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Supply Chain Resilience as a Higher Order Dynamic Capability: The Mediating Role of Supply Chain Agility in SMEs

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ABSTRACT

This study examines how supply chain resilience (SCR) is formed within a dynamic capability framework by positioning it as a higher-order capability. Drawing on the Dynamic Capabilities View (DCV), the study proposes that dynamic digital capabilities (DDC) and relational capability (RC) influence supply chain resilience both directly and indirectly through supply chain agility (SCA). Data were collected from 225 SMEs and analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The results show that DDC and RC significantly enhance SCA, which in turn has a strong positive effect on SCR. Both DDC and RC also exhibit significant direct effects on SCR, indicating complementary mediation. These findings confirm that SCR emerges through a hierarchical capability-building process, where agility acts as a transformation mechanism linking lower-order capabilities to higher-order resilience. This study contributes to theory by clarifying the hierarchical relationship between agility and resilience and integrating digital and relational capabilities into a unified model. Managerially, the results highlight the importance of capability orchestration in building resilience under resource constraints.

Keywords: supply chain resilience, supply chain agility, dynamic digital capabilities, relational capability, SMEs.

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INTRODUCTION

The growing frequency and magnitude of global disruptions including pandemics, geopolitical tensions, climate-related shocks, and technological turbulence have fundamentally altered the logic of supply chain management. Supply chains that were historically optimized for efficiency, cost minimization, and lean coordination are increasingly exposed to systemic vulnerabilities under conditions of environmental turbulence (Kaneberg et al., 2025; Tufan et al., 2024). This shift has redirected scholarly attention from efficiency-centric models toward adaptability-oriented frameworks, positioning supply chain resilience (SCR) as a central construct in both operations and strategic management research.

SCR is commonly defined as the capability of a supply chain to prepare for, respond to, and recover from disruptions while maintaining operational continuity (Chowdhury & Quaddus, 2017). Although

this definition captures important functional dimensions, most prior research treats SCR either as an operational capability or as a direct predictor of firm performance. Such positioning limits theoretical development because it does not explicitly embed resilience within the hierarchical architecture of capabilities as conceptualized in the Dynamic Capabilities View (DCV) (Teece, 2007; Teece et al., 1997).

DCV argues that sustained competitive advantage in turbulent environments depends not merely on operational routines but on higher-order capabilities that enable firms to integrate, build, and reconfigure internal and external competences. Dynamic capabilities operate hierarchically: lower-order operational capabilities ensure efficiency, while higher-order capabilities orchestrate and transform these operational components (Teece, 2007; Peteraf et al., 2013). Despite this hierarchical logic, SCR has rarely been conceptualized as a higher-order dynamic capability. Instead, it is often modeled as the outcome of discrete technological or relational resources.

Recent research has begun to explore resilience as a mediating mechanism linking digital or AI-enabled capabilities to organizational outcomes. For example, studies have examined how AI capabilities enhance sustainability performance through the mediating role of supply chain resilience in SMEs (Ratanacharoenchai & Jantapoon, 2026). While such findings advance understanding of the functional role of resilience, they primarily position SCR as an intermediate capability rather than theorizing its place within a hierarchical dynamic capability structure. Consequently, resilience remains conceptually underdeveloped as a higher-order adaptive capability emerging from the structured integration of lower-order capabilities.

A second theoretical gap concerns the fragmentation of SCR antecedents. On one hand, technological capabilities such as supply chain redesign capacity and adaptive planning systems have been shown to strengthen resilience (Rajesh, 2017; Dubey et al., 2023). On the other hand, relational and network-based capabilities enhance access to resources, knowledge, and coordination mechanisms that mitigate environmental vulnerability (Choi, 2018; Priyono et al., 2020). Research on network-based dynamic capabilities suggests that SMEs, in particular, leverage relational embeddedness to overcome resource constraints and orchestrate external competencies (Priyono et al.,2020)/. However, existing studies tend to examine technological and relational capabilities independently, without theorizing how they are integrated into a higher-order adaptive structure.

A third ambiguity lies in the conceptual distinction between supply chain agility (SCA) and resilience. Agility refers to the ability to sense and respond rapidly to environmental changes, whereas resilience encompasses a broader structural capacity to absorb shocks, maintain functionality, and adapt over time (Chowdhury & Quaddus, 2017). From a DCV perspective, agility can be interpreted as a dynamic operational capability, while resilience represents a higher-order capability reflecting deeper reconfiguration and transformation capacity (Teece, 2007). Yet empirical research often treats agility and resilience as parallel or interchangeable constructs, limiting cumulative theory building.

