Embracing Supply Chain Complexity for Enhanced Viability: The Influence of Strategic Information Flow and Network Capability

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Abstract

The literature on supply chain complexity (SCC) has traditionally focused on its negative aspects, such as increased vulnerability to disruption. However, this study takes a different perspective, exploring the potential for SCC to trigger positive outcomes like enhanced supply chain viability (SCV). Informed by the dynamic capabilities view, we delve into the relationship between SCC and SCV, and how this is influenced by strategic information flow (SIF) and network capability (NC). Survey data from 242 firms is collected to examine hypothesized relationships. The data were analysed using the partial least squares (PLS) structural equation modelling (SEM) technique. The findings reveal that exposure to SCC significantly indirectly influences SCV via both SIF and NC. Investigation of the serial mediation pathway (SCC → SIF → NC → SCV) indicates a partial mediation effect. This suggests that, while both

mediators (SIF and NC) can independently enhance SCV, their combined sequential influence can synergistically offer additional advantages to achieving SCV. These findings provide a new perspective on SCC and guide managers and policymakers in establishing SCV in the face of SCC. For example, our findings suggest that investing in both NC and SIF enhances SCV more effectively than investing in either one alone.

Keywords: *Supply chain complexity, viability, network capabilities, strategic information flow, survey.*

Managerial relevance statement

Our study offers valuable insights for managers navigating complex supply chains (SCs), providing a strategic roadmap for developing supply chain viability (SCV) to withstand disruptions and maintain competitiveness. By reframing supply chain complexity (SCC) as an opportunity, managers can restructure their networks to thrive in dynamic environments. We highlight the importance of strategic information flow (SIF) and network capabilities (NC) in enhancing SCV, urging investment in strong internal communication, coordination, and collaborative partnerships. Industry leaders like General Motors (GM) exemplify this by utilizing network resources for ventilator production during the pandemic, strengthening partnerships to address the semiconductor crisis, and investing in data analytics to ensure seamless information flow with suppliers at multiple tiers. Policymakers also play a role in building SC resilience through legislation, such as the US "Supply Chain Resilience Act" and the EU's "Recovery and Resilience Facility," which aim to strengthen SCs against disruptive shocks.

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Introduction

The increasingly interconnected, dynamic, and global nature of business operations has led to an elaborate interplay between supply chain complexity (SCC) and viability [1, 2]. As firms navigate the complex terrain of global markets, the relationship between these two vital factors may hold the key to sustained success and resilience. SCC – operationalized as both structural complexity (multiple nodes in a supply chain) and dynamic complexity (a complex and dynamic system of interactions among actors in a network) – has received growing research attention [3-6]. It has emerged as a formidable challenge, prompting firms to scrutinize the fundamental elements that ensure the resilience and success of their supply chain (SC) operations. Amidst this SCC, the concept of supply chain viability (SCV) is paramount and could serve as a beacon of stability and endurance [2, 7]. SCV provides an integrated framework that spans three perspectives, i.e., agility, resilience, and survivability, establishing a holistic approach that goes beyond individual SC resilience and agility frameworks [8]. It is oriented toward adaptation and survival amid ongoing disruption rather than being focused on reverting to the "old normal" [8, 9].

While prior research suggests SCC is detrimental to SC resilience and obstructs a firm's responsiveness to disruptions [4], a few other studies have conceptualized SCC as a potential catalyst for positive change and improved performance [10]. However, the mechanism through which SCC either facilitates or hinders firm outcomes (performance, resilience, agility, or viability) is not well explored [5]. SCC arises due to globalization, market uncertainties, and technological advancements; therefore, dealing with it necessitates developing dynamic capabilities (DCs) [11]. The occurrence of any disruptive event in structurally complex and highly interdependent SCs, i.e., SCC, could cause enormous effects across the network. Thus, firms develop specific mechanisms for long-term viability to avoid the disruptive impact while operating under SCC. For example, during the COVID-19 pandemic, the World Economic Forum suggested that firms operating global, complex SCs must adapt and adjust their approach by dynamically leveraging SC capabilities [12]. We, therefore, argue that one such potential

approach through which SCC may facilitate SCV is by developing DCs, particularly those related to network-level relationships [13], i.e., network capabilities (NC), and the leveraging of digital technology for strategic information sharing, i.e., strategic information flow (SIF).

The dynamic capability view (DCV) is the theoretical lens adopted in this study. DCV argues that firms deploy superior resources to enhance performance. This offers a unique perspective on whether SCC triggers the need and opportunity for firms to cultivate DCs. For instance, to address complex SC issues, firms may invest in advanced technologies to gather and process real-time information and adapt their strategies and processes to maintain a competitive edge [14]. Similarly, to address emerging challenges, firms may build strategic-level relationships with SC partners that enable them to adapt, mobilize resources, and foster innovation [15, 16].

More specifically, choosing an optimal combination of strategies can be challenging in structurally diverse and uncertain SCs. There is a need for empirical research to evaluate the impact of SCC on SCV and help firms make informed decisions about their investments. NC, which involves the ability to develop and maintain relationships with external partners [17-19], and SIF [20, 21], which denotes the use of digital technology to share strategic information, have received significant attention in the SC literature, but it is unclear if the strategic nature of NC and SIF can act as a bridge between SCC and SCV. Addressing this gap can aid researchers and practitioners in identifying ways to build SCV and ensure its effectiveness. Thus, we integrate these concepts within the model developed in this paper to unpack the mechanisms that connect SCC to SCV.

Furthermore, SCV has recently been introduced as a response to major global disruptions such as the COVID-19 pandemic [8]. It is argued that SCV is more than the sum of its parts (resilience, agility, and survivability), acting as a robust framework that extends beyond crisis management to embody a proactive approach to thriving in an ever-changing world. This perspective of and paradigm shift towards

SCV prompts firms to anticipate, adapt, and seize opportunities while maintaining a steadfast commitment to enduring success [1, 2]. That is, SCV, as a construct, characterizes SCs as adaptable systems by emphasizing how companies align themselves with emerging challenges during rapid and widespread transformations in the business environment [22]. This differs from conventional responsiveness, which often expounds on firms' short-term reactions, where the emphasis is on either returning to the old normal or undergoing a deliberate and time-phased adjustment to long-term market changes [23]. That said, much is yet to be explored about the true potential of SCV concerning SCC.

