



Digitalization efforts and firm performance: decomposing the mediation effect of dynamic capabilities in supply chain management

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Abstract

Digital transformation is inevitable, but some adaptation efforts remain resultless. Previous literature suggests that dynamic capabilities (DCs) are essential for adapting to digitalization challenges while maintaining business performance. In this complex research field, this paper aims to add to prior knowledge by analyzing two research questions in a supply chain management context. Firstly, by identifying general modernization and supply chain process development as observable organizational manifestations of DC development, we examine their mediating roles in the relationship between digitalization efforts and firm performance. Secondly, by comparing two mediation models, we aim to explore whether the mediation effects of differently combining the sensing, seizing and reconfiguration DC components differ. We argue that when sensing the business opportunities resulting from digitalization, general modernization in supply chain management only represents the seizing DC component, as opposed to supply chain process development, which is considered to be an outcome including the effects of both the seizing and resource reconfiguration. The empirical analysis is based on data of 335 Hungarian medium-sized and large firms. Structural equation modeling results suggest that only the findings about supply chain process development are consistent with positive mediation, the results about general modernization are not consistent with mediation between digitalization efforts and firm performance. By highlighting the prominence of the reconfiguration DC component in achieving competitive advantage, these findings provide novel insights into DC effects on firm performance. In addition to this, the results also point out the importance of comprehensive digital transformation, as opposed to rather isolated modernization investments.

Keywords Digitalization · Dynamic capabilities · Supply chain management · Mediation · Process development

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1 Introduction

This paper studies the question why some supply chain digitalization investments do not achieve the expected results. Although a comprehensive answer requires several considerations, we argue that some aspects of this topic can be related to how adequately dynamic capability (DC) components are combined during digitalization development. Although previous studies have examined individual dynamic capability components in different contexts (Mousavi et al. 2018; Torres et al. 2018; Khan et al. 2021; Engelmann 2024), comparatively little attention has been paid to how different combinations of these components shape the organizational mechanisms through which digitalization contributes to firm performance. Our research aims to contribute to filling this gap in the literature.

To illustrate our research questions with practical managerial insights, take the example of Decathlon as they achieved significant business results with a comprehensive digitalization approach. Decathlon developed a product recognition, tracking and inventory monitoring system in their supply chain, by including their suppliers in this development, that decreased the processing and throughput time significantly (GS1 Decathlon case 2021; Yang 2023). Less overarching digitalization efforts often fail to result in the expected efficiency outcomes (Kallmuenzer et al. 2025; Nagy et al. 2020).

Our research has its theoretical foundations in managerial literature. The resource-based view of the firm emphasizes the role of unique resources in achieving business success (Barney 1991); however, oversight of dynamism may be viewed as one of its limitations (Sirmon et al. 2007). Dynamic capabilities enable firms to create intangible assets possibly supporting long-run business performance (Teece 2007), and resource orchestration can have a prominent role in creating competitive advantage (Sirmon et al. 2011). In their seminal work, Teece et al. (1997) outline that DCs include three components: the sensing (emerging tendencies in the external environment), seizing (capturing opportunities that are identified through sensing) and transforming (by reconfiguring processes to adapt to changes) constitute elements in the creation of organizational resource base. Digitalization is accompanied by the emergence of various disruptive technologies (Calderon-Monge and Ribeiro-Soriano 2024), and DCs, as representing organizational capability to respond to changing environment (Engelmann 2024), can have a prominent role in maintaining competitive advantage (Fabrizio et al. 2022), or corporate performance (Hernández-Linares et al. 2024). Our research questions are related to a comparison between performance effects of differently combining DC components.

Previous management literature on a comparison of DC components is in an evolutionary stage. Muhic and Bengtsson (2021) identify different business model innovation stages that are characterized by specific types of capabilities, and examine sensing, seizing, and transforming aspects of DCs separately. Torres et al. (2018) considers business intelligence and analytics as the sensing and seizing components of DCs. Mousavi et al. (2018) conclude that sensing, seizing and reconfiguring capabilities all have a significant direct effect on innovation towards sustainability, with sensing having the most important role. Previous literature has already examined DC components separately also when analyzing circular economy implementation

(Khan et al. 2021), and with a focus on social interaction contexts (Engelmann 2024). Markovich et al. (2021), when comparing firm performance effects of sensing, seizing, and reconfiguring, conclude that DCs follow a sequence in which seizing, that enhances reconfiguring, is driven by sensing. Our research aims to extend previous literature with a comparison of the mediation role of different DC component combinations in the link between digitalization efforts and firm performance.

Digital transformation has a unique nature that is only partially covered by conventional frameworks on organizational change (Hanelt et al. 2021). Digitalization can influence several areas, including enhancing economic growth (Calderon-Monge and Ribeiro-Soriano 2024), and financial performance (Abakpa and Dvoulétý 2025), in addition to other possible advantages of digital ecosystems (Baptista and Nunes 2026). Unlike digital maturity or digital capability, which capture an organization's achieved level of digital development (Verhoef et al. 2021), digitalization efforts refer to the managerial and organizational actions undertaken to advance digital transformation, such as strategic prioritization, resource commitment and implementation activities (Kane et al. 2017; Szukits 2022), thereby emphasizing the process rather than the achieved state. However, the organizational mechanisms through which digitalization efforts translate into superior firm performance remain insufficiently understood, particularly in the context of supply chain management. Building on the dynamic capability perspective, we propose that these mechanisms can be examined through observable organizational manifestations theoretically associated with different combinations of dynamic capability components. Specifically, we distinguish between general modernization, which primarily reflects technology implementation and organizational modernization initiatives, and supply chain process development, which captures broader organizational changes more closely associated with resource reconfiguration. With the analysis of data about 335 Hungarian medium and large firms and by applying structural equation modeling, we show that although digitalization efforts are significantly directly associated with firm performance, only the findings about supply chain process development are consistent with significant mediation. These findings contribute to a more nuanced understanding of how dynamic capability development may translate into improved firm performance.

