.9 is suggested as a reasonable model fit for fit indexes such as the CFI, IFI, and NFI (Bentler and Bonett, 1980). The acceptable value proposed for the RMSEA to ensure that the model fits is less than 0.08 (Browne and Cudeck, 1993). Therefore, the results of the fit indices reveal a good fit of the model.

Regression analysis using a structural equation model in IBM SPSS AMOS 25 was applied to test the hypotheses. Table 3 shows unstandardized maximum likelihood estimates, including the structural paths, estimates, standard error of regression weight estimates (S.E.), critical ratios (C.R.), and P-values. As shown in Table 3, there is no significant direct structural path between exogenous and endogenous variables. Therefore, there is no significant direct effect between digital transformation and relationship performance (C.R. = -1.952; P = 0.051), which means that the first hypothesis is not supported. As suggested by Baron and Kenny (1986), the full mediation is supported when the direct effect of the exogenous variable on the endogenous variable is not significant, and the mediating variable significantly affects the endogenous variable. As shown in Table 3, digital transformation does not have a significant effect on relationship performance (C.R. = -1.952; P = 0.051), but digital transformation has a significant direct effect on smart technologies (C.R. = 8.130; $P \leq 0.001$), and smart technologies have a significant effect on relationship performance (C.R. = 3.616; $P \leq 0.001$), which means the second hypothesis is supported. Therefore, the results reveal a full mediation effect of smart technologies between digital transformation and relationship performance.

5. Discussion and conclusion

5.1. Theoretical implications

This study investigated the mediating effect of smart technologies on the connection between digital transformation and relationship performance. Thus, the study provides evidence to suggest that investment in smart technologies can provide firms with substantial relationship benefits. Therefore, the study contributes to research on the digital supply chain (Scuotto et al., 2017; Büyüközkan and Göçer, 2018). As a first contribution, the findings show that digital transformation of companies alone does not have a direct effect on relationship performance. This is in line with the previous research that mentioned the importance of comprehensive procedures, strategies, and tools to experience benefits from the digital supply chain (Akter et al., 2016; Büyüközkan and Göçer, 2018; Matt et al., 2015; Weichhart et al., 2016; Zhu et al., 2015). The reason might be that digital transformation alone does not create value in the relationships, as digitality requires strategy and goals. Furthermore, digitality can be adopted into organizations quite easily without thinking about the benefits and effectiveness of its implementation (i.e., the actual use of digitality in managing the company). In other words, before redesigning a business in the digital age, there is a need to think about the type of business and the appropriate digital procedures for implementation.

Second, the results support the claim that smart technologies mediate the relationship between digital transformation and relationship performance, covering both internal and external aspects. Therefore, when companies couple smart technologies with digital transformation, the impact on relationship performance will be enhanced. This is in line with previous research that mentioned building stronger collaboration in digital transformation through smart technologies (Berman, 2012; Matt et al., 2015). Furthermore, many different researchers stated the determinant role of smart technologies in combining software and software components, and mixing content across platforms, infrastructures, and production systems (Langlois, 2003; Merrifield et al., 2008; Yoo et al., 2010; Kallinikos et al., 2013). According to Merschbrock and Mundvold (2015), there is a need for a collaborative work environment that facilitates interactions. In this regard, it is worth mentioning that smart technologies provide a concrete tool to implement digital transformation in a company. Additionally, in order to adopt smart technologies (as it is challenging and time-consuming), companies need to have certain skills and an understanding of what they seek to accomplish with the technology. Consequently, the benefits (in terms of relationship performance) will follow. With regard to the perspective of the dynamics of the digital supply chain, it can be presented that smart technologies stimulate the growth in relationship performance. This stimulation may occur when smart technologies are integrated into the current supply chain or when smart technologies entirely or partially replace the existing supply chain.

5.2. Managerial implications

This study increases awareness and understanding of the scant previous studies on the links between digital transformation of companies and smart technologies to achieve relationship performance. The empirical evidence of the study showed that digital transformation provides many opportunities for organizations to support smart technologies, leading to relationship performance. Thus, the managers of SMEs should invest in different types of smart technologies that may improve relationship performance in the supply chain. Because smart technologies help transform digitality into value for relationships throughout the supply chain. Additionally, this study provides guidance for managers of SMEs on how to develop relationship performance in the digital supply chain. This study suggests that managers considering digital transformation should focus on how this phenomenon integrates with current systems to support their relationship performance. While the vast number of firms might be able to implement digitalization in their business, turning this phenomenon into opportunities to enhance both internal and external relationship performance will likely necessitate the investment in smart technologies to support and complement firm strategies.

5.3. Limitations and further research

There are some limitations in this study, which create opportunities to promote more research on this topic. First, cross-sectional data and a lack of longitudinal data might threaten an in-depth analysis of the data to find the required approaches in the digital supply chain. Second, collecting data from a single country (Finland) and analyzing them based on managerial perceptions could introduce bias and a lack of generalizability into the findings of the research. In future studies, it can be suggested to conduct research in different countries and to utilize multiple respondents from different departments of the companies. Lastly, the only endogenous variable in this study is relationship performance, which creates opportunities to expand the theoretical model of this study for other performance measures, including sales and market shares, as well as business brand and image, in terms of studying them as other endogenous variables.

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Publication II

Saunila, M., Nasiri, M., Ukko, J., and Rantala, T.

Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy

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Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy

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ABSTRACT

The focus of this paper is on the relation between smart technologies and corporate sustainability. Specifically, the purpose of this paper is to empirically examine the mediating role of corporate sustainability strategy between smart technologies and corporate sustainability. By building on a survey of 280 SMEs, the results show that corporate sustainability strategy fully mediates the relation between smart technologies and environmental sustainability, and smart technologies and social sustainability. Moreover, smart technologies have a direct significant influence on economic sustainability, but the relationship is also partly mediated by corporate sustainability strategy. Smart technologies do not have a direct influence on environmental or social sustainability.

1. Introduction

Smart technologies increasingly derive utility from the functional relations they maintain, and potential benefits are indicated by the growing prospects of combining software and software parts and mixing content across infrastructures, production systems, and platforms [1–7]. Manufacturing is going smart, and firms are progressively utilizing wireless technologies and sensors to seize data at multiple phases of a product's lifecycle [8]. Smart technologies that make physical products addressable, programmable, communicable, sensible, traceable, memorable, and associable authorize novel incorporations of physical and digital proportions to generate fresh products and manufacturing [3,4]. As a continuation of rapid development of smart technologies, there is a need to examine the implications they have generated [9,10].

Regarding the development of technology, especially smart technology, many studies emphasize that the implications need to be investigated through the aspects related to environmental, social, and economical dimensions ([11,12]; Becthsis et al., 2018). However, in profit-oriented organizations, the social and environmental dimensions may be considered subsets of corporate competitive strategy [13]. As a solution, a growing number of studies suggest that companies should have corporate sustainability strategies, which intend at stabilizing the economic, social, and environmental needs of both the society and company to achieve corporate sustainability performance [14–16]. This means that corporate sustainability strategy compounds environmental and social dimensions into the process of strategic management [13]. However, there is lack of research considering the role of corporate sustainability strategy in the relation between smart technologies and corporate sustainability.

Based on the notions above, this study has the ambition to empirically examine the effect of the utilization of smart technologies on the three dimensions of corporate sustainability: environmental, social, and economical sustainability. The paper also aims to study the mediating role of corporate sustainability strategy between smart technologies and corporate sustainability. In other words, it is essential to study whether the corporate sustainability strategy can facilitate the impacts of smart technologies on corporate sustainability. The study builds on the analysis of 280 responses from a random survey of Finnish SMEs. The results show that corporate sustainability strategy completely mediates the relation between smart technologies and environmental sustainability, and smart technologies and social sustainability. Moreover, smart technologies have a direct significant influence on economic sustainability, but the relationship is also partly mediated by corporate sustainability strategy. Smart technologies do not have a direct influence on environmental or social sustainability.

The remnant of this article is organized like this: First, the current understanding of smart technologies, corporate sustainability strategy, and corporate sustainability has been explored,

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and the conceptual framework for the study established. Then, the hypotheses are discussed, followed by a section on the research methodology and results. Finally, the theoretical and managerial implications of the study and avenues for further studies are proposed.

2. Conceptual framework

2.1. Smart technologies

Today, smart technologies pervade each firm's operations and change the nature of the business. For instance, firms try to provide intelligent management systems by embedding smart technologies in machines [17]. Products and services equipped with smart technologies offer novel functions that convert their designing, manufacture, delivery, and use [4]. Additionally, smart technologies provide huge potential for building new processes, experiences, organizational forms, and relationships in which radio-frequency identification (RFID) tags, digital sensors, networks, and processors create required properties related to smart technologies [17].

Yoo [3] has used the term "digitalized artifacts" to describe the necessary and desirable properties of artifacts to be digitalized. He defined seven features of digitalized artifacts, including addressability, programmability, communicability, sensibility, traceability, associability, and memorizability. Programmability is the first characteristic of digitalized artifacts, meaning that the devices should have the capability to accept new reconfigurations or changes of their functions. The second characteristic is addressability, which refers to the devices' ability to answer messages individually. The next characteristic is sensibility, which enables devices to track and react to changes in the surroundings. Communicability is another characteristic, defined as the devices' ability to send and receive messages with other devices. Memorizability is the next characteristic, defined as the devices' ability to both record and store the information that created, sensed, or communicated. Traceability is another characteristic that enables devices to chronologically recognize, memorize, and integrate incidents and totalities over time. The final characteristic is associability that provides the capacity for devices to be recognized with other totalities, such as other artifacts, places, and people. Kallinikos et al., [6] use the term "digital artifacts," and state that interactivity, editability, distributedness, and reprogrammability/openness are among the four aspects of digital artifacts. Editability refers to continuous updating of the content, items, and data, while interactivity means enabling exploitation of information using the receptive and flexible nature of the objects embedded in digital artifacts. They defined reprogrammability/openness as the ability of the digital artifacts to be accessible and modifiable, while distributedness refers to the borderless capability of digital objects.

In another study, Yoo et al. [4] refer to reprogrammability, data homogenization, and self-referential as the fundamental properties of smart technologies. Reprogrammability means that new functions or abilities can be added to the devices after they are designed or produced, while data homogenization refers to different types of digital contents (e.g., text, audio, image, and video) being stocked up, dispatched, refined, and displayed utilizing the identic digital networks and devices. Self-referential refers to the necessity of utilizing smart technology in offerings. Further, Yoo et al. [4] referred "the incorporation of digital capabilities into objects that had a purely physical materiality beforehand" as the main characteristics of pervasive digital technology. They also explained physical materiality as the tangible artifacts that are usually hard to move in terms of time and place limitations.

As discussed before, similar ideas have developed with different terminology [3,4,6,17]. Thus, in this study, smart technologies refer to the bundle of properties embedded into previously nondigital devices and enabling smartness for those devices.

2.2. Corporate sustainability

From the corporate perspective, sustainability research often adopts a systems perspective that concentrates on business-driven operations in natural systems [18]. It is widely accepted that firms, albeit, business-driven schemes, are coevolving with sundry schemes (involving the society and environment) [19]. This necessities investing in economic factors, but also in environmental and social aspects [20–24]. For example, Elkington's [25] triple bottom line approach considers the prolonged prosperity of a firm to be dependent on paying attention to three aspects of sustainability: social (social surroundings), environmental (natural surroundings), and economic. Environmental sustainability is based on the presumption that people live within the physical and biological boundaries that attend on the source of life and waste disposal [26–28]. Social sustainability adverts to accompanying social capital for example by means of participating to local communities [26]. This requires balancing human needs with economic and environmental wellbeing [29,30]. Economic sustainability concentrates on the financial value of things, including the costs of environmental effects [26]. Triple bottom line is the most prominent framework to understand the facets of sustainable development and that is why it was selected as a basis of this study. The three dimensions of triple bottom line were considered as the most essential from the perspective of corporate sustainability performance. Lozano [31] has proposed an extension to the triple bottom line by incorporating the dynamics of the three dimensions over time. This temporal dimension highlights the tension among environmental, social, and economic troubles, but also over long and short-term perspectives. We use the term "corporate sustainability" to describe the idea that, to induce sustainability in the long run, firms need to process all three dimensions that they are coevolving with: environmental, social, and economic [20,22].

2.3. Corporate sustainability strategy

Ranged sustainability and business strategies mirror the amplitude and nature of the possibilities affiliated with sustainable development as regards to the recreation of value for the company [32]. Baumgartner and Rauter [13] present that the prime justification for selecting a sustainability stance is to decrease the negative social and environmental effects of company operations, while enhancing the economical performance of the organization. Corporate sustainability strategies can be considered as strategies that point towards "balancing the social, environmental and economic needs of both the company and society" [14,15,33]. Baumgartner and Rauter [13] suggest that a corporate sustainability strategy connects environmental and social aspects into the process of strategic management and emphasizes the strategic standing of a corporation in terms of sustainable development. The unification of social and environmental factors into company mid-time and long-time visions claims that a prudent stability is reached between the requirements of external and internal stakeholders [13]. Building on the above, this study defines corporate sustainability strategy as the integration of sustainable development principles into business operations.