These theoretical tensions become particularly salient in the context of small and medium-sized enterprises (SMEs). SMEs typically operate under severe resource constraints and heightened vulnerability, yet they may possess structural flexibility and relational proximity that facilitate capability development (Priyono et al., 2020).Unlike large firms that rely on redundancy and slack resources, SMEs must orchestrate digital and relational capabilities more efficiently to achieve resilience. Understanding how resilience emerges under resource scarcity therefore offers a theoretically rich opportunity to refine DCV at the interorganizational supply chain level.

In response to these gaps, this study reconceptualizes supply chain resilience as a higher-order dynamic capability that emerges from the structured integration of dynamic digital capabilities and relational capability, with supply chain agility functioning as a mediating mechanism. By embedding SCR within a hierarchical dynamic capability architecture and empirically testing this structure in SMEs, this research contributes in three ways. First, it clarifies the hierarchical relationship between agility and resilience. Second, it integrates digital and relational capability perspectives into a unified model of supply chain adaptation. Third, it extends DCV beyond the firm boundary by explicating how

interorganizational supply chain capabilities are orchestrated under conditions of environmental turbulence and resource constraints.

LITERATURE REVIEW

Dynamic Capabilities Perspective and Hierarchical Architecture

The Dynamic Capabilities View (DCV) provides the overarching theoretical foundation for this study. DCV posits that sustained performance in turbulent environments depends on a firm's ability to integrate, build, and reconfigure internal and external competences in response to rapid change (Teece et al., 1997; Teece, 2007). Rather than focusing solely on operational efficiency, DCV emphasizes higher-order capabilities that orchestrate and transform lower-level routines.

However, the dynamic capabilities literature has evolved through multiple conceptual streams. Eisenhardt and Martin (2000) describe dynamic capabilities as identifiable organizational processes shaped by market dynamism, while Teece (2007) conceptualizes them as higher-order meta-capabilities rooted in sensing, seizing, and reconfiguring activities. This divergence has led to theoretical fragmentation, as highlighted by Peteraf, Di Stefano, and Verona (2013), who call for clearer hierarchical specification of capabilities.

Building on this hierarchical logic, dynamic capabilities can be conceptualized at multiple levels. Lower-level adaptive capabilities enable firms to adjust specific resources, mid-level capabilities operationalize responsiveness, and higher-order capabilities orchestrate systemic reconfiguration. In the supply chain context, this study positions dynamic digital capabilities and relational capability as lower-level adaptive capabilities, supply chain agility as a mid-level dynamic capability, and supply chain resilience (SCR) as a higher-order dynamic capability reflecting systemic adaptive capacity.

Supply Chain Resilience as a Higher-Order Dynamic Capability

Increasingly complex global disruptions, ranging from pandemics to geopolitical instability, have shifted the focus of supply chain management from efficiency to resilience. Supply Chain Resilience (SCR) is generally understood as the ability of the supply chain to prepare for, respond, and recover from disruptions and maintain operational sustainability (Chowdhury & Quaddus, 2017).

Chowdhury and Quaddus (2017) developed SCR as a multidimensional and hierarchical construct that includes proactive supply chain capability, reactive supply chain capability, and supply chain design quality. They even modeled SCR as a higher-order hierarchical construct, which suggests that resilience is not a simple operational attribute, but rather an integration of various interrelated capabilities. The dimensions of proactive capability include readiness, flexibility, reserve capacity, integration, as well as market and financial strength, while supply chain design is dynamic and can be redesigned in response to changing environments.

Nonetheless, many previous studies still treated SCR as an operational variable or a direct predictor of performance, without placing it in a clear capability structure. In a Dynamic Capabilities View (DCV) perspective, organizations need to have the ability to reconfigure their resources and capabilities to respond to rapid and uncertain environmental changes. The latest literature also emphasizes that major disruptions such as the pandemic require organizations to build dynamic capabilities at the supply chain level, not just at the level of a single organization.

Based on this argument, this study positions SCR as a higher-order dynamic capability, which is formed through the integration of lower-level capabilities, especially dynamic digital capabilities and relational capabilities through the supply chain agility mechanism.