The paper is structured as follows. Section 2 reviews the relevant literature and develops the research hypotheses. Section 3 describes the data and methodology; Sect. 4 presents the empirical results, and Sect. 5 discusses the implications and conclusions.

2 Literature review and hypothesis development

2.1 Digitalization in supply chain management

Digitalization has become a central phenomenon shaping contemporary supply chain management, fundamentally altering how firms coordinate activities, manage information flows and interact with partners (Zekhnini et al. 2021; Zouari et al. 2021). Beyond technological adoption, digital transformation is increasingly conceptualized as an organizational change process that reshapes structures, routines and coordina-

tion mechanisms, often requiring firms to move toward more flexible and adaptable organizational designs (Hanelt et al. 2021). Recent research further conceptualizes digitalization as fostering the emergence of digital ecosystems, in which interdependent actors co-create value through shared digital platforms and digitally enabled coordination mechanisms (Baptista and Nunes 2026). This ecosystem-oriented view is consistent with findings indicating that digital transformation increasingly transcends firm boundaries and is embedded in digitally interconnected business environments that reshape both intra- and inter-organizational coordination patterns (Hanelt et al. 2021). Prior literature commonly distinguishes between digitization, digitalization and digital transformation, describing them as consecutive but conceptually distinct stages of technological and organizational change (Verhoef et al. 2021). While digitization refers to the conversion of analogue information into digital form, digitalization encompasses the use of digital technologies to redesign business processes, and digital transformation represents a broader, organization-wide strategic shift enabled by digital technologies. In a supply chain management context, digitalization therefore extends beyond the adoption of specific technologies and increasingly affects inter-organizational coordination, process integration and decision-making structures (Zekhnini et al. 2021; Zouari et al. 2021).

Research on supply chain digitalization has devoted substantial attention to technological solutions and architectures, such as Industry 4.0 technologies, data analytics and digital platforms, highlighting their potential to enhance efficiency, transparency, and resilience (Zekhnini et al. 2021; Zouari et al. 2021). However, empirical evidence also suggests that firms adopting similar digital technologies often experience markedly different performance outcomes. Recent systematic reviews confirm that the financial and performance effects of digitalization are highly heterogeneous and depend on organizational readiness, implementation quality and complementary organizational capabilities (Abakpa and Dvouletý 2025). This heterogeneity indicates that digital technologies alone are insufficient to explain the performance implications of digitalization in supply chains. Instead, the way digital initiatives are strategically framed and implemented within the organization appears to play a decisive role. Collectively, these findings further suggest that digitalization constitutes a multidimensional organizational phenomenon affecting strategy, structure and performance outcomes across industries (Calderon-Monge and Ribeiro-Soriano 2024).

Recent contributions emphasize that successful digitalization requires coherent strategic intent with managerial commitment and structured implementation processes (Kane et al. 2017; Verhoef et al. 2021). Digital initiatives that lack strategic clarity or are treated as isolated IT projects frequently fail to generate lasting organizational benefits. Conversely, firms that articulate clear digitalization objectives, embed digital initiatives into formal project management processes and allocate adequate resources are more likely to realize meaningful operational and strategic improvements (Kane et al. 2017; Szukits 2022). This perspective shifts attention from the presence of digital technologies to the quality of organizational actions surrounding their implementation (Verhoef et al. 2021).

Building on this view, the current study conceptualizes digitalization in SCM in terms of digitalization efforts, defined as the intentional and coordinated organizational actions aimed at advancing digital transformation. Digitalization efforts capture

managerial and organizational dimensions of digitalization, including the clarity of digitalization strategy, the existence of formalized processes for initiating and implementing digital projects and the allocation of sufficient material resources to support these initiatives (Kane et al. 2017; Szukits 2022). By focusing on efforts rather than outcomes or maturity levels, this approach acknowledges that digital transformation is an ongoing process and that its performance implications depend critically on how consistently and effectively firms pursue digitalization over time. This emphasis on organizational efforts aligns with recent research highlighting that digital technologies act as triggers of capability development only when supported by structured organizational transformation processes and managerial reconfiguration efforts (Muhic and Bengtsson 2021). This distinction is particularly important in a supply chain management context. Supply chain digitalization often involves multiple organizational units and external partners, making the success of digital transformation dependent not only on existing digital capabilities but also on the organizational efforts devoted to coordinating implementation activities, aligning stakeholders and allocating resources across organizational boundaries (Zekhnini et al. 2021; Kane et al. 2017). For this reason, an effort-based perspective may provide additional insights beyond measures focusing exclusively on achieved digital development.

This perspective is particularly relevant in supply chain management, where digitalization typically involves multiple organizational functions and external partners. Supply chains are inherently interdependent systems characterized by complex coordination requirements and high sensitivity to disruptions. Consequently, successful digital transformation depends not only on existing digital capabilities but also on the organizational efforts devoted to implementation, coordination and resource allocation across organizational boundaries (Zekhnini et al. 2021; Kane et al. 2017). These characteristics increase the importance of implementation quality and managerial commitment, reinforcing the notion that digitalization efforts, rather than isolated technological investments, are central to understanding the impact of digitalization on supply chain-related outcomes.