3. Hypotheses development

Our hypotheses are built on the following argumentation. Smart technologies reduce the need for resources (human, material, etc.) and increase the expectation for efficiency, so they are hypothesized to be a driving force for corporate sustainability

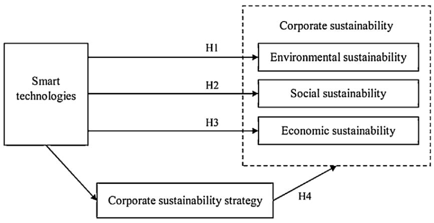

Fig. 1. Research model and hypotheses.

strategy and corporate sustainability. Corporate sustainability is examined through social, environmental and economic sustainability. The hypotheses' development is defined and discussed next (Fig. 1).

3.1. Smart technologies and environmental sustainability

Smart technologies, such as information and communication technologies, and digitalized production machines have been considered to have potential positive impacts to the environment, for example, by reducing greenhouse gas (GHG) emissions (e.g., [34,35]). In addition to the reduction of GHGs, smart technologies currently provide possibilities for intelligent and automated solutions and production optimization among different industries, such as manufacturing, power generation, and agriculture, thus improving energy efficiency. For example, different kinds of digital twins can produce real-time data and automatically adjust and optimize processes. Iacovidou et al. [36] present that RFID technologies can be used to support and increase the reutilization of building components and decrease their waste, thus supporting environmental sustainability achievements within the building sector. Smart technologies can also be used to support the achievement of sustainable development and environmental protection goals by supporting information flow throughout production processes. For example, Tao et al. [37] conclude that if data are gained in real time, manufacturing processes can be effectively controlled, and this may decrease the energy expenditure in public premises, production devices, and workpieces.

As such, smart technologies can be considered enablers that can reduce the energy consumption and emissions of industrial processes, electrical grids, and transportation systems [38]. Different studies have reported that smart technologies, such as digitalized manufacturing technologies and automatized working machines, can be an important part of the solution in dealing with current environmental challenges and issues related to climate change [38,39]. Thus, based on the evidence from previous research, the following hypothesis is presented:

H1. Smart technologies are positively related to environmental sustainability.

3.2. Smart technologies and social sustainability

It is suggested that the growing prospects of combining software and software parts and mixing content across infrastructures, production systems, and platforms increasingly derive utility from the functional relations they maintain [1–4,6]. Social sustainability is one of the most important perspectives when considering the benefits and impacts of these smart technologies [11,40]. Chen et al. [11] studied the incorporation of production technology and product modeling that straightly transforms digital patterns to physical affairs without the demand for tooling, suggesting social sustainability outcomes such as: equivalent opportunities to all parties in societies and markets, user-oriented goods and services, enhanced customer value, possible advantages for worker/human health, and influence on an industry's working situation. Further, Bechtsis et al. [40] studied intelligent, self-governing vehicles in digital supply chains, suggesting that, considering the social sustainability, employee accessibility and safety, together with safety and health of the conveyors, is dominant. Furthermore, they highlighted the ongoing recreation of proficient jobs, the sustained enhancement of ergonomics for the workforce, the recognition of possibilities for sensors' applicability to upgrade work safety, and the enactment of objects for tracking and estimating possible dangers.

Summarizing this, smart technologies seem to have implications for social sustainability in terms of increasing safety [40] and employment [11]. Thus, the evidence from prior studies supports the formation of the following hypothesis:

H2. Smart technologies are positively related to social sustainability.

3.3. Smart technologies and economic sustainability

Bekaroo et al. [34] present that, so far, scholars have shown that main drivers for sustainability using smart technologies usually include an economic expectation to improve efficiency. Issues related to climate change and growing environmental worries are changing the form of operations and organizations in the energy sector [41]. Further, the power-saving features of current smart technologies can help reduce cooling burdens by decreasing the quantity of heat produced to deliver a more effective economic benefit [34]. Technological development and new types of smart technologies can offer inferior cost structures and opportunities for reaching the goals of different sustainability aspects (Costa-Campi, 2018). In addition to the possibilities of economic sustainability in the energy sector, current and emerging smart technologies also provide possibilities for economic sustainability among many other industries. Automated and digitalized energy-efficient smart technologies and different resource-saving technologies and processes can reduce costs and, thus, improve the productivity of organizations among different industries [42]. Smart technologies assist in optimizing production processes and the entire life cycle of products. Thus, smart technologies provide greater benefits for the state of the workforce, the site and organization of lots, and the state of manufacturing machinery [43]. Further, self-organizing production, predictive and cooperative maintenance, efficient transport planning, as well as accurate classification of retirement and disposal decisions, can increase economic returns from smart technologies [37,43].

Based on the above, by digitalizing traditional manufacturing environments, smart technologies can be used to increase productivity, speed, quality, and the safety of operations aiming to increase economic sustainability (e.g., [44]). Thus, based on the evidence from previous research, the following hypothesis is presented:

H3. Smart technologies are positively related to economic sustainability.

3.4. Corporate sustainability strategy as a mediator

Demands for cleaner production have increased because of issues related to environmental, social, and economic sustainability. Referring to Caputo et al. [45], to achieve sustainability, research on both structural and dynamic dimensions must be conducted. The structural dimensions refer to the existence of resources and feasible strategic pathways, while the second dimension is the way of managing those resources and the pathway according to sustainable strategy. In their research, they also refer to the being of a solid relationship between sustainability and smartness. They mentioned that, to clarify the presence of this relationship, there is a need for the precise definition of emerging and evolving this relationship over time. Despite the fact that cleaner production strategy provides huge potential for environmental, social, and economic benefits, many difficulties and barriers (e.g., absence of sufficient awareness about cleaner technologies, shortage of enough tools and information, and weak communication schemes) [46,47] need to be overcome.

As one of the main characteristics of smart technologies is being present at any time, they are always threatened by certain risks, such as being lost, hardware crash, or other accident. Consequently, sustainability of smart technology can be mentioned as one of the ideal approaches to reducing the number of the above-mentioned risks [48]. Additionally, the way that knowledge is collected, distributed, and exploited with technologies can be considered as the most important issues in achieving sustainability [39]. According to Stuermer et al. [48], full exploitation of sustainability needs sustainability of smart technologies. Thus, smart technologies can be considered the means to sustainability.

Based on Caputo et al. [45], smart technologies support the definition by clarifying more efficient, effective, and sustainable pathways. Besides, they address the interlinkage between smartness and sustainability, leading to new insights. Thus, in light of sustainability science, the effective approach toward smartness will be achieved based on building a collaborative approach among the actors involved. Similarly, Maher et al. [49] refer to the way digital tools can help tackle sustainability issues by making progress in ways of thinking, communicating, and collaborating. In their research, they refer to the need for a synergy map to develop sustainability. In this synergy map, they refer to finding the linkage between key issues of sustainability, identifying devices to tackle these issues, the relationship between these devices, and they underline the potential for adding digital artifacts to these devices. In this regard, Romanelli's [50] reference to building sustainable value using technology depends heavily on cooperation and collaboration within the ecosystem and named governments, businesses, and communities as the key actors and enablers of value. Furthermore, he refers to the impact of utilizing technology in knowledge creation to sustain development in the long term. Thus, constituting a corporate sustainability strategy that integrates sustainability with business operations plays an important role between smart technologies and the achievement of sustainability.

To sum up, smart technologies can be considered the bundle of properties that are embedded into previously nondigital devices and enable smartness for those devices. To provide benefits from smart technologies, there is a need for corporate sustainability strategy, which will fuel corporate sustainability in three dimensions (environmental, social, economic). Therefore, smart technologies enable corporate sustainability strategy, which fuels corporate sustainability in all three dimensions (social, environmental, and economic) (cf. [51]). Therefore, based on the beyond-mentioned evidence, the last hypotheses formed is as follows:

H4. Corporate sustainability strategy mediates the positive relation between smart technologies and corporate sustainability.

H4a. Corporate sustainability strategy mediates the positive relation between smart technologies and environmental sustainability.

H4b. Corporate sustainability strategy mediates the positive relation between smart technologies and social sustainability.

H4c. Corporate sustainability strategy mediates the positive relation between smart technologies and economic sustainability.

4. Methodology

4.1. Sample and data collection

The sample of the research includes Finnish firms with 20–250 employees. According to the database, the population comprised approximately 20,000 firms. A population of 6816 firms was randomly selected. Among the 6816 SMEs, 986 had invalid contact information; thus, the survey was conducted with 5830 firms. Therefore, the sample represents approximately 30% of the entire population of Finnish firms that met the criteria. The decision of working with a sample of firms with more than 20 employees is based on the idea that microfirms usually do not have the opportunity to concentrate on sustainability, as they have fewer financial resources and knowledge.

To collect data, a structured questionnaire was created, and a direct link was sent to the respondents by e-mail. The questionnaire was aimed at the top managers of the firms, as they have a general vision of the topics of this study. In the end, 280 valid questionnaires were obtained. Approximately 70% of the responses came from small companies, and approximately 30% came from medium-size companies. Further, 81.8% of the companies were established more than 15 years ago. About 57.1% of the respondents were from service-oriented firms, whereas 42.1% were from manufacturing firms.

Non-response bias was assessed by testing for differences between early respondents and late respondents on study items (independent, mediation, and dependent variables). Early respondents responded within a reasonable period after receiving the first e-mail. Late respondents were those who responded after several reminders. Late respondents most precisely reminded non-respondents (Armstrong and Overton, 1977). Both tests on the means of the constructs, as well as on the means of each of the items, revealed no statistically significant differences (at significance level 5%). Thereby, non-response bias did not cause any problems.

Several practices were used to diminish a common method bias (Podsakoff et al., 2003). First, every questionnaire item was informed by previous studies, and scales were informed by expert views to decrease item obscurity. Second, a letter of invitation ensured confidentiality to decrease social desirability bias. In addition, Harman's single factor test was used to explore for common method bias (Podsakoff et al., 2003). The exploratory factor analysis of all items displayed more than single factor with eigenvalues higher than 1.0, proposing that common method bias does not exist.

4.2. Measures

This study utilized a managerial assessment of the utilization of smart technologies, as well as the state of sustainability strategy, and corporate sustainability in the respondents' firms. Thus, the respondents provided evaluations of the constructs in their firms. The response to the question required adequate knowledge concerning their firm's operations. Managers were selected as respondents because they were expected to have this knowledge. The items measuring theoretical constructs were informed by literature review, but where existing items were not identified, the researchers relied on the extant literature to specify the content of each construct. Since the target firms are SMEs, the items were selected based on relevance in the SME context. Detailed description of measurement items are presented in the Appendix.

Smart technologies. This independent variable is a multidimensional construct, and we used a six-item measure that has been previously used (in [3]) to assess smart technologies. The respondents were requested to express the degree to which they agreed with the consequent statements: "In our company, all the devices are programmable," "In our company, all the devices are able to be uniquely identified," "In our company, all the devices are aware of the respond to changes in their environment," "In our company, all the devices can send and receive messages," "In our company, all the devices can record and store all information," and "In our company, all the devices can be identified with other devices, places, or people." The respondents were asked to choose a number from 1 to 7 (from (1) strongly disagree to (7) strongly agree). Cronbach's alpha of the construct is 0.945, which exceeded the recommended threshold of 0.7 [52].

Sustainability strategy. The mediating variable, sustainability strategy, was measured by the following: "what is your company's ability to integrate sustainable development principles into business operations over the last three years". The respondents were asked to choose a number from 1 to 4 (1=weak, 2=satisfactory, 3=good, 4=excellent).

Corporate sustainability. Three widely accepted dimensions measured the dependent variable: environmental sustainability, social sustainability, and economic sustainability. The respondents were asked to assess the following over the last three years: environmental sustainability, social sustainability, and economic sustainability. The items were as follows: "what is the state of your company's environmental sustainability (ability to take into account and reduce the environmental impact of the activity) over the last three years", "what is the state of your company's social sustainability (ability to promote health, safety, and well-being) over the last three years", and "what is the state of your company's economic sustainability (ability to ensure the long-term economic balance of the company) over the last three years". The respondents were asked to choose a number from 1 to 4 (1=weak, 2=satisfactory, 3=good, 4=excellent).

Single-item measures have started to suffer puzzles with their validity and reliability (Sarstedt and Wilczynski, 2009; Diamantopoulos et al., 2012). However, they are acceptable with some limitations: if the empirical setting contains concrete singular objects (Bergkvist and Rossiter, 2007, 2009), if the objects are homogenous (Loo, 2002), and if the objects are unequivocal to the respondent (Sackett and Larson, 1990). These terms are met in this study.

The control variables—company size, age, and industry—were included, as they are considered the determinants of sustainability. Company size was estimated as the amount of employees in the company. Company age was computed as the amount of years since its foundation. Industry was controlled by using a dummy variable according to the value of "1″ if the firm operated in a manufacturing sector.

5. Results

The validity and reliability of the variables were investigated past to hypothesis testing, and this examination was presented in the methodology section. Table 1 presents the correlations for the smart technologies, sustainability strategy, and corporate sustainability. The Table 1 demonstrates significant correlations along with the variables throughout. These results express a relationship between the study variables. To test the possibility of multicollinearity, the variance inflation factors were computed. They were below the cutoff value of 10 and, therefore, multicollinearity did not cause problems.