Overall, this study aims to investigate (i) whether and how SCC prompts or drives firms towards SCV and (ii) if NC and SIF act as DCs that mediate the impact of SCC on SCV. The DCV informs our framework and associated hypotheses. Given that heightened SCC is presently causing unprecedented disruptions, exploring NC and SIF under DCV is imperative if businesses are to adapt, sustain, and survive. The two research questions that motivate this research are: 1) *What is the impact of supply chain complexity (SCC) on supply chain viability (SCV)?* and 2) *Do network capabilities (NC) and strategic information flow (SIF) mediate the relationship between SCC and SCV?* To answer these questions, we draw on responses from 242 SC managers in Pakistan and use structural equation modelling (SEM) to test the proposed hypotheses.

The paper contributes to the operations and supply chain management (SCM) literature by empirically examining why SCC motivates firms to build SIF and NC, i.e., two capabilities that enhance SCV. This provides a fresh perspective when compared with earlier research, which predominantly focused on the detrimental effects of SCC on organizational outcomes [5]. Recent literature has called for studying the simultaneous effect of SCC (structural and dynamic perspectives) on organizational outcomes. Additionally, no prior study has examined the influence of SCC on SCV, limiting our understanding of how firms can navigate complex and uncertain networks. Addressing these gaps, we

conceptualize SCC, incorporating structural and dynamic perspectives simultaneously, as an opportunity to motivate firms to navigate complex issues and enhance SCV. We also explore how SIF and NC independently mediate the relationship between SCC and SCV. The SCC literature has provided limited guidance on whether it enhances or hinders operational improvements [5], except for [24]. We reveal that the most intriguing aspect of this research is the partial mediation effect in the serial pathway from SCC to SCV, passing through SIF and NC. This suggests that although both SIF and NC can independently contribute to enhanced SCV, their combined sequential influence is not merely additive but synergistic. This finding implies that firms aiming to improve SCV should not view these two factors separately. Instead, firms should recognize the compounding benefits that can be achieved when SIF and NC work in tandem. In essence, when information flows seamlessly within the SC, and a firm possesses the necessary resources and relationships to act upon it, the SC becomes more resilient, agile, and viable.

The remainder of this paper is organized as follows. Section 2 presents the literature review and theoretical background before Section 3 outlines the conceptual model and proposes the research hypotheses. Section 4 discusses the methodology, followed by a discussion of the data analysis and results in Section 5. Lastly, Section 6 outlines the theoretical and managerial implications and discusses the limitations and future research directions.

1. Literature Review and Theoretical Background

1.1 Network capabilities and strategic information flow as dynamic capabilities

The dynamic capability view (DCV) was proposed [25] in response to the need for adaptability in dynamic environments. DCV offers a valuable theoretical lens that emphasizes the importance of building, renewing, reconfiguring, and combining resources to sustain and survive in a rapidly changing environment within the realm of SCV. Notably, NC and SIF emerged as DCs within the context of SCC,

allowing firms to effectively leverage their network and information resources to address dynamic challenges [19, 20].

In a dynamic and complex SC, NC resolves SC partner conflicts and enables strategic resource sharing [18]. The extant literature holds great promise to support the significant role played by NC in managing the SC [17, 19]; however, it is essential to understand how NC functions as a DC. Walter, et al. [19] defined NC as "*firms' abilities to develop and utilise inter-organizational relationships to gain access to various resources held by other actors"*. This definition underscores the dynamic nature of NC as it involves continuously developing, maintaining, and leveraging relationships to adapt to changing market conditions. NC encompasses effectively mobilizing resources from the broader network through building relationships, strategic alliances, and social bonds. These capabilities enable firms to effectively navigate and survive in complex environments and capitalize on new opportunities. Building upon Walter, et al. [19] conceptualization, this study integrates various dimensions representing a firm's ability to manage relationships with SC partners, including internal communication, interfirm coordination, relationship skills, and partner knowledge. Furthermore, by conceptualizing NC as a DC, this research aims to investigate its effect on SCV in the presence of SCC. Moreover, by understanding how firms can leverage NC to adapt and thrive in dynamic environments, we seek to contribute to a broader understanding of DCs in SCM.

In today's highly dynamic business landscape, SIF, facilitated by digital technology, holds immense significance [20, 21]. In line with Klein and Rai [20], this study conceptualizes SIF in terms of digitally sharing strategic information, such as cost structures, margin structures, decision-making processes, etc. Within this conceptual framework, SIF emerges as a DC that enables firms to enhance their responsiveness and adaptability. By leveraging SIF, firms can proactively sense market conditions, swiftly seize new opportunities, and transform strategies accordingly [17]. It involves efficiently

gathering, processing, and disseminating information relevant to the firm's strategic objectives [26]. This enables firms to access real-time, accurate, and comprehensive information to quickly process and act upon new information and adjust strategies both to retain a competitive advantage and survive dynamic situations [2]. In this context, we aim to examine the effectiveness of SIF in enhancing SCV in the presence of SCC.

1.2 Supply chain complexity

SCC is a multidimensional concept that originated from complexity science and has been investigated in different disciplines, such as biology [27] and management science [28]. It has been studied through multiple theoretical lenses, emphasizing its multifaceted nature. Extant literature has discussed several factors that contribute to SCC, such as hyper-consumerism, global sourcing, and outsourcing [5]. It is defined as a compound network of connections involving multiple participants across the SC [3], leading to unpredictability and external conditionalities due to interactions and interdependencies among participants.

Research has grouped SCC characteristics into two main dimensions: structural and dynamic complexity [3, 5, 29]. Structural complexity refers to the multiple actors in a SC [10], whereas dynamic complexity involves complex and ever-changing interactions among network actors [29, 30]. In line with earlier studies [3, 4], we conceptualize structural complexity as upstream detail complexity, upstream spatial complexity, and downstream detail complexity. Dynamic complexity involves delivery complexity and internal operational complexity.