Dynamic Digital Capabilities and Supply Chain Agility

Digital transformation has become a key driver of change in supply chain management. However, the determinant is not just the adoption of technology, but the dynamic ability to adapt and reconfigure the technology according to changes in the environment.

Dubey et al. (2023) show that digital adaptability has a positive effect on digital agility and digital agility in turn increases supply chain resilience. These findings support a hierarchical structure in DCV, where higher-level capabilities form rapid response capabilities that then result in strategic outcomes. In addition, the study also shows that the effectiveness of digital capabilities in increasing resilience is influenced by institutional contexts, such as the effectiveness of government policies (Dubey et al., 2023).

Rajesh (2017) also emphasized that the ability to modify supply chain design and planning capabilities are the most influential technological capabilities in increasing flexibility and resilience. This ability to redesign and plan adaptively conceptually improves agility because organizations are able to respond to change quickly and in a structured manner.

Thus, dynamic digital capabilities allow for increased visibility, flexibility, and speed of decision-making, which are key characteristics of supply chain agility. Based on the above, the hypothesis developed is as follows:

H1: *Dynamic digital capabilities positively influence supply chain agility.*

Relational Capability and Supply Chain Agility

The supply chain is a network between organizations that depends on the quality of relationships. The relational view emphasizes that trust, collaboration, and information sharing become increasingly important when organizations face disruption (see discussion in the SCR–Agility study).

Managers who develop collaboration based on mutual trust and information sharing will be better able to build an agile and resilient supply chain. Strong relationships accelerate coordination and minimize information asymmetry, thereby increasing the speed of response to change.The concept of guanxi enriches this perspective by explaining that business relationships evolve gradually from acquaintance to trust and loyalty, which strengthens a long-term commitment in the network (Choi, 2018). Guanxi also created a multi-layered interdependence system that reduces opportunistic behavior and encourages value-sharing in collaborative networks (Choi, 2018).

In the context of SMEs, relational capability is a strategic resource because it allows access to market information, external resources, and faster coordination in uncertain situations. Therefore, relational capability theoretically increases supply chain agility, so the 2nd hypothesis is:

H2: *Relational capability positively influences supply chain agility.*

Supply Chain Agility and Supply Chain Resilience

Agility and resilience are often treated as intersecting concepts, but conceptually they are different. Agility refers to the ability to respond to change quickly and flexibly, while resilience includes the broader ability to absorb disruptions, maintain function, and recover and adapt structurally (Chowdhury & Quaddus, 2017).

Dubey et al. (2023) show that digital agility has a positive effect on supply chain resilience. In addition, the study on SCR-Agility also emphasizes the importance of building an agile and resilient supply chain to deal with disruption contingencies. In the hierarchical framework of DCV, agility can be understood as a mid-level capability that is a mechanism for building resilience. In other words, a more agile organization will be better able to build resilience as a high-level dynamic capability.

H3: *Supply chain agility positively influences supply chain resilience.*

Direct Effects of Lower-Level Capabilities on Resilience

Beyond their indirect effects through agility, lower-level capabilities may also contribute directly to higher-order resilience. Dynamic digital capabilities enhance real-time visibility, system integration, and adaptive planning, which directly strengthen resilience (Rajesh, 2017; Dubey et al., 2023).

Similarly, relational capability strengthens resilience through collective learning, collaborative governance, and network coordination. Trust-based relationships reduce disruption impact and enhance recovery capacity (Choi, 2018). Therefore, both capabilities may exert direct effects on resilience. In guanxi's perspective, loyalty and value-sharing strengthen network governance and reduce the risk of opportunistic behavior, thereby improving the network's collective ability to survive and adapt (Choi, 2018). Thus, relational capability not only increases agility, but also contributes directly to resilience.

H4: *Dynamic digital capabilities positively influence supply chain resilience.*
H5: *Relational capability positively influences supply chain resilience.*

The Mediating Role of Supply Chain Agility

The hierarchical perspective of the Dynamic Capability View (DCV) suggests that higher-order capabilities are typically developed through intermediate-level mechanisms rather than emerging directly from lower-level capabilities. In line with this perspective, prior empirical evidence such as Dubey et al., 2023 highlights a sequential linkage in which adaptability fosters agility, which subsequently enables the development of resilience. This sequence underscores the critical role of agility as a mechanism through which adaptive capabilities are transformed into resilient outcomes.

