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Exploring the link between supply chain resilience and organisational performance

Author:
Welby V. Loury Okoumba[1]

Affiliation:
[1]Department of Business Management, Faculty of Economic and Management Sciences, University of the Free State, Bloemfontein, South Africa

Corresponding author:
Welby Loury Okoumba,
louryokoumbawv@ufs.ac.za

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Background: This study was prompted by the worsening of the mortality rate of South African small and medium-sized enterprises (SMEs), which is attributed to the emergence of the coronavirus disease pandemic.

Aim: The aim of this study was to explore a strategic avenue to assist SMEs in withstanding market-related hindrances and boost their performance. This strategy is based on optimising SMEs' supply chain agility by adopting supply chain resilience enablers such as supply chain alertness, visibility, robustness and velocity.

Setting: This study focused on registered South African SMEs operating in the Gauteng, Free State and KwaZulu-Natal provinces.

Method: The study was grounded in the positivist paradigm, which informed its quantitative nature. In total, 407 purposively selected supply chain management (SCM) professionals were identified. The correlation design was used to establish the perceptions of these SCM professionals of the study's constructs and their predictive relationships using a questionnaire.

Results: The results revealed that three of the four supply chain resilience (SCR) enablers, namely velocity, alertness and robustness, positively and significantly influence SMEs' supply chain agility (SCA). In contrast, SMEs' agile endurance significantly influences their performance.

Conclusion: The study established the fact that supply chain resilience practices of alertness, velocity and robustness are critical antecedents of SMEs' SCA capabilities. Furthermore, SCA was found to be a significant driver of SME performance.

Contributions: This study contributes to the SCR discourse by outlining determinant practices that facilitate SCA and firm performance. Practically, the findings offer strategic insights into key success factors that must be implemented to sustain SMEs' performance and survival prospects.

Keywords: supply chain resilience enablers; alertness; robustness; visibility; velocity; agility; organisational performance.

Introduction

Coronavirus disease 2019 (COVID-19) has devastated socioeconomic dynamics worldwide, and its impact on business survival has been well-documented. In South Africa, its effects on business sustainability were dire, given the various contingency measures implemented by government to curb its sharp spread. Notable interventions included the travel ban across provinces and internationally, and the universally adopted practice of social distancing, which hampered business operational capacities. The significance of small and medium-sized enterprises (SMEs) for countries' economic growth is well-established, as is their high failure rate. In South Africa, this economic cohort has borne the brunt, with a substantial rise in mortality despite several COVID-19 relief programmes to tame this dying spree. Small and medium-sized enterprises' lack of resilience was exposed during the pandemic, with many firms' supply chain networks unable to demonstrate the agility and adaptability required to respond effectively to such external hindrances. Examples of COVID-19-related challenges include logistical network congestion because of port and road closures, limited access to services and supplies and operational capacity reduction resulting from changes in working conditions and the unavailability of supplies (Kerr 2020; Pretorius et al. 2022). Additional consequences include firms' inability to embrace technology to respond to the demands of digital service-savvy customers and consumers (Takawira & Pooe 2024). These consequences underline the need for SMEs to restructure their operational strategies, with many having to readapt and readjust their business models to cope efficiently with these pandemic-induced challenges (Biyela & Utete 2023). This led to more

financial pressure and vulnerabilities characterised by layoff measures and downscaling of business operations and infrastructures. These drawbacks had a severe impact on consumers' food security and affordability, exposing the strain many SMEs' supply chains were under (Panwar, Pinkse & De Marchi 2022). These adversities underscore the degree of stress SMEs were subjected to, which further contributed to their poor performance and subsequent closure.

Against this backdrop, the call to develop resilient supply chain strategies has become an imperative solution for SMEs globally (Golan, Jernegan & Linkov 2020; Ramanathan, Aluko & Ramanathan 2022). The urge to adopt proactive systems designed to optimise SMEs' resilience and agile capabilities to sustain future macroeconomic shocks and turbulence has become evident in South Africa. This is particularly plausible given the established theoretical connection that exists between supply chain resilience (SCR) and supply chain agility (SCA) (Pasupuleti et al. 2024; Tarigan, Siagian & Jie 2021a). Several scholarly studies have commended the salutary merit that resilience proficiencies exert on boosting firms' agile capabilities (Belhadi et al. 2024; Kazancoglu et al. 2022; Kochan, Nowicki & Glassburner 2024; Queiroz et al. 2024). This positive relationship can be demonstrated through resilient SMEs' abilities to oversee and monitor their supply chain activities, which further enables them to swiftly and timely detect potential demand variations (Susitha, Jayarathna & Herath 2024). Such capability to have a real-time overview of operational activities and data is critical to ensure rapid and sustained responses to market changes (Asamoah, Agyei-Owusu & Ashun 2021; Hussain et al. 2022). These agile attributes, therefore, contribute significantly to providing proactive measures to mitigate and cope adequately with market dynamics. Thereby, increasing firms' overall performance objectives in terms of order fulfilment, prompt delivery and customer satisfaction. This outcome underscores the strategic importance of the link between SCR and agility as resilient firms are more equipped to showcase agile characteristics that allow them to respond effectively and efficiently to market volatility and still deliver on contractual commitments to their customer base.

Given the outlined observation, the present study's primary objective was to investigate the strategic influence of SCR enablers on SMEs' SCA and performance. To achieve the stated purpose, the following empirical objectives were formulated:

- To assess the association between SCR enablers of alertness, visibility, velocity and robustness and SCA.
- To examine the influence of SCA on SMEs' organisational performance.

The concept of SCR has gained considerable attention during the COVID-19 pandemic, with many scholars outlining its relevance in boosting firms' capabilities to re-engineer their conventional structures and models to provide countermeasures to sudden and unpredicted pandemic-induced adversities (Kazancoglu et al. 2022; Shen & Sun 2023). The pressing need to simplify firms' supply chains by adopting efficient approaches such as agility, lean practices, supply-based localisation, technology and innovation has provided a solid perspective to minimise and mitigate supply chain structural complexities (Ozdemir et al. 2022). This view is essential to reduce uncertainty and improve the visibility and adaptability of firms' supply ecosystems (Yang et al. 2018).