This study operationalizes SCC by integrating its structural and dynamic aspects into a formative construct. Chand, et al. [3] suggested that these dimensions collectively shape SCC, setting its causal direction. Prior research lacks a comprehensive insight into SCC's overall effect and its impact on firms' DCs, hindering a complete understanding of how SCC influences firm outcomes [3, 5]. Incorporating

these dimensions as a formative construct in our framework, individually and collectively, offers valuable insights for both researchers and practitioners. Expanding on resilience, agility, and survivability – represented as SCV – this study ventures into an underexplored area [8, 31]. Past literature mainly focused on the impact of SCC on performance [5], particularly its detrimental impact [32, 33]; however, recent discussions have begun to highlight SCC's potential to enhance resilience [10, 31, 34]. To date, empirical studies have not delved into how SCC affects a firm's survival in a complex network, presenting an opportunity to explore how complex networks may benefit firms. Understanding these impacts can aid in developing strategies and practices that enhance SCV in complex networks.

1.3 Supply chain viability

Previous research advocated proactive and reactive capabilities to enhance SC resilience [35, 36]. The traditional view of resilience and agility in the literature fails to explain how businesses can navigate rapid changes [9, 37], such as in response to pandemic-like disruptions. Also, there have been calls to establish a holistic approach beyond individual SC resilience and agility frameworks [2, 38, 39], leading to the emergence of the SCV perspective [1]. SCV focuses on adaptation and survival amid ongoing disruption rather than reverting to the "old normal" [9]. According to the SCV framework, SCs are open systems striving to adapt to disruptions through agility while simultaneously possessing the capability to withstand, recover, and persist via resilience and survivability dimensions [40, 41].

In this study, we adopt Ivanov's [7] definition of SCV as "*the ability for a supply chain to survive and exist after a disruption, re-planning economic performance with long-term effects, and redesigning the supply chain structure"*. Building on prior studies [7, 8], we argue that the concept of SCV encompasses an integrated framework spanning three perspectives, i.e., agility, resilience, and survivability. Within the SCV framework, agility focuses on adapting and adjusting to the dynamic landscape and reconfiguring existing resources to maximize profitability [2]. Resilience focuses on

absorbing negative events and recovering after unexpected disruptions [42], empowering firms to weather shocks and disturbances, and orchestrating a rebound that minimizes disruption and fosters business continuity. Lastly, survivability aims to meet societal demands by adjusting capacity utilisation and allocation to match demand in response to altered environments [2]. Its objective goes beyond mere recovery, embodying the essence of persistence, long-term endurance, and the ability to flourish despite adversities. As such, the concept of SCV is more oriented toward the long term and extends the traditional resilience view [1, 2, 8].

SCV adopts a holistic perspective by considering both positive (market growth and profitability) and negative changes (disruptions) in the environment [41]. However, resilience mostly reacts to negative events, such as by absorbing, recovering from, and adapting to them [42]. Still, resilience remains a central component of the SCV framework; if an SC can withstand and recover from disruptions, it is resilient. If a resilient SC maintains itself and survives in a dynamic environment with a long-term impact, then it is a viable SC [1]. Therefore, SCV represents an adaptation-based resilience perspective that incorporates the "bounce forward and adapt" perspective instead of the "bounce back" view [43].

The extant SC literature on viability is nascent and lacks empirical validation. The available studies on SCV are predominantly conceptual, with only a few being analytical or empirical. As exemplified by [43] and [1], conceptual studies have established a foundational framework for understanding SCV factors and their interdependencies. Analytical studies [9, 44] assessed vulnerability and viability performance. Finally, empirical studies [2, 45] have provided scale development and theoretical framing for SCV. However, despite these contributions, the influence of SCC on SCV remains unexplored. Hence, empirical validation is crucial. As discussed above, SCV encompasses three crucial characteristics: agility, resilience, and survivability. Therefore, SCV is a formative construct in this study.

2. Conceptual Model and Research Hypotheses

2.1 Relationship between SCC and SCV

SCC, characterized by multiple SC partners belonging to different tiers with interdependencies between them, has become challenging in today's globalized world [5]. To effectively navigate SCC, firms require strategic responses aligned with the DCV framework [46]. DCV provides a theoretical perspective on a firm's ability to sense environmental changes, seize opportunities within the network, and reconfigure resources to manage the challenges posed by SCC. Within this context, it is crucial to understand how exposure to SCC influences SCV, a DC, thus enabling firms to thrive and sustain a competitive advantage.

SCC represents the intricacies and challenges inherent in managing material, information, and financial flows across an interconnected network of upstream and downstream SC actors. A complex environment is perceived as being more uncertain, impeding a firm's ability to make strategic decisions [4]. However, to achieve a given level of performance in dynamic environments, firms must gather information about their surroundings and develop different mechanisms that enable them to adapt and coevolve with the environment [12]. Thus, firms are compelled to intensify their efforts and transform the challenges inherent in SCC into opportunities to develop SCV. A viable SC can survive in a dynamic environment by continuously refining existing and exploring new resources and capabilities [43].

Prior research on SCC has indicated that having a complex web of SC connections can impede disruption recovery [3]. Some authors, however, have challenged this view by arguing for the positive influence of SCC on organizational outcomes [10]. For example, the structural aspect of SCC reflects the built-in redundancy and flexibility within the network [47]. This allows firms to use alternative arrangements and adapt quickly to changing market conditions, enabling them to effectively navigate and respond to disruptions [15]. Moreover, with structural SCC, firms also develop integrative and

coordinative mechanisms to speed up the recovery process by fostering collaboration and resource sharing with SC partners [24]. Complex SCs also encounter delivery uncertainty and demand volatility, i.e., dynamic SCC, heightening the impact of a disruption. However, to maintain agility and resilience, firms can improve internal and external integration and implement digital technologies that analyze vast amounts of data to identify patterns and insights, helping them anticipate and prepare quick responses to disruptions [46].

Aligned with the DCV, when operating in the presence of SCC, firms can proactively build a system that dynamically adjusts to changing circumstances. Firms adapt to SCC by leveraging capabilities from the wider SC, actively utilising and reconfiguring resources to respond effectively, leading to the development of SCV as a DC. Thus, it enables firms to embrace SCC as an opportunity and uncover new ways of streamlining operations [39]. Considering the above discussion, we propose the following hypothesis:

H1: *Exposure to SCC positively influences SCV*.

