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The link between supply chain risk management and innovation performance in SMEs in turbulent times

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Abstract

Purpose – Acknowledging, on the one hand, the increasing fragility of supply chains and the number of risks involved in supply chain operations and, on the other hand, the role of small- and medium-sized enterprises (SMEs) in supply chains and the high exposure of these firms to risks of different types, this study aims to examine the relationship between supply chain risk management (SCRM) and innovation performance in SMEs. Furthermore, the impact of technological turbulence on this relationship was studied to take into account recent technological changes.

Design/methodology/approach – Structural equation modelling was carried out on a sample of Turkish SMEs to test the hypotheses developed.

Findings – The findings presented allow the authors to better understand the link between SCRM and innovation performance in SMEs. More precisely, empirical evidence is provided about the impact of SCRM components such as maturity and ability on innovation performance. Furthermore, the findings show the impact of technological turbulence on both SCRM and innovation performance.

Originality/value – By focusing on SCRM in SMEs, this paper contributes to the body of knowledge with regard to SCRM in general and with regard to SMEs in particular; research on the latter has only started recently. Moreover, by having studied SMEs from a developing country (other than China), this paper helps to develop a broader and more diverse perspective of SCRM.

Keywords SMEs, Supply chain, Risk management, Supply chain risk management, Innovation performance, Technological turbulence

Paper type Research paper

1. Introduction

Recent events (e.g. COVID-19, Invasion of Ukraine) have put significant pressure on value chains and their smooth operation. In addition, the progressive digitalisation and increasing

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connectivity of supply chains have made supply chain operations quite fragile (Rajesh, 2017; Bak, 2018; Birkel and Hartmann, 2020; Kraus *et al.*, 2022). Consequently, supply chains have been exposed to a large number of risks, old and completely new (Parast and Subramanian, 2021; Shekarian and Mellat Parast, 2021; Wicaksana *et al.*, 2022). These developments underscore even more the relevance of not only systematic and holistic risk management (RM) in organisations (Smallman, 1996; El Baz and Ruel, 2021) but also proactive approaches (Ratten, 2020). Already in 2012, Colicchia and Strozzi have identified the management of supply chain risks as a crucial capability of firms to compete in the long term.

Although the study of supply chain risk management (SCRM) has attracted increasing interest and research efforts (Colicchia and Strozzi, 2012; Bak, 2018; Fan and Stevenson, 2018), since the outbreak of COVID-19 there is even more research (El Baz and Ruel, 2021; Rodríguez-Espíndola *et al.*, 2022) – our understanding of this topic regarding small- and medium-sized enterprises (SMEs) is underdeveloped (Ferreira de Araújo Lima *et al.*, 2020; Zeiringer *et al.*, 2022). This is surprising given the role of SMEs both in supply chains and the majority of economies (Thun *et al.*, 2011), and the situation that smaller firms are highly sensitive to external threats (Doern *et al.*, 2019) which increases the probability of failure among them, in particular the younger ones (May and Lixl, 2019).

Extant research on SCRM has focused primarily on large companies (Birkel and Hartmann, 2020) and tends to be (still) conducted in developed countries (Fan and Stevenson, 2018; Zeiringer *et al.*, 2022). Furthermore, there seems to be an emphasis on a specific industry such as automotive, manufacturing or food (Fan and Stevenson, 2018). As regards the research methodologies, Ferreira de Araújo Lima *et al.* (2020) noticed a need for quantitative research approaches that would help determine answers to the "what" questions surrounding SCRM. About the different sub-processes of SCRM, there seems to be a primary interest in studying risk treatment, more precisely risk mitigation approaches to treating risk (Fan and Stevenson, 2018). Reviews have also shown a lack of research on the effect of SCRM on firm performance (Colicchia and Strozzi, 2012; Fan and Stevenson, 2018; Ali and Gurd, 2020). Given that RM is not only costly and time-consuming (Parast and Subramanian, 2021), it is also a demanding business function (Callahan and Soileau, 2017). Consequently, organisations have to make a tradeoff between risk and benefits (Tang *et al.*, 2011). Hence, one can easily conclude that a positive link between SCRM and performance would mean a clear signal to organisations and their efforts. This applies in particular to smaller organisations given the lack of both financial and human resources often found with these firms (Henschel and Durst, 2016; Ferreira de Araújo Lima *et al.*, 2020; Ali and Gurd, 2020), which in turn increases the danger of making the wrong decision or a semi-optimal one only.

In addition, an understanding of the link between SCRM and performance is viewed of high relevance considering recent radical innovation/technological developments which have already shown their power in turning entire business models upside down (Temel and Durst, 2020). As a consequence, companies may set other priorities for the allocation of resources. Hence, in terms of the related link between RM and innovation (Gilley *et al.*, 2002; Colicchia and Strozzi, 2012; Durst *et al.*, 2019), companies need to carefully consider whether they are willing to pay the price for an even stronger emphasis on risks, considering a business environment that has become even more uncertain due to the COVID-19 pandemic. This means an additional challenge to SMEs because many of these firms not only find the implementation of new technologies a challenge but also often lack the necessary technical knowledge within the company to, for example, operate and monitor applications supported by them in a legally compliant manner (Temel and Durst, 2020). At the same time, the importance of innovation performance cannot be ignored for minimising supply chain risks (Kwak *et al.*, 2018). To a large extent, the disruption of the COVID-19 pandemic has reaffirmed the essence of innovation, as demonstrated by leading companies (e.g. Apple, Microsoft), in safeguarding the supply chain process. In the case of SMEs, the management of supply chain risks is extremely critical to increasing the potential to become more resilient as a result (Kull *et al.*, 2018; Durst and Henschel, 2021).