However, despite the noted benefits of SCR for firms' survival, its implementation is somewhat lacking among South African SMEs. Testimony to this observation is the well-documented high mortality rate among SMEs. This substantial failure rate is commonly attributed to several key elements, such as poor access to finance and the lack of expertise (Fatoki 2018), exacerbated during the pandemic. Fundamentally, South African SMEs are unable to cope with challenges inherent in the volatile, highly hostile and competitive markets in which they operate. Their inability to handle market dynamics calls for redesigning their supply chain model to be more agile and resilient to cope decisively with markets and environmental disruptions.

Therefore, this study sought to propose an SCR model designed to optimise SMEs' SCA capability and performance. This proposed model is anchored on key enablers of alertness, velocity, robustness and visibility. The study further submits the fact that combining these practices can boost SMEs' agile readiness and performance objectives. This submission is valuable given the paucity of empirical evidence of the proposed association (the influence of SCR enablers on SCA and SMEs' performance) from a South African perspective, despite the rise to prominence of SCR after the pandemic. This assertion is noteworthy given the empirical work by Pretorius et al. (2022) and Omoruyi and Makaleng (2022), who explored SCR capabilities as a strategy to combat future environmental challenges. Hirsch, Niemann and Swart (2024) interrogated the nexus between artificial intelligence and information systems capabilities as determinants of SCR. Takawira and Pooe (2024), Omoruyi and Quayson (2023) and Biyela and Utete (2023) analysed the lessons learned from the COVID-19 impact while proposing preventive measures to mitigate potential environmental adversities.

The presented research void outlines the merit of the present study in developing a supply chain resilience model that can assist SMEs in identifying critical operational processes and procedures to heighten their performance. This objective will be achieved by building proactive mechanisms to be more alert to environmental uncertainties, while mapping out their network dynamics to allow them to react swiftly and concisely to market disruptions and unpredictability. Such beneficial capabilities are critical to increasing SMEs' survival prospects and competitiveness.

The rest of this article is organised as follows: The following section presents a literature review of the study's constructs, followed by the research model, hypotheses development, the research methodology, data analysis and results and the

conclusion, implications, limitations and recommendations for future studies.

Literature review of constructs

The literature review of the extant literature on the study's constructs is addressed in this section.

Supply chain resilience

The concept of SCR refers to a firm's capability to visualise and identify potential risks, uncertainties and bottlenecks, and provide swift responses to minimise their occurrence (Brandon-Jones et al. 2014). An important aspect of this definition is the adaptability and ability to act effectively in the face of unpredicted disruption. This proactiveness or quick reaction time appeared to be lacking from South African SMEs during turbulent macroeconomic events. As such, developing resilience competencies is primordial to withstand environmental and market uncertainties. This assertion is echoed by several scholars (Rice & Caniato 2003; Wieland & Durach 2021; Wieland & Wallenburg 2013), who argue that the core element of a resilient supply chain resides in its capability to adapt and prevent internal and external operational and strategic challenges that could impede a firm's performance. This characteristic outlines the critical nature of SCR as an antecedent of firm performance, because it ensures risk visibility and provides countermeasures to address potential supply chain distortions. In addition, SCR is an adaptive mechanism designed to provide precautionary measures tailored to alleviate short- to medium-term disruptive events (Ivanov 2021; Singh & Singh 2019; Vugrin, Turnquist & Brown 2014). This view underlines its strategic nature as an important mitigating factor for SMEs' risks. Therefore, it is paramount that South African SMEs develop core resilient-related operational abilities to equip employees and supply chain members with the required tools to prevent and adjust to potential unforeseen or anticipated disruptions.

Supply chain resilience enablers

As articulated previously, SCR is a vital strategy that enables a firm's value and supply chain network to cope with unprecedented internal and external shocks while maintaining a sound grip on demand volatility (Singh & Singh 2019; Xu et al. 2024). In view of the enunciated relevance to the supply chain debate, there seems to be a lack of consensus on SCR dimensionality, with one school of thought viewing it as an unidimensional concept (e.g. Ambulkar, Blackhurst & Grawe 2015; Gölgeci & Ponomarov 2015). Other literature described it as a multifaceted concept, with dimensions such as adaptability, flexibility, robustness, agility, visibility, velocity, redundancy, capacity, culture and collaboration (Brandon-Jones et al. 2014; Christopher, Lowson & Peck 2004; Ponomarov & Holcomb 2009; Scholten, Sharkey-Scott & Fynes 2014; Tukamuhabwa et al. 2015). Additional dimensions of SCR include alertness, risk awareness, engineering, information sharing, knowledge management, network design, market positioning, supply chain risk management and security (Glickman & White 2006; Jüttner & Maklan 2011; Scholten et al. 2014; Tukamuhabwa et al. 2015; Wieland & Wallenburg 2013). Based on the reviewed discussion of the SCR elements, the present study regards SCR as a multidimensional construct, with aspects such as alertness, visibility, velocity and robustness as its critical enablers. This selection was derived from these enablers' abilities to help South African SMEs to spot, prevent, adapt and respond swiftly and proactively to internal and external environmental challenges (Novak, Wu & Dooley 2021; Pettit, Croxton & Fiksel 2013; Rahman et al. 2023). These practices are discussed in the following text.

Supply chain alertness

Supply chain alertness (SCAL) refers to a firm's capacity to oversee, detect and uncover possible variations and unpredictable events in its supply chain environment and provide counteraction and measures to elevate these constraints (Shin & Park 2021). Developing SCAL capabilities allows firms to oversee their operations and supply chain network dynamics. Such capabilities can result in better monitoring and appreciation of potential disruptions and risks (Mandal 2019). This view outlines the role that SCAL plays in contributing to the resilience practices of South African SMEs. This observation is substantiated by Queiroz et al. (2022), who argue that investing in tools such as big data analytics enhances firms' ability to visualise and anticipate uncertainties. Therefore, South African SMEs must devote their critical resources to detecting and anticipating current and future market developments to withstand any potential challenges or exploit opportunities.