2.2 The mediating effects of network capability and strategic information flow

Under SCC, firms continuously scan their environment to adapt to changes [32]. To address challenges, firms develop DCs by collaborating with existing and potential partners across different stages of the SC. NC, recognized as a DC, comprises *internal communication*, *interfirm coordination*, *relationship skills,* and *partner knowledge* [19]. These dimensions transcend organizational boundaries, fostering innovative ideas and expertise. Thus, NC enhances the opportunities efficiently developed in the presence of SCC [17, 48]. It can enhance inter-organizational relationships and offer a continual stream of knowledge, hedging against the uncertainty inherent in SCC [46, 49]. NC's applicability under SCC is crucial for improving SCV. Prior research has highlighted NC's significance in adapting to changes, maintaining operational excellence, and enhancing SCV elements [9, 36, 45].

As a DC, *internal communication* integrates external relationships and facilitates information dissemination across departments [50]. It enables the rapid adjustment of operational strategies, plans, and actions to address structural complexities and fosters collaboration across functional departments [15]. This adaptability aids in anticipating disruptions, developing safeguarding mechanisms, and strategizing during turbulence [51]. *Interfirm coordination* embodies a DC by enabling agile responses to dynamic complexity indicators, such as delivery intricacies and operational challenges. It provides opportunities for joint value creation, conflict resolution, and the mitigation of opportunistic behaviour amidst SCC [52-54]. This strengthens the resilience of the SC and aligns with the DCV to adapt and navigate through complexities.

Relationship skills within NC contribute to DC development by fostering mutually beneficial partnerships amidst uncertainties inherent to SCC [5]. Effective relationship management aids in nurturing trust, enhancing collaboration, and facilitating joint problem-solving, ultimately improving adaptability and responsiveness [7]. These are the crucial elements considered within the DCV to sustain a competitive advantage [25]. Lastly, *partner knowledge,* enables firms to leverage their SC partners' expertise, identify risks, and seize new opportunities [49]. This knowledge-sharing enhances strategic planning by facilitating informed decision-making and rapid adjustments, showcasing the DC of reconfiguring competencies. This aids in overcoming SCC challenges and strengthens SCV [2, 19].

Based on the above discussion, we argue that exposure to SCC motivates firms to leverage NC to deal with the uncertainties and interdependencies that exist under SCC. These NCs further enhance SCV. However, extant literature lacks empirical validation of the mediating role of NC in the relationship between SCC and SCV. We explore these relationships to understand how firms adapt and thrive under SCC. We, thus, propose the following hypothesis:

H2: *Exposure to SCC positively influences SCV by developing NC.*

NC in H2 reflects partners' knowledge sharing without specifying the type or method of information exchange. SIF utilises digital technology to share strategic details such as inventory planning, cost structures, marketing strategies, and decision-making processes [17, 20]. Prior literature has discussed how quality information exchange and knowledge transfer are critical to managing SCC [55]. As such, technology-based information sharing under structural and dynamic SCC enhances decision-making adaptability [56], representing a DC. Within the context of DCV, SIF manifests as an adaptive DC that allows firms to continuously gather, process, and disseminate strategic information across the SC ecosystem, fostering agility and responsiveness. For instance, a critical commodity manufacturer may share forecasts and schedules with suppliers through a digital platform, ensuring the timely delivery of quality products by reducing uncertainty. Thus, firms dealing with SCC recognize the significance of SIF in bolstering SCV by leveraging digital capabilities for dynamic information exchange and adaptation.

Information flow shapes organizational structures for SCV [7]. It processes data for informed decision-making, fostering transparency and coordination [45]. Moreover, high-quality information exchange enables better decision-making [57]. In the presence of SCC, SIF facilitates continuous adaptation and learning, offering insights that create a dynamic market understanding and help develop agile and resilient SC strategies [10]. Moreover, technology-based information sharing enhances network visibility, coordination, and responsiveness, strengthening SCV [58, 59]. Based on the above discussion, we argue that exposure to SCC is a potential driver for firms to leverage the DC of SIF to enhance SCV. Thus, we hypothesize:

H3: *Exposure to SCC positively influences SCV through SIF*.

Besides the distinct mediating role played by NC and SIF in the link between SCC and SCV, we examine the existence of a serial mediation link. We probe whether SIF and NC jointly and sequentially mediate the link between exposure to SCC and SCV. Extant literature has highlighted the challenges of

developing NC under turbulence and SCC for resilience and agility [60, 61]. Prior literature points to the significance of integrating technology-based SIF with NC in developing SC strategy to ensure long-term responsiveness and adaptability in the face of SCC [62]. Therefore, we posit that SIF fosters collaboration among network partners by sharing sensitive and critical data. Aligning with the DCV, the integration of strategic information-sharing through SIF with NC demonstrates a firm's commitment to collectively addressing challenges, encouraging knowledge sharing, facilitating joint decision-making, and developing innovative solutions that manage SCC and enhance SCV. Thus, both SIF and NC would be required in the face of SCC to develop the DC of SCV. We, therefore, hypothesize that:

H4: *Exposure to SCC positively influences SCV sequentially through SIF and NC.*

Our proposed research hypotheses are shown in Figure 1.