Importantly, digitalization efforts are not expected to translate automatically into superior firm performance. Instead, their effects are likely to materialize through changes in organizational and operational capabilities, particularly through the development and improvement of supply chain processes. This observation suggests that digitalization efforts influence firm performance indirectly by enabling transparency which allows firms to redesign, integrate and continuously improve their supply chain processes, thereby laying the foundation for sustained competitive advantage. Such an indirect effect logic is consistent with contemporary research emphasising that digitalization contributes to performance largely through intermediate organizational and process-level transformations rather than through immediate technological gains (Calderon-Monge and Ribeiro-Soriano 2024; Muhic and Bengtsson 2021; Abakpa and Dvouléty 2025). This logic provides a theoretical bridge to the DC perspective, which is discussed in the following section.

2.2 Dynamic capability development in the supply chain

The dynamic capability perspective provides a useful theoretical point of view for explaining how firms, and furthermore supply chains, cope with rapidly changing technological and competitive environments. DCs refer to a firm's ability to sense changes in its environment, seize emerging opportunities, and reconfigure resources and processes accordingly (Teece et al. 1997; Teece 2007). These capabilities are particularly relevant in contexts characterized by high levels of technological dynamism, where static resource availabilities are insufficient to sustain competitive advantage over time. DCs only create value when they are translated into specific organizational routines, in line with Khan et al. (2021). In the field of supply chain development, sensing can manifest itself in the form of supplier innovations, ESG pressure and risk recognition, while seizing can take the form of strategic partner transformation, and reconfiguring can take the form of network structure reorganization. As digitalization represents a major source of environmental change, it naturally raises questions about the mechanisms through which firms translate digital initiatives into improved performance, including organizational changes theoretically associated with resource reconfiguration.

Dynamic capabilities are higher-order organizational capabilities that are inherently latent and therefore cannot be observed directly. Consequently, empirical research frequently operationalizes them through observable organizational manifestations that reflect how sensing, seizing and reconfiguration become embedded in organizational routines and operational practices (Barreto 2010; Teece 2007). This distinction between dynamic capabilities and their observable organizational manifestations is important for empirical research. As higher level organizational capabilities, dynamic capabilities cannot be captured directly through individual managerial practices or operational activities. Instead, empirical studies typically operationalize them through organizational outcomes and process-level manifestations that reflect how firms translate sensing, seizing and reconfiguring capabilities into concrete organizational change (Helfat and Peteraf 2009; Bruyaka et al. 2024). Consequently, different observable manifestations may represent different combinations or intensities of the underlying dynamic capability components. Rather than serving as direct measures of dynamic capabilities themselves, such organizational manifestations provide empirically accessible representations of how dynamic capabilities become embedded in organizational processes and routines. According to Sirmon et al (2007), dynamic capabilities do not directly create value but rather reorganize, combine and activate the resources from which value is ultimately created. This is a key theoretical basis for supply chain development.

In supply chain management, DCs are of outstanding importance due to the need for continuous adaptation of processes, structures and inter-organizational relationships. Supply chains operate in environments marked by fluctuating demand, technological innovation and increasing complexity, all of which require firms to repeatedly adjust their operational configurations. The ability to innovate, reconfigure and align supply chain processes in response to these challenges can therefore be interpreted as an expression of underlying DCs (Frank et al. 2017). From this perspective, supply chain management represents a natural context in which the outcomes of DCs

become visible at the process level. Within this conceptual framework, the two mediating constructs examined in this study capture different observable manifestations of dynamic capability development. General modernization primarily reflects the implementation of digital technologies and organizational modernization initiatives that are consistent with firms' ability to seize identified opportunities. In contrast, supply chain process development encompasses the introduction of innovative operational technologies together with the systematic application of continuous improvement practices, thereby reflecting deeper organizational changes that are consistent with the sequential development of dynamic capability components described by Markovich et al. (2022) and are theoretically more closely associated with resource reconfiguration. Accordingly, the distinction between the two mediators does not imply that they measure different dynamic capabilities directly. Rather, they represent different observable organizational manifestations through which dynamic capability development may contribute to improved organizational performance (Helfat and Peteraf 2009; Bruyaka et al. 2024).

Building on this logic, the current study treats supply chain process development as a tangible manifestation of DCs in a supply chain management context. Supply chain process development refers to the extent to which firms are able to introduce innovative technologies into their operations and systematically apply tools of continuous improvement. These activities reflect the firm's capacity to translate environmental sensing and strategic intent into concrete operational changes, consistent with the reconfiguring dimension of dynamic capabilities (Teece 2007). Importantly, supply chain process development does not substitute for dynamic capabilities; rather, it represents their operational outcome, capturing how abstract capabilities materialize in observable organizational practices. Fabrizio et al. (2022) further strengthens this statement since the embodiment of DC is wide-ranging. It can be interpreted as an outcome of supply chain development, but beyond that they interpret it as a source of competitive advantage, and it can also serve as a field of operation for supply chain development. Hernández-Linares et al. (2024) conclude that DCs indirectly create value by playing a role in supply chain development. This may take the form of supplier knowledge integration, interorganizational learning, or even shared digital platforms.

The relationship between DCs and firm performance has been the subject of considerable debate in the literature. While some studies suggest that DCs can contribute to competitive advantage (Fainshmidt et al. 2019), others highlight that their performance effects are contingent on contextual factors and are often indirect rather than immediate (Barreto 2010; Schilke 2014). In line with this view, DCs are unlikely to enhance firm performance directly. Instead, they are expected to exert their influence by enabling firms to develop and refine organizational processes that improve efficiency, responsiveness, and coordination. In supply chain management, well-developed processes can enhance competitive advantage by supporting reliable delivery, cost efficiency, responsiveness, and adaptability to environmental changes (Zouari et al. 2021).