Table 2 shows the results of the regression analysis for the relationship between smart technologies and corporate sustainability. The significance of the F-value determines whether the model in question supports the hypothesis. Moreover, the coefficient of determination, noted as R^2, measures the power of the regression model. According to Hair et al. [52], there is interplay between the sample size and number of independent variables in detecting a significant minimum value of R^2. Based on the sample size ($N = 280$) and number of independent variables ($IV = 1$) in this study, the R^2 values of 3% and greater have been detected. Model 1 includes the effect of smart technologies on the environmental dimension of corporate sustainability. The model is significant, but only industry explains the variance in environmental sustainability. Thus, environmental sustainability is considered better in service-oriented firms than in manufacturing-oriented firms. Model 2 includes the effect of smart technologies on the social dimension of corporate sustainability. Model 2 is not significant. Model 3 is significant, and the results indicate a positive relation between the smart technologies and economic dimension of corporate sustainability. The results show that smart technologies positively and significantly influence only one dimension of corporate sustainability, economic sustainability, supporting Hypothesis H3. However, contrary to our expectations, no significant results were found regarding the link between smart technologies and two dimensions of corporate sustainability: environmental and social. Thus, our findings provide no support for H1 or H2. Finally, model 4 includes the effect of smart technologies on the mediating variable, sustainability strategy. As Table 2 shows, model 4 is significant, and smart technologies explain the variance in sustainability strategy. The model also shows that firm age is positively related to sustainability strategy. To sum up, the results from the analyses show that smart technologies are directly connected with the economic dimension of corporate sustainability, but not the environmental and social dimensions of corporate sustainability.

Hypothesis 4 proposed that corporate sustainability strategy mediates the relationship between smart technologies and corporate sustainability. This mediation was tested by using the Baron and Kenny (1986) procedure. This procedure includes three steps. First, a regression analysis between the independent variable and dependent variables is conducted. Second, the effect of independent variable on the mediator is determined. These analyses are presented in Table 2 when testing for H1-H3. Finally, a regression analysis is conducted with all the variables, and these results are presented in Table 3. Based on Zhao et al. (2010), the model has full mediation if there is a significant mediated effect but no significant direct connection between the independent

Table 1
Mean values, standard deviations, and correlations among the variables.

	Mean	Std. Dev.	1	2	3	4	5
1 Smart technologies	3,7574	1,64131	1000				
2 Sustainability strategy	2,52	,734	,083	1000			
3 Environmental sustainability	2,70	,691	,012	,680***	1000		
4 Social sustainability	2,90	,641	,095	,426***	,433***	1000	
5 Economical sustainability	2,86	,793	,152*	,167**	,149*	,230***	1000

Sign. *** ≤ 0.001, ** 0.001 < p ≤ 0.01, * 0.01 < p ≤ 0.05.

Table 2
Regression results for direct effects.

Models	β	SE	St. β	t	R	R^2	Adj. R^2	SE	F
Dependent: Environmental sustainability									
1. (Constant)	3,056	,180		16,965	,194	,038	,023	,682	2,611*
No of employees	-,001	,001	-,050	-,817					
Firm age	,000	,002	,017	,268					
Industry	-,269	,087	-,193	−3,113**					
Smart technologies	,024	,026	,056	,891					
Dependent: Social sustainability									
2. (Constant)	2,832	,170		16,688	,128	,016	,002	,642	1,118
No of employees	,001	,001	,050	,808					
Firm age	,000	,002	-,005	-,086					
Type of operation	-,087	,082	-,067	−1,066					
Smart technologies	,047	,025	,120	1,892+					
Dependent: Economic sustainability									
3. (Constant)	2,536	,208		12,204	,173	,030	,015	,786	2,062+
No of employees	-,001	,001	-,065	−1,052					
Firm age	,000	,002	,014	,231					
Type of operation	,061	,100	,038	,612					
Smart technologies	,068	,030	,142	2,243*					
Dependent: Sustainability strategy									
4. (Constant)	2,333	,190		12,249	,185	,034	,020	,721	2,372+
No of employees	-,002	,001	-,114	−1,863					
Firm age	,004	,002	,123	1,991*					
Type of operation	-,028	,092	-,019	-,307					
Smart technologies	,051	,028	,116	1,839+					

Sign. ** $0.001 < p \leq 0.01$, * $0.01 < p \leq 0.05$, + $0.05 < p \leq 0.1$.

variable and dependent variables. If there is a direct connection between the independent variable and dependent variables but also a significant mediated effect, the mediation is partial.

Following this procedure, it was observed that smart technologies are not related to environmental sustainability (model 1) and social sustainability (model 2) but are related to economic sustainability (model 3). Second, the effect of smart technologies on sustainability strategy was examined. The results indicate that this relationship is positive and significant (model 4). Finally, the joint effects were examined. The coefficients show that the inclusion of the sustainability strategy variable in model 5 makes the relationship between smart technologies and environmental sustainability non-significant and the relationship between sustainability strategy and environmental sustainability significant. Therefore, sustainability strategy plays a full mediator role in the relationship between smart technologies and environmental sustainability, thus supporting H4a. The same procedure was followed to evaluate H4b-4c. The coefficients show that the inclusion of the sustainability strategy variable in model 6 makes the relationship between smart technologies and social sustainability non-significant and the relationship between sustainability strategy and social sustainability significant. Therefore, sustainability strategy plays a full mediator role in the relationship between smart technologies and social sustainability, thus supporting H4b. The results also show that, when including sustainability strategy and smart technologies together in model 7, the effect of smart technologies on economic sustainability continues to be significant, but sustainability strategy is also significant. This indicates partial support for H4c.

To sum up, the results suggest that corporate sustainability strategy fully mediates the relationship between smart

Table 3
Regression results for mediation effects.

Models	β	SE	St. β	t	R	R^2	Adj. R^2	SE	F
Dependent: Environmental sustainability									
5. (Constant)	1,475	,157		9,381	,729	,532	,523	,476	60,628***
No of employees	,001	,001	,032	,736					
Firm age	-,002	,001	-,072	−1,647					
Industry	-,250	,060	-,180	−4,140***					
Smart technologies	-,011	,019	-,027	-,607					
Sustainability strategy	,678	,040	,715	16,786***					
Dependent: Social sustainability									
6. (Constant)	1,938	,192		10,111	,445	,198	,183	,581	13,198***
No of employees	,002	,001	,100	1,767+					
Firm age	-,002	,001	-,059	−1,034					
Type of operation	-,076	,074	-,059	−1,032					
Smart technologies	,027	,023	,070	1,210					
Sustainability strategy	,383	,049	,434	7,780***					
Dependent: Economic sustainability									
7. (Constant)	2,160	,257		8,398	,226	,051	,033	,779	2,862*
No of employees	-,001	,001	-,047	-,771					
Firm age	,000	,002	-,004	-,072					
Type of operation	,066	,099	,041	,670					
Smart technologies	,060	,030	,124	1,973*					
Sustainability strategy	,161	,066	,148	2,431*					

Sign. *** ≤ 0.001, * $0.01 < p \leq 0.05$.

Table 4
Summary of hypothesis test results.

Hypothesis	Models	Hypothesis support
H1: Smart technologies are positively related to environmental sustainability	1	Not supported
H2: Smart technologies are positively related to social sustainability	2	Not supported
H3: Smart technologies are positively related to economic sustainability	3	Supported
H4a: Corporate sustainability strategy mediates the positive relation between smart technologies and environmental sustainability	1, 4, 5	Supported
H4b: Corporate sustainability strategy mediates the positive relation between smart technologies and social sustainability	2, 4, 6	Supported
H4c: Corporate sustainability strategy mediates the positive relation between smart technologies and economic sustainability	3, 4, 7	Supported

technologies and corporate sustainability, but only in the case of environmental sustainability and social sustainability. In the case of economic sustainability, the mediation effect is partial. Summary of hypotheses testing is presented in Table 4.

6. Discussion and conclusions

6.1. Theoretical implications

The purpose of this study was to explore the mediating role of corporate sustainability strategy between smart technologies and corporate sustainability. Smart technologies have been suggested to play a crucial role in the sustainable development of firms (e.g., [36,37,43]). Our findings add to the evidence supporting sustainability strategy as an important factor in smart technologies research. The main contributions to theory are as follows.

First, the study contributes to the literature on smart technologies [3,4,6,8,17] and their role as a driver of corporate sustainability [37,40]. As predicted, smart technologies had a direct effect on economic sustainability. Thus, the study supports the views of previous research indicating that smart technologies can reduce costs ([42]; Costa-Campi, 2018) and increase economic returns by using self-organizing production, assisting predictive and cooperative maintenance, intensifying transport planning, as well as classifying retirement and disposal decisions accurately [37,43]. This finding suggests that the smart technologies have a crucial role to play in attaining economic sustainability.

Contrary to previous research (cf. [10,11,36]), the study did not find support for the direct linkage between smart technologies and environmental and social sustainability. Previous research has indicated that smart technologies may contribute to environmental and social sustainability, for example, by decreasing energy consumption [37], and improving the safety and employment situation [11,40]. Our results show that the environmental and social returns from smart technologies are not self-evident, and smart technologies alone are not sufficient to generate environmental and social sustainability.

Second, the study adds to the evidence regarding the role of sustainability strategy in obtaining corporate sustainability [14,15,33,45,49]. Our results also indicate that corporate sustainability strategy fully mediates the effect of smart technologies on environmental sustainability. This suggests that smart technologies act on corporate sustainability by encouraging a firm to integrate sustainable development principles into business operations. In turn, corporate sustainability strategy enables the firm to increase its environmental sustainability. Similarly, the results show that the effect of smart technologies on social sustainability was fully mediated by corporate sustainability strategy. The finding suggests that implementing smart technologies increases the integration of sustainable development principles into business operations which, as above, drives increased social sustainability. Our results support the results of Caputo et al. [45] who highlight the managing corporate resources and pathway according to sustainable strategy.

6.2. Managerial implications

We entrust that this study offers novel insights for firms looking for to enhance the utilization of smart technologies in increasing corporate sustainability. The implications of these findings for managerial practice are as follows. Smart technologies can generate financial returns, but they alone are not sufficient to generate environmental and social sustainability. Instead, the influence of smart technologies on corporate sustainability is influenced by the extent of the integration of sustainable development principles into business operations. Implementing smart technologies is not in itself sufficient; rather, it is the process of integrating sustainable development principles into daily business operations that creates the returns of smart technologies in terms of corporate sustainability. Firms often prefer to implement smart technologies without integrating them into sustainable development goals. Evidence from this study suggests that smart technologies serve to improve corporate sustainability primarily because they stimulate the integration of sustainable development principles into business operations. Thus, managers need to recognize the importance of this strategy for integrating the use of smart technologies and firm-level sustainable development and ensure that the resources required to support such activities are adequate and available.

6.3. Limitations and further research directions

First, this study is cross-sectional, which limits the ability to study issues that evolve over time. Thus, our findings may be validated with additional longitudinal research. Second, geographical area of the research should be taken into account when generalizing the results. The data is also based on the self-reports of managers within the firms and, therefore, potentially subject to biases. A better assessment of the relationships between smart technologies, corporate sustainability strategy, and corporate sustainability outcomes could be gathered if additional perspectives were sought. Finally, there may be other contingency factors that affect the relationships in the model. Due to practical restrictions, the number of control variables in the survey was limited. Future research could take closer look into the context that smart technologies generate corporate sustainability.

Appendix A. Measurement items

Construct	Items
Smart technologies [3]	*Indicate the degree to which you would agree with the following statements between [1–7] (1 = Strongly disagree ; 7 = Strongly agree)*
	All the devices are programmable.
	All the devices are able to be uniquely identified.
	All the devices are aware of and respond to changes in their environment.
	All the devices can send and receive messages.
	All the devices can record and store all information.
	All the devices can identify with other devices, places, or people

(*Continued*)

Construct	Items
Sustainability strategy	*The response scale to the following items ranged 1 – 4 (1= weak, 2 = satisfactory, 3= good; 4= excellent)* What is your company's ability to integrate sustainable development principles into business operations over the last three years?
Corporate sustainability	What is the state of your company's environmental sustainability (ability to take into account and reduce the environmental impact of the activity) over the last three years? What is the state of your company's social sustainability (ability to promote health, safety, and well-being) over the last three years? What is the state of your company's economic sustainability (ability to ensure the long-term economic balance of the company) over the last three years?

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Publication III

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Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance

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Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance

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A B S T R A C T

This paper empirically examines the role of a sustainability strategy in the relation between a digital business strategy and financial performance. By classifying two capabilities (managerial capability and operational capability) that are needed to realize a digital business strategy, this study suggests that a sustainability strategy serves as a promoter in the relation between managerial capability and financial performance but inhibits the relation between operational capability and financial performance. Using a structured survey questionnaire, the data was collected from 280 small and medium-sized enterprises (SMEs), which operate in both the service and manufacturing industries in Finland. Four developed hypotheses were tested using the regression analysis to find the relationship between digital business strategy, sustainability strategy and financial performance. The findings suggest that a sustainability strategy serves as a promoter in the relation between managerial capability and financial performance but inhibits the relation between operational capability and financial performance.