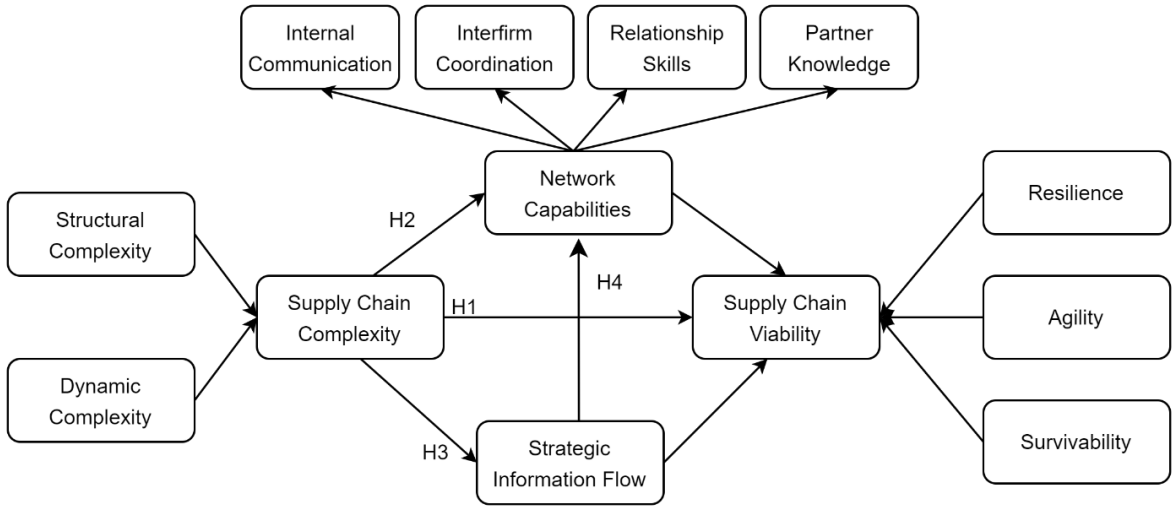

Figure 1. Research Framework

3. Methodology

This research employs a quantitative online survey to validate the research framework (Figure 1) and proposed hypotheses in line with recent studies [3, 63]. We collected 242 responses from SC managers of Pakistani firms using simple random sampling to ensure unbiased participant selection. The data was obtained through the Security and Exchange Commission of Pakistan (SECP), the country's primary

regulatory body. This approach enhances the sample's representativeness, making our findings more robust. Our study focused on the firm level in Pakistan, an under-researched emerging economy, offering a unique chance to contribute valuable insights to SCC literature. Pakistan's economy relies heavily on its extensive SC networks, worth around $25-30 billion annually (2021 Pakistan Economic Survey). These SCs are vital to the global market, and disruptions could have far-reaching effects on downstream segments worldwide. This highlights the importance of addressing and understanding SC challenges in Pakistan.

3.1 Constructs and measures

The research framework draws from a comprehensive review of existing literature, utilising validated item scales rated on a 5-point Likert scale, ranging from (1) "strongly disagree" to (5) "strongly agree". The study centres around a single independent variable, namely, SCC. It is conceptualized as a second-order formative construct consisting of two first-order constructs of structural and dynamic complexity. The scales for structural and dynamic complexity were adapted from prior studies [5, 11, 29]. We have conceptualized the dependent variable, SCV, as a second-order formative construct with three first-order constructs: SC resilience [64], SC agility [65], and SC survivability [7, 45]. The theoretical justification for a formative construct is that the first-order constructs are combined and collectively develop the meaning and measurement of the second-order construct [66, 67]. In line with [68], the construct's measurement items met the criteria specification for formative constructs, indicating that the items are distinct and not interchangeable. Moreover, the direction of causality is from the first-order to the second-order construct (see Figure 1).

NC and SIF are used as the mediating variables. These variables, based on the seminal work of Walter [19] and Klein and Rai [20], respectively, are instrumental in shaping the relationships between SCC and its outcome. In line with Partanen, et al. [17], we conceptualized NC as a second-order reflective

construct, with internal communication, interfirm coordination, relationship skills, and partner knowledge as the first-order constructs.

3.2 Main survey

Data for this study was gathered from firm managers operating in multiple industries. To obtain the necessary information, a structured questionnaire was distributed to 1,200 respondents. Two email reminders were sent to the participants to improve the response rate. We received 242 valuable responses, resulting in a response rate of 20.2%. The demographic information of the participants can be seen in Table I-OA in the Online Appendix. Before the final rollout, we pre-tested the questionnaire, as discussed in the Online Appendix.

To ensure the validity of the findings, non-response bias was rigorously examined following the established guidelines outlined in Armstrong and Overton's work [69], a methodology commonly adopted in previous survey-based studies within this field (e.g. [70]). Specifically, early and late respondents were compared across the four variables of the model at the construct level (see Figure 1). Based on an independent sample t-test, the analysis revealed no statistically significant differences ($p > 0.05$) between the two groups of respondents. Thus, the study confirmed that non-response bias did not pose a concern for interpreting results.

4. Data Analysis and Results

This study utilised the partial least square structural equation modelling (PLS-SEM) technique using SmartPLS 4.0. We selected this approach as it is suitable for predictive modelling, can test complex mediation models, handles formative constructs, and can evaluate mediating effects with fewer restrictions on distributional assumptions, as evidenced by earlier studies in the SC literature [71, 72].

Following the suggestion of Chin [73], we first analyse our research model by assessing the reliability and validity of the measurement model before examining the structural model.

4.1 Measurement model evaluation

The reliability and validity tests were performed following recent work [3, 63]. The average variance extracted [74] and composite reliability values surpassed the required threshold levels of 0.50 and 0.70, respectively, in line with Nunnally [75] and Hair [76]. Furthermore, we assessed convergent validity by examining the factor loading of individual items. All items exhibited factor loadings greater than 0.50 and were adequately loaded onto their respective variables, consolidating the convergent validity of our measurement model. We also tested variance inflation factors (VIF) to address any concerns regarding multicollinearity. The VIF values were well below the threshold of 10 [71], with the highest VIF recorded at 3.425 (see Table II-OA in the Online Appendix). This result confirms that multicollinearity is not a significant issue in our analysis.

Additionally, we report the Heterotrait-Monotrait Ratio (HTMT) metrics to assess discriminant validity (see Table III-OA in the Online Appendix). The values of each construct are significantly below the threshold level of 0.85 recommended by [77]. This suggests that discriminant validity is established, i.e., that constructs are distinct.

We took proactive and reactive steps to tackle common method bias (CMB) [78]. Proactively, before data collection, we minimized CMB by using established measurement items, ensuring respondent anonymity so they complete the survey objectively, structuring the questionnaire distinctly, and segregating variables [14, 79]. Post-data collection, we used the marker variable (MV) technique to assess the CMB [80]. We considered employee experience as the MV as it has no theoretical relationship with the endogenous variable, SCV. Our analysis demonstrated that the MV exhibited a non-significant correlation (maximum R-value <0.08) with all relevant variables in our model. In addition, the VIF

values were much lower than the threshold level, confirming the accuracy and quality of responses. As such, multiple statistical analyses indicated that CMB was not a serious issue in our study.