Therefore, this study aims to examine the relationship between SCRM and innovation performance in SMEs. By focusing on innovation performance, the present paper aims to provide a more nuanced understanding of SCRM on this relevant type of organisational performance. In addition, in this study, the authors also examine the effect of technological turbulence on the relationship between SCRM and innovation performance. A data set from Turkish SMEs is used. Turkey is considered to be an ideal setting considering that there is evidence that innovation efforts in Turkey outperformed those in previous years despite the pandemic (World Intellectual Property Organisation, 2020).

The study's primary contribution is to recognise the trade-off between SCRM and innovation performance in SMEs. Secondly, the study improves our understanding of how technological turbulence mediates the impact of SCRM on innovation performance. Thirdly, by focussing on SMEs and having collected data from a developing country, the study provides more diversity regarding the study of SCRM (Parast and Subramanian, 2021) and advances the underdeveloped research on SCRM in SMEs (Ferreira de Araújo Lima *et al.*, 2020).

The paper is structured as follows. Firstly, a short overview of SCRM is provided. Then the concepts of interest are introduced, and hypotheses are formulated. This section is followed by a description of the methodology used. After that, the analysis and results are presented. The paper terminates with discussion and conclusion sections.

2. Literature background

2.1 Supply chain risk management

SCRM has been defined in a variety of ways in the literature. Wieland and Wallenburg (2012), for example, describe SCRM as a process of reducing vulnerability to risks. Fan and Stevenson (2018) define SCRM, as the identification, assessment, treatment and monitoring of risks, thus covering the typical phases of RM (Vaughan and Vaughan, 2001). In this study, SCRM is defined as identifying potential sources of risk and applying appropriate strategies to reduce supply chain vulnerability with the involvement and collaboration of supply chain partners.

From this definition, it is evident that SCRM is concerned with risks associated with supply chains; commonly referred to as supply chain risks. In Parast and Subramanian (2021, p. 2), a supply chain risk is defined as "the potential deviation from the expected value of a certain supply chain performance measure". To date, there have been several categories of supply chain risks proposed by scholars (Chara and Zerin, 2021), including internal or external (Birkel and Hartmann, 2020), source or outcome (Schiele *et al.*, 2021), probability or severity (Majumdar *et al.*, 2021), macro or micro (Ho *et al.*, 2015) among others. According to Essaber *et al.* (2021), for example, supply chain risk has five broad divisions, namely: operational risks, financial risks, environmental risks, collaboration risks and disruption risks. Operational risk is the risk of losses as a result of failed processes, human error or the occurrence of an unexpected external event that interrupts supply chain operations (Settembre-Blundo *et al.*, 2021). Operation risk may arise due to demand risk.

Demand risk is a downstream emerging risk that occurs due to poor demand forecasts (Sharma *et al.*, 2020) or when a customer order is misunderstood (Essaber *et al.*, 2021). In the case of financial risk, a firm's financial performance is threatened by supplier delays and defaults in payments. This could also arise when a firm experiences a drop in revenue or exchange rate volatility (Er Kara *et al.*, 2020). Environmental risk arises from "supply chain disruption that may result from the changes in political environment and regulations, modification and renewal of laws, natural disasters, disease, epidemics, or international terror attacks" (Essaber *et al.*, 2021, p. 5). Although the environmental risk is mostly considered an unavoidable supply chain risk, it can be effectively managed using logistics innovation, including sophisticated technology and new processes (Wang *et al.*, 2020). Collaboration risk arises as a result of poor collaboration among supply chain partners due to differences in the interests and cultures of these partners. This could result in delays in decision-making, which, in turn, deteriorates the competitiveness of the supply chain. Disruption risk is any threat that is likely to affect the overall supply chain system and interrupt normal routines (Essaber *et al.*, 2021). This risk includes scheduling and routing failures, government bans, piracy, etc.

The different types of risks associated with supply chains contribute significantly to the complexity of SCRM. Considering such complexity, companies are expected to initiate and enforce strategies to ensure optimal supply chain stability. These strategies can be proactive and reactive (Juttner, 2005). The existing SCRM literature has discussed various SCRM strategies. Suresh *et al.* (2020) identified two prominent categories supply chain professionals usually consider when addressing supply chain risks which are SCRM tools and techniques and developing a company that is flexible, agile and resilient with regard to supply chains. Supply chain integration is also considered a strategy to reduce supply chain risks (Zhao *et al.*, 2013) as it allows firms to consciously collaborate with supply chain partners to ensure a free flow of information, materials, and funds. Can Saglam *et al.* (2021) investigated the effect of proactive RM strategies on SCRM performance in large and mid-sized manufacturing companies located in Turkey and found that supply chain resilience and responsiveness are suitable strategies to improve SCRM performance. Yang *et al.* (2021) drew on the information processing theory to better understand the relationship between supply chain capability and supply chain resilience. Data were sampled from manufacturing firms in China after the coronavirus outbreak in 2020. Their results suggested that supply chain capability has a positive influence on supply chain resilience. As SCRM requires certain capabilities of companies, Rajesh (2017) rightly emphasised that organisations should first understand whether they have relevant capabilities, in particular technological ones, before investing too much in SCRM practices. This author proposed and tested a model containing a number of technological capabilities that can influence the resilience capabilities of companies' supply chains. The author found that crucial capabilities are the ability to modify SC design and planning capabilities. The study also stressed the relations among capabilities and suggested that some major capabilities may act as a catalyst for the enhancement of other ones. As regards capabilities in general, existing research (Brusset and Teller, 2017) suggests that advanced RM capabilities enable firms to keep running its operations, production, and deliveries of quality products to customers in the time of turbulences.