Supply chain visibility

Supply chain visibility (SCV) is defined as a firm's capability to visualise its value as well as the operations and resources of its supply networks (Christopher & Lee 2004). This means that SCV integrates the ability to appreciate and oversee operational processes and procedures while incorporating information flow from the inbound to the outbound activities in a supply chain network (Brandon-Jones et al. 2014). Simply put, it visualises all operational activities across a supply network while exchanging information between counterparts. The core value of SCV to a firm's supply chain cannot be understated. Mubarak et al. (2023) describe it as a cornerstone of a firm's dynamic capabilities because it influences resource synchronisation. This attribute is vital, as South African SMEs can identify and categorise their core resources based on their strategic nature. Furthermore, visualising the upstream and downstream operational activities of their supply chain networks allows SMEs to coordinate their operational processes to prevent or avert operational bottlenecks. This view is supported by Sunmola et al. (2023), who opined that a visible supply chain leads to better risks and disruption aversion through sound activities mapping and design, resource harmonisation and efficient and effective sustained operational process execution.

Supply chain velocity

Supply chain velocity (SCVL) denotes the reactive speed of actions in response to unforeseen or predicted adverse events in the firm's internal or external environment (Jüttner & Maklan 2011). Supply chain velocity is categorised into three velocity elements: (1) the pace of risk occurrence, (2) the speed of loss occurrence and (3) the pace at which risk, uncertainty events and disruption are discovered and avoided (Manuj & Mentzer 2008; Stevenson & Spring 2007). Therefore, it could be argued that South African SMEs can optimise their response to market turbulence by developing their core capabilities by facilitating an efficient exchange of information and quality data and streamlining their operational procedures across a firm's network. This point was echoed by several scholars (Razak, Hendry & Stevenson 2023; Sumukadas 2021), who noted that SCVL is a key determinant of SCR, because it allows firms to recover from and adapt to damage or unprecedented market turbulence swiftly. Thus, South African SMEs must establish alliance relationships with strategic partners to ensure a seamless and uninterrupted exchange of real-life information and quality data, and an on-time delivery schedule and inventory traceability. This argument further reinforces the merit of equipping supply chains with the necessary velocity attributes to respond promptly to minimise or prevent unplanned supply chain disturbances.

Supply chain robustness

Supply chain robustness (SCRO) refers to the capability of a supply chain to withstand and absorb shocks from unwanted internal and external turbulences (Wieland & Wallenburg 2013). Mackay, Munoz and Pepper (2020) characterise robustness into two aspects, namely (1) resistance and (2) avoidance capabilities. Therefore, firms that demonstrate these attributes are predisposed to build agile competencies, create value across their internal operations and configure their procedures effectively to meet sudden changes among customers and markets (Ehrenhuber et al. 2015; Izadi & Kimiagari 2014). In addition, Simchi-Levi, Wang and Wei (2018) stress that SCRO is a proactive coping mechanism designed to assist firms in maintaining their operational performance trajectory while navigating through sustained macroeconomic pressures and disturbances. It is worth pointing out the similarity that exists between SCRO and SCR, with the former premised on sustaining and maintaining planned performance objectives after a disturbance, and the latter focusing on the speedy recovery of performance after turbulence (El Baz, Ruel & Ardekani 2023). The outlined discussion underlines the need for South African SMEs to have more flexible and adaptable supply chain networks that can navigate through market shocks and still maintain their levels of productivity. The urge to redesign SMEs' supply networks could not be more pressing, given the pressure the South African economy is under and the constant need to respond efficiently to market demands.

Supply chain agility

Firms' SCA is defined as responding and adapting rapidly to internal and external environmental changes and opportunities (Swafford, Ghosh & Murthy 2008). Core to SCA is the speed factor that allows the optimisation of performance and competitiveness through benefits related to dependability, flexibility, low cost and quality of product offerings (DeGroote & Marx 2013). This argument is advocated by Swafford, Ghosh and Murthy (2006), who postulate that firms with agile supply chain operations and processes are more equipped to take advantage of market opportunities. This can be attained by synchronising their core resources against sudden and fluctuating demands and reducing lead and cycle time responses. Furthermore, SCA underlines a firm's capabilities to meet customers' expectations during market uncertainties (Shukor et al. 2021). For this to happen, synergistic working relations between supply chain members are required to ensure an effective exchange of real-time information, coordination of resources and reduction of turnaround response time (Tarigan et al. 2021b). The value proposition of developing agile capacity is well-documented post-pandemic. Thus, the urgent quest for South African SMEs to build sustainable agile competencies as a key success strategy cannot be understated. This is particularly relevant given that SMEs with agile supply chain networks tend to be better equipped to cope with extreme market volatilities. Such an agility trait contributes to improving their performance, resulting in satisfied customers and competitive superiority.

Organisational performance

Organisational performance derives from effectiveness, which denotes a firm's ability to fulfil its operational and strategic objectives (Strasser et al. 1981). Key performance indicators to assess effective performance include quality (production and operation management), costs and finance and market share and position (Combs, Russell-Crook & Shook 2005). Mackey, Mackey and Barney (2007) offer a revised view of the performance indicators, grouping them into two broad categories: financial and non-financial factors. Financial factors comprise return on equity, investment, profit margins, revenue ratios (profit-to-revenue) and sales volume. Non-financial factors include operation-based aspects related to employee operational activities, customer satisfaction and social and environmental performance. In sum, organisational performance encompasses interactive dynamics between a firm's micro- and macroeconomic spheres to attain its success projections (Hamann et al. 2013). Inthavong et al. (2023) established the fact that effective organisational performance is attained through robust supply chain networks. This means that sound, interactive engagement across a value chain will lead to better management of resources, which correlates to meeting customers' requirements. Evaluating key success factors driving South African SME performance and survival is a critical strategic commitment that owners and managers must adopt in today's highly turbulent and uncertain market environment, subjected to macro environmental shocks and disruption.

Research model

The study's research model, as depicted in Figure 1, presents the study's predictive association between the SCR enablers (predictors), SCA (mediator) and organisational performance.

Hypotheses development

The hypotheses development discussion is addressed in this section.