4.2 Structural model analysis - Hypotheses testing

Following the guidelines recommended for using the PLS-SEM technique [81], we tested the direct and specific indirect effects (mediation effects) using a 5,000 subsample bootstrapping procedure based on a 95% bias-corrected confidence interval. The results are summarized in Table IV below. The results show that exposure to SCC positively and significantly impacts SCV ($\beta = 0.351$, $p = 0.000$); thus, H1 is supported. We also tested the mediation effects via H2, H3, and H4 by following the recommendation of Preacher and Hayes [82]. The indirect effects of NC on the relationship between SCC and SCV were positive and significant ($\beta = 0.107$, $p = 0.002$). Thus, H2 is supported, and mediation exists. The indirect effects of SIF on the relationship between SCC and SCV were positive and significant ($\beta = 0.024$, $p = 0.040$). Thus, H3 is supported, and mediation exists. Similarly, the indirect effects of the sequential mediation from SIF to NC on the relationship between SCC and SCV were positive and significant ($\beta = 0.125$, $p = 0.001$). Thus, H4 is supported, and mediation exists.

Table IV: Structural model results

Hypothesis	Path Coeff.	T stats	P - Value	CI LL	CI UL	Decision
H1) SCC -> SCV	0.351	5.214	p<0.001	0.199	0.464	Supported

Mediation Analysis

Hypothesis	Total Effect	Direct Effect	Indirect Effect	CI LL	CI UL	T stats	P - Value	Decision
H2) SCC -> NC -> SCV	0.584	0.351	0.107	0.045	0.174	3.093	0.002	Supported
H3) SCC -> SIF -> SCV	0.584	0.351	0.024	0.053	0.105	1.999	0.04	Supported
H4) SCC -> SIF -> NC -> SCV	0.584	0.351	0.125	0.062	0.200	3.455	0.001	Supported

4.3 Robustness tests

To ensure the robustness of our results, we tested for endogeneity. In particular, we conducted a Gaussian Copula (GC) test [83]. Before conducting the GC test, we confirmed that the variables presenting the potential bias of endogeneity are non-normally distributed. The Kolmogorov-Smirnov test with Lilliefors correction on our empirical constructs returned p-values <0.05, thus suggesting the constructs were non-

normally distributed [81]. Thereafter, the GC test was performed by creating different combinations of the model (see Table V-OA in the Online Appendix). The GCs of all combinations showed insignificant p-values (>0.05). This indicates that there is no evidence of endogeneity, thus confirming the robustness of our model.

5.4 Test for control variables

The dataset differs in terms of the work experience and gender of respondents, company size, and industry. Hence, we control for their effect using dummy variables. The dummy variables were created as follows: experience (1 = less than 11 years, and 2 = more than 11years); firm size (1 = below 500 employees, 2 = 500–1,000 employees, 3 = more than 1,000 employees); gender (1 = male, and 2 = female); and industry type (1 = food & beverages, 2 = apparel and textile, 3 = automotive, 4 = construction, 5 = consumer goods, 6 = consumer electronics, 7 = shipping and logistics, 8 = pharmaceuticals, 9 = banking, hospitality and consulting, 10 = energy and utility, 11 = others). We then regressed the dummy variables on the dependent variable. The results were non-significant for experience ($p = 0.513 > 0.05$), firm size ($p = 0.321 > 0.05$), gender ($p = 0.432 > 0.05$), and industry type ($p = 0.234 > 0.05$), confirming that these variables have no confounding effect on the main relationships (hypotheses) in our model.

5. Discussion

SCC has become a prevalent phenomenon in today's globalized business environment. We contribute to research on SCC by leveraging DCV as a theoretical lens to explore how SCC prompts firms to build organizational capabilities. Firms operating under SCC are exposed to dynamic and uncertain environments. Thus, they must adapt to the environment to survive, thrive, and maintain competitiveness [12]. Using DCV, we explain that firms develop SIF and NC as DCs motivated by SCC to enhance SCV.

We have examined the intricate relationship between SCC and SCV. In doing so, we have empirically validated that exposure to SCC has a positive and significant relationship with SCV (H1). This implies that firms operating under the influence of SCC are compelled to strategically organize their SCs to outperform the competition and strive for long-term viability. Through the lens of DCV, firms, when faced with the high level of uncertainty inherent to SCC, are pressured to adapt by changing their course of action, such as by introducing new products or reconfiguring their SCs [24, 32]. This line of argument is also congruent with the SC strategy-structure-performance paradigm, which posits that firms revisit SC strategies when exposed to external environmental shocks, leading to enhanced performance [12]. The positive relationship also implies that firms under SCC have access to diverse sources of knowledge, reflecting an open innovation paradigm [39], enabling them to explore the knowledge and expertise of SC partners to develop novel and innovative solutions. Drawing from the DCV lens, our argument is consistent with earlier studies that suggest an uncertain environment triggers firms to enhance agility, resilience, and survivability [15, 46].

Earlier research on SCC was mostly qualitative and pointed out the importance of ambidextrous relationships with SC partners [6]. However, the validation of the mechanisms between SCC and SCV has been missing [5, 10]. Our study adds to existing scholarship by adopting a DCV lens to empirically examine how exposure to SCC motivates firms to enhance and develop NC. Our finding related to H2 suggests that NC has a significant mediating impact on SCC and SCV. This means that NC is instrumental to understanding how firms navigate the complexities inherent in today's SCs, leveraging their NC to effectively mitigate uncertainties and attain resilience, agility, and survivability objectives. Indeed, disruptive shocks under SCC impede SC performance, underscoring the imperative for firms to employ adaptive capabilities. Our results suggest that to maintain competitiveness and operational continuity in today's dynamic business landscape, firms must adopt a more collaborative approach and

form strategic alliances [17, 32]. Traditionally, firms have pursued lean principles within their SCs, prioritizing efficiency gains by eliminating slack resources [9]. While this approach has yielded significant efficiency dividends, the inflexibility of this approach became evident during the COVID-19 pandemic. In contrast, NC retains the ability to outperform the competition through robust inter-organizational alliances and by nurturing a culture of knowledge-sharing and innovation, offering firms the agility, resilience, and survivability needed to thrive amidst SCC.

Our analysis for H3 revealed that firms rely on SIF under the influence of SCC to enhance their SCV. Using the DCV lens, SIF transcends mere data exchange. It becomes an adaptive competence. Firms enhance network visibility by proactively sharing sensitive, quality information. Moreover, real-time insights enable quick adjustments by modifying production schedules, redistributing inventory, or changing logistics routes. The test results also indicate that firms with SCC prioritize investments in information systems and advanced analytics to detect potential disruptions and develop survival strategies. Our findings align with the theory that firms under SCC engage in more collaborative behaviours with SC partners, as SIF promotes ongoing adaptation, alignment, and process reconfiguration to boost agility and resilience [84, 85]. SIF emerges as a DC within this dynamic context, positioning firms for enhanced viability.