Taken together, these arguments suggest that the impact of digitalization efforts on firm performance is mediated by supply chain process development, which reflects the outcomes of DC development in the supply chain. Digitalization efforts provide

the motivation and organizational support for change, DCs enable firms to respond effectively to this impetus and supply chain process development represents the observable mechanism through which these capabilities contribute to superior firm performance (Muhic and Bengtsson 2021). Dynamic capabilities do not directly create value but generate sustainable competitive advantage through the reconfiguration of supply chain structures and routines, knowledge integration and digital platforms. This reasoning forms the basis for the research hypotheses developed in the following section.

3 Research gap and hypothesis development

The resource-based view of the firm (Barney 1991) highlights the importance of unique firm resources in achieving competitive advantage. The development and management of these corporate resources can be especially challenging in a volatile environment shaped by continuous and rapid technological development. Digitalization is one of the key components of current technological changes, and the focus of our analysis is on the question how digitalization efforts influence firm performance. This question is strongly linked to the role of DCs that enable firms to create intangible assets possibly supporting long-run business performance (Teece 2007). Business environments characterized by rapid technological change can be a relevant context for the exploration of DCs (Teece et al. 1997). Enterprises with strong DCs not only adapt to business ecosystems, but also shape them (Teece 2007). The struggle with dynamic environments can be supported by firm's ability to innovate and reconfigure (Frank et al. 2017). As a result of the complexity of these coping mechanisms, DCs could be conceptualized as an aggregate multidimensional construct (Barreto 2010).

In our paper, we assume that, in a supply chain management context, supply chain process development represents an observable organizational manifestation theoretically associated with dynamic capability development (Helfat and Peteraf 2009; Bruyaka et al. 2024). Previous literature, although explored digitalization effects thoroughly, has not yet focused on the mediating role of DC-related supply chain development in the link between digitalization and firm performance. Similarly, digitalization efforts, as opposed to already implemented digitalization development, received limited academic attention. As a result, relatively little is known about how managerial commitment, resource allocation and implementation mechanisms contribute to firm performance through distinct organizational development pathways. Our research aims to contribute to filling these gaps in the literature. An additional contribution of the paper is the decomposed exploration of DC mediation effects by distinguishing between two observable organizational manifestations theoretically associated with different combinations of dynamic capability components. The research framework is illustrated in Fig. 1.

As Fig. 1 indicates, combinations of sensing, seizing, and reconfiguring as DC components are studied (Teece et al. 1997). These combinations are assumed to contribute to different supply chain digitalization developments, ranging from general modernization (predominantly reflecting seizing through technology adoption and digital investments) to supply chain process development (reflecting both seizing

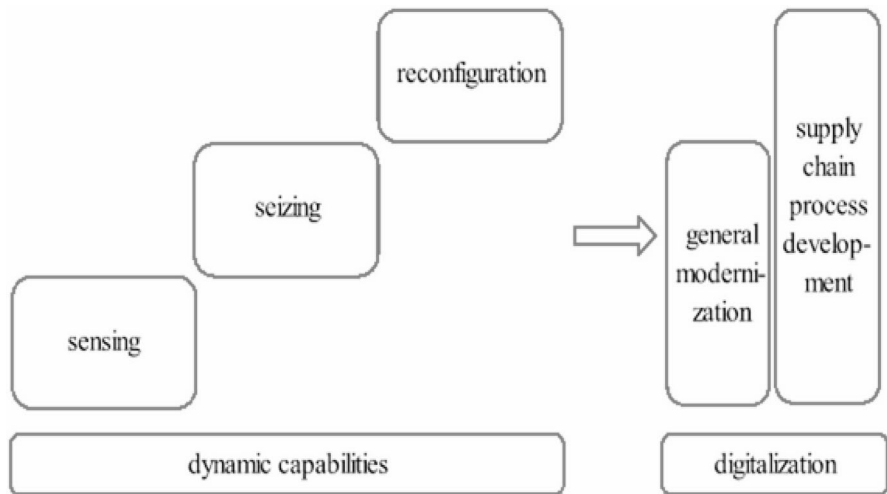


Fig. 1 Overview of the research framework. *Source:* authors' compilation

and reconfiguration through changes in organizational processes and routines). The applied research approach related to the assumed sequence of DC components in digitalization developments is in line with the findings of Markovich et al. (2021), and the separate analysis of the reconfiguration component is also similar to previous literature (Khan et al. 2021; Mousavi et al. 2018).

Digital transformation may promote technological innovation (Xu et al. 2025), and Verhoef et al. (2021) identify digitization, digitalization, and digital transformation as its stages. Pressure from industry rivals can also contribute to implementing digital transformation (Yang and Chen 2026). General modernization and supply chain process development, as two observable organizational manifestations theoretically associated with different combinations of dynamic capability components (Helfat and Peteraf 2009; Bruyaka et al. 2024) and also including elements of innovation, may partly result from digital transformation within a supply chain management context. Therefore, we formulate the following research hypotheses:

H1a: *Digitalization efforts are positively associated with general modernization.*

H1b: *Digitalization efforts are positively associated with supply chain process development.*

Although there are various views about the link between DCs and performance (Barreto 2010), it is possible that DCs contribute to competitive advantage (Schilke 2014), partly through the innovative potential that can be empowered by employee relationships (Salvato and Vassolo 2018) and possibly when supporting a strategic orientation that is appropriate for the level of dynamism and environment munificence (Fainshmidt et al. 2019). Therefore, we formulate the following research hypotheses:

H2a: *General modernization is positively associated with firm performance.*

H2b: *Supply chain process development is positively associated with firm performance.*

Digital transformation may influence firm performance in several ways, for example an effect on ESG performance is also possible (Zhang et al. 2025). Supply chain management also has been profoundly transformed by digital advancements and currently the transition from Industry 4.0 to Industry 5.0 also underlines the importance of technological development in supply chains (Hajjem et al. 2025). When examining future research directions for supply chain research, Zekhnini et al. (2021) highlighted the importance of examining appropriateness of technology for supply chain processes, and our research about the link between digitalization efforts and firm performance is in line with this finding. Based on previous literature and the practical relevance of the question, we formulate the following research hypotheses:

H3a: *Digitalization efforts are directly and positively associated with firm performance, after accounting for the indirect association through general modernization.*

H3b: *Digitalization efforts are directly and positively associated with firm performance, after accounting for the indirect association through supply chain process development.*

H3c: *Digitalization efforts are indirectly and positively associated with firm performance through general modernization.*

H3d: *Digitalization efforts are indirectly and positively associated with firm performance through supply chain process development.*

The research hypotheses emphasize the conceptual distinction between two observable organizational manifestations of dynamic capability development. While general modernization primarily reflects technology implementation and organizational modernization initiatives associated with opportunity seizing, supply chain process development captures broader organizational changes that are theoretically more closely related to resource reconfiguration. Accordingly, the two mediators represent different pathways through which dynamic capability development may influence firm performance. The conceptual model and the research hypotheses are illustrated in Fig. 2.

4 Data and methodology

4.1 Data

The analysis is based on survey data from the Competitiveness Research Center (CRC) at Corvinus University of Budapest, it is a periodic survey of Hungarian firms performed since 1996. The recent (seventh) wave involved face-to-face interviews conducted from September of 2024 through January 2025. The data collection was

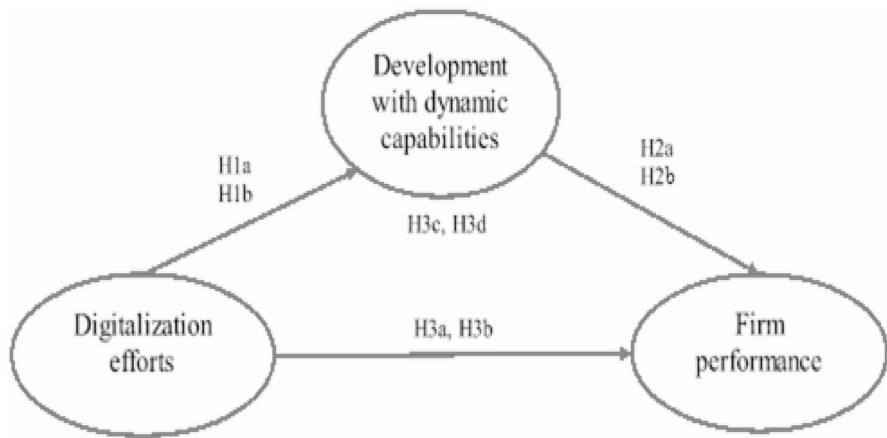


Fig. 2 Conceptual model. *Source:* authors' compilation

Table 1 Descriptive statistics. *Source:* authors' calculations

	Frequency	Percent (%)
<i>Region</i>		
Budapest (capital city)	122	36.4
Other	213	63.6
<i>Firm size</i>		
Medium-sized	292	87.2
Large	43	12.8
<i>Sector</i>		
Manufacturing	164	49.0
Other	171	51.0

carried out by a professional survey company, whose trained interviewers contacted randomly selected firms and conducted the interviews with senior managers responsible for strategic and operational decision-making. This data collection approach ensures access to relevant and reliable firm-level primary data (Competitiveness Research Centre 2026). The latest competitiveness questionnaire drew heavily on previous surveys, which were revised, updated, and methodologically improved by a group of experts set up at the request of the CRC. The perception-based questionnaire included several items organized into one single questionnaire covering corporate strategy and key functional areas like production, marketing, finance, human resource, and, among other topics, leadership, management, supply chain management and digitalization. The dataset includes 335 companies (Hungarian medium-sized and large firms with at least 50 employees, randomly selected from the total Hungarian population of 3748 companies) (Chikán et al. 2025). Table 1 summarizes the main descriptive statistics.

As seen in Table 1, most firms are medium sized with number of employees between 50 and 250 (87.2%), while the other firms may be classified as large based on the number of employees (12.8%). Manufacturing sector represents 49% of respondents, and 36.4% of the firms are located in the capital city.

4.2 Methodology

The paper primarily addresses the research question of how digitalization efforts are related to firm performance. Specifically, it examines whether, in addition to a direct association, indirect relationships consistent with mediation through general modernization or supply chain process development can also be observed. The development and measurement of the analyzed constructs are based on previous literature. With the aim to holistically capture the essential strategic, procedural and resource dimensions, digitalization efforts are quantified with indicators reflecting findings in prior research on the effects of digitalization in the corporate sector (Kane et al. 2017; Szukits 2022). The measurement of supply chain process development is inspired by the literature on digitalization effects in supply chain management (Zouari et al. 2021), and general modernization measurement is related to indicators based on expert opinions (Demeter et al. 2021). The supply chain DC development related questions represent a subset of survey questions related to supply chain management, manufacturing and services in the questionnaire. During data collection, respondents were asked to evaluate, with reference to their own company, how much they agree with statements related to digitalization efforts, general modernization and supply chain process development, with possible answers ranging from “not at all” (indicated by 1) to “completely” (indicated by 5).