2.2 Supply chain risk management in SMEs

Reviewing the existing research on SCRM in SMEs suggests it is scarce and of a recent nature – an observation that applies to research on RM in SMEs in general as well (Henschel and Durst, 2016; Ferreira de Araújo Lima *et al.*, 2020). With the results of complexity increased in goods and services globally, the focus on SCRM has increased and therefore it has become one of the major issues for all organisations including SMEs. Thus, SMEs' managers need to understand the various risk factors for effective supply chain risk mitigation. Thun *et al.* (2011) examined supply chain vulnerability, drivers of supply chain risks and instruments of SCRM taking data collected through a survey conducted in the German automotive industry. The authors found amongst others that SMEs tend to focus on reactive SCRM instruments, e.g. safety stocks or overcapacities while large enterprises prefer preventive SCRM instruments, e.g. suppliers with high quality or on-time deliveries. The study further found that firms are exposed to the same supply chain risks when firms internationalise their production network, underlining the role of SMEs in the original equipment manufacturer's supply base.

A study by Hoffmann *et al.* (2013), aimed at investigating the antecedents of SCRM performance, revealed that SCRM maturity has a positive impact on firms' efforts to maintain the performance of SCRM. Given that, the study consequently confirmed that the concept of SCRM maturity is adequately effective in dealing with supply chain risks. Given the situation that SMEs have scant resources, RM in those organisations differs from that found in large organizations, and thus the adoption of RM approaches and practices developed for large companies is not expedient (Ferreira de Araújo Lima *et al.*, 2020). Addressing the negative link between operational risk and supply chain performance, Ali and Gurd (2020) found that intensive knowledge sharing (e.g. joint business planning, exchange of data on production and sales, goal sharing and shared R&D capabilities) can be an effective risk mitigation measure for small firms to address the link.

Chen *et al.* (2016) proposed that supply chain risk can be mitigated by sharing knowledge and information, building trust, commitment and strong buyer–supplier collaboration. Previous research has suggested that RM in firms is not only influenced by the sector (Fan and Stevenson, 2018) but also by the experience, risk knowledge, beliefs and attitudes of the firms' decision-makers (Jayathilake, 2012; Hove-Sibanda *et al.*, 2021). The study by Henschel and Durst (2016), which involved small firms from China, Germany and Scotland, also found country- and size-specific differences regarding the maturity level of RM. Regarding the effect of size, RM tends to be more formal and systematically developed the larger and more experienced the firm is (Ferreira de Araújo Lima *et al.*, 2020). Generally, the need to consider the heterogeneity found in SMEs (Curran and Blackburn, 2001) is important to increase the overall quality of findings and thus their applicability. However, regardless of size, it has been argued that RM is crucial for small firms (Lepistö *et al.*, 2021).

Given the above, the following hypotheses appear plausible:

H1. Firm size has a positive influence on the (supply chain) risk management maturity level of organisations.

H2. The risk management maturity level has a positive influence on a small firm's ability to manage risks.

2.3 Risk management and innovation performance

Innovation is a key factor for the sustainability of all companies, regardless of size (Wadho and Chaudhry, 2018; Lee *et al.*, 2019). Thus, for SMEs who want to continuously improve their business performance, it is also necessary to continue doing innovation activities. For SMEs, the smaller ones, in particular, it is often rather challenging to have both continued innovation activities and innovation performance. Thus, it has been suggested that SMEs should carefully work on their internal capabilities, e.g. identify organisational potential and continuously develop skills and knowledge, thus their strength(s) (Prajogo and Ahmed, 2006; Yıldız *et al.*, 2021).

Small companies use different activities and methodologies to improve their internal capacities for better innovation performance. For example, SMEs with enhanced capabilities practice learning by doing activities (Tamer Cavusgil *et al.*, 2003) that help them have both better innovation performance and innovation capability (Li *et al.*, 2020). This, in turn, shows the importance to SMEs by acknowledging their internal environment to choose appropriate and low risk related activities to increase innovation performance.

RM is expected to support firms and their efforts with regard to the aforementioned, as it is an approach to prioritise risks and allocate resources in the best way to minimise the risks (Smith and Merritt, 2002). Thus, SMEs, too, are supposed to implement different RM practices for their R&D, innovation projects as well as supply chain operations (Shafiq *et al.*, 2017; Nguyen *et al.*, 2018). This, in turn, will increase the success rate of their innovation projects and eventually lead to improved business performance, particularly on the supply side of the chain (Tukamuhabwa *et al.*, 2021). This is because, if SMEs identify and prioritise material risks improperly, or even worse, not at all, company survival can be at risk, and failures in this area can discourage SMEs and stifle innovation performance (Bowers and Khorakian, 2014). Bromiley *et al.* (2017) argue that for proper risk minimisation, all SMEs control the critical issues, and they try not to leave any space for failure. Durst *et al.* (2019) could empirically show that the management of risks related to knowledge can impact the innovativeness of organisations while Lendowski *et al.* (2022) found in their study of German firms a positive attitude to risk taking activities along with proper RM increases innovation performance. On the other hand, having too tight controls and excessive RM practices in conjunction with innovation activities can reduce the room available for discovering and learning from failures and mistakes, which can affect innovation capacity negatively (Bowers and Khorakian, 2014). For instance, technological innovation involves high uncertainty that indicates potential unknown and unexpected risks (Florin, 2019), thus, too rigid and narrow RM bears the risk that these kinds of development are excluded from the outset.