In the context of this study, dynamic digital capabilities (DDC) and relational capability (RC) represent lower-level capabilities that enhance a firm's ability to adapt to environmental changes. DDC enables firms to reconfigure digital resources and leverage data-driven insights, while RC strengthens collaboration and information sharing across supply chain partners. These capabilities, however, do not directly translate into resilience unless they are operationalized through a firm's ability to respond swiftly and effectively to disruptions.

Supply chain agility (SCA), therefore, functions as an essential intermediate capability that converts the adaptive potential of DDC and RC into resilience outcomes. By enabling rapid sensing and response, agility allows firms to cope with uncertainty and disruptions, ultimately strengthening supply chain resilience (SCR).

Based on this reasoning, supply chain agility is expected to mediate the relationships between both dynamic digital capabilities and relational capability with supply chain resilience.

H6a: Supply chain agility mediates the relationship between dynamic digital capabilities and supply chain resilience.
H6b: Supply chain agility mediates the relationship between relational capability and supply chain resilience.

Research Model

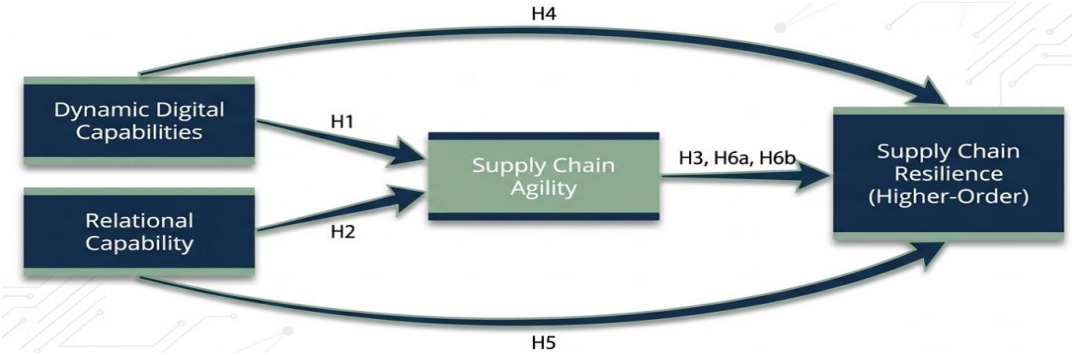


Figure 1. Conceptual model

METHOD

Population and sampling

The population of this study consists of business actors involved in supply chain activities across various sectors, including manufacturing, trade, services, and other related industries. The unit of analysis focuses on individuals who are engaged in operational and strategic decision-making processes within their organizations, such as owners, managers, and employees. A non-probability sampling technique, specifically purposive sampling, was employed to select respondents with relevant knowledge and experience in supply chain activities. This approach ensures that participants are capable of providing meaningful insights into dynamic digital capabilities, relational capability, supply chain agility, and supply chain resilience. A total of 225 respondents participated in this study, which is considered sufficient for structural equation modelling (SEM) analysis.

The demographic profile of respondents, as presented in Table 1, indicates a diverse and balanced sample. In terms of business age, the majority of respondents operate businesses that have been established for 3 to 5 years (29.8%), followed by those aged 1 to 3 years (28.0%) and 6 months to 1 year (21.3%), while 20.9% have been operating for more than 5 years. This distribution suggests that most firms are in the growth and development stage, where adaptability and responsiveness are particularly critical.

Table 1. Profile summary

Demographic Information		Frequency	%
Business age	6 month - 1 years	48	21,3%
	> 1 - 3 years	63	28,0%
	> 3 - 5 years	67	29,8%
	> 5 years	47	20,9%
Position	Employees	78	34,7%
	Owner	69	30,7%
	Manager	78	34,7%
Industry	Manufacturing	52	23,1%
	Trade	61	27,1%
	Services	49	21,8%
	Food	45	20,0%
	Others	18	8,0%

Regarding respondents' positions, the sample is relatively evenly distributed among employees (34.7%), managers (34.7%), and business owners (30.7%), providing perspectives from multiple organizational levels involved in supply chain decision-making. In terms of industry, respondents are drawn from a range of sectors, with the largest proportion from trade (27.1%), followed by manufacturing (23.1%), services (21.8%), and food-related businesses (20.0%), while the remaining 8.0% represent other sectors.

Overall, the diversity in business age, organizational roles, and industry sectors enhances the representativeness of the sample and strengthens the robustness of the study in examining supply chain agility and resilience across different business contexts.