Firm performance is quantified with a competitive advantage-based approach inspired by Schilke (2014). Although the measurement of competitive advantage is not straightforward, according to Schilke (2014) it may be considered a two-dimensional construct, including a strategic performance related qualitative dimension, and a quantitative dimension associated with financial performance. Similar to this approach, firm performance is quantified with three items associated with both strategic and financial aspects. To measure firm performance, respondents were asked to evaluate the position of the firm in comparison to the sectoral average on a scale from 1 (indicating a position well below the industry average) to 5 (substantially higher than the industry average).

Table 2 presents the results of exploratory factor analysis (based on the computation of principal component analysis results). Principal components analysis is one possible method of factor extraction (Henson and Roberts 2006), and in exploratory factor analysis it may provide insights into data characteristics if the assessment of total variance is relevant in the analysis (Howard 2023). Since some results in principal component analysis and other factor analysis methods often exhibit similarities (Szüle 2017), the application of principal component analysis may be adequate in the exploratory analysis.

As seen in Table 2, based on the exploratory factor analysis results, convergent validity can be considered adequate, since all loading values are above 0.8. Although other measures could also be applied for reliability evaluation (Deng and Chan 2017), internal reliability may be assessed based on Cronbach's alpha values. In this analysis, internal reliability can also be considered adequate because Cronbach's alpha values are above 0.7. The Pearson correlation coefficient between the constructs indicating general modernization and supply chain process development is 0.434 ($p < 0.001$); this result indicates differences between the two mediator variables in the analysis.

Table 2 Summary of measures. *Source:* authors' calculations

	Loading	TVE	KMO	Cronbach's alpha
<i>Digitalization efforts inspired by Kane et al. (2017) and Szukits (2022)</i>		0.728	0.708	0.812
Our company has clear and coherent digitalization (aimed at digital transformation) strategy	0.837			
We have a clear process for starting and implementing digitalization projects	0.878			
We assign enough material resources to the digitalization strategy and its implementation	0.844			
<i>General modernization based on expert opinions Demeter et al. (2021)</i>		0.772	0.684	0.852
Use of modern processes (e.g., laser and water-jet cutting, additive manufacturing/3D printing, high-precision technologies)	0.838			
Digitization of operations (e.g., smart/digital factory/service solutions, adaptive manufacturing systems, scalable production, sensor data collection)	0.924			
Automation of operational processes (e.g., automated machine tools and material handling/transport equipment, industrial robots, chatbots, self-service)	0.872			
<i>Supply chain process development inspired by Zouari et al. (2021)</i>		0.791	0.500	0.727
We develop innovative technologies to develop our operation	0.890			
We efficiently apply the tools of continuous development	0.890			
<i>Firm performance inspired by Schilke (2014)</i>		0.730	0.709	0.810
Regarding profit-sales ratio the performance of the main business line compared to the country industry average ...	0.863			
Regarding profitability the performance of the main business line compared to the country industry average ...	0.872			
Regarding sales based market share the performance of the main business line compared to the country industry average ...	0.827			
The table contains principal component analysis results (component matrix data, Kaiser–Meyer–Olkin measure of sampling adequacy, and total variance explained for each construct separately) and Cronbach's alpha				

In addition to the exploratory factor analysis, when further testing the research models with general modernization and supply chain process development, a two-stage approach was applied (Anderson and Gerbing 1988). First, the validity and reliability of the measurement model was examined with confirmatory factor analysis. Second, structural equation modeling was applied to test the hypothesized relationships between the variables. As seen in Tables 3 and 4, composite reliability (CR) indicators are above 0.7 in both models, which indicates adequate reliability. Convergent validity was supported for both models, since the average variance extracted (AVE) values were above 0.5 (Fornell and Larckner, 1981), and all factor loadings were above 0.5.

As Tables 5 and 6 indicate, discriminant validity is also supported by the results for both models, since the correlation values between any two constructs were less than the square root of the average variance extracted values (Fornell and Larcker 1981).

Table 3 Confirmatory factor analysis results (with general modernization). *Source:* authors' calculations

	Loading	CR	AVE
<i>Digitalization efforts</i>		0.815	0.596
Our company has clear and coherent digitalization (aimed at digital transformation) strategy	0.736		
We have a clear process for starting and implementing digitalization projects	0.829		
We assign enough material resources to the digitalization strategy and its implementation	0.747		
<i>General modernization</i>		0.859	0.673
Use of modern processes (e.g., laser and water-jet cutting, additive manufacturing/3D printing, high-precision technologies)	0.707		
Digitization of operations (e.g., smart/digital factory/service solutions, adaptive manufacturing systems, scalable production, sensor data collection)	0.949		
Automation of operational processes (e.g., automated machine tools and material handling/transport equipment, industrial robots, chatbots, self-service)	0.787		
<i>Firm performance</i>		0.816	0.598
Regarding profit-sales ratio the performance of the main business line compared to the country industry average ...	0.783		
Regarding profitability the performance of the main business line compared to the country industry average ...	0.834		
Regarding sales based market share the performance of the main business line compared to the country industry average ...	0.696		
Loadings standardized regression weights, CR composite reliability, AVE average variance extracted			

Table 4 Confirmatory factor analysis results (with supply chain process development). *Source:* authors' calculations