It is also observed that whenever a firm undertakes any RM strategies, typically it involves the utilisation of resources, and most often than not these resources are either misallocated or overutilised and in effect may lead to poor innovation performance (Molina-Morales *et al.*, 2011). Therefore, the authors of this paper argue that if an SME has developed a high level of ability and maturity in RM, which reduces the “unknown” yet, which is one of the driving forces of innovation, it will hurt the firm’s innovation performance.

Thus, the following two hypotheses are proposed:

H3. A firm’s ability to manage risks has a negative influence on the small firm’s innovation performance.

H4. The risk management maturity level has a negative influence on a small firm’s innovation performance.

2.4 Technological turbulence and innovation performance

In the past 20 years, the world has experienced dramatic changes in technology such as information technology (IT), communication and digital technology, and this technological turbulence has brought threats and opportunities for companies (Hou *et al.*, 2022). Technological turbulence has been defined as the rate of change and unpredictability of technology in an industrial or market environment (Song *et al.*, 2005).

As the adoption of new technologies is influenced by the external environment (Autry *et al.*, 2010), in environments that are characterised as technologically turbulent, it is rather likely to assume that technologies that are perceived as useful and easily adaptable are preferred. Consequently, the adoption of incremental innovations might be easier compared to radical innovations, as the latter have greater uncertainties (Wassmer, 2010). A recent study by Wang and Quan (2021) reveals technological turbulence as an essential tool that could transform firms to meet the evolving open innovation generation. Hence, it can be concluded that SCRM is likely to be improved by the recent technological developments, e.g. the implementation of the Internet of Things system (Birkel and Hartmann, 2020) too. In a similar study, Huo *et al.* (2022) confirm that technological turbulence improves innovation performance among 213 manufacturing firms in China. Puriwat and Hoonsopon (2022) investigate the effect of organisational agility on radical and incremental innovation performance under technological turbulence. The authors found that organisational agility improves both radical and incremental innovation performance when technological turbulence exists.

Technological turbulence has increased information processing capacity (Ku, 2022) and has led companies to focus more on following trends regarding technology development and their consequences on customer needs (Hou *et al.*, 2022). Hanvanich *et al.* (2006) have stressed that technological turbulence forces companies to update their knowledge to be ready for the new technologies that follow. Therefore, learning and internalisation of newly created knowledge are crucial (Brem *et al.*, 2016) which in turn can also result in innovation.

This leads to the following hypothesis:

H5. Technological turbulences have a positive influence on a small firm's innovation performance.

However, for many SMEs, these new technologies may be viewed as both too costly and risky, given that technology implementation involves high direct and indirect costs (Temel and Durst, 2020), even though the impact of these technologies may be significant. Furthermore, in SMEs, due to resource constraints, it is likely to assume that there is an "either-or" question regarding the adoption of these developments, hence it can be argued that firms that are more mature in SCRM may benefit less from these developments compared to less mature companies as the decision whether to incorporate these new developments and innovations is easier for the latter.

Therefore, the following is proposed:

H6. There is a negative relationship between technological turbulence and the SCRM maturity level of a small firm.

The research model developed in this study is shown in Figure 1.

3. Methodology

3.1 Sample and data collection

The companies contacted for this study were selected from the Enterprise Europe Network-Izmir data set (EBIC-Ege), which is the regional consortium of the Enterprise Europe Network (EEN) of the European Union since 2008. The main objective of the EEN is to provide services, such as innovation assessment, technology audit, access to finance and international collaboration between SMEs in the network, to enhance their competitiveness. EBIC-Ege is a local consortium that consists of three partners: a university, a Chamber of Industry and a Chamber of Trade and Industry, providing services to SMEs in Turkey since 2008. SMEs frequently visit the EBIC-Ege office to ask for support regarding R&D, innovation, intellectual property rights, entrepreneurship, access to finance and creating business links with other companies. EBCI-Ege registers each SME that applies for services. The database contains several contact details of the SMEs, such as their representatives, sector and company size. As far as Turkey is concerned, it can be argued that there is a lack of research on the relationship between SCRM and innovation performance. The Global

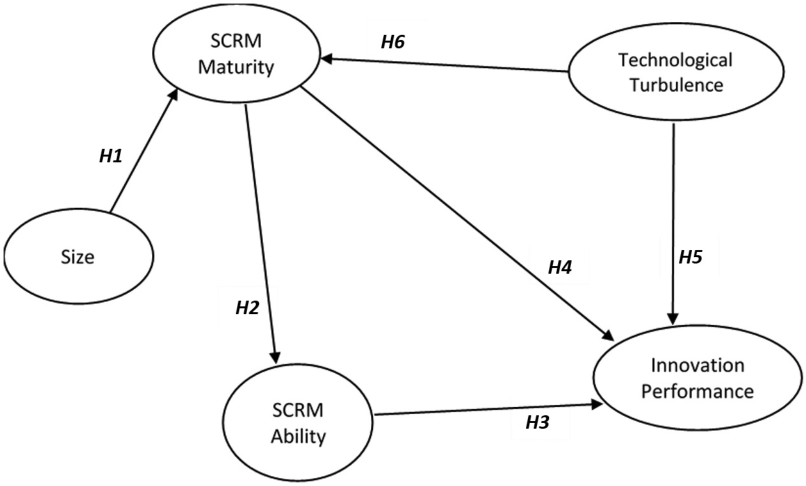

Figure 1.
Research model

Innovation Index published in 2019–2020 showed that innovation inputs in Turkey outperformed those in previous years despite the pandemic (World Intellectual Property Organisation, 2020). Therefore, it is crucial to understand SCRM practices through which firms (i.e. SMEs) can optimise their innovative performance in an environment where innovation is so fierce.