Supply chain resilience enablers and supply chain agility

Supply chain alertness is critical in enhancing firms' visibility and identifying possible risk events. It further allows firms to manage their resources effectively by assessing the seriousness and impactful nature of potential environmental shocks (Mandal 2019). In addition, SCAL is a driver of SCR and agility, as it enables firms to promptly uncover disruptions to adjust the capability, production and delivery schedule of their operations to mitigate any adverse implications (Khan & Rahat 2023; Shin & Park 2021). Considering the presented argument, the anticipation of and speed of reaction to volatile market conditions contribute to firms' agile response. This is evident by reducing lead and cycle times of operations as well as streamlining demand processes (Barhmi & Hajaji 2023). Furthermore, supply chains that are robust enough in their capability to absorb shocks and preserve the integrity of their operations are better equipped to navigate through unexpected demand volatility (Mackay et al. 2020). Drawn from the above discussion, the study's proposed hypotheses were formulated as follows:

H_1: SCAL exerts an influence on SCA.
H_2: SCV exerts an influence on SCA.
H_3: SCVL exerts an influence on SCA.
H_4: SCRO exerts an influence on SCA.

Supply chain agility and organisational performance

The salutary value of SCA as a determinant of business performance and success has been well-documented in various empirical studies (Dhaigude & Kapoor 2017; Hwang & Kim 2019; Liu et al. 2018; Tarigan, Sebayang & Basana 2021a). This observation is supported by DeGroote and Marx (2013), who found that firms that demonstrate agile traits in swift adaptability and response to market-induced changes and disruption enhance their performance objectives, satisfy their customers and achieve a sustained competitive position. Furthermore, Çetindaş et al. (2023) found that SCA significantly affects performance because of its ability to facilitate agile and prompt responses to customers' demand variations. Similarly, Ahmad and Khokhar (2024) established the fact that agile supply networks enable firms to manage their upstream and downstream supply chain activities. This capability boosts their demand forecasting operations and minimises any potential market demand volatility. This forecasting capability is vital in organising and controlling warehouse and inventory capacity, which is needed to ensure quick adjustment to demands and optimise on-time delivery (Zhu & Gao 2021). In view of the preceded discussion, the following hypothesis was formulated:

H_5: SCA exerts an influence on organisational performance.

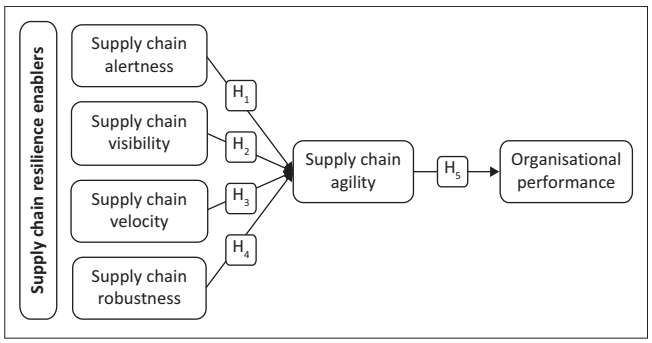


FIGURE 1: The research model.

Methods

The research methodology that guided the present study is discussed in this section.

Research design

This study adopted the quantitative method derived from the positivism paradigm and deductive reasoning to test the predictive connection between the identified SCR enablers, SCA and organisational performance. These approaches are suitable for studies that seek to ascertain predictive relationships between constructs and generalise their findings (Creswell & Creswell 2017). In addition, the correlation and survey design methods were used to ascertain the predictive influence of the constructs as well as the perception of supply chain professionals. The cross-sectional time horizon technique was used to collect data at a single point in time.

Sampling technique and population

The study's population comprises employees working for registered SME firms operating in Gauteng, Free State and KwaZulu-Natal provinces. The plurality of SMEs in the three targeted provinces made it difficult to obtain an accurate list of registered firms. This lack of availability of a sample frame led to the selection of non-probability convenient sampling as a suitable sample method to identify the target population. The purposive sampling approach was deemed adequate for the study, given that the target population is supply chain professionals working in registered SME firms operating in the selected provinces. These supply chain professionals were relevant for the study because of their expertise and understanding of supply chain management (SCM) operations and functions.

Sampling procedure

A structured questionnaire was used to collect data conveniently from supply chain professionals in Gauteng,

Free State and KwaZulu-Natal provinces. A combination of an online and a physical (hard copy) questionnaire was employed. Respondents were approached in person to seek consent to participate in the study. They were given the option to choose between the two versions of the questions (online vs. hard copy). A link to the online survey was emailed to those who opted for the online version, while the hard copy was issued to those who decided to complete it on-site. Of the 500 issued questionnaires, 410 were returned, with three discarded because of irregularities such as incomplete sections or sections not completed at all. In total, 407 were found appropriate for analysis, which brought the final sample to 407 SCM professionals. This sample size adhered to Hair et al. (2021)'s minimum 150 sample size determination threshold for quantitative research. These professionals were part of SME firms operating in Gauteng, Free State and KwaZulu-Natal provinces.

Measures and fieldwork

The study used a structured questionnaire distributed online and physically to 500 SME owners and managers. Respondents were approached in person to seek consent to participate in the study. The study's questionnaire consisted of 27 items. Supply chain resilience enablers accounted for 15, while the mediator and outcome (SCA and organisational performance) had nine instruments in total. These instruments were derived from previously validated scales. Supply chain alertness had four items, adapted from several studies, with a reported reliability score between 0.83 and 0.89 (Christopher et al. 2004; Lee 2004; Li et al. 2017). Similarly, a four-item scale was used for SCV, and adapted from other studies (Barratt & Oke 2007; Dubey et al. 2018), which recorded a reliability score ranging between 0.81 and 0.90. Supply chain velocity had a three-item scale adapted from Juan, Li and Hung (2022), Kaufmann and Gaeckler (2015) and Chiang, Chen and Wu (2015), which registered a reliability score of 0.85. Supply chain robustness had four items adapted from El Baz et al. (2023) and Wieland and Wallenburg (2013), which had a Cronbach's alpha score ranging between 0.80 and 0.87. Supply chain agility and organisational performance had four and five items, respectively, adapted from Liu et al. (2018), with reported reliabilities of 0.88 and 0.89. A five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was the response option used in the study.