	Loading	CR	AVE
<i>Digitalization efforts</i>		0.815	0.596
Our company has clear and coherent digitalization (aimed at digital transformation) strategy	0.750		
We have a clear process for starting and implementing digitalization projects	0.819		
We assign enough material resources to the digitalization strategy and its implementation	0.744		
<i>Supply chain process development</i>		0.754	0.611
We develop innovative technologies to develop our operation	0.893		
We efficiently apply the tools of continuous development	0.652		
<i>Firm performance</i>		0.816	0.598
Regarding profit-sales ratio the performance of the main business line compared to the country industry average ...	0.787		
Regarding profitability the performance of the main business line compared to the country industry average ...	0.828		
Regarding sales based market share the performance of the main business line compared to the country industry average ...	0.699		
Loadings standardized regression weights, CR composite reliability, AVE average variance extracted			

Table 5 Discriminant validity analysis (with general modernization). *Source:* authors' calculations

	DE	GM	FP
Digitalization efforts	0.772		
General modernization	0.568	0.821	
Firm performance	0.479	0.306	0.773

DE digitalization efforts, GM general modernization, FP firm performance

Table 6 Discriminant validity analysis (with supply chain process development). *Source:* authors' calculations

	DE	SCPD	FP
Digitalization efforts	0.772		
Supply chain process development	0.568	0.782	
Firm performance	0.481	0.474	0.773

DE digitalization efforts, SCPD supply chain process development, FP firm performance

Model fit is assessed based on multiple criteria. When assessing model fit, for TLI and CFI a cutoff value close to 0.95, while for RMSEA a cutoff value close to 0.06 could be needed in case of a relatively good fit (Hu and Bentler 1999). Confirmatory factor analysis results suggest that model fit is acceptable for the models with general modernization ($\chi^2/\text{df}=1.36$, $p=0.112$, RMSEA=0.033, CFI=0.993, TLI=0.990), and with supply chain process development ($\chi^2/\text{df}=1.81$, $p=0.021$, RMSEA=0.049, CFI=0.986, TLI=0.977).

To study the relationships across digitalization efforts, general modernization, supply chain process development and firm performance, structural equation modeling (SEM) is applied, since it may reveal complex relationships between variables (Kline 2016), and the sample size may also be considered as adequate for SEM (Bagozzi and Yi 2012). Since previous literature suggests that supply chain management questions can be influenced by sectoral (Hennequin et al. 2025) and firm size effects (Clohessy and Acton 2019), the binary variables indicating whether the firm can be classified as large (based on the number of employees) and whether the firm belongs to the manufacturing sector are included as control variables in the examined models. The empirical results of the analysis are introduced in the following section.

5 Results

The calculations were performed with SPSS Amos version 30 and IBM SPSS Statistics Version v29.0. Based on the results the fit indices for the structural model can be considered acceptable in case of the mediation model with general modernization ($\chi^2/\text{df}=1.61$, $p=0.011$, RMSEA=0.043, CFI=0.983, TLI=0.975), and with supply chain process development ($\chi^2/\text{df}=1.41$, $p=0.078$, RMSEA=0.035, CFI=0.989, TLI=0.982). Estimation methods may influence the results in structural equation modeling (Xia and Yang 2019), and in the analysis, bootstrap confidence intervals have been calculated. In the bootstrap analysis, a bootstrap sample size of 5,000 was used with a 95% confidence interval. Figure 3 summarizes the main results of structural equation modeling.

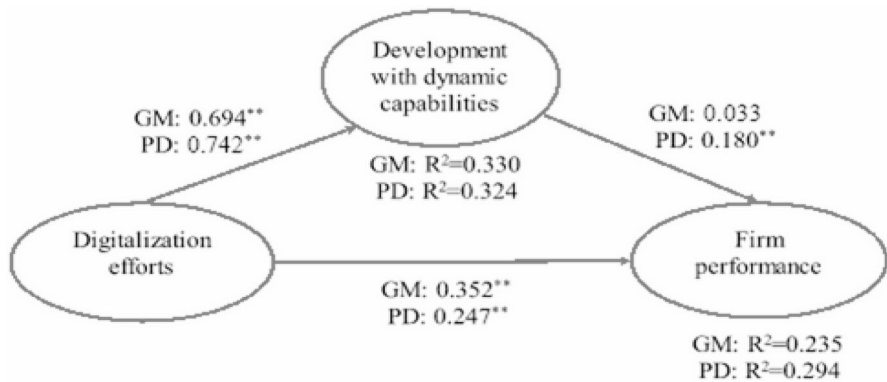


Fig. 3 Empirical results. *Notes:* The asterisks ** denote statistical significance at the 1% level. The control variables are the large firm binary indicator and the manufacturing binary indicator. GM: general modernization, PD: supply chain process development. *Source:* authors' calculations.

Table 7 Mediation analysis results. *Source:* own calculations

Relationships	Direct effect	Indirect effect	Confidence interval (indirect effect)	
			Low	High
Digitalization efforts → General modernization → Firm performance	0.352** (0.000)	0.023 (0.527)	-0.055	0.093
Digitalization efforts → Supply chain process development → Firm performance	0.247** (0.001)	0.133** (0.002)	0.065	0.233

Bootstrap analysis with sample size 5000. The values in parentheses are *p*-values. The asterisks ** denote statistical significance at the 1% level. The control variables are the large firm binary indicator and the manufacturing binary indicator

As Fig. 3 indicates, the regression weights are almost all statistically significantly positive. The results about the mediation effects of general modernization and supply chain process development are summarized in Table 7. The results in Table 7 indicate that the relationship between digitalization efforts and firm performance may be partially mediated through supply chain process development (representing outcomes of DCs); both the direct and the indirect effect may be considered statistically significant at the 1% significance level. However, the findings about general modernization are not consistent with significant mediation in the relationship between digitalization efforts and firm performance.