1. Introduction

Businesses, as well as industries, are undergoing an exhaustive transformation, leading to digitalized business operations. This digital transformation poses great challenges to companies (Li et al., 2018), when connected products, services, and operations transform businesses, making new strategies for adopting changes necessary (Kallinikos et al., 2013; Yoo et al., 2012). Digitization is pushing companies to create entirely new strategies (El Sawy et al., 2016), and forcing all company activities from management to operations to digitize (Chuang and Lin, 2015; Sia et al., 2016). This has resulted in a stream of research concentrating on the elements of a successful digital business strategy (Bharadwaj et al., 2013; Matt et al., 2015; Woodard et al., 2012). Digital business strategy refers to the transformation in the business process (Cui and Pan, 2015), company capabilities (Cha et al., 2015), and operational routines (Chen et al., 2014), and their integration with the corporate strategy. The discussion on digital transformation has highlighted managerial aspects (Helfat and Martin, 2015; Li et al., 2018), as well as technical and operational aspects (Chen et al., 2014; Li et al., 2018; Yoo et al., 2012). Regarding the performance impacts of a digital transformation, managers who are dynamic and abreast of the times may engage the potentiality of novel technologies and encourage their introduction, which acts as a prerequisite for a digital business strategy (Chatterjee et al., 2002; Li et al., 2018). It has also been reported that superior managerial capabilities facilitate successful strategic changes, such as a digital transformation, realized as improvements in business performance (Helfat and Martin, 2015; Li et al., 2018). Further, researchers have suggested that performance improvements can be realized in areas such as business process optimization, cost reduction, and efficiency improvement (Ash and Burn, 2003; Kauffman and Walden, 2001; Li et al., 2018).

However, some studies suggest that in digital transformations, companies that obtain comprehensive information on the sustainability of their business and use that information to reshape their strategy (Steurer et al., 2005; Torugsa et al., 2013) may succeed in digital businesses. Little research has been conducted to fully understand the role of a sustainability strategy (Engert and Baumgartner, 2016; Lamboglia et al., 2018) in relation to the digitization of businesses. However, Baumgartner and Rauter (2017)

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present that corporate sustainability management can influence the productivity and efficiency of processes, support the development of more sustainable products and services, and result in improvements in financial performance, such as higher profits, reduced costs, or increases in share prices (Baumgartner and Rauter, 2017). Thus, to fill the research gap, we investigate whether a sustainability strategy can facilitate the relation between a digital business strategy and financial performance.

Based on the notions above, the study aims to examine the connections between a digital business strategy, a sustainability strategy, and financial performance. The main contribution of this paper is the empirical investigation of the role of sustainability strategy in the relation between a digital business strategy and financial performance. The paper classifies two capabilities (managerial capability and operational capability) that are needed to realize a digital business strategy. The findings suggest that a sustainability strategy serves as a promoter in the relation between managerial capability and financial performance but inhibits the relation between operational capability and financial performance. The findings of this paper will help companies adjust the focus of their sustainability strategies to serve the company's financial returns.

The article is structured as follows. First, the theoretical framework is presented by defining sustainability strategy and digital business strategy in the context of this research. Then, the hypotheses and research model are discussed, followed by the research methodology and results. Finally, the theoretical and managerial implications of the study and avenues for further research are proposed.

2. Theoretical background

2.1. Sustainability strategy

As the concept of sustainability is complex and far reaching (Amini and Bienstock, 2014), sustainability must become a strategic and integral part of business operations (Engert and Baumgartner, 2016; Lamboglia et al., 2018; Tomšič et al., 2015). Based on the business perspective, sustainability can be represented as "the adoption of business strategies and activities that meet the needs of the enterprise and its stakeholder today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future" (IISD, 1992). Thus, the role of strategy in sustainable development is emphasized. Hart and Dowell (2011) defined a sustainable development strategy as considering environmental, economic, and social sustainability with the main focus on sustaining eco-friendly production processes in the future. In another study, Torugsa and his colleagues (2013) defined a proactive sustainability strategy as integrating all three dimensions of sustainability (environmental, economic, and social) into strategies with the main consideration a natural resources—based perspective. In this regard, an environmental strategy refers to the harmless activities of humans, while an economic strategy addresses high-quality living standards (Bansal, 2005), financial performance, and long-term profits (Steurer et al., 2005). Social sustainability includes equality in allocated resources and opportunities, internal and external social growth, as well as international equity (Steurer et al., 2005; Torugsa et al., 2013). Based on the various terms used for a sustainability strategy, in this research the term a *sustainability strategy* refers to integrating sustainable development principles into business operations.

2.2. Digital business strategy

Competitive advantages in digitalization are mainly concerned with the strategy, culture, and talent development instead of technical issues (El Sawy et al., 2016; Li et al., 2018). Digital transformations encompass central transitions in the business process and strategies (Cui and Pan, 2015), company capabilities (Cha et al., 2015), and operational routines (Chen et al., 2014). As strategy refers to the plan of achieving an objective or goal, capabilities (defined as "the proficiency of a bundle of interrelated routines within firms for performing specific tasks" (Ngo and O'Cass, 2013, p. 1135)) are the key ingredients of digital business strategy. Table 1 shows various perspectives on digital business strategy, the main focus, related capabilities, and references. Based on the main elements presented in Table 1, we define managerial capabilities and operational capabilities (Li et al., 2018) as the main dimensions of a digital business strategy.

2.2.1. Managerial capability

Managers' ability to operate with digitality is considered one of the issues that shape companies' strategies in the digital era (El Sawy et al., 2016). Based on a survey conducted in 2015 of U.S. managers, strategy, culture, and skill development are the issues of concern in digitalization in comparison with technology issues. Thus, to move companies toward utilizing digitality, there is a need for managers who support the development and implementation of digitality and can transition toward digitality as organizational culture (Chuang and Lin, 2015). For example, knowledge is one of the levers that assists managers in understanding threats and opportunities better. Therefore, good knowledge of digital tools and a digital business strategy helps managers proactively identify risks and find solutions for those risks (Xue, 2014). Additionally, the development of digital skills must be mature in the digital environment. Therefore, a management team with good knowledge of digital tools and a clear vision for digitality is necessary for digitality (Parida et al., 2015; Sia et al., 2016). Thus, managerial capability is crucial in the context of digitality. In this context, *managerial capability* refers to managers' abilities to utilize digitality in a business strategy, employees' mindsets and skillsets, as well as the workplace (El Sawy et al., 2016).

2.2.2. Operational capability

In general, operational capabilities arise from explicit elements, such as resources and practices, and tacit elements, such as know-how, skill sets, and leadership (Wu et al., 2010). As the increase in digitality can be seen in various areas of business operations, digitality should be integrated in the business strategy (El Sawy et al., 2016), and digitality should be considered the main part of the business (Sia et al., 2016). Additionally, digitality transforms companies' business by utilizing new ways to reap the benefits of the current strategic assets. In other words, operational capability in the digital era is a strategic choice for obtaining and embedding digital-related capabilities across the business (Pagoropoulos et al., 2017). It is necessary for companies to change their business process to align with digitality, to complement and add other related capabilities in the entire business process (Chuang and Lin, 2015; Xue, 2014). As operational capabilities are used to manage certain problems or uncertainty (Flynn et al., 2010; Wu et al., 2010), they are crucial in the context of digitality. In this context, *operational capability* refers to the company's capability to integrate digitality into the overall business process and corporate strategy (Chuang and Lin, 2015; Xue, 2014).

3. Hypotheses and research model

3.1. Hypotheses

3.1.1. Digital business strategy and financial performance

As part of the ongoing digital transformation, companies are

Table 1
Dimensions of a digital business strategy.

Terms	Definitions	Focus	Capabilities	References
Digital Business Strategy	The concept of business strategy should be enlarged to include digitalization	Doing the proper things to attain strategically successful digitalization for the company and its business ecosystem (i.e., new business strategy, different business model, different people's mindsets and skill sets)	Managerial capabilities, Operational Capabilities	El Sawy et al. (2016), p. 142
Digital Business Strategy	Digital economics enable digital business strategy that leverages a company's ability to rapidly deploy systems on developmental platforms	The role of the managing in system visibility and value when formulating digital business strategy	Managerial Capabilities	Grover and Kohli (2013), P. 655
Digital Business Strategy	A company engages in any category of IT activity	A dynamic synchronization between business and IT	Operational Capabilities	Mithas et al. (2013), p. 513
Digital Business Strategy	Organizational strategy formulated and executed by leveraging digital resources to create differential value	Functional-level strategy that must be aligned with the company's chosen business strategy	Operational Capabilities	Bharadwaj et al., (2013), p. 472
Digital Transformation Strategy	A blueprint that supports companies in governing the transformations that arise owing to the integration of digital technologies and in their operations after a transformation	Transformations of key business operations, products, and processes, as well as organizational structures and management concepts	Managerial Capabilities, Operational Capabilities	Li et al. (2018); Matt et al. (2015), p. 340

making significant investments in infrastructures to digitalize their operations, facilitating the flow of information and knowledge across companies and their supply chains that can help the companies receive and maintain a competitive advantage and generate improved performance (Liu et al., 2013). By digitalizing their operational environments and infrastructures, companies aim at increasing financial performance, which can be achieved, for example, by redefining existing business processes or automating traditional industry operations and replacing human labor by automating business processes (Chae et al., 2018).

However, although digital transformations in companies are intended to generate business benefits and financial performance, challenges exist. A digital transformation, realized through the adoption of digital tools and solutions in accordance with digital business strategies, create challenges for the managers of the companies (Lim et al., 2012; Liu et al., 2013). For example, performance benefits, such as the increased financial performance of the digital transformation, may not be fully realized if the digitalized solutions and applications are not properly adopted (Liu et al., 2013). Thus, Lim et al. (2012) argue that organizational outcomes are predicted by managerial characteristics, and managers' capabilities and abilities to develop IT capabilities enhance companies' ability to exploit superior IT capability. Managers must make strategic decisions about the digital transformation in companies to avoid risks resulting from incorrect identification and deployment of processes and resources, to avoid unreliable benefits from the transformation and difficult implementation processes (Chae et al., 2018).

To make the right decisions in contemporary digitalizing business environments, managers must be familiar with existing digital tools, applications, and solutions, need to have a clear vision for utilizing digitality in the company now and in the future, and need to create a management culture that supports the utilization of digitality in the company. Thus, digital transformations in companies can be turned into competitive advantages and enhanced financial performance, for example, by leveraging digitalized business applications that enable better execution of operational actions (Benitez et al., 2018). Thus, in line with the considerations above, the following hypothesis is proposed:

H1. Managerial capabilities are positively related to financial performance.

A digital transformation causes turbulence and changes companies' operational environments. In continuously changing operational and business environments, companies must be able to adapt to these changes by considering operations in the digital business strategies. In other words, companies must be able to keep and maintain their operational routines, that according to Benitez et al. (2018) are patterns of activities or processes that companies perform at the operational level and can lead to superior company performance. According to El Sawy and Pavlou (2008), in an age in which process execution matters, it is generally accepted that companies' operational capabilities can provide strategic advantages. In digitalizing operational environments, these operational capabilities are companies' proficiency in adopting and implementing digital tools and solutions and using them as a natural part of the business processes to achieve higher performance (Benitez et al., 2018; Peng et al., 2008). In digitalizing business environments, operational capabilities are also needed to utilize digitality in internal processes to produce solutions and service, with quality and at the lowest possible cost. According to Zawislak et al. (2018), operational capabilities are responsible for executing the products and processes and can be considered by production planning, the quality system, and the objectives of reducing production costs. In other words, operational capabilities in digitalized business environments reflect the planned ability to effectively execute substantive daily operations, such as manufacturing, logistics, and sales (El Sawy and Pavlou, 2008), leading to higher financial performance.

From a different point of view, Benitez et al. (2018) argue that in digitalized business environments operational competence has a positive effect on companies' profitability and financial performance. The authors also contend that as companies can develop different proficiencies, for example, in managing product margins, this operational capability can generate differences in companies' benefits and financial performance. Thus, in line with the considerations above, the following hypothesis is proposed:

H2. Operational capabilities are positively related to financial performance.

3.1.2. Sustainability strategy as a moderator

It has been suggested that a digital transformation emphasizes managerial issues over technical ones, in which a flourishing digital transformation requires not only supplying and introducing technical resources but also handling managerial aspects (Besson and Rowe, 2012; Doherty and King, 2005; Li et al., 2018). These managerial issues refer to managerial capabilities with which managers build, integrate, and reconfigure organizational resources and competences (Adner and Helfat, 2003), drive their organizations' digital transformation, and lead their organizations to success (Li et al., 2018). According to Li et al. (2018), managers with the accompanying experience, knowledge, and skills may be more successful in identifying and capturing opportunities (Kickul and Gundry, 2001; Wright et al., 2014) and redefining the utilization of company resources, abilities, and organization (Helfat and Martin, 2015), driving the digital transformation. It has also been suggested that superior managerial capabilities drive successful strategic-level changes, such as a digital transformation, and subsequently lead to enhanced business performance (Helfat and Martin, 2015; Li et al., 2018).

Further, it is important to examine how a sustainability strategy affects the relationships between managerial capabilities and financial performance. Previous studies suggested that corporate sustainability management affects companies' economic success (Baumgartner and Rauter, 2017; Engert et al., 2016; Harmon et al., 2009; Kurucz et al., 2008). Researchers have shown that managers' attitudes and behavior are often guided by economic performance, and thus, the ability or willingness to incorporate sustainability integration may be limited (Baumgartner and Rauter, 2017). However, Harmon et al. (2009) argue that changing manager attitudes and behavior regarding corporate sustainability integration would minimize internal organizational deficiencies and make for a much stronger business case. Further, Baumgartner and Rauter (2017) present that companies pursue sustainability, based on either ethical or economic motivations (Kurucz et al., 2008). Baumgartner (2014) suggests that the urge to connect sustainability factors can be facilitated by normative considerations which they call ethical rationality or economic rationality. Economic rationality can be driven by a company's internal forces, when sustainability-adjusted operations are developed in line with the actions to attain competitive advantages. In line with the considerations above, the following hypothesis is proposed:

H3. A sustainability strategy positively moderates the relationship between managerial capabilities and financial performance.

