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

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Abstract

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

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

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

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

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

Paper type Research paper

1. Introduction

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

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

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

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

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

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

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

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

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

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

2. Theory development

2.1 Contingent and complementary effect of data capability

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

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

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

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

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

2.2 Research model and hypotheses

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

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

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

H1. Data capability positively impacts SCC.

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

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

H2. SCC relates positively to operational performance

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

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

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

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

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

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

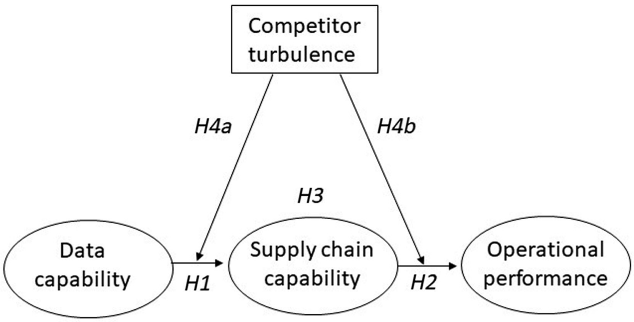
H4b. The direct effect between SCC on operational performance is stronger when the competition is intense

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

3. Research methodology

3.1 Sampling and data collection

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



Source(s): Author's own work

Figure 1. Research framework

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

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

3.2 Non-response bias

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

3.3 Measures

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

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

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

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

Table 1.
Profile of responding firms

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

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

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

3.4 Reliability and validity

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

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

The Fornell-Larcker criterion was used to test discriminant validity following an evaluation of the square roots of AVE values (Fornell and Larcker, 1981). The results show good values and the square root of the AVE was higher than the values of the constructs (Fornell and Larcker, 1981). The values are bolded diagonally in the correlation matrix (see Table 3). In addition, the maximum share variance (MSV) was calculated for discriminant validity. The values remained below the constructs' AVE values (Hair *et al.*, 2019). Finally, the heterotrait-monotrait ratio (HTMT) was calculated and the values ranged between 0.10 and 0.45, so they were below the threshold value of 0.9 (Henseler *et al.*, 2015). Together these findings provide evidence of discriminant validity. The correlations, means and standard deviations of the constructs can be found in Table 3.

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

4. Analysis and results

4.1 Hypotheses testing

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

Table 2. Reliability and validity of the constructs

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

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

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

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

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

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

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

Table 4. The results of SEM

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

4.2 Moderation analysis

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

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

5. Discussion and implications

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

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

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

5.1 Theoretical implications

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

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

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

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

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

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

5.2 Managerial implications

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

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

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

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

5.3 Limitations of the study and future research directions

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

6. Conclusion

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

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

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Further reading

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Appendix

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

Table A1.
Measurement scales

(*continued*)

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

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

Table A1.

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