Ethical considerations

The study adhered to ethical principles, as evidenced by the ethical clearance certificate granted by the University of the Free State General/Human Research Ethics Committee on 11 December 2024 (Ethical Clearance number: UFS-HSD 2024/2468).

Data analysis

The results derived from the data analysis are presented in this section.

Demographic results

The study's response rate was established at 81.0% (407 retrieved were deemed valid for analysis from the 500 issued questionnaires, with 93 found to be spoiled, either not returned or improperly completed). This ratio conforms with Babbie's (2020) proposition of 50.0% as an acceptable response rate. The results of the respondents' profile showed that the majority of respondents were male (n = 247; 60.7%) while 39.3% (n = 160) were female. A total of 42.3% (n = 172) of these professionals were operating in the fast-moving consumer goods (FMCG) sector. An equal share of 146 firms (n = 73 for manufacturing and n = 73 for retail) were in the manufacturing and retailing sectors. This contributes to a combined percentage of 35.8. Agriculture (n = 51; 12.5%) and service (IT and Logistics [n = 38; 9.3%]) make up the last sectoral distribution. In terms of professional positions held, most respondents were either operations manager or supervisor (n = 122; 30.0%). This was followed by procurement managers (n = 81; 20.0%). A total of 61 (n = 61) occupied positions of logistics manager (15%) and warehouse coordinator (15%), respectively. Similarly, a combined 82 (n = 82) respondents held positions of inventory manager and supervisor (n = 41; 10%) and distribution officers (n = 41; 10%).

Factor analysis assessment

Exploratory factor analysis (EFA) was conducted to confirm the dimensionality of the scale. Table 1 presents the results of the EFA, taking into account three distinct indicators in the principal components technique. These indicators include the Kaiser–Meyer–Olkin (KMO $\geq$ 0.50) and the Bartlett's test of sphericity (X^2 = 8105.213; $p < 0.01$).

Table 1 reveals the unidimensionality of the constructs, with all items loading well with the measured constructs, apart from one item, SCAL1, and SCV4, which were removed during scale purification because they did not conform to the criteria prescribed by Peterson (2000). These items recorded low loadings (factors) under 0.5.

Psychometric scales

Table 2 presents the psychometric properties aimed at determining scale accuracy.

The scale reliability was measured by means of three indicators: Cronbach's alpha coefficient (α), the composite reliability (CR) test and the Rho_A. The results confirmed the reliability of all constructs, as their reliability scores met the prescribed thresholds of 0.7 (Howard & Forehand 1962).

Scale validity was ascertained using three parameters: content, convergent and discriminant. A revision of the questionnaire by an academic whose area of expertise is SCM was conducted for content validity of the instruments before proceeding with the piloting phase, comprising

TABLE 1: Exploratory factor analysis results.

Construct code	Item code	Factor loadings	KMO sampling adequacy	Bartlett's test of sphericity			Eigen value	% variance explained
				X^2	*df*	*p*		
SCAL	-	-	0.696	484 732	3	0.001	2.235	74 511
	SCAL2	0.662	-	-	-	-	-	-
	SCAL3	0.752	-	-	-	-	-	-
	SCAL4	0.842	-	-	-	-	-	-
SCV	-	-	0.730	695 455	3	0.001	2.445	81 500
	SCV1	0.803	-	-	-	-	-	-
	SCV2	0.950	-	-	-	-	-	-
	SCV3	0.798	-	-	-	-	-	-
SCVL	-	-	0.744	770 056	3	0.001	2.505	83 492
	SCVL1	0.770	-	-	-	-	-	-
	SCVL2	0.898	-	-	-	-	-	-
	SCVL3	0.930	-	-	-	-	-	-
SCRO	-	-	0.818	908 968	6	0.001	2.984	74 598
	SCRO1	0.833	-	-	-	-	-	-
	SCRO2	0.778	-	-	-	-	-	-
	SCRO3	0.805	-	-	-	-	-	-
	SCRO4	0.832	-	-	-	-	-	-
SCA	-	-	0.732	711 491	6	0.001	2.722	68 055
	SCA1	0.798	-	-	-	-	-	-
	SCA2	0.661	-	-	-	-	-	-
	SCA3	0.734	-	-	-	-	-	-
	SCA4	0.830	-	-	-	-	-	-
OP	-	-	0.856	1816 552	10	0.001	3.976	79 514
	OP1	0.768	-	-	-	-	-	-
	OP2	0.785	-	-	-	-	-	-
	OP3	0.904	-	-	-	-	-	-
	OP4	0.914	-	-	-	-	-	-
	OP5	0.930	-	-	-	-	-	-

SCAL, supply chain alertness; SCV, supply chain visibility; SCRO, supply chain robustness; SCVL, supply chain velocity; SCA, supply chain agility; OP, organisational performance; KMO, Kaiser-Meyer Olkin; *df*, degrees of freedom.

60 questionnaires to ascertain the validity of the instruments. This process allowed testing of the convergent validity of the items to establish whether they converged well with the constructs they were designed to measure. This was conducted using two factors: (1) factor loadings and (2) average variance extracted (AVE).

Table 2 shows that the loading and AVE score of all items met the threshold of 0.5, as stipulated by Anderson and Gerbing (1988). This demonstrates that the items converged well with the constructs, measuring 50% of the aspects they intended to assess. The heterotrait-monotrait (HTMT) ratio was performed to determine discriminant validity, as revealed in Table 3.

Discriminant validity is ascertained when the HTMT scores of the constructs are below the 0.9 threshold (Anderson & Gerbing 1988) value. As observed in Table 3, the values of the HTMT ratios demonstrated discriminant validity, outlining the distinction between the constructs in measuring what they intended to measure.