According to Li et al. (2018), a digital transformation involves fundamental changes in redesigning business processes (Markus, 2004), operational routines (Chen et al., 2014), and organizational capabilities (Tan et al., 2015). To manage this transformation, there is a need for operational capabilities concerning technologies that make physical products programmable, addressable, sensible, communicable, memorable, traceable, and associable for new combinations of digital and physical components that produce novel manufacturing and products (Yoo, 2010; Yoo et al., 2010). Researchers have suggested that combining software and software components and mixing content across platforms, infrastructures, and production systems increasingly derive utility from the functional relations they maintain (Kallinikos et al., 2013; Yoo, 2010; Yoo et al., 2010). Thus far, improvements in performance have been realized within organizational boundaries in areas such as efficiency improvement, cost reduction, and business process optimization (Ash and Burn, 2003; Kauffman and Walden, 2001; Li et al., 2018).

Baumgartner and Rauter (2017) emphasize that understanding the business value of sustainable strategic management requires that the company's interests or utility be analyzed. Sustainable development by companies can influence the process efficiency and productivity, support more sustainable products and services, reduce risks to the environment and social impacts, and improve business opportunities. Thus, the resulting benefits may arise in the form of improved economic performance or improved competitiveness. The former may arise in the form of reduced costs or higher profits (Baumgartner and Rauter, 2017). In line with the considerations above, the following hypothesis is proposed:

H4. A sustainability strategy positively moderates the relation between operational capabilities and financial performance.

3.2. Research model

The research model was developed based on the reviewed literature on digital business strategy, sustainability strategy, and financial performance. Both managerial capabilities and operational capabilities are necessary to actualize digital business strategy, which is relevant to create financial performance. In addition, a sustainability strategy is considered a critical factor that affects the strength of the relation between the digital business strategy and financial performance. It means that digital business strategy and sustainability strategy interact with each other to create economic success. Therefore, built on previous literature review, the research and hypotheses are represented as shown in Fig. 1.

4. Methodology

4.1. Sample description

This survey targeted service and manufacturing SMEs in Finland. An online questionnaire was used to collect the data. A total number of 6816 SMEs were randomly selected among 20,000 Finnish SMEs, which represents approximately one-third of the whole Finnish SME population. An email with a cover letter and a direct link to the questionnaire was sent to the managers of the 6816 Finnish SMEs, of which 986 were invalid. Among the total

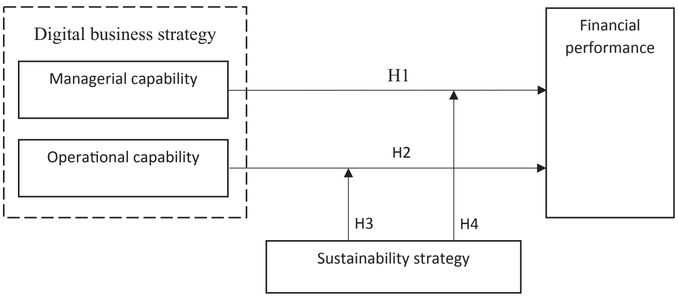

Fig. 1. Research model and hypotheses.

Table 2
Respondents' demographics.

Characteristics	Category	No.	%
Number of employees	Small (fewer than 49 employees)	197	70.3
	Medium (50–249 employees)	78	27.9
	No response	5	1.8
Years since established	Less than 15 years	51	18.2
	15–29 years	87	31.1
	30–44 years	61	21.8
	More than 45 years	81	28.9
Service/Industry	Industrial	118	42.1
	Service	160	57.1
	No response	2	0.8

valid number of 5830 SMEs, 280 responded (a 4.8% response rate). Information about the respondents' demographics is presented in Table 2.

4.2. Non-response bias and common method variance

Non-response bias and common method variance were checked to verify that the respondents represent the whole population. Analysis of the variance (ANOVA) was conducted to compare the early respondents to the late respondents (Armstrong and Overton, 1977), including independent, moderator, and dependent variables. The ANOVA results show that non-response bias is not a concern for this study.

For common method variance, there are many approaches for checking and reducing its potential effect (Podsakoff et al., 2003), such as conducting the survey anonymously, defining different scales for the items, and using an iterative approach to construct the items. Additionally, common method variance was checked with Harman's single factor test, in which exploratory factor analysis of all items was loaded into more than one factor. According to the results, this research is not threatened by non-response bias and common method variance.

4.3. Development of survey instruments and measurements

The survey instruments were developed based on an extensive literature review linking digital business strategy and sustainability strategy. According to Brislin (1986), to be certain about the accuracy of a translation and avoid misunderstanding, the survey questionnaire was conducted in Finnish, the official language in Finland. First, the items were written in English, translated into Finnish by a Finnish native speaker, and then translated into English. Table 3 depicts all the items (the independent variables, moderator variable, and dependent variable), evaluation scales, and their references.

The digital business strategy (managerial and operational capabilities) were the independent variables, and each was measured with three items. Managerial capability as a dimension of a digital business strategy included items related to managers' knowledge of and skills in digital tools, managers' clear vision for utilizing digitality, and managers' support for digitality (El Sawy et al., 2016; Parida et al., 2015; Sia et al., 2016; Xue, 2014). Another dimension of a digital business strategy is operational capability, which includes digitality in internal processes, the integration of digitality across the whole business, and the existence of digitality in all business functions (Chuang and Lin, 2015; El Sawy et al., 2016; Sia et al., 2016; Xue, 2014). In addition, both dimensions of a digital business strategy, the scales are 1–7 points, in which 1 represents *strongly disagree* and 7 *strongly agree*.

The sustainability strategy is the moderator variable, which refers to the assessment of the company in terms of integrating sustainable development principles into business operations during the last three years (Tomšič et al., 2015). Financial performance is the dependent variable, which addresses the assessment of the company's financial performance over the last three years (Henri, 2006). Both were measured with a single item and 1- to 4-point scales, in which 1 represents *weak* and 4 *excellent*. Despite the research about the lack of reliability and validity for single items (Diamantopoulos et al., 2012; Sarstedt and Wilczynski, 2009), some researchers believe that single items are not a big issue if three standards are met. Those standards are the existence of homogeneous objects (Loo, 2002), the presence of concrete singular objectives (Bergkvist and Rossiter, 2007, 2009), and the existence of unambiguous objects to the respondents (Sackett and Larson, 1990), all of which are fulfilled in this study.

The survey included three control variables: company size, company age, and company type. Company size was measured by the number of employees, company age was measured by the years since the company was founded, and company type was measured by whether the company operates in service or industry.

5. Results

Before the hypotheses were tested, the model was assessed for reliability and validity (Tables 3 and 4) by confirmatory factor analysis (CFA). Reliability was assessed by computing Cronbach α values (managerial capabilities $\alpha = 0.831$, and operational capabilities $\alpha = 0.862$), and they met the standard of reliability for survey instruments (Nunnally, 1967). Content validity was assured by basing the selection of the items for the constructs on the literature review. CFA supported structural validity as the standardized parameters for each item (managerial capabilities items, 0.684–0.868, and operational capabilities items, 0.793–0.904) were above + 0.5.

Table 3
Survey instruments.

Constructs	Items	References	Cronbach's α
Evaluation of the statement on a 1- to 7-point scale (Strongly disagree [1] to strongly agree [7])			
Managerial capabilities	1. Our company's management is familiar with digital tools. 2. Our company's management has a clear vision for utilizing digitality in the future. 3. Our company's management supports the utilization of digitality in our company.	El Sawy et al. (2016); Parida et al. (2015); Sia et al. (2016); Xue (2014)	0.831
Operational capabilities	1. Utilizing digitality in internal processes has become an important part of our business. 2. Digitality is a natural part of our business. 3. Digitality enhances our business.	Chuang and Lin (2015); El Sawy et al. (2016); Sia et al. (2016); Xue (2014)	0.862
Evaluation of the statement on a 1- to 4-point scale (Weak [1] to Excellent [4])			
Sustainability strategy	Over the last three years, how do you assess your company in terms of integrating sustainable development principles into business operations?	Tomšič et al. (2015)	
Financial performance	Over the last three years, how do you assess your company in terms of financial performance?	Henri (2006)	

Table 4
Tests of validity and reliability.

Latent variables	Observed variables	Standardized parameter	AVE	CR	MSV	Reliability and validity results
Managerial capabilities	MC1	0.868	0.643	0.842	0.471	AVE >0.5 → Convergent Validity
	MC2	0.841				CR > 0.7 → Reliability
	MC3	0.684				MSV < AVE → Discriminant validity
Operational capabilities	OC1	0.793	0.697	0.873	0.471	AVE >0.5 → Convergent Validity
	OC2	0.904				CR > 0.7 → Reliability
	OC3	0.803				MSV < AVE → Discriminant validity

Table 5
Nonparametric correlations.

	Mean	St. Dev.	1	2	3	4
Digital business strategy						
1. Managerial capabilities	5.22	1.144	1.00			
2. Operational capabilities	5.35	1.167	.641**	1.00		
3. Sustainability strategy	2.52	0.734	.145*	.088	1.00	
4. Financial performance	2.82	0.880	.164**	.136*	.128*	1.00

Sign. ***≤ 0.001, **0.001 < p ≤ 0.01, *0.01 < p ≤ 0.05.

According to Hair et al. (1998), these values are highly statistically significant. Thus, construct validity was supported. To sum up, the CFA supports convergent validity, reliability, and discriminant validity as shown in Table 4. Table 5 shows the descriptive statistics and correlation matrix for the study variables. Correlations among the constructs were statistically significant and thus, provided support for the hypotheses.

The hypotheses were tested using the regression analyses presented in Table 6. As stated, company size, company age, and company type were used as the control variables. Three models were formed to test the hypotheses. First, financial performance as a dependent variable was regressed on the control variables (Model 1). The model is not statistically significant.

Second, the dependent variable was regressed on the control variables plus the predictor variable to test for the main effects (Model 2). Thus, financial performance was regressed on the control variables, the two dimensions of the digital business strategy (managerial and operational), and the sustainability strategy. Results show that the model is not statistically significant, and neither of the two dimensions of a digital business strategy had positive and statistically significant regression coefficients. Neither managerial capabilities nor operational capabilities are statistically significantly related to financial performance; thus, H1 and H2 were not supported.

Finally, a test for moderation was conducted by including the interaction variables in the model (Model 3). The results for moderation show that a sustainability strategy enhances the effect of managerial capabilities on financial performance; thus, H3 was supported. However, the interaction of a sustainability strategy and operational capabilities for digitality shows a negative and statistically significant beta value. Thus, H4 was not supported. Otherwise, the results indicate a suppressing effect of a sustainability strategy on the operational capability financial performance relationship.

6. Discussion and conclusions

6.1. Theoretical implications

In this study, we analyzed the relations between a digital business strategy, a sustainability strategy, and financial performance by incorporating sustainability strategy as a vehicle that facilitates the relation between a digital business strategy and financial performance. This forms the novel contribution of the study as most studies on the topic neglect the role of obtaining comprehensive information on the sustainability of the business and use that information to reshape the strategy. Further, we examined digital business strategies through the two main dimensions needed to realize a digital business strategy: managerial capability and operational capability. The theoretical contributions are as follows.

Table 6
Results of the analyses.

Variables	Control model			Main effects model			Full model		
	β	St. β	*t*	β	St. β	*t*	β	St. β	*t*
Controls									
Company size	−.002	.001	−1.202	−.001	,001	−1.002	−.001	,001	−.819
Company age	−.001	.002	−.564	−.001	,002	−.440	−.001	.002	−.318
Company type	.182	.109	1.672	.155	.110	1.414	.166	.108	1.534
Main effects									
Managerial capabilities				.047	.061	.780	−.576	.220	−2.618**
Operational capabilities				.033	.060	.560	.712	.233	3.058**
Sustainability strategy				.105	.075	1.406	.286	.377	.759
Interaction effects									
Managerial capabilities* Sustainability strategy							.248	.085	2.925**
Operational capabilities* Sustainability strategy							−.266	.088	−3.030**
Model summary									
F	1.803			1.745			2.661**		
R^2	.020			.038			.075		
Adjusted R^2	.009			.016			.047		

Sign. ***≤ 0.001, **0.001 < p ≤ 0.01, *0.01 < p ≤ 0.05.

First, this study contributes to the literature on sustainability strategies. In particular, we contribute to the studies concerning the impact of adopting sustainability strategies, a topic not much investigated in the literature, as most research is based on theoretical models and case studies. The present findings suggest that a sustainability strategy serves as a promoter in the relation between managerial capability and financial performance. Previous literature suggested that superior managerial capabilities foster successful strategic-level changes, such as digital transformations, and subsequently lead to enhanced business performance (Helfat and Martin, 2015; Li et al., 2018). Further, Harmon et al. (2009) argue that changing manager attitudes toward and behavior for corporate sustainability integration minimize internal organizational deficiencies and make for a much stronger business case. The present results support these findings by providing support for the idea that managerial recognition must be simultaneously focused on digitality and a sustainability strategy to achieve high financial performance. Previous studies also suggested that a digital transformation is a managerial issue rather than a technical or operational one, because the transformation requires not only acquiring and deploying technical resources but also tackling managerial issues, such as redesigning business processes and training and investing in organizational capabilities (Besson and Rowe, 2012; Cha et al., 2015; Doherty and King, 2005; Li et al., 2018; Markus, 2004). Managers with the accompanying experience, knowledge, and skills may be more successful in identifying and capturing opportunities (Kickul and Gundry, 2001; Wright et al., 2014). Thus, capable managers are likely to be very quick to adjust to the changes caused by the digital transformation, which can explain the positive moderation effect of a sustainability strategy in the relation between managerial capability and financial performance.