Measurement and Construct Operationalization

All constructs in this study were measured using Likert scales five points, with items adapted from prior studies and adjusted to the SME context. Supply chain resilience (SCR) is modelled as a higher-order construct, reflecting a firm's overall capability to withstand and recover from disruptions. Referring to Chowdhury and Quaddus (2017), SCR consists of three main dimensions: proactive supply chain

capability, reactive supply chain capability, and supply chain design quality. These dimensions are modelled reflectively to capture the multidimensional nature of resilience.

Supply chain agility (SCA) is conceptualized as a firm's ability to respond quickly and flexibly to changes in demand and supply disruptions. Dynamic digital capabilities (DDC) represent the firm's ability to leverage and reconfigure digital technologies to enhance visibility, integration, and decision-making. The measurement items for SCA and DDC were adapted from prior studies, including Dubey et al.2023

Relational capability reflects the quality of inter-organizational relationships with supply chain partners, including trust, collaboration, information sharing, and joint problem solving. The relational perspective and concept of guanxi (Choi, 2018) reinforce the understanding that trust-based relationships and loyalty improve the coordination and effectiveness of collective responses. The measurement items were adapted from prior literature on relational capability and inter-firm relationships, including Choi (2018).

Data Analysis Procedure

Data analysis was conducted using Smart PLS following a two-stage approach to account for the hierarchical structure of supply chain resilience. In the first stage, the measurement model for all lower-order constructs was assessed by examining indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Indicator loadings above 0.70, composite reliability above 0.70, and average variance extracted (AVE) above 0.50 were considered acceptable thresholds. Discriminant validity was evaluated using the heterotrait monotrait (HTMT) ratio.

In the second stage, the structural model was evaluated to test the hypothesized relationships. Collinearity was assessed using variance inflation factor (VIF) values, while the explanatory power of the model was examined using R^2 values. Effect sizes (f^2) and predictive relevance (Q^2) were also evaluated to determine the model's explanatory and predictive capabilities. Model fit was assessed using the standardized root mean square residual (SRMR), with values below 0.08 indicating acceptable fit.

The significance of path coefficients was tested using a bootstrapping procedure with 5,000 resamples. Both direct and indirect effects were examined using bias-corrected confidence intervals.

Measurement model

Validity and reliability analysis was conducted to assess the adequacy of the measurement model for the latent constructs used in this study. The constructs assessed in the model were dynamic digital capabilities (DDC), relational capability (RC), supply chain agility (SCA), and supply chain resilience (SCR). Because SCR is conceptualized as a higher-order construct, its lower-order dimensions, namely proactive supply chain capabilities (PSCC), reactive supply chain capabilities (RSCC), and supply chain design quality (SCDQ), were also evaluated.

In the first step, indicator reliability, internal consistency reliability, and convergent validity were assessed. As presented in Table 2, the AVE values range from 0.595 to 0.761 for the lower-order constructs and 0.609 for the higher-order SCR construct, exceeding the recommended minimum value of 0.50. Thus, the measurement model demonstrates adequate convergent validity. Internal consistency reliability is also supported, as the Cronbach's alpha and composite reliability values of all constructs exceed the recommended threshold of 0.70. Most indicators show outer loadings above 0.70. Two indicators, SCA3 (0.634) and RC3 (0.594), are below 0.70 but remain above the minimum acceptable range of 0.40; therefore, they may be retained because the corresponding constructs still meet the AVE and reliability criteria. The results are presented in Table 2.

Table 2. Construct reliability and validity

Construct	Item	Outer loading	AVE	Cronbach's Alpha	CR
Dynamic Digital Capabilities (DDC)	DDC1	0,735	0,595	0.774	0,854
	DDC2	0,835			
	DDC3	0,764			
	DDC4	0,746			
Supply Chain Resilience (SCR)			0,609	0,928	0,939
Proactive Supply Chain Capabilities	PSCC1	0,884	0,761	0,895	0,927
	PSCC2	0,876			
	PSCC3	0,904			
	PSCC4	0,823			
Reactive Supply Chain Capabilities	RSCC1	0,862	0,705	0,790	0,877
	RSCC2	0,854			
	RSCC3	0,802			
Supply Chain Design Quality	SCDQ1	0,712	0,678	0,758	0,863
	SCDQ2	0,874			
	SCDQ3	0,875			
Supply chain agility (SCA)	SCA1	0,911	0,694	0,770	0,869
	SCA2	0,922			
	SCA3	0,634			
Relational capability (RC)	RC1	0,910	0,650	0,809	0,878
	RC2	0,910			
	RC3	0,594			
	RC4	0,768			