Path analysis

The hypotheses were tested through structural equation modelling using the partial least squares composite-based technique (PLS-SEM). Two criteria were used to establish the path results: The beta (β) is paramount in determining the strength and explanatory power of the examined relationship, whereas the significance of the tested association is revealed by *p*-values (represented by a set of stars [***], indicating *p*-values less than 0.001, [**] representing less than 0.05 and [*] denoting less than 0.1). Path coefficients from the analysed model results can be observed in Figure 2.

Structural model

The study's structural model results are shown in Figure 2.

Figure 2 reveals the structural model, underscoring the hypotheses testing results. It can be observed that there was a relationship between the constructs, which is evident by the path coefficients ranging from 0.017 to 0.767. Supply chain robustness (β = 0.450) and SCAL (β = 0.317) exerted a moderate influence on SCA, with SCVL (β = 0.177) exerting a weak influence. Supply chain visibility (β = 0.017) had an insignificant influence on SCA. Moreover, SCA (β = 0.767) exerted a significant influence on OP.

Hypothesis testing results (path coefficient)

The hypothesis results are presented in Table 4.

Table 4 shows that four hypotheses were statistically supported (H_1, H_2, H_4 and H_5). This means that SCRO, SCAL

TABLE 2: Psychometric properties results.

Research constructs	Item code	Descriptive statistics		Cronbach's test		CR	AVE	Rho_A	Factor loading
		Mean	s.d.	Item total	α				
SCAL	-	4.39	0.667	-	0.824	0.828	0.548	0.835	-
	SCAL2	-	-	0.606	-	-	-	-	0.662
	SCAL3	-	-	0.710	-	-	-	-	0.752
	SCAL4	-	-	0.732	-	-	-	-	0.842
SCV	-	4.62	0.534	-	0.886	0.889	0.728	0.897	-
	SCV1	-	-	0.763	-	-	-	-	0.803
	SCV2	-	-	0.826	-	-	-	-	0.950
	SCV3	-	-	0.747	-	-	-	-	0.798
SCVL	-	4.56	0.615	-	0.901	0.901	0.755	0.909	-
	SCVL1	-	-	0.789	-	-	-	-	0.770
	SCVL2	-	-	0.837	-	-	-	-	0.898
	SCVL3	-	-	0.786	-	-	-	-	0.930
SCRO	-	4.54	0.569	-	0.886	0.886	0.660	0.886	-
	SCRO1	-	-	0.759	-	-	-	-	0.833
	SCRO2	-	-	0.802	-	-	-	-	0.778
	SCRO3	-	-	0.734	-	-	-	-	0.805
	SCRO4	-	-	0.711	-	-	-	-	0.832
SCA	-	4.58	0.595	-	0.842	0.843	0.575	0.843	-
	SCA1	-	-	0.624	-	-	-	-	0.798
	SCA2	-	-	0.625	-	-	-	-	0.661
	SCA3	-	-	0.744	-	-	-	-	0.734
	SCA4	-	-	0.714	-	-	-	-	0.830
OP	-	-	-	-	0.935	0.935	0.745	0.940	-
	OP1	4.64	0.532	0.756	-	-	-	-	0.768
	OP2	-	-	0.842	-	-	-	-	0.785
	OP3	-	-	0.842	-	-	-	-	0.904
	OP4	-	-	0.864	-	-	-	-	0.914
	OP5	-	-	0.836	-	-	-	-	0.930

CR, composite reliability test; s.d., standard deviation; AVE, average variance extracted; SCAL, supply chain alertness; SCV, supply chain visibility; SCRO, supply chain robustness; SCVL, supply chain velocity; SCA, supply chain agility; OP, organisational performance.

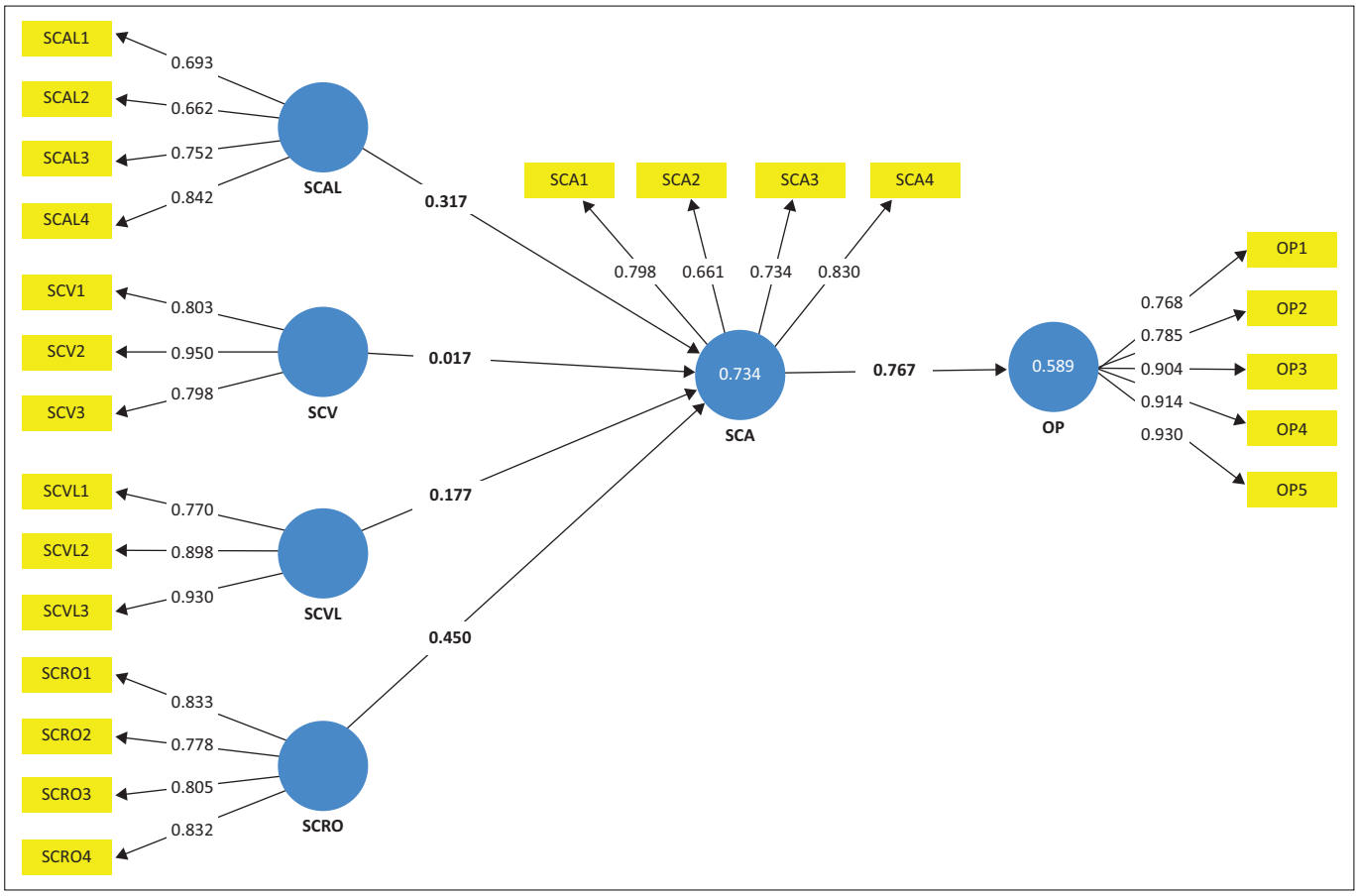
and SCVL statistically influenced SCA, with SCRO exerting the strongest influence of the two identified SCR enablers. Similarly, SCA was found to strongly predict OP, whereas SCV was found not to influence SCA.