However, the results of hypothesis 4 show that a sustainability strategy inhibits the relation between operational capability and financial performance. This finding is somewhat contrary to previous research that considered corporate sustainability management a facilitator of the productivity and efficiency of processes (Baumgartner and Rauter, 2017), and even as a means to realize economic benefits (Kurucz et al., 2008). This negative moderation of a sustainability strategy could be due the profit orientation of companies (Rantala et al., 2018; Saunila et al., 2018): If they focus on a comprehensive sustainability strategy (social and environmental sustainability in addition to economics), the focus moves away from finances and hinders the relation between operational capabilities and financial performance. This highlights the notion that it is mainly the task of managers and leaders to decide which sustainability values, in addition to economic values, have strategic importance (Duarte, 2010; Hemingway and Maclagan, 2004; Rauter et al., 2017). It seems that when companies try to achieve financial progress with a sustainability strategy, digitizing company operations and developing the operational capability of the digital business strategy are not enough. Companies need to make bigger moves toward digitality, for example, by digitalizing the flow of information and knowledge across companies, their supply chains, service deliveries, and marketing that can help the companies receive and maintain a competitive advantage and achieve better performance (Liu et al., 2013). Another explanation of the negative moderation is that improvements in performance can be realized in terms of cost reduction, increased efficiency, and business process optimization (Ash and Burn, 2003; Kauffman and Walden, 2001; Li et al., 2018), and the financial returns of a sustainability strategy in the digital transformation are too far reaching. In addition, this notion highlights the need to make a bigger move toward digitality (Liu et al., 2013). This means that managers have to make strategic decisions about the digital transformation in companies to avoid risks resulting from incorrect identification and deployment of processes and resources (Chae et al., 2018), as well as the decision which sustainability values, in addition to economic values, has strategic importance (Rauter et al., 2017). As mentioned, operational capabilities in digitalized business environments reflect a planned ability to effectively execute substantive daily operations, such as manufacturing, logistics, and sales (El Sawy and Pavlou, 2008). Therefore, in business operations, companies should focus on reducing unsustainable behavior rather than increasing the sustainability of the business operations by changing strategies to be more sustainable (Rauter et al., 2017). Therefore, companies need to reconfigure business operations as a prerequisite for holding on to market position and sustaining revenue. Thus, as the second theoretical contribution, we extend previous studies on the dark side of sustainability strategies, because there are a lack of studies (Tura et al., 2018). A sustainability strategy is an important factor in contemporary business management (Engert and Baumgartner, 2016; Lamboglia et al., 2018), and it is critical to understand the contexts in which this strategy provides positive returns. This is crucial, as the potential dark side effects remain under-researched.

Concerning the results of hypotheses 1 and 2, the study's third theoretical contribution is research on the returns of a digital business strategy (Helfat and Martin, 2015; Li et al., 2018). The results show that a digital business strategy, in terms of managerial and operational capability, is not enough to achieve a direct effect on financial performance. The reason may be that the impacts of a digital business strategy reach only the process level (productivity and efficiency; Ash and Burn, 2003; Kauffman and Walden, 2001; Li et al., 2018) and are not realized as financial returns. Jay Barney stated already in 1991 that IT is not a strategic resource in itself, and this seems to be the case also with digital business strategy. Companies' perception of their financial performance is connected to other companies' success, and they can all digitize their operations. Thus, it is not possible to differentiate by digitizing operations. Managerial capability makes the difference because, based on the study results, with a sustainability strategy managerial capability contributes to a high financial performance. Most of the previous research on the topic studied the effects on business performance (Ash and Burn, 2003; Helfat and Martin, 2015; Kauffman and Walden, 2001; Li et al., 2018), and the connection to financial performance needs further clarification.

6.2. Managerial implications

The findings of this paper will help companies adjust the focus of their sustainability strategies to serve the financial returns of the company. First, managerial recognition of the digital transformation of the company is the key to attain an increased financial performance through the facilitation of a sustainability strategy. Thus, managers need to have the competence and a positive attitude to simultaneously guide a digital strategy and a sustainability strategy to achieve financial returns for the company. Therefore, the manager is responsible for designing a strategy that takes into account sustainability principles. In other words, managers should prioritize tasks based on their goals. In this case, in a digital business strategy, a sustainability strategy boosts managerial capabilities to improve the financial performance because the managers' capabilities expand sustainability in the core of business operations and consider the sustainability strategy the main concern in their business. In contrast, digitizing operations does not work if a sustainability strategy is utilized; the managerial capability to seize digital opportunities plays a bigger role. Second, companies need to find a balance between a sustainability strategy and the pursuit of financial performance. Adopting a sustainability strategy is not necessarily the solution to achieve economic success. Instead, focusing on a comprehensive sustainability strategy (social and environmental sustainability in addition to economics) can move the business focus away from finances and hinder the potential positive effect of a sustainability strategy.

6.3. Limitation and further research

There are some limitations in this study, which provide more opportunities for extensive research in this context. Because this research was conducted among Finnish SMEs during a specific time, considering data for a single country and a specific period might threaten the generalizability of the study and cause issues related to cross-sectional data, respectively. However, these limitations open up the opportunity to conduct the research in other countries, as well as to validate it with longitudinal data and compare the acquired and available results. Next, conducting survey-based research with single respondents and managerial perceptions might have caused bias in this study. However, these issues were mitigated according to several justifications, including different statistical and common method variance tests (Section 4.2). Additionally, because the questions in this study were mainly related to facts and companies' perceptions rather than psychological issues, there might be no difference between the managerial perceptions and the actual results. Nevertheless, collecting data from other resources and using more than one respondent from each company could be an option for further research.

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Publication IV

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Digital-related capabilities and financial performance: The mediating effect of performance measurement systems

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Digital-related capabilities and financial performance: the mediating effect of performance measurement systems

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Digital-related capabilities and financial performance: the mediating effect of performance measurement systems

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ABSTRACT

The aim of this research is to investigate the mediating effect of performance measurement systems (PMS) in the connection between digital-related capabilities and financial performance. Moreover, this research examines how different types of digital-related capabilities can fuel PMS, leading to improved financial performance. The findings show that PMS significantly mediate the relationship between digital-related human and collaboration capabilities and financial performance. However, a significant mediating effect of PMS was not found between digital-related technical and innovation capabilities and financial performance. Using a structured survey questionnaire, the data was collected from Finnish SMEs, which operate in both the service and manufacturing industries.

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1. Introduction

During the last two decades, performance measurement systems (PMS) have been considered comprehensive procedures that affect firms' entire business activities (Neely, Gregory, and Platts 1995; Nudurupati, Tebboune, and Hardman 2016). Thus, the utilisation of PMS is still a high priority and frequently recommended to achieve higher performance (Franco-Santos, Lucianetti, and Bourne 2012; Neely, Gregory, and Platts 1995). Moreover, digitality provides a broad range of opportunities to support PMS, leading to companies' higher performance (Nudurupati, Tebboune, and Hardman 2016). Hence, digitality brings many changes to businesses, which influence firms' operations and business strategies, which, in turn, will be connected to their PMS (Bititci et al. 2012; Melnyk et al. 2014; Nudurupati, Tebboune, and Hardman 2016).

With the emergence of digitalisation, organisations need to handle larger amounts of data than ever before (Chen, Chiang, and Storey 2012). In these circumstances, the main challenge of PMS is utilising the data in applicable and meaningful ways for decision-making processes (Bititci et al. 2012; Loebbecke and Picot 2015). Digitality enables efficient decision-making processes by improving all aspects of business operations, thereby providing new opportunities for PMS (Günther et al. 2017; Nudurupati, Tebboune, and Hardman 2016). Because of this, the development of several digital-related capabilities necessitates addressing the challenges and opportunities presented by digitality (Sia, Soh, and Weill 2016). In this study, digital-related capabilities refer to those that move companies towards digitality, which is defined as the condition of conducting business in a digital culture (El Sawy et al. 2016). Human, collaboration, technology, and innovation have been found to be essential digital-related capabilities (Parida et al. 2015; Lenka, Parida, and Wincent 2017; De Oliveira et al. 2020;

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Khin and Ho 2019). However, the current literature lacks information about how capabilities relate to performance. The connection between PMS and digital capabilities is not adequately understood either (Nudurupati, Tebboune, and Hardman 2016). Thus, there is a unique need for empirical research to discover the links between digital capabilities and PMS in financial performance.

Different studies have explained that the impact of PMS is heavily dependent on the way they are used (Bititci et al. 2006). Thus, this study argues that the utilisation of digital-related capabilities influences the extent to which a company is able to exploit PMS. The digital-related capabilities mentioned earlier complement each other, and building these capabilities requires a comprehensive organisational approach to rewiring related structures, technology, and employees' characteristics.

This research contributes to this research gap by investigating the mediating effect of PMS in the connection between digital-related capabilities and financial performance. In other words, this research examines how different types of digital-related capabilities can fuel PMS, leading to improved financial performance. The results presented in this research are based on a structured online survey questionnaire of small and medium-sized enterprises (SMEs), which operate in both the manufacturing and service industries in Finland. Among the total number of responses, 280 valid responses were received from the respondents, all of whom are employed in managerial positions.

2. Theoretical background

2.1. Theoretical model

This paper examines how different types of digital-related capabilities can fuel PMS, leading to improved financial performance. Figure 1 presents the tested research model.

Overall, there are two main gaps in the literature that require further investigation. The first gap connects to the role of PMS in company performance: do PMS benefit organisations financially? The relationship between PMS and financial performance is not clear (Franco-Santos, Lucianetti, and Bourne 2012). As PMS are widely used to evaluate actions in relation to set targets, which in the long run aim to enhance performance, it is assumed that the impacts of PMS are positive. Then, it is crucial to understand under which conditions PMS can result in enhanced performance.

PMS can be described as the processes of setting goals, in which these processes include collecting, analysing and interpreting performance data (Melnyk et al. 2014). Comprehensive PMS provide a wide bundle of measures that support entire parts of the business (Henri 2006; Ullrich and Tuttle 2004) and enable understanding the relationship between business operations and strategy (Chenhall 2005). The use of PMS has been increasing in the last couple of decades based on the premise

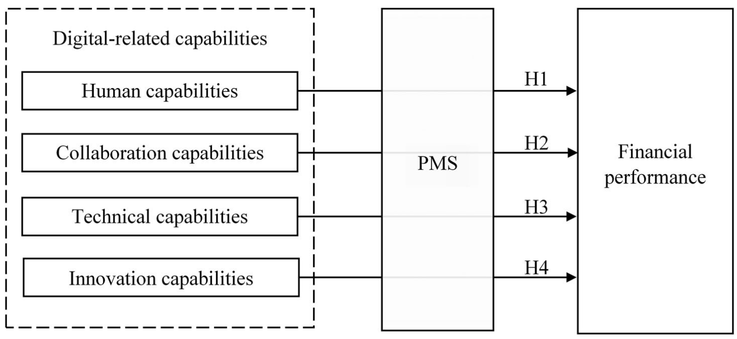

Figure 1. Research model and hypotheses.

that it enhances financial and non-financial performance (Koufteros, Verghese, and Lucianetti 2014; Melnyk et al. 2014). Additionally, the role of PMS in a larger digitalisation setup can involve measuring and evaluating the use of digital-related capabilities in order to utilise them more effectively. For example, prior research showed evidence that performance measurement can be used as a tool for improving the performance of SMEs through innovation capability (Saunila, Pekkola, and Ukko 2014). It is thus important to study whether this is also the case with digital-related capabilities. Furthermore, the researchers agree on the positive effects of PMS on people's behaviour, such as strategic focus, cooperation, motivation, goal commitment, citizenship behaviours, and role understanding (Franco-Santos, Lucianetti, and Bourne 2012). Hence, measuring and assessing digital-related capabilities can positively affect people's behaviour and further contribute to higher performance.

Thus, the second gap concerns the conditions under which PMS explain variations in company performance: what factors affect PMS? Previous research has indicated that company performance is affected by capabilities, such as networking (Mitrega et al. 2017), humans (Bauters et al. 2018; Bourne et al. 2013), technology (Barton and Court 2012; Nudurupati, Tebboune, and Hardman 2016), and innovations (Saunila 2017). However, the current literature lacks knowledge on how capabilities are connected to performance in the digital era. This study, in turn, argues that the utilisation of digital-related capabilities influences the extent to which a company is able to exploit PMS. Therefore, the digital-related capabilities mentioned earlier complement each other, and building these capabilities requires a comprehensive organisational approach to rewire the related structures, technology and employees' characteristics. Consequently, enabling digitality in the context of business is a necessity (Sia, Soh, and Weill 2016). In the existing competitive digital business era, it is critical to advance an understanding of the ways in which PMS assist the exploitation of different digital-related capabilities to enhance financial performance. In this research, financial performance is modelled as an outcome of the effective exploitation of PMS. Therefore, PMS is considered a mediating variable that allows us to explore the processes by which digital-related capabilities improve financial performance.

Moving towards digitality involves many challenges and opportunities; therefore, it is necessary for companies to address the challenges that arise in the digital era and use the opportunities to improve performance. Consequently, to benefit from digitality, it is vital to develop digital capabilities, as represented in Figure 2.