Discriminant validity was assessed using the heterotrait-monotrait ratio (HTMT), which provides a more stringent assessment of construct distinctiveness in PLS-SEM method (Henseler et al., 2015). As presented in Table 3, the HTMT values range from 0.721 to 0.897. All values are below the recommended threshold of 0.90, indicating that the constructs are empirically distinguishable from one another. Several values exceed the more conservative threshold of 0.85, including the relationships between dynamic digital capabilities and supply chain resilience (0.897), proactive and reactive supply chain capabilities (0.878), relational capability and supply chain design quality (0.871), supply chain agility and supply chain resilience (0.855), as well as dynamic digital capabilities with reactive supply chain capability and supply chain agility (0.854). However, because these constructs represent closely related supply chain capabilities and all values remain below 0.90, discriminant validity is considered acceptable. The relatively high HTMT value between dynamic digital capabilities and supply chain resilience suggests conceptual proximity, but it does not indicate a critical discriminant validity problem.

Table 3. Heterotrait-Monotrait Ratio (HTMT)

	DDC	**PSCC**	**RSCC**	**RC**	**SCA**	**SCDQ**	**SCR**
DDC							
PSCC	0,852						
RSCC	0,854	0,878					
RC	0,825	0,818	0,761				

	DDC	PSCC	RSCC	RC	SCA	SCDQ	SCR
SCA	0,854	0,852	0,782	0,843			
SCDQ	0,838	0,837	0,729	0,871	0,808		
SCR	0,897	0,721	0,757	0,836	0,855	0,796	

Note. *DDC = Dynamic Digital Capabilities; PSCC = Proactive Supply Chain Capability; RSCC = Reactive Supply Chain Capability; RC = Relational Capability; SCA = Supply Chain Agility; SCDQ = Supply Chain Design Quality; SCR = Supply Chain Resilience.*

RESULTS

The path estimation from the PLS-SEM analysis is presented in Figure 2. Table 4 reports the bootstrapping results, including standard deviations, t-statistics, and p-values for each hypothesized relationship. Because all reported t-statistics exceed 1.96 and all p-values are below 0.05, the results indicate that the proposed hypotheses (H1-H6b) are statistically supported.

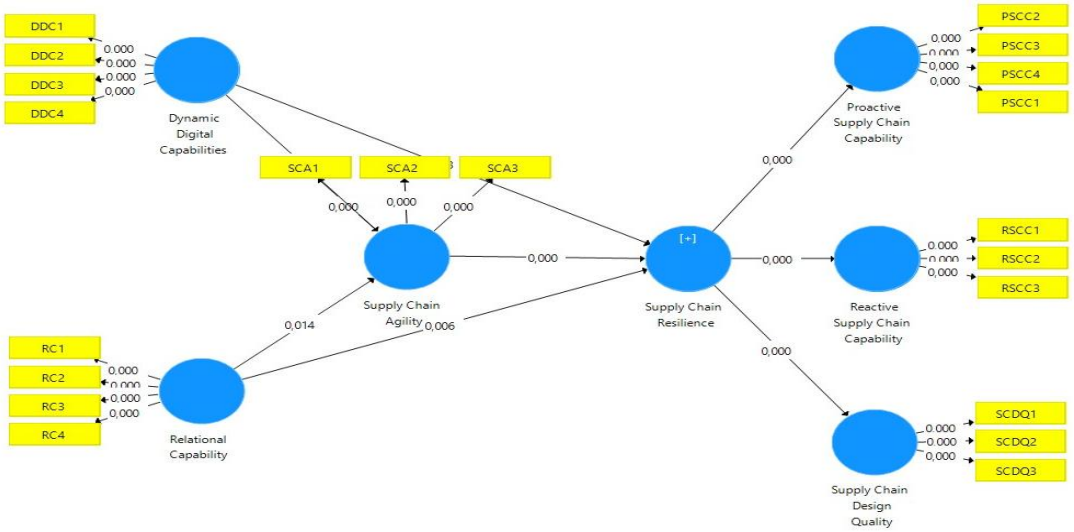


Figure 2. Hypothesized model

First, dynamic digital capabilities have a positive and significant effect on supply chain agility (T = 7.085, p = 0.000), supporting H1. This suggests that firms with stronger digital competencies, such as data integration, digital platforms, and real-time information processing, are better positioned to enhance supply chain responsiveness and flexibility. Relational capability also has a positive and significant effect on supply chain agility (T = 2.468, p = 0.014), supporting H2. These findings indicate that both digital and relational capabilities contribute to agility, although the relative strength of their effects should be interpreted based on the path coefficients reported in the model output.