For this study, SMEs that approached EBIC-Ege in 2019 for different reasons were selected. The reason for selecting only 2019 was the size of the data set, which in turn could increase the likelihood of generating a high(er) response rate. There was a total of 207 SMEs, who contacted the EBIC-Ege consortium in 2019. These companies were also contacted for the present study. Firstly, a list was prepared including the names of the companies, names and contact details of the firms' representatives. The link to an online survey was sent to the SMEs' high-level representatives (CEO, CFO, Manager, Deputy Manager) via email. This email was accompanied by a letter that explained the purpose of the study. Data were collected between March and June 2020.

Of the 207 SMEs, 151 responded to the survey. Due to missing or non-useful information, 14 responses were removed which left 137 full responses. This means a response rate of 66% which can be deemed as good. Table 1 shows some demographics of the companies involved in the study.

3.2 Measures

The instrument of this study included five subjective measures, of which four (SCRM maturity, RM ability, technological turbulence, innovation performance) were measured on a five-point Likert scale, except for company size. To measure:

(1) SCRM maturity, the authors used the items proposed by Hoffmann *et al.* (2013). That is, 1) the company has introduced a detailed supply risk management process; 2) the company's supply risk management process is practiced cross-functionally; 3) the company regularly assesses the risks of individual suppliers (e.g. quarterly, yearly); 4) the company improves its risk management process regularly; and 5) part of the company's risk management process is the in-depth analysis of problematic suppliers. Item 6) "The company has sufficient competence in terms of laws and regulations

Table 1. Demographics of participating companies

Characteristics	Categories	(%)
Does your company do risk management?	Yes	72
	No	28
Year of company foundation	1941–1960	8
	1961–1980	16
	1981–2000	36
	2001–2020	40
Type of company	Family business	7
	Non-family business	48
	Part of a corporate group	26
	Other	19
Size (employees)	1–9	21
	10–49	30
	50–249	49

Note: n = 137

related to risk management" was added to consider the increasing requirements set by the government concerning risk management.

(2) Risk management ability – Items used by Hoffmann *et al.* (2013) were applied, namely 1) in recent years, the company was able to (considering the industry cycle), 2) minimise the frequency of supply risks occurring and 3) minimise the magnitude of the effect of occurring supply risks.

(3) Technological turbulence – Items proposed by Jaworski and Kohli (1993) were applied, namely, 1) the technology in our industry is changing rapidly, 2) technological changes provide big opportunities in our industry and 3) a large number of new product ideas have been made possible through technological breakthroughs in our industry.

(4) Innovation performance – A single-item measure was used in which firms were asked to assess their innovation performance relative to their competitors, that is, 1) compared with our key competitors, our company is more innovative. This way of measure was considered appropriate and valid as demonstrated by Oke (2004).

(5) Company size – the definition of SME proposed by the European Commission was used. According to this definition, firms can be classified as micro-, small- or medium-sized depending on the number of employees, annual turnover and balance sheet totals (Commission of the European Communities, 2005). Referring to the number of employees, a company with fewer than 10 employees is considered a micro firm, between 10 and 49 employees it is a small firm, and between 50 and 249 employees, the firm would be considered a medium-sized firm.

3.3 Statistical method

A descriptive analysis was initially performed using percentages, means, standard deviations and correlation matrix to better understand the data set. Furthermore, the authors applied structural equation modelling (SEM) using ADANCO version 2.2.1 – based on the methodological recommendations of McDonald and Ho (2002) – to test the hypotheses of this study. As stated by Creswell (2014), to generalise findings from a quantitative research method study, it is required that the study use a technique that supports the analysis of “causal paths and the identification of the collective strength of multiple variables” (p. 13), for which SEM is particularly useful. SEM is a robust statistical method that is mostly executed to test the relationships among observed (e.g. innovation performance and firm size) and latent variables; variables that are not easily detected (e.g. ability to manage risks, technological turbulence and RM maturity level) (Beran and Violato, 2010).

Specifically, the use of SEM in this study is justified given the issues of multicollinearity that are commonly associated with most statistical techniques, such as multiple regression. Multicollinearity is a phenomenon in which there is a high degree of correlation among the predicted variables in a model, leading to inaccurate and unreliable results. Several studies (Nsereko, 2021; Tefera and Hunsaker, 2022; Sandoval and Rank, 2022) have demonstrated that SEM is useful in dealing with multicollinearity issues. In addition, SEM has been proven to be successful in several SCM studies. For instance, Zhao *et al.* (2013) examined the relationship between supply chain risks, supply chain integration and business performance; Tukamuhabwa *et al.* (2021) tested the relationship between internal social capital, logistics capabilities, SCRM capabilities and supplier performance; and Ku (2022) analysed how technological capabilities enhance supply chain agility among SMEs.

In SEM, two models are included: the measurement model and the structural model. The measurement model describes how well latent variables are measured to ensure the validity and reliability of the model. To assess the reliability and validity of the model, construct and indicator reliability and discriminant validity tests were conducted as recommended by previous studies (Awang, 2015; Blunch, 2013; Raines-Eudy, 2000). The structured model follows to model the proportional relationship between latent and observed variables by analysing the unexplained and explained variances (Chinda and Mohamed, 2008). Theoretically, there are three main model-of-fit indices under the structured model (Awang, 2015; Hair *et al.*, 2010; Hooper *et al.*, 2007), the authors applied the standardised root mean squared residual (SRMR) index under the umbrella of the absolute fit indices to fit the model, based on the rationale and objective of the study.