2.2. Hypotheses development

Bauters et al. (2018) argue that in contrast to conventional digitalised automation systems, humans have the ability to adapt their behaviour and learning based on changes in the work environment. These cognitive abilities can be considered important components of employees' achievement of adaptability and flexibility in contemporary businesses. In other words, human capabilities and proper management and support of them can bolster companies' achievement of higher performance through digitality.

As one main aspect of digitalisation is to improve and modernise traditional ways of working, it changes employees' work environments. Employees' digital-related capabilities, thus, have an effect on how these advantages can be realised and followed. According to Bourne et al. (2013), a company's employees and working culture appear to be included as the most essential factors that affect to successful outcome of PMS. Thus, employees' capabilities also affect how the performance measurement of the increased digitality is pursued. For example, Bauters et al. (2018) showed that contemporary work evaluation methods still rely on stopwatch measurements, but in digital business environments, more automated and advanced PMS are required for improvements in contemporary production facilities. To be able to maintain flexibility while maximising the efficiency of the processes, employeeś should have possibility to obtain information from automated PMS that generate diagnoses with real-time information about the digitalised processes and show

Definition	Dimension	References
Digitalization capabilities consist of intelligence, connection, and analytic capabilities. Intelligence capabilities require low human intervention in the configuration of hardware components to collect information. Connection capabilities represent the integration of products and services through wireless communication networks, which enable networked functionalities. Analytic capabilities denote the ability to interpret data into valuable insights that can be exploited in a digitalization strategy.	Human, Collaboration, Technical	Lenka et al., 2017, p. 95
"Global digitalization capabilities represent an advanced ability to use smart and connected physical products to facilitate global service innovation."	Technical, Innovation	Parida et al., 2015, p. 41
"In the context of digital innovation, digital capability could be defined as a firm's skill, talent, and expertise to manage digital technologies for new product development."	Human, Technical, Innovation	Khin and Ho, 2019, p. 182
Digital capabilities are defined as the main building blocks that firms use to support their activities in a digital world. Digital capabilities can be divided into two categories: those that relate to technological infrastructure and operations and those that influence the digital customer experience (e.g. sharing knowledge and experience through digital channels).	Technical, Collaboration	De Oliveira et al., 2020, p. 4
⬇ **Digital-related capabilities** ⬇		
The bundle of employee capabilities that enable people to operate in the digital era with adaptable mind-sets and skillsets as well as digital know-how.	Human	El Sawy et al., 2016; Lerch and Gotsch, 2015;
The bundle of firm capabilities created by digitality through collaborative activities with both external and internal partners.	Collaboration	Amit and Han, 2017; El Sawy et al., 2016
The bundle of firm capabilities that facilitate technological implementation and operation in the digital era (e.g. borderless activities in terms of time, place, and function).	Technical	El Sawy et al., 2016; Parida et al., 2015; Setia et al., 2013; Xue, 2014; Yoo et al., 2012
The bundle of firm capabilities that generate new knowledge, new products and services, and new solutions through digitalization.	Innovation	Amit and Han, 2017; Hervas-Oliver et al., 2018; Parida et al., 2015; Sia et al., 2016; Xue, 2014; Yoo et al., 2012

Figure 2. Dimensions of digital-related capabilities.

opportunities and possible potentials for improving financial performance (Bauters et al. 2018). According to Henri (2006), the diagnostic role of PMS refers to the evaluation and understanding of the cause-and-effect relationships among process performance, organisational learning and organisational performance. Thus, employees' own capabilities effect the utilisation of these PMS and make it possible for companies to achieve financial performance through digitality. Franco-Santos, Lucianetti, and Bourne (2012), have revealed that the effects of employee engagement in PMS and performance improvements can be positive.

To summarise, digital-related human capabilities can be seen as those that employees need to successfully adapt and utilise increased digitality. However, these capabilities also affect employees' interest in utilising PMS, which will have an effect on financial performance. Thus, build on the literature review and the arguments discussed above, the first hypothesis is suggested:

H1: PMS mediate the relationship between digital-related human capabilities and financial performance.

In the era of moving towards digitality, collaboration management is facing new challenges when it comes to discovering new ways to generate added value as part of efficiency-oriented behaviour and to look for effectiveness by, for example, utilising suppliers' process and product innovations or participating product innovation development (Bals, Laine, and Mugurusi 2018). To increase the utilisation of IT and digitality in business collaborations, previous studies have focused on the relationships between clients and digital service suppliers, which include for example IT outsourcing relationships (Goo et al. 2007) and relationships between buyers and digital service suppliers (Kishore et al. 2003). Brito and Nogueira (2009) showed that in the relationships between buyers and digital service suppliers, IT resources from both parties are exchanged and combined, thus improving their related capabilities. Further, Nudurupati, Tebboune, and Hardman (2016) studied PMS in digital economies and suggested that companies need to evaluate their performance in collaborative and social networks and on social media, instead of measuring performance only internally. It seems that collaborative capabilities and PMS are needed (Maestrini et al. 2017) to achieve higher performance in digital businesses (Nudurupati, Tebboune, and Hardman 2016).

When it comes to achieving higher performance through collaboration, PMS should involve inter-firm performance metrics that, therefore, pose challenges for data sharing and integration across companies. Managing the relationship of supply chain partners together with the coordination of inter-firm infrastructures and processes were highlighted as key elements of the measurement process (Maestrini et al. 2017; Nudurupati, Tebboune, and Hardman 2016). Further, in their study about PMS in digital economies, Nudurupati, Tebboune, and Hardman (2016) concluded that trust, security and responsibility are noteworthy in collaborations. They also highlighted that it is essential to create a common platform to share relevant skills and resources and, therefore, engage in joint continuous improvement activities through common goals and measures.

In sum, digital-related collaboration capabilities can be viewed as those that provide opportunities for firms to utilise digitality to collaborate on new products, services and supply chain management. These capabilities can encourage actions that are essential for enhancing the effectiveness of PMS, which will result in improved financial performance. Build on the literature review and the arguments discussed above, the next hypothesis is suggested:

H2: PMS mediate the relationship between digital-related collaboration capabilities and financial performance.

The increased use of digital technologies is raising customers' awareness of options for products and services and, consequently, their expectations (Nudurupati, Tebboune, and Hardman 2016). To respond to this, companies must have technical capabilities to utilise the affordances of digital technologies, for example, by allowing designers to enlarge the existing physical materiality by *entangling* it with software-based digital capabilities (El Sawy et al. 2016; Yoo et al. 2012). Furthermore, it has also been presented that digital-related technical capabilities can be utilised in the development of PMS (Nudurupati, Tebboune, and Hardman 2016).

Digital technologies and technical capabilities can also create competitive advantages through more sophisticated PMS. It has been documented that with social media (LinkedIn, Twitter, Facebook etc.) and other new technologies (web stream data, video and voice data, high-speed network connections), companies need to cope with such a huge amount of data that has never been encountered before (Chen, Chiang, and Storey 2012; Nudurupati, Tebboune, and Hardman 2016). With regard to technological developments in digitalisation, three things can be proposed that companies need to strengthen and pay attention to achieve higher performance and to reap the full benefits from advanced analytics of big data (Barton and Court 2012; Nudurupati, Tebboune, and Hardman 2016). Barton and Court (2012) suggest that firstly, companies need creative thinking and ways when sourcing for data from social media, networks, web analytics etc., and also when creating the infrastructure to analyse, store and capture data. Secondly, they suggest that companies need to create models to optimise and predict performance based on an understanding of their critical success factors that are essential to their businesses. Finally, they suggest that user-friendly tools and information are needed, when results are presented to decision-makers.

In sum, digital-related technical capabilities can be viewed as those that provide opportunities for firms to utilise digitality for new products and services as well as more sophisticated PMS. These capabilities can thus encourage actions that are essential for enhancing the effectiveness of PMS, which will result in improved financial performance. Build on the literature review and above-mentioned arguments, the following hypothesis is suggested:

H3: PMS mediate the relationship between digital-related technical capabilities and financial performance.

Firms put much of their emphasis on innovation (Jiménez-Jiménez and Sanz-Valle 2011; Melnyk et al. 2014; Saunila 2017; Hervas-Oliver et al. 2018), and together with the rise of the digital economy (Sia, Soh, and Weill 2016; Xue 2014), innovation creates one of the driving forces that shape PMS (Melnyk et al. 2014; Mohamed et al. 2009). PMS that contain both non-financial and financial aspects correlate with firm innovativeness and organisational learning (Mohamed et al. 2009). Also, Melnyk et al. (2014) found that innovation as well as new business models affect PMS. They state that in order to evaluate new solutions, firm need to make sure they have the necessary capabilities in place, such as the right people, the right processes, adequate communication and opportunities for accidental innovation.

Many studies have also concluded that changes in firms' other capabilities, which are closely related to innovation, influence PMS (Taylor and Taylor 2014). Kennerley and Neely (2002) highlighted the role of key capabilities, such as effective processes and appropriate culture, for PMS to evolve. Having effective processes and establishing a culture that embraces the use of PMS are crucial for effective management (Kennerley and Neely 2002). Also, Bititci et al. (2012) noted that firm culture has an effect on how performance is measured. Taylor and Taylor (2014) studied learning orientation as one of the contingency factors affecting PMS implementation. As both learning and innovation are related to a firm's capacity to develop and execute new ideas (Jiménez-Jiménez and Sanz-Valle 2011), innovation is likely to affect PMS.

However, PMS in organisations change how people think, act and interact (Franco-Santos, Lucianetti, and Bourne 2012). Melnyk, Stewart, and Swink (2004) maintained that performance measures and related PMS are 'essential links between strategy, execution and ultimate value creation' (209). Further, managing performance measurement processes acts as a driver for turning both capabilities and resources into desired outcomes. Walker, Damanpour, and Devece (2010) also studied the role of performance management in organisational performance. They found that the relationship between management innovations aimed at enhancing the effectiveness of firm operations and processes and performance is mediated by performance management. The authors considered performance management the practice of setting goals, including measures to link goals to performance outcomes and taking action to reach the goals (Walker, Damanpour, and Devece 2010). Hence, in order to manage changes in firms, effective PMS are required.

In sum, digital-related innovation capabilities can be viewed as those that provide opportunities for firms to utilise digitality for innovation and renewal. These capabilities can encourage actions that are essential for enhancing the effectiveness of PMS, which will result in improved financial performance. Build on the literature review and the arguments discussed above, the last hypothesis is suggested:

H4: PMS mediate the relationship between digital-related innovation capabilities and financial performance.

3. Methodology

3.1. Sample and data collection

Using a structured online survey questionnaire, the data was collected from SMEs, which operate in both the service and manufacturing industries in Finland. The survey questionnaire with a direct link was sent by e-mail to the respondents, all of whom are in managerial positions. The first reminder was sent one week later, and the survey questionnaire was completed after a total number of four reminders. From the total number of 5,830 respondents, 280 valid responses were received.

The characteristics of the respondents were analysed based on four elements, which were revenue, number of employees, years since company was established and industry. Approximately

70% of the respondents were small companies (less than 49 employees with 2–10 million-euro revenue), and approximately 30% were medium companies (between 50–249 employees with 10–50 million euros revenue). From the data received, most of the companies were mature, in which 81.8% of the companies were established more than 15 years ago. Considering the type of industry, the percentage of service-oriented companies was greater than manufacturing firms, at 57.1% and 42.1%, respectively.

3.2. Bias

3.2.1. Non-response bias

In order to determine the non-response bias, an analysis of the variance test (ANOVA) was conducted (Armstrong and Overton 1977). The respondents were divided into two groups, early respondents and late respondents. Making comparisons (regarding study variables) between early and late respondents revealed no significant differences between these two groups. Thus, non-response bias is not a problem in this case and the respondents represent the whole population.

3.2.2. Common method bias

Different approaches can be used to reduce the probability of common method bias. Conducting the survey anonymously and using two different scales for the variables lowers the possibility of common method bias. In addition, Harman's one factor test was conducted to check the impact of bias. Based on the results of the principle component analysis (PCA), four components loaded for 70% of the total variance, and the first component loaded for less than 50% of the variance. Therefore, this study does not suffer from common method bias (Podsakoff et al. 2003). Consequently, according to the mentioned approaches, there is no significant common method bias or risk of common method bias to threaten the validity of the results of this research.

3.3. Measures

To test the hypotheses, a survey-based approach was used in this research. The structured survey questionnaire was created based on a previous literature review and developed during different sessions with expert researchers. Table 1 shows the measurement instruments, including constructs, scale of the items, the items, their references, Cronbach's α and factor loadings.

3.3.1. Independent variables

In this study, four different digital-related capabilities have been identified as independent variables and defined as capabilities towards digitality: human capabilities, collaboration capabilities, technical capabilities and innovation capabilities. As shown in Table 2, the response scale of the mentioned items ranged from [1] to [7], in which [1] defined as *strongly disagree* and [7] defined as *strongly agree*.

3.3.2. Mediating variable

PMS is the mediating variable, which was measured by three items adapted from previous research: using performance measurement as a tool to provide information, documented form and tool for comparison (Hall, 2008). Information about PMS was collected using a seven-point Likert-type scale, ranging from [1] *strongly disagree* to [7] *strongly agree*.

3.3.3. Dependent variable

Financial performance is the only dependent variable in this research, which was measured with a single item. Using single-item measures is acceptable in some circumstances, such as if the research setting encompasses concrete singular objects and attributes (Bergkvist and Rossiter 2007) that are homogeneous (Loo 2002) and unambiguous to the respondents (Sackett and Larson 1990). These can be verified by high internal consistency or unidimensionality through factor analysis (Loo 2002). The

Table 1. Measurement instruments.