Table 4. Path estimates

Hypothesis	Standard Deviation	T Statistics (|O/STDEV|)	P-values	Results
Dynamic Digital Capabilities -> Supply Chain Agility	0,082	7,085	0,000	H1 Accepted
Relational Capability -> Supply Chain Agility	0,079	2,468	0,014	H2 Accepted
Supply Chain Agility -> Supply Chain Resilience	0,055	9,636	0,000	H3 Accepted
Dynamic Digital Capabilities -> Supply Chain Resilience	0,077	2,938	0,003	H4 Accepted
Relational Capability -> Supply Chain Resilience	0,068	2,745	0,006	H5 Accepted

Hypothesis	Standard Deviation	T Statistics (|O/STDEV|)	P-values	Results
Dynamic Digital Capabilities -> Supply Chain Agility -> Supply Chain Resilience	0,051	6,079	0,000	H6a Accepted
Relational Capability -> Supply Chain Agility -> Supply Chain Resilience	0,044	2,344	0,019	H6b Accepted

Second, supply chain agility has a positive and significant effect on supply chain resilience (T = 9.636, p = 0.000), supporting H3. This highlights the important role of agility in enabling firms to respond to disruptions and maintain operational continuity. Furthermore, both dynamic digital capabilities (T = 2.938, p = 0.003) and relational capability (T = 2.745, p = 0.006) have significant direct effects on supply chain resilience, supporting H4 and H5, respectively. These results suggest that resilience is shaped not only by agility but also by firms' technological capabilities and external relational strengths.

Third, the mediation analysis demonstrates that supply chain agility significantly mediates the relationship between dynamic digital capabilities and supply chain resilience (T = 6.079, p = 0.000), supporting H6a. Similarly, supply chain agility mediates the relationship between relational capability and supply chain resilience (T = 2.344, p = 0.019), supporting H6b. These findings confirm the pivotal role of agility as an intervening mechanism through which both digital and relational capabilities enhance resilience.

Overall, the results emphasize that supply chain agility serves as a central mechanism in the model, linking organizational capabilities to resilience outcomes. Dynamic digital capabilities and relational capability both contribute directly and indirectly to supply chain resilience, indicating that resilience is developed through multiple capability pathways.

From a managerial perspective, these findings suggest that firms should prioritize investments in digital transformation initiatives while simultaneously fostering strong collaborative relationships with supply chain partners. Enhancing supply chain agility should be a strategic focus, as it plays a crucial role in achieving long-term resilience in an increasingly uncertain business environment.

This study advances the understanding of supply chain resilience (SCR) by empirically positioning it as a higher-order dynamic capability that emerges from the structured integration of lower-level capabilities through a mediating mechanism. The results provide strong empirical support for the proposed hierarchical model, in which dynamic digital capabilities (DDC) and relational capability (RC) shape supply chain agility (SCA), which in turn drives SCR. This finding directly addresses the theoretical ambiguity identified in prior literature regarding the positioning of resilience within the Dynamic Capabilities View (DCV).

First, the significant effect of DDC on SCA reinforces the argument that digital capabilities should not be conceptualized merely as technological resources, but as adaptive, reconfigurable capabilities that enable rapid sensing and responding (Teece, 2007; Dubey et al., 2023). This aligns with the DCV perspective that emphasizes the role of lower-order capabilities in facilitating organizational responsiveness. In the SME context, digital capabilities may help firms improve visibility, coordination, and decision-making despite resource constraints. This finding extends prior work by demonstrating that digital adaptability contributes meaningfully to the formation of supply chain agility.

Second, the significant effect of RC on SCA confirms the importance of relational capability as a source of inter-organizational responsiveness (Choi, 2018; Priyono et al., 2020). Trust, collaboration, information sharing, and joint problem solving can help firms coordinate more effectively with supply chain partners when facing uncertainty. In dynamic environments, relational capability may become more effective when supported by digital infrastructures that enable timely information exchange and coordinated responses.