Our final hypothesis, H4, confirms a partial mediation effect within the sequential path connecting SCC to SCV, mediated by SIF and NC. It signifies that SIF and NC, while individually valuable for enhancing SCV, yield even greater benefits when combined sequentially. This finding is pivotal because it underscores the importance of viewing these factors not in isolation but as a synergistic duo, emphasizing the compounding advantages when SIF and NC are aligned in organizational efforts to bolster SCV. This suggests that NC and SIF can operate independently since they address different aspects of SCM [17, 20]. We are the first to argue theoretically and offer empirical evidence that supports

the distinct nature of the underlying mechanisms, SIF and NC. While both factors contribute to SCV, they do so in different ways. SIF focuses on sharing inventory planning, marketing strategies, cost structures, and production schedules to facilitate informed decision-making. In contrast, NC primarily addresses the interconnections and relationships between partners, emphasizing the importance of smooth coordination and communication. Since they address separate aspects of SCM, strengthening one factor does not necessarily depend on the strength of the other. Firms can independently improve NC and SIF, which can positively impact SCV.

5.1 Theoretical implications

This study builds on and extends prior SCC and SCV research [31, 34]. Prior literature has predominantly portrayed SCC as a hindrance, highlighting its detrimental effect on resilience and agility. However, our research diverges from this conventional perspective by offering a novel outlook on managing SCC. Rather than viewing it as a source of challenge, we argue that it allows firms to utilise their network resources and develop response mechanisms. While existing literature confirms that SCC affects SC resilience [31, 86], our study offers a more detailed explanation that goes beyond the traditional view of resilience from "bouncing back" to "bouncing forward", as reflected in the overarching concept of SCV. Given the contradictory findings relating to SCC in the disruption management literature [67], what remains unaddressed is whether SIF and NC could serve as a response mechanism to SCC and act as an enabler of SCV.

Grounded in DCV, our research stresses the role of SIF and NC in managing the challenges that occur when a firm is exposed to SCC and reveals how these capabilities enhance SCV. When operating under the conditions of SCC, firms develop DCs as response mechanisms to effectively adapt and thrive to remain competitive and ensure long-term success. Our research contributes to existing scholarship by highlighting that NC and SIF are related concepts, yet they can influence organizational outcomes

independently and synergistically. Additionally, we address the call for research that explores the role of DCs in managing SCC [87] and contribute to the theoretical development of SCC through the lens of DCV.

The ongoing debate about SC relationships centres on whether building relationships with stakeholders (i.e., NC) diminishes in turbulent and uncertain environments [60]. We propose, however, that NC strengthens the positive impact when SIF initially enhances the relationship between SCC and SCV. Essentially, the two mediators complement each other, amplifying their effects and leading to even better outcomes for SCV. This combined advantage arises from the synergistic relationship between the two mediators, which work harmoniously to optimize SCM in complex environments. DCV supports this idea by highlighting the interconnectedness of different organizational capabilities. Our findings are consistent with Frazier, et al. [88] and Wiengarten and Longoni [89] by showing that, in complex SCs, strategic information sharing establishes the foundation for exchange relationships and mitigates the adverse escalation of uncertainties emerging from these networks. Finally, the DCV perspective helps explain how firms develop and apply DCs, such as SIF and NC, to enhance SCV in the face of SCC.

5.2 Practical implications

This study offers significant insights for managers of complex SCs seeking to develop SCV to survive disruptions and sustain long-term competitive advantage. Recognizing that exposure to SCC can lead to positive outcomes for SCV can improve managers' understanding that SCC is not just a challenge; firms must embrace it as an opportunity. Modern SCs have become more globalized and complex over time. Since SCC is inevitable, managers can consider it an opportunity or catalyst to strategically redesign their SC networks with changing business dynamics to ensure long-term survivability and adaptability (resilience). For example, General Motors (GM) utilised the challenges posed by SCC during the pandemic to drive innovation and resilience in its SC. Facing disruptions in component supplies, GM

rapidly adapted its manufacturing processes to produce essential medical equipment, such as ventilators. By repurposing existing production facilities and collaborating with new suppliers, GM addressed critical shortages and diversified its SC network, enhancing its resilience to future disruptions.

Given the indirect positive influence of SIF on SCV, firms should prioritize enhancing strategic information-sharing practices among SC partners. SIF, for instance, necessitates the alignment of inventory and capacity planning, production schedules, and cost structures to optimize margins. Additionally, it encourages firms to adapt marketing strategies and decision-making processes in response to evolving demand patterns for more effective SCM. The findings also underscore the importance of investing in NC to achieve SCV. Based on our analysis, we suggest managers should cultivate open internal communications and proactive coordination with partners to foster NC, create a collaborative working environment, and ensure effective external relationships. We also suggest to policymakers that governments could play a significant role in building SC resilience and viability through legislation and incentives. Depending on resource availability, firms can strengthen either one or both aspects to improve SCV. However, it is important to recognize that while both capabilities contribute positively to SCV in the presence of complexity, their combined effect leads to even more substantial improvements. Thus, addressing both NC and SIF in tandem is vital for optimizing SC performance.

5.3 Limitations and future research directions

Our research has a solid foundation but is not without limitations. First, the empirical data obtained in this research was from a developing and emerging economy, Pakistan. Therefore, the findings may not directly apply to other economies that differ significantly from Pakistan. However, the findings are relevant to developing regions facing intense global competition. Another limitation is the conceptualization of the SCC construct. Future studies may consider adopting different dimensions of

SCC than ours and examine their interactions with SCV or examine contextual factors, like culture, regulatory environment and market integration, to explain the mixed results in the literature. Longitudinal methods or action research could also provide deeper insights into the SCC – SCV domain through systematic inquiry and reflection, offering both practical solutions and theoretical contributions.