Discussion of results

Considering the study's primary objective to ascertain the influence of the SCR enablers on SCA and organisational performance, the results obtained provided an empirical, informed assessment of the outlined relationships sought. A moderate positive association was established between SCRO and SCA (β = 0.450; t = 4.150; p = 0.000). These results further established SCRO as a vital antecedent of SCA, as an increase in SCRO will result in an increase in SCA by 45% (β = 0.450). This result corroborates with seminal scholarly work (Chopra & Sodhi 2014; Sheffi & Rice 2005), which applaud the critical role of robust value and supply of operations in strengthening firms' agile endurance to absorb market-related shocks and heighten operational performance. This finding further outlines South African SMEs' appraisal of developing their core competencies in product and supplier differentiation, maintaining and managing inventory through safety stock and information technology adoption across value chain operations. These competencies contribute significantly to improving their agile capabilities and quickness to respond to market disruptions. This is particularly important when SMEs diversify their supply base by having multiple suppliers, which optimises the response time and order fulfilment.

Furthermore, SCAL was found to be an important driver of SCA, even though it exerted a moderate influence (β = 0.319; t = 3.761; p = 0.000) among South African SMEs. This result showed that an increase in SCAL will lead to an increase in SCA by 32%. The established results, therefore, mean that SCAL is an important factor in SME performance. This observation resonates with empirical evidence by Christopher and Holweg (2011) and Opoku (2025), who found that alertness capabilities among firms contribute significantly to enhancing agile attributes. This view is plausible in the South African SME context, given the results obtained, which denote that SMEs had been able to redesign their operational models by emphasising quickness, flexibility and responsiveness as critical practices to detect and/or adjust their operations seamlessly. Such abilities are essential in proactively reconfiguring operational activities to respond to adverse turbulence swiftly. This point underlines the proactiveness of SMEs to scan their market environment and detect and predict market trends and variations and provide responsive measures promptly.

Similarly, a weak yet positive connection between SCVL and SCA (β = 0.177; t = 2.157; p = 0.031) was established.



Note: PLS-SEM-generated (SmartPLS Version 4.0).

SCAL, supply chain alertness; SCV, supply chain visibility; SCRO, supply chain robustness; SCVL, supply chain velocity; SCA, supply chain agility; OP, organisational performance.

FIGURE 2: Structural model analysis.

TABLE 3: Heterotrait-monotrait ratio matrix.

Constructs	OP	SCA	SCAL	SCRO	SCV	SCVL
OP	-	-	-	-	-	-
SCA	0.764	-	-	-	-	-
SCAL	0.578	0.744	-	-	-	-
SCRO	0.672	0.803	0.671	-	-	-
SCV	0.536	0.631	0.590	0.701	-	-
SCVL	0.580	0.712	0.596	0.753	0.676	-

SCAL, supply chain alertness; SCV, supply chain visibility; SCRO, supply chain robustness; SCVL, supply chain velocity; SCA, supply chain agility; OP, organisational performance.

TABLE 4: Path coefficient.

Hypotheses	R^2	β	*T* statistics	*p*	Decisions
SCA -> OP	0.589	0.767	16.773	0.000	Supported
SCAL -> SCA	0.734	0.319	3.761	0.000	Supported
SCRO -> SCA	0.734	0.451	4.150	0.000	Supported
SCV -> SCA	0.734	0.013	0.177	0.859	Rejected
SCVL -> SCA	0.734	0.177	2.157	0.031	Supported

SCAL, supply chain alertness; SCV, supply chain visibility; SCRO, supply chain robustness; SCVL, supply chain velocity; SCA, supply chain agility; OP, organisational performance.

This result ranks SCVL as the least effective enabler compared to the other established practices (SCRO and SCAL enablers). This weak influence further means that an increase in SCVL will only result in an increase of SCA by 18%. This observation aligns with Kim and Kim's (2024) findings, which underline the role of supply chain networks in boosting agile endurance through efficient coordination of operational processes and velocity responses to market turbulence. These results underscore the adoption of the practice of SCVL by South African SMEs in their abilities to redesign and re-engineer their operations through process automation and digitalisation characterised by real-time inventory tracking, just-in-time approaches, data visibility, quicker order processing, supply-based localisation and diversity. Such attributes are crucial in fostering the speed and pace at which they react and respond to demand and market volatility.