Construct	Items	References	Cronbach's α	Factor loadings
Digital-related capabilities	*Evaluation of the statement between 1–7 scale*			
Human capabilities	Digital skills development is supported and promoted in our company	El Sawy et al. (2016); Lerch and Gotsch (2015); Taylor (2017)	0.772	0.763
	Our employees are well trained in digital tools usage.			0.879
	Digitalisation of the operating environment is easily accepted by our employees.			0.843
Collaboration capabilities	Digital cooperation is made with other companies.	Amit and Han (2017); El Sawy et al. (2016)	0.799	0.886
	Digital channels are used to share information with other companies.			0.893
	Digitality transforms the shape of social relationships in our business.			0.749
Technical capabilities	Digitality increases the value of our products or services.	El Sawy et al. (2016); Parida et al. (2015); Xue (2014); Yoo et al. (2012)	0.862	0.857
	Digitality enables the integration of products and services into our company.			0.879
	Digitality enables up-to-date, location-independent services for our customer.			0.894
	Digitality allows us to work across boundaries of time, place or activities.			0.74
Innovation capabilities	Digitality enables innovations and new ideas in our company.	Parida et al. (2015); Sia, Soh, and Weill (2016); Xue (2014); Yoo et al. (2012)	0.859	0.922
	Digitality forces us to develop new solutions.			0.862
	Digitality helps to produce new products and services.			0.872
Performance measurement systems (PMS)	The performance measurement provides a broad range of performance information about different areas of the business.	Hall (2008)	0.879	0.855
	The performance measurement is produced in a documented form.			0.908
	The performance measurement enables the formation of links between the current operating performance and the long-term strategies.			0.930
	Evaluation of the statement between 1–4 scale			
Financial performance	Over the last three years, how would you assess your company's financial performance?	Henri 2006		

respondents were polled to assess their financial performance based on their perceptions on a scale of [1] *weak* to [4] *excellent*.

3.3.4. Control variables

Four control variables, including company size build on the number of employees and revenue, company age, and the type of industry, were defined in this study.

4. Results

The reliability and validity of the data were assessed before testing the hypotheses. Cronbach's alpha (α) was used to test the reliability of the scales. As shown in Table 1, all the values are greater than 0.7, which confirmed an acceptable level of reliability for all constructs (Hair et al. 1998). Additionally,

Table 2. Correlation matrix.

	Mean	St. Dev.	1	2	3	4	5	6
1. Human capabilities	4.9000	1.12408	1					
2. Collaboration capabilities	5.0048	1.26913	.543**	1				
3. Technical capabilities	5.3232	1.30067	.591**	.525**	1			
4. Innovation capabilities	5.7067	1.08828	.533**	.568**	.775**	1		
5. PMS	5.1883	1.18036	.296**	.299**	.299**	.269**	1	
6. Financial performance	2.82	.880	.114	.088	.069	.102	.174**	1

Sign. *** $\leq$ 0.001, ** 0.001 < $p \leq$ 0.01, * 0.01 < $p \leq$ 0.05.

cross loading is not an issue in this study due to the high loadings on each particular factor. As a result, discriminant validity is supported in this study.

Correlation analysis was used to check the validity of the research as shown in Table 2. A high correlation between independent variables might cause problems related to multicollinearity. Thus, multicollinearity was checked by the variance inflation factors (VIF) and the tolerance value. Multicollinearity is not a problem if the recommended value for VIF is 5 with the tolerance greater than 0.2 (Kleinbaum, Kupper, and Muller 1988). In this study, the range of VIF is 1.113–2.95 with a tolerance of 0.339–0.898, both of which are in the suggested ranges. Consequently, in this case multicollinearity is not a problem. All these analyses are perquisites for testing hypotheses and supporting the reliability and validity of the research. As a result, the testing of the hypotheses can continue due to the supportive results provided.

This research concentrated on mediation analysis to provide a deep understanding about the relationships between digital-related capabilities, PMS and financial performance. Three steps were conducted to analyse the hypotheses. First, regression analysis was employed between dependent variables and independent variables. Next, the effect of independent variables on the mediator was checked, and finally, regression analysis was conducted with all the variables (Baron and Kenny 1986). Based on previous research, the model has full mediation if there was a significant mediated effect but no significant direct effect between dependent variables and indirect variables. Table 3 shows the result of mediation analysis for digital-related capabilities and financial performance. In all these regressions, company size, company age and industry were applied as control variables. The results of the three models are presented as follows.

Model 1 analyses the relationship between each of the digital-related capabilities (human capabilities, collaboration capabilities, technical capabilities and innovation capabilities) and financial performance. As mentioned earlier, the direct impact of each of the digital-related capabilities must first be tested on financial performance. Therefore, the results in Table 3 show no significant direct effect between all four digital-related capabilities and financial performance.

Model 2 analyses the relationship between all the digital-related capabilities (human capabilities, collaboration capabilities, technical capabilities and innovation capabilities) and PMS. As noted earlier, the second step is to check the relationship between all the digital-related capabilities (independent variables) and PMS (mediator). As shown in Table 3, the direct effect of digital-related human capabilities ($\beta = 0.160$; $P = 0.043$) and digital-related collaboration capabilities ($\beta = 0.148$; $P = 0.046$) on PMS is significant. However, the direct effect of digital-related technical capabilities ($\beta = 0.189$; $P = 0.052$) and digital-related innovation capabilities ($\beta = -0.078$; $P = 0.418$) on PMS is not significant.

Model 3 analyses the relationship between digital-related capabilities (human capabilities, collaboration capabilities, technical capabilities and innovation capabilities), PMS and financial performance. Based on the abovementioned, the last step is to check the relationships between digital-related capabilities (independent variables), PMS (mediator) and financial performance (dependent variable). The results revealed that the mediation effect of PMS is significant between digital-related human and collaboration capabilities and financial performance ($\beta = 0.165$; $P = 0.012$). Thus, it can be concluded that digital-related human and collaboration capabilities influence financial performance through their effect on PMS.

Table 3. Result of mediation analysis for digital-related capabilities and financial performance.

	β	SE	St. β	t	R	R^2	Adj. R^2	SE	F
Dependent: Financial Performance									
1. Constant	2.135	.374		5.709***	.206	.042	.013	.876	1.442
Firm Age	-.001	.002	-.020	-.308					
No. of employees	-.003	.002	-.153	−2.068*					
Revenue	1.241E-8	.000	.141	1.865					
Industry	.194	.113	.109	1.716					
Human Capabilities	.071	.065	.091	1.082					
Collaboration Capabilities	.015	.054	.022	.274					
Technical Capabilities	-.061	.070	-.089	-.866					
Innovation Capabilities	.056	.083	.069	.675					
Dependent: PMS									
1. Constant	3.742	.470		7.962***	.398	.158	.133	1.102	6.141***
Firm Age	-.005	.003	-.099	−1.639					
No. of employees	.000	.002	.015	.222					
Revenue	1.219E-8	.000	.103	1.457					
Industry	-.300	.142	-.125	−2.110*					
Human Capabilities	.167	.082	.160	2.031*					
Collaboration Capabilities	.136	.068	.148	2.002*					
Technical Capabilities	.172	.088	.189	1.954					
Innovation Capabilities	-.085	.105	-.078	-.811					
Dependent: Financial Performance									
1. Constant	1.675	.413		4.060***	.255	.065	.033	.868	2.013*
Firm Age	.000	.002	-.004	-.056					
No. of employees	-.003	.002	-.156	−2.123*					
Revenue	1.091E-8	.000	.124	1.650					
Industry	.231	.113	.129	2.045*					
Human Capabilities	.050	.065	.065	.771					
Collaboration Capabilities	-.002	.054	-.003	-.036					
Technical Capabilities	-.082	.070	-.121	−1.171					
Innovation Capabilities	.067	.083	.082	.807					
PMS	.123	.049	.165	2.519*					

Sign. *** $\leq$ 0.001, ** 0.001 < $p \leq$ 0.01, * 0.01 < $p \leq$ 0.05.

Therefore, the results support hypotheses (1) and (2), which is that PMS mediate the relationship between digital-related human and collaboration capabilities and financial performance. As shown in Table 3, number of employees has a negative significant effect, but type of industry has a positive significant effect on the mediating model. This means that the effect is stronger in service companies than in manufacturing companies. Additionally, the effect is stronger in smaller companies.

5. Discussion and conclusion

5.1. Theoretical implications

The aim of this research was to investigate the mediating effect of PMS on the connection between digital-related capabilities and financial performance. The results showed that PMS significantly mediate the relationship between both digital-related human and collaboration capabilities and financial performance. However, a significant mediating effect of PMS was not found between both digital-related technical and innovation capabilities and financial performance. This is because of the nature of PMS, which is more compatible with people's behaviour (Franco-Santos, Lucianetti, and Bourne 2012). In this case, the human and collaboration dimensions of digital-related capabilities are compatible with this, and the technical and innovation dimensions are not. Thus, the present study's findings provide new insights about the mediating effect of PMS between digital-related capabilities and financial performance as follows.

First, the results showed that digital-related human capabilities contribute to higher financial performance with the use of PMS systems. This indicates that realising the higher financial performance, employees' capabilities to operate in a digital era with adaptable mind-sets and skillsets as well as digital know-how (El Sawy et al. 2016) have been devoted to the better utilisation of PMS. This new way of utilising PMS can provide employees with diagnoses of digitalised processes with real-time information and show opportunities for improving financial performance (cf. Bauters et al. 2018). Thus, employees' own capabilities related to digitality seem to affect the development and utilisation of PMS and make it possible for companies to achieve financial performance. This refers to humans' capabilities of adapting their behaviour and learning based on changes in work environments, and to their understanding of the cause-and-effect relationships between performance, organisational learning and performance measurements (Bauters et al. 2018; Henri 2006). In this case, the employees may have had opportunities to train in the use of digital tools, which would facilitate the rapid adoption of digitality in the operating environment.

Second, the results showed that digital-related collaboration capabilities also contribute to financial performance with PMS use. Collaborations between companies have been practiced for some time in terms of inter-firm processes, infrastructures and relationship management, and it seems that these capabilities and mechanisms also work in the transition to digital-related collaborations. Digital-related collaboration capabilities enable the use of PMS in decision-making, such as when to bring in the supplier's products or process innovations and involving the supplier in product innovation activities (Bals, Laine, and Mugurusi 2018), or when to outsource digital services (Goo et al. 2007).

Third, the results showed that PMS does not assist digital-related technical capabilities with achieving higher financial performance. However, the result was very close to statistical significance, which may indicate that companies' digital-related technical capabilities are already quite near to utilising the possibilities of PMS. It seems that the rapid pace of technological developments (i.e. high-speed network connections, web stream data, voice/video data, social media, etc.) (Chen, Chiang, and Storey 2012; Nudurupati, Tebboune, and Hardman 2016) sets high standards for technical capabilities in relation to both the variety of technologies and the volume of data. Thus, more creative ways of sourcing data together with more advanced analytics may be needed to fully exploit the potential of PMS as presented by Barton and Court (2012).

Fourth, PMS does not assist digital-related innovation capabilities with achieving higher financial performance. Although some previous studies have suggested that innovation creates one of the driving forces that shape PMS (Melnyk et al. 2014; Mohamed et al. 2009), it seems that PMS are not developed enough to enhance digitally enabled innovations in a way that will realise direct financial performance. The underlying cause for this result may be that companies focus on measuring new solutions instead of evaluating them, as suggested by Melnyk et al. (2014). Melnyk et al. (2014) also highlighted the importance of evaluating necessary capabilities, such as the right people, the right processes, adequate communication and opportunities for accidental innovation.

5.2. Managerial implications

Reflecting on the managerial implications, this study provides guidance for managers of SMEs on how and when to develop capabilities in the digital era. First, all the capabilities in the digitally enabled context are not at the same level, and their impact on financial performance differ. For example, the digital-related human capabilities were on the lowest level but a significant effect was found. Hence, managers can achieve higher financial performance through PMS by developing digital-related human capabilities. Additionally, considering the limited number of resources for SMEs, the choice of appropriate capabilities becomes vital. Therefore, it is vital to pay attention to the capabilities required in digital contexts to support PMS, leading to financial performance. Second, the results reveal that firms should first have mature digital-related human capabilities and collaboration capabilities towards digitality, implying that both digital-related human and collaboration capabilities should be developed before digital-related innovation and technical capabilities. Third, considering the importance of type of industry as a contingent factor in digitality, the findings suggest that SMEs in the manufacturing industry must be prepared to change their capabilities in the digitally enabled context to achieve financial performance through PMS.

5.3. Limitations and further research

Reflecting on the limitations of this research will provide several opportunities for further research in the future. First, the data was collected from SMEs in Finland, which might limit this study's generalizability since the data is from one country. Second, longitudinal data has been acknowledged due to the full understanding of the development and impact of digital-related capabilities on financial performance through PMS; in that sense, cross-sectional data might impose limitations in this study. Third, financial performance is the only dependent variable studied in this research, which keeps other options for performance measures, such as operational performance and sustainability performance, open for future research. Fourth, digital-related capabilities in this study were limited to human capabilities, collaboration capabilities, technical capabilities and innovation capabilities, which are functional. Building on this, further research could investigate strategic capabilities in the digitally enabled context. Thus, research undertaken in the future could transcend these limitations based on the findings of this research.

Disclosure statement

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