4. Results

4.1 Descriptive statistics

Table 2 presents the means, standard deviations and correlation matrix of the variables. It aims to measure the central tendency, variations and degree of relationship among the variables. Using a five-point Likert scale, maturity and ability attained averages of 3.146 and 3.161, with standard deviations of 1.179 and 1.251, respectively, showing an overall fair or moderate level of attitude in that regard. Furthermore, innovation performance and size obtained means of 2.149 and 2.578 with corresponding standard deviations of 1.179 and

Variables	Mean	SD	1	2	3	4	5
1. Innovation performance	2.149	1.179	1.000				
2. Maturity	3.146	1.251	−0.326**	1.000			
3. Ability	3.161	1.220	−0.250**	0.641**	1.000		
4. Technological turbulence	1.985	1.022	0.252**	−0.264**	−0.010	1.000	
5. Size	2.578	1.116	0.110	0.165**	0.189**	0.073	1.000

Note: **Correlation is statistically significant at the 0.05 level

Table 2. Means, standard deviations and correlation matrix

1.116. Technological turbulence assumed the lowest mean (1.1985) and standard deviation (1.022) among all variables.

The strengths of relationships among the variables were also tested using the correlation matrix. The correlation coefficient is used to establish and measure the strength of associations (Asuero *et al.*, 2006). Using the 95% confidence level, the association between more innovation and the rest of the variables is all statistically significant except for size. Furthermore, it is also observed that maturity and ability have a negative relationship with innovation performance, but there exists a positive relationship between technological turbulence and innovation performance.

4.2 Common method bias

The present study applied a cross-sectional survey that involves the taking of a single response from each firm. This approach is usually characterised by the issue of common method bias (CMB) arising from methodological errors (Podsakoff *et al.*, 2003). To check for this bias, the Harman single-factor test was performed using exploratory factor analysis. From the results (see Appendix Table A1), the first component percentage of variance is 45.03%, which is below the recommended cut-off of 50% (Podsakoff and Organ, 1986). Therefore, CMB is not an issue for this study.

4.3 Construct and indicator reliability

To assess the reliability of both the construct and indicators, the authors used composite reliability (CR) and factor loading point or interval values (Fornell and Larcker, 1981). Table 3 reports the result of the reliability and validity of the instrument. According to Hair *et al.* (2010), above a 0.5-factor loading point is the minimum requirement for an item in any of the constructs to be statistically significant. The result proves that the minimum requirements were met, thus the indicator reliability test is passed.

A construct is deemed reliable if its CR is greater than or even equal to 0.5 (Hair *et al.*, 2010; Molina *et al.*, 2007). From Table 3, it is shown that all five constructs in this study are reliable. Each of the CR's values generated is between the range of 0.8748 and 1.0000, indicating robust construct reliability. In sum, the instrument has met the overall reliability test requirement.

4.4 Convergent and discriminant validity

Convergent and discriminant validity (DV) tests were performed to evaluate the level of deviation that exists among the constructs (Churchill, 1979). This helps to determine the validity of the instrument by comparing the square root of the average variance extracted (AVE) with the inter-construct correlation. Statistically, DV is achieved when the square roots of AVEs represented by the main diagonal in Table 4 are greater than the inter-

Table 3. Reliability and validity of the instrument

Construct	Items	Factor loading point/interval[a]	Composite reliability**	AVE*
Innovation performance	1	1.000	1.0000	1.0000
Maturity	6	0.732–0.913	0.9242	0.6716
Ability	2	0.912–0.985	0.9481	0.9015
Technological turbulence	3	0.793–0.887	0.8748	0.7001
Size	1	1.000	1.0000	1.0000

Note: **Should be ≥0.7 (Molina *et al.*, 2007) [a]and * should be ≥ 0.5 (Molina *et al.*, 2007) construct correlation (Hair *et al.*, 2010). By comparing each leading diagonal, that is, the square root of AVE as illustrated in Table 4, with its corresponding rows and columns, it could be observed that the inter-construct correlation is lower than the square root of AVE. In the same way, all AVE scores are above 0.5, and all indicators have loadings above-accepted thresholds, providing evidence of adequate convergent validity (CV). Therefore, the CV and DV requirements were fully met.

In reference to Hair *et al.* (2010), the minimum sample size required for constructs of 5 or less, is 100. Our study used a sample size of 137, hence, the minimum threshold condition for sample size as far as SEM is concerned, in our case, is fully met. The distribution of the data was also examined using the skewness and kurtosis values that were independently computed from each of the construct items. Our values obtained are within the acceptable domains recommended by Curran *et al.* (1996), i.e. values for skewness and kurtosis should not be more than 2.0 and 7.0 respectively. Based on that, the authors proceeded to run the SEM because all required assumptions pertaining to SEM were duly met. The results show a good SRMR index (0.0554; see Table 5), below the maximum threshold of 0.09 (Hu and Bentler, 1999). In addition, the model explains 8.6% of maturity, 58.2% of ability and 16.7% of innovation performance.

This conclusion is based on the resulting R^2 values (see Table 6), which indicate the percentage of variability accounted for by the predictive constructs in the model. The adjusted R^2 values take into account the complexity and sample size of the model and are therefore used to compare different models or the explanatory power of a model in different data sets (Henseler *et al.*, 2016).