Conversely, SCV exerted no influence on SCA (β = 0.013; t = 0.177; p = 0.859), which contrasts with several empirical studies (Al-Gharaibeh, Nair & Yanamandra 2024; Beigi Firoozi et al. 2024; Zhang & Sharifi 2007), which endorse the impact of SCV as a determinant of SCA through its effects on lead and response time optimisation. This conflicting finding could be attributed to inherent challenges facing South African SMEs in terms of limited financial capabilities and inefficient technological integration, obstructing their ability to invest in technological advancement tools and software upgrades required to scan their market environments effectively. This view could be probable in a volatile environment that requires significant technology and infrastructure adoption. This is particularly the case with the likes of enterprise resource planning (ERP) and electronic data interchange systems that enable the effective integration of real-life information and data monitoring. This scenario

further underscores the need for big data analytical capability, which SMEs with limited technological competence and expertise could find difficult to perform to ensure a real visibility of demand variations and supply chain adjustments required. Furthermore, containment measures taken by the South African government in travel (international and interprovincial) bans could have hampered SMEs' ability to track and trace their supplies, severely obscuring supply visibility in the planning and management of the inventory cycle and lead time because of delivery delays.

Finally, a strong positive relationship was discovered between SCA and OP ($\beta = 0.767$; $t = 16.773$; $p = 0.000$), placing SCA as a strategic antecedent of OP among South African SMEs. This result is supported by the fact that 59% of the variance in OP is explained by SCA. This result implies that South African SMEs' supply chains are agile enough to respond optimally to market-related challenges. Moreover, such agile traits enable SMEs to cope effectively with demand variations. This is relevant, as agile supply chain operations facilitate sound adjustment of procurement and production operations, which results in better product delivery. This result aligns with several studies (Al Mamun et al. 2025; Hohenstein & Sturm 2025; Rashid, Rasheed & Ngah 2024; Wang et al. 2024) that have established the link between SCA and organisational performance.

Implications

The study offers various implications based on the conclusions drawn. Theoretically, it supports the premise of the dynamic capability and resource-based view theories by reinforcing the link between supply chain resilience practices in robustness, velocity and alertness as core resource capability attributes to SCA and SMEs' competitive superiority. These resilience capabilities are critical in withstanding, sensing and responding to market uncertainties in real-time. Practically, the study suggests that SCM professionals operating in SMEs devote their competencies and core resources to speeding up (velocity) their detection (alertness) and efficient response (robustness) to market volatility. The combined adoption of these key resilient-related performance indicators can strengthen SMEs' operational agility and lead to heightened success across their supply chain ecosystems. Tactics such as supplier diversification, big data analysis, real-time information visibility and sharing, information technology adoption and concise risk management strategies are a few examples of activities that could improve SMEs' resilience readiness. Furthermore, embracing advanced analytics technology, adopting cross-functional operations and decentralising value chain activities would be beneficial in providing accurate forecasting, optimising operational visibility and boosting agile capabilities to maintain SMEs' supply chain productivity and success.

Limitations and recommendations

Despite the relevance of the nature of the scope of the study, it was not exempt from challenges that impeded its completion. Firstly, the narrow scope, as the study focused on the three provinces of Gauteng, Free State and KwaZulu-Natal provinces, may be problematic in painting a holistic picture of the perception of the South African SME population. The lack of broader sample representation may limit the application of the identified SCR enablers as antecedents of SCA and OP. Secondly, adopting a mixed-method approach could identify omitted factors to enrich the study's model, given that 27% and 41% of the variances explaining SCA ($r^2 = 0.734$) and OP ($r^2 = 0.589$), respectively, were derived from aspects not considered in the study. Lastly, employing a longitudinal approach to better assess SMEs' perceptions and resilience measures over a long timeframe could offer a more accurate reading of factors contributing to their survival prospects after the pandemic.

In terms of recommendations, studies could consider expanding the conceptual scope of this study by adding SCR components such as flexibility, responsiveness, dependability, information technology adoption, integration (supply chain) and just-in-time approaches, to name a few, to provide a comprehensive assessment of key resilience practices. Moreover, the non-significance of SCV can be further explored, given its salutary merit as a critical determinant of SCA, with several SMEs using visibility tools and systems such as radio frequency identification and real-time tracking and monitoring systems and tools. Furthermore, extending the study's geographical scope to all nine provinces could provide a large-enough representative sample of the South African SME population, where possible results could be adequately generalised.

Conclusion

This study sought to establish the predictive influence of selected SCR enablers of SCAL, SCRO, SCV and SCVL on SCA and OP. The empirical results found that SCRO, SCAL and SCVL are significant SCR practices, with SCRO ($\beta = 0.450$) exerting the strongest influence on SCA. Furthermore, the statistical significance of these activities was supported by the fact that they explained 73% of the variance in SCA ($r^2 = 0.734$), with the remaining 27% ascribed to factors other than the ones identified in the study. In addition, 59% of the variance in OP ($r^2 = 0.589$) is attributed to SCA, coupled with the strong positive association established. Interestingly, SCV, despite its notable significance as a driver of SCA as documented in various studies, was not supported in this study. Several factors could be attributed to this result, one of which could be the lack of a concise overview of SMEs' supply network operations, especially during lockdown measures, which hindered firms' abilities to maintain their order fulfilments, resulting in production and delivery bottlenecks and delays.

Based on these results, the study proposes a resilience-driven model anchored on the three established enablers of SCRO, SCAL and SCVL as determinants of SCA and organisational performance. Therefore, the study suggests that South African SMEs must invest in developing core competencies and resources that would enable them to sustain their resilience capabilities. This objective is essential, as it will strengthen their alertness to monitor and detect market variations, which will facilitate the implementation of proactive measures to withstand and cope with market dynamics decisively and respond speedily and adequately to changes in customers' and consumers' demands. Such attributes offer a solid foundation upon which South African SMEs can optimise their performance objectives, efficiently navigate through various environmental disturbances and challenges and maintain their level of competitiveness and survival aspirations.

The study's value proposition, derived from the empirical evidence proposed, cannot be understated, given the strategic nature of the South African SME sector in its contribution to curbing unemployment. Fundamentally, this model could provide a sound basis for SMEs to restructure their business model by embracing SCA to boost their resilient prospects and survival aspirations, given recent environmental and market-induced turbulences and shocks.

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Data availability

Data that support the findings of this research are available upon reasonable request from the corresponding author, W.V.L.O.

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