Third, the significant effect of SCA on SCR provides empirical support for the hierarchical architecture of dynamic capabilities (Teece, 2007; Peteraf et al., 2013). Specifically, the findings indicate

that agility functions as a mid-level dynamic capability that translates adaptive inputs into systemic resilience outcomes. This is a critical contribution, as prior studies have often treated agility and resilience as parallel or interchangeable constructs (Chowdhury & Quaddus, 2017). By demonstrating a directional and mediating relationship, this study clarifies that agility operates as a transformational mechanism through which firms build resilience. Thus, resilience should be understood not merely as an immediate response capability, but as an emergent property of accumulated adaptive processes.

Moreover, the presence of significant direct effects of DDC and RC on SCR suggests that resilience formation follows a dual-path structure. On one hand, resilience is indirectly constructed through agility; on the other hand, it is directly reinforced by foundational capabilities. This dual mechanism aligns with recent extensions of DCV, which argue that higher-order capabilities may arise both from mediated processes and from direct resource reconfiguration (Teece et al., 1997; Rajesh, 2017). Importantly, this finding nuances the hierarchical model by showing that capability development is not strictly sequential, but may involve overlapping and reinforcing pathways.

The mediation results further strengthen this interpretation. The identification of complementary (partial) mediation indicates that SCA serves as a critical, but not exclusive, mechanism linking lower-order capabilities to resilience. This supports the argument of Zhao, Lynch, and Chen (2010) that mediation should be understood in terms of effect configuration rather than strict causal chains. In this context, agility operates as a core conduit of adaptation, but resilience remains partially anchored in the direct effects of digital and relational capabilities. This finding refines the DCV framework by empirically illustrating how multiple pathways coexist within a capability system.

From a theoretical standpoint, this study makes three key contributions. First, it reconceptualizes SCR as a higher-order dynamic capability, thereby extending DCV into the inter-organizational supply chain domain. While prior research has predominantly treated resilience as an operational attribute or performance outcome (Chowdhury & Quaddus, 2017), this study embeds it within a hierarchical capability structure, providing a more robust theoretical grounding. Second, it integrates digital and relational perspectives into a unified framework, addressing the fragmentation in the literature where these capabilities are often examined in isolation (Dubey et al., 2023; Priyono et al., 2020). Third, it provides empirical clarification of the agility-resilience relationship, demonstrating that agility is a necessary but not sufficient condition for resilience.

However, the findings also invite critical reflection. The relatively lower explanatory power of SCA (R^2 = 0.565) compared to other endogenous constructs suggests that additional factors such as organizational culture, leadership, or environmental dynamism may play a role in shaping agility. This indicates that the current model, while robust, may not fully capture the complexity of agility formation. Furthermore, the strong reliance on self-reported data from SMEs may introduce perceptual bias, potentially inflating the observed relationships. Future research could address these limitations by incorporating longitudinal designs or multi-source data.

In the SME context, these findings carry important implications. Unlike large firms that rely on redundancy and slack resources, SMEs appear to build resilience through capability orchestration, leveraging digital adaptability and relational embeddedness in a more integrated manner. This supports the argument that dynamic capabilities in SMEs are not merely scaled-down versions of those in large firms, but are structurally distinct and more dependent on efficient resource reconfiguration (Priyono et al., 2020).

CONCLUSION

This study confirms that dynamic digital capabilities and relational capability significantly enhance supply chain agility and supply chain resilience, with all proposed hypotheses supported. Among these variables, dynamic digital capabilities emerge as the most influential factor, while supply chain agility is identified as the key determinant of resilience. Furthermore, supply chain agility plays a crucial

mediating role, indicating that organizational capabilities must be translated into agile practices to effectively strengthen resilience.

Theoretically, this study enriches the supply chain management literature by integrating dynamic capability and relational perspectives, while emphasizing the mediating role of agility. Managerially, the findings suggest that firms should prioritize digital transformation initiatives and strengthen collaboration with supply chain partners. More importantly, enhancing supply chain agility should be a strategic focus, as it serves as the main pathway to achieving resilience.

However, this study has several limitations. The use of cross-sectional data limits causal interpretation, and the specific research context may reduce generalizability. Additionally, the study focuses on a limited number of variables and relies on self-reported data, which may introduce bias. Future research is encouraged to adopt longitudinal approaches, include broader contexts such as different industries or countries, and incorporate additional variables such as environmental uncertainty or innovation capability. Exploring the role of emerging technologies and applying mixed-method approaches would also provide deeper insights into how firms can effectively build agile and resilient supply chains.

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