As shown in Table 7, five out of the six hypotheses could be accepted in this study. The accepted hypotheses are *H1*, *H2*, *H4*, *H5* and *H6* while *H3* happened to be rejected. Among

Construct	Size	Maturity	Innovative capacity	Ability	Technological turbulence
Size	1.0000*				
Maturity	0.0269	0.8195*			
Innovation performance	0.0100	0.1143	1.0000*		
Ability	0.0308	0.5823	0.0892	0.9495*	
Technological turbulence	0.0123	0.0501	0.0831	0.0236	0.8367*

Note: *Square root of AVE

Table 4. Discriminant validity: Fornell–Larcker criterion

	Value	HI95	HI99
SRMR	0.0554	0.0656	0.0849
dULS	0.2790	0.3919	0.6567
dG	0.2004	0.4986	0.8247

Table 5. Goodness-of-fit model

Construct	Coefficient of determination (R^2)	Adjusted R^2
Maturity	0.0862	0.0720
Innovation performance	0.1667	0.1472
Ability	0.5823	0.5791

Table 6. *R*-Squared results

Table 7.
Hypotheses testing results

Hypotheses	Original coefficient	Mean value	Standard error	*T*-values	*P*-values	Interpretation
Size → Maturity (*H1*)	0.1911	0.1844	0.0844	2.2650	0.0119	Accepted
Maturity → Ability (*H2*)	0.7631	0.7634	0.0414	18.4379	0.0000	Accepted
Ability → Innovation performance (*H3*)	−0.1066	−0.1116	0.1602	−0.6654	0.2530	Rejected
Maturity → Innovation performance (*H4*)	−0.2876	−0.2838	0.0821	−3.5041	0.0002	Accepted
Technological turbulence → Innovation performance (*H5*)	0.2963	0.2923	0.1034	2.8667	0.0021	Accepted
Technological turbulence → Maturity (*H6*)	−0.2450	−0.2487	0.1006	−2.4359	0.0075	Accepted

the hypotheses accepted, the results indicate that there is a positive significant influence of firm size ($\beta = 0.1911$; $p = 0.0119 < 0.05$) and a negative significant influence of technological turbulence ($\beta = -0.245$; $p = 0.0075 < 0.05$) on SCRM maturity. Similarly, the result indicates that the SCRM maturity level ($\beta = -0.2876$; $p = 0.0002 < 0.05$) has a significant negative influence, while technological turbulence ($\beta = 0.2963$; $p = 0.0021 < 0.05$) has a significant positive influence on innovation performance. Lastly, the results show that RM maturity level ($\beta = 0.7631$; $p = 0.0000 < 0.05$) has a positive significant influence on a firm's ability to manage risk. On the other hand, the results do not support the hypothesis that a firm's ability to manage supply chain risks ($\beta = -0.1066$; $p = 0.2530 > 0.05$) has a negative influence on innovation performance.

5. Discussion

The findings of the present paper have re-emphasised the crucial need for SCRM in SMEs – not just its existence, but its effectiveness – in today's business era where processes, the development of products, and operations are highly characterised by technology (Van Veldhoven and Vanthienen, 2021). In general terms, the present paper has confirmed previous studies (Kwak *et al.*, 2018; Wang and Rafiq, 2014; Tzokas *et al.*, 2015) which share the common view that SCRM has a pivotal role to play as far as SMEs' level of innovativeness is concerned.

This research improves our understanding of the relationship between SCRM and the innovation performance of small businesses by showing the impact of technological turbulence on this relationship. From the perspective of both SCRM and innovation performance, the effect of technological turbulence on the former is negative while on the latter it is positive. These empirical findings suggest that SMEs must carefully balance the efforts they invest in SCRM to not minimise the positive effect that technological performance has on their innovation performance. Thus, this finding is in line with previous research that highlighted the implications of resource constraints on SMEs and their activities (Durst *et al.*, 2019; Zeiringer *et al.*, 2022).

The present study further shows that there is a link between the SCRM maturity of SMEs and their ability to manage risks, which is in line with previous research (Hofmann *et al.*, 2013; Hove-Sibanda *et al.*, 2021) that has underlined those efforts in SCRM are beneficial for companies. However, the findings of the present article also show that an increase in SCRM ability impacts innovation performance – even though this finding was not statistically significant. Improved SCRM capabilities can thus help SMEs to better manage the risks associated with innovation, at the same time, this situation has an impact on companies' innovation performance.

The results further suggest that SMEs interested in improving their innovation performance should carefully monitor the possible consequences of technological turbulences for their operations; in the case that the technological solutions are perceived both as useful and easy to adapt (Autry *et al.*, 2010) integrate them into their business operations. Therefore, the results of the present study seem to confirm the link between technological turbulence and increased innovation performance (Jaworski and Kohli, 1993; Autry *et al.*, 2010; Puriwat and Hoonsopon, 2022; Huo *et al.*, 2022).

The influence of firm size on SCRM maturity (Henschel and Durst, 2016; Ferreira de Araújo Lima *et al.*, 2020) has been confirmed in the present research too. Hence, in the bigger SMEs more sophisticated approaches to SCRM can be expected, which in turn can increase those firms' ability to manage risks as well. This size effect also stresses that the smaller the company the more it must pay attention to making the best possible use of resources.

In summary, the findings highlight that SCRM is beneficial to SMEs as well; too much of it, however, can be detrimental to innovation performance. Consequently, a strict balance must be made between costs and benefits.