The empirical findings enable the formulation of conclusions in the analysis: the research hypotheses H1a, H1b, H2b, H3a, H3b and H3d are supported by the empirical results, but the research hypotheses H2a and H3c are not supported by the results. Digitalization efforts are statistically significantly positively associated with both general modernization and supply chain process development, but only supply chain process development is statistically significantly positively associated with firm performance. In addition to this, when examining the mediation role of supply chain process development, then according to the SEM results digitalization efforts have both a statistically significantly positive direct and indirect effect on the competitive

advantage related firm performance. When the mediation role of general modernization is examined, only the direct effect is statistically significant.

6 Discussion and conclusions

Several perspectives on DCs were already extensively examined by previous scholarly work, but the separate analysis of DC components is a currently evolving research stream that, until now, received limited academic attention. We aim to add to this line of research by examining the mediation role of DCs in the link between digitalization efforts and firm performance. Our analysis focuses on whether organizational manifestations theoretically associated with different combinations of DC components differ in their mediating role in the relationship between digitalization efforts and firm performance.

When studying the mediation effects, different combinations of DC components are identified. General modernization is interpreted as an observable organizational manifestation primarily associated with opportunity seizing, whereas supply chain process development captures broader organizational changes that are theoretically more closely associated with resource reconfiguration. This approach is partly similar to that of Muhic and Bengtsson (2021), who analyzed sensing, seizing and transforming DCs separately. However, the focus on the reconfiguration DC component varies in previous literature. For instance, Torres et al. (2018) examine primarily business intelligence and analytics, which is considered as representing the sensing and seizing components of DCs, and this perspective in their analysis differs from that in our paper. Some of our findings related to the relationship between DCs and firm performance are also similar to those of Mousavi et al. (2018), who conclude that innovation towards sustainability is influenced by sensing, seizing and reconfiguring capabilities. However, differences in the role of mediation in the link between digitalization and firm performance as a result of differently combining DC components have not yet been extensively studied in previous literature, and our research aims to contribute to filling this gap.

6.1 Theoretical contribution

Our paper contributes to earlier scholarly work on DCs in several ways. Sensing, seizing, and reconfiguring as DC components were already examined separately by prior research in various contexts (Engelmann 2024; Khan et al. 2021; Mousavi et al. 2018; Torres et al. 2018), but the decomposition of DCs' mediation role received surprisingly limited attention until now. Our results contribute to addressing this research gap by examining two observable organizational manifestations theoretically associated with different combinations of dynamic capability components in a supply chain management context. Furthermore, by examining the relationship between digitalization efforts and firm performance through organizational manifestations theoretically associated with dynamic capability development, the study provides further insight into the mechanisms through which digitalization contributes to firm performance. In addition, the focus on digitalization efforts, rather than on

achieved digitalization outcomes or maturity levels, extends the digital transformation literature by examining how managerial commitment, resource allocation and implementation processes contribute to organizational change and firm performance. More specifically, we compare two observable organizational manifestations theoretically associated with different combinations of dynamic capability components (general modernization, supply chain process development) and examine their mediating roles between digitalization efforts and firm performance. By distinguishing between these two manifestations, the study offers a more nuanced interpretation of how dynamic capability development may contribute to firm performance, thereby contributing to the ongoing debate on the relationship between dynamic capabilities and organizational performance (Barreto 2010).

6.2 Practical implications

Our findings have numerous managerial implications. The results suggest that digitalization should not be treated as a purely technological initiative; instead, managerial attention should focus on how digitalization is strategically framed, implemented and supported within the organization. Accordingly, managers should avoid ad hoc digital projects and align digitalization initiatives closely with corporate objectives instead. The findings are consistent with the interpretation that mediation becomes observable when supply chain development includes organizational changes theoretically associated with resource reconfiguration.

Empirical results also point out that investments in digitalization are unlikely to generate lasting competitive advantage unless they result in tangible improvements in supply chain processes, such as the adoption of innovative operational technologies and the effective application of continuous improvement practices. From a managerial perspective, this highlights the importance of evaluating digital initiatives not only based on project completion, but also on their impact on process efficiency, integration, and adaptability.

6.3 Limitations

Like all research, the current study has several limitations which should be acknowledged. Firstly, the analysis is based on cross-sectional survey data, which limits the ability to draw causal inferences about the examined relationships. Secondly, the study relies on perception-based measures collected from top management respondents. Although this approach is not uncommon in this field, it may be subject to response bias, and future studies could complement survey data with objective performance indicators or multi-respondent designs. Thirdly, the empirical analysis focuses on medium-sized and large firms operating in a single national context. While this setting offers a coherent institutional environment, the conclusions of the study do not necessarily apply to small firms or other countries. However, the diversity of firms in the sample may contribute to increasing the generalizability of the findings.

6.4 Conclusions

This study provides empirical evidence that digitalization efforts in supply chain management can be associated with firm performance. The findings also suggest that this association with performance may involve indirect relationships through organizational developments. In particular, the results are consistent with mediation through supply chain process development, which is theoretically more closely associated with resource reconfiguration than general modernization. With other words, the empirical results may be considered supporting a well-known managerial insight that suggests avoiding wasting valuable resources. More specifically, research findings highlight that in a supply chain management context the association of digitalization efforts with firm performance may be more complex if, instead of general modernization, digitalization investments aim at developing supply chain processes. Considering the extent of digitalization developments in the corporate sector, these insights may enrich both academic knowledge and managerial practice.

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