6. Conclusions

The purpose of this study was to examine the relationship between SCRM and innovation performance in SMEs. It also shows the effect of technological turbulence on this relationship. Having used a dataset involving SMEs from a developing country (i.e. Turkey), the study has addressed recent calls for more diversity regarding the study of SCRM (Parast and Subramanian, 2021). With this research, the authors contribute not only to the increasing number of research on SCRM in general but also to SCRM in SMEs (Ferreira de Araújo Lima *et al.*, 2020). Given the role of SMEs in the functioning of supply chains, on one hand, and the fact that SMEs have been significantly affected by the recent supply chain disruptions, on the other hand, there is a clear need for more research.

The results of the present paper allow the authors to draw conclusions that are relevant to both academics and practitioners. As for the theoretical implications, this study provides empirical evidence about the relationship between SCRM maturity and ability on innovation performance in SMEs, by considering technological turbulence. By providing empirical evidence, the present paper not only advances research on SCRM in SMEs, which still is an underdeveloped field of research (Zeiringer *et al.*, 2022), but it also contributes to the general study of RM in SMEs (e.g. Lepistö *et al.*, 2021) by showing the need for focusing on the trade-off between SCRM-related skills and organisational performance (here innovation performance). Moreover, this study has demonstrated that SCRM ability and SCRM maturity could have opposing implications on innovation performance, a finding that gives a more fine-grained understanding of SCRM in SMEs. Understanding this trade-off is essential to cope better with rapid environmental changes and to balance risk and return (Durst *et al.*, 2019) which do not stop at SMEs. The premise that technological turbulence triggers innovation holds, as shown in this study, even among SMEs from emerging economic landscapes.

Having a better understanding of the link between SCRM and innovation performance has important managerial implications for decision-makers in SMEs or supply chain/RM professionals operating in SMEs as it can help them to make better (i.e. more informed) decisions as to how to use the available resources in the best possible way. This research shows the clear trade-off between the level of SCRM maturity and innovation performance. Thus, decision-makers must not only be aware of it but also act upon it to find the best possible balance for the company at a given period in time. Considering the costs involved in proper SCRM and the limited financial and human resources found in many SMEs, the smaller and younger ones, in particular, finding a good balance between the costs and benefits is of utmost importance.

To improve the firm’s innovation performance, SME decision-makers are advised to take advantage of technological turbulence. Given the effect of the latter on SCRM, however, they should realise that while SCRM is important, close attention should be paid to the moment when the efforts put into SCRM outweigh the benefits, i.e. at the expense of the firm’s innovation performance. Also, supply chain or risk managers who want to improve the small firm¨s level of maturity in SCRM should try to develop measures that increase the firm¨s ability to better cope with disruptions triggered by rapid technological advancement within the industry and across them. A possible measure could be the formation of a small task force, Ogbeibu *et al.* (2020, p. 5), for example, have argued that technological turbulence “can cause team members to challenge the current status quo of existing technological frontiers". The task force might trigger multiple avenues through which innovation can be fostered and thrive. This finding underlines once again the permanent need for continuous training and empowerment of all employees in general, as well as regarding SCRM and technological development to make possible better and more informed decisions in SMEs. This study has shown that an increased maturity level of SCRM reduces the innovation performance of SMEs. At the same time, it is known that many SMEs find it challenging to do innovation systematically. Therefore, to ensure that there is a right balance between investment in SCRM practices and innovation, SMEs are advised to implement more digital tools in their business operations. In doing so, not only their efforts regarding both SCRM and innovation performance will be optimised but the use of these tools can also help them to better deal with the scarcity of competencies and skills due to size.

The limitations of this study can be used to derive further research opportunities. As context matters, the industry is likely to influence the SCRM practices of SMEs, thus, future research should follow that focuses on the impact of the industry on SCRM. One may include dynamic (e.g. IT sectors) and more conservative industries (e.g. logistics) to further advance our understanding. Given that a typical supply chain covers a number of partners, a focus on single companies is not able to consider the consequences technological turbulences can have for the entire supply chain and thus SCRM. The same applies to the relationship between innovation performance of the entire supply chain and the partners' SCRM. The data used in this study was collected by conducting a cross-sectional survey. Such design is not able to capture the dynamics of internal and external developments in organisations over time. Therefore, future research should be based on longitudinal research designs to observe change and its impact on SMEs' operations regarding SCRM and innovation. There is also a need for replication studies in other regions with similar and different social and business norms to enhance the external validity of the study's results given the role of country-specific differences in decisions regarding RM in SMEs (Henschel and Durst, 2016).

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Appendix

Table A1.
Exploratory factor analysis

Factor	Eigenvalue	Difference	Variance	Cumulative
Factor1	5.85403	3.49302	0.4503*	0.4503
Factor2	2.36101	1.20737	0.1816	0.6319
Factor3	1.15363	0.35274	0.0887	0.7207
Factor4	0.80089	0.06473	0.0616	0.7823
Factor5	0.73616	0.29156	0.0566	0.8389
Factor6	0.44460	0.05963	0.0342	0.8731
Factor7	0.38497	0.06806	0.0296	0.9027
Factor8	0.31691	0.04483	0.0244	0.9271
Factor9	0.27209	0.02316	0.0209	0.9480
Factor10	0.24892	0.06379	0.0191	0.9672
Factor11	0.18513	0.03058	0.0142	0.9814
Factor12	0.15455	0.06744	0.0119	0.9933
Factor13	0.08711	.	0.0067	1.0000

Note: *Should be < 0.50
Source: Podsakoff and Organ (1986)

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