Additionally, our study utilised a single-respondent survey approach. While this approach is common in SCM research, it also raises concerns about CMB. To address this, we employed rigorous procedural and statistical controls, including established scales, construct separation, pre-testing, VIF analysis, marker variable technique, and endogeneity tests, as detailed in sections 4 and 5. While some studies advocate for a multiple-respondent survey approach, this view should be considered a guideline, not a strict rule [90]. While acknowledging the limitation of single respondent design, future research could expand on our findings by examining how SC managers perceive and respond to complexity through multiple respondents or secondary data to corroborate our results.

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Online Appendix

Pre-test:

Most items in the study were validated through prior research. Additionally, we conducted content validity and reliability tests on the adapted measurement items. We sought feedback from four industry executives and two academics with practical and theoretical knowledge to enhance the robustness of the study. The four industry executives were identified through the first author's professional network and possessed extensive supply chain experience in local and international markets across the manufacturing and service sectors. They suggested refining certain survey items for clarity. For example, regarding the NC construct, initially, we listed all scale items together in the questionnaire to keep it concise, but one executive recommended segregating them into different dimensions. Within the demographic section for the industry classification, we used ISIC descriptions. However, feedback suggested aligning these classifications with local industry terminology to better reflect current practices. An earlier version of the questionnaire also referred to annual sales in US dollars. However, we were advised to change this as small enterprises report their sales in local currency.

The two academics, who were selected for their expertise in theoretical constructs, were approached through internal university channels. They provided feedback on positioning the empirical constructs in the questionnaire to address potential common method bias issues. They suggested separating the dependent variables, i.e., supply chain resilience, agility, and survivability, in the questionnaire to avoid confusion. For the supply chain survivability construct, the phrase "adapt to disruptions" was revised to "adapt to internal/external disruptions" for greater clarity. Similarly, "facilitating rapid recovery" for the supply chain resilience construct was

modified to “enabling rapid recovery”. Overall, these combined insights refined the questionnaire and improved its effectiveness. We then conducted a pre-test with 50 industry respondents. The industry respondents for the pre-test were contacted through the professional social networking site, LinkedIn. Importantly, pre-test participants were excluded from the main survey and subsequent analysis to avoid biases.

Endogeneity Bias:

We also took additional steps to address the potential endogeneity bias. Endogeneity may occur from reverse causality or omitted variable [1]. However, our study's hypotheses are grounded in the DCV, which avoids reverse causality; that is, SCV does not cause SCC. We ran the Gaussian Copula test and developed different combinations of empirical constructs and received insignificant p-values, thereby suggesting no endogeneity issues in the study. The satisfactory common method bias results also ensure a lack of endogeneity issues [1, 2].

Table I-OA: Demographic Profile of the Respondents

Dimension	Category	Number	Percentage
Age	25 - 34	65	27%
	35 - 44	108	45%
	45 - 54	42	17%
	Over 55	27	11%
Work Experience (years)	Less than 11 years	115	48%
	More than 11 years	127	52%
Firm size	Below 500 employees	98	40%
	500 - 1000 employees	66	27%
	More than 1000 employees	78	32%
Annual Sales (Million PKR)	0 - 1000	59	24%
	1001 - 2000	41	17%
	2001 - 3000	53	22%
	> 3001	89	37%
Managerial Designation	Manager/Senior Manager	163	67%
	General Manager	28	12%
	Director	20	8%
	CEO/Owner	20	8%
	Assistant Manager	11	5%
Industry	Consumer Goods	68	28%
	Apparel and textile	40	17%
	Automotive	31	13%

Pharmaceuticals	30	12%
Consumer Electronics	19	8%
Others	15	6%
Energy and Utility	14	6%
Banking, Hospitality and Consulting	12	5%
Construction	8	3%
Shipping and Logistics	5	2%

Table II-OA: Reliability of Constructs and Items

Construct/dimension/indicator	VIF	Loading	CR	AVE
SC Complexity				
Structural Complexity	1.378	0.772	0.771	0.564
We have multiple suppliers for each material/part.	1.299	0.766		
Our suppliers are located in diverse geographical areas.	1.130	0.712		
Our firm/plant serves a large number of customers	1.278	0.746		
We have multiple production or logistics facilities in different areas.	1.349	0.783		
Dynamic Complexity	1.378	0.901	0.812	0.519
We can depend on on-time delivery from suppliers in this supply chain.	1.129	0.765		
Our company strives to shorten supplier lead time to avoid inventory and stockouts.	1.085	0.690		
We often face demand variation in our products.	1,194	0.721		
Our customer desire different products with multiple features.	1.113	0.691		
Network Capability				
Internal Communication	2.318	0.783	0.802	0.576
In our company we have regular meetings for every project.	1.047	0.714		
In our company employees develop informal contacts among themselves.	1.052	0.754		
In our company managers and employees often give feedback to each other.	1.083	0.801		
Coordination	2.467	0.816	0.858	0.672
In our company, we develop relations with each partner based on what they can contribute.	2.532	0.901		
In our company, we discuss regularly with our partners how we can support each other.	2,437	0.884		
We judge in advance which possible partners to talk to about building up relationships.	1.106	0.646		
Relationship Skills	2.072	0.840	0.866	0.684
In our company we have the ability to build good personal relationships with our business partners.	1.197	0.722		
In our company we can deal flexibly with our partners.	1.553	0.892		
In our company we almost always solve problems constructively with our partners.	1.327	0.853		
Partner Knowledge	1.812	0.800	0.904	0.759
In our company we know our partners' markets.	2.013	0.901		
In our company we know our partners' products/procedures/services.	1.293	0.804		
In our company we know our partners' strengths and weaknesses.	2.100	0.903		
Strategic Information flow			0.948	0.724
Inventory/capacity planning	2.825	0.835		
Production schedules	2.354	0.814		
Cost structures	3.214	0.851		
Margin structures	3.420	0.846		
Marketing strategies	3.425	0.881		
Demand patterns	2.087	0.836		
Decision-making processes	3.176	0.867		
SC Viability				
SC Resilience	1.262	0.865	0.903	0.651
Our supply chain demonstrates swift response capabilities, efficiently restoring product flow in the face of unexpected disruptions.	1.583	0.810		
We possess effective strategies to address the financial implications resulting from potential supply chain disruptions.	1.770	0.808		

We can promptly respond to supply chain disruptions, ensuring minimal disruption to our operations.	2.409	0.874		
Our supply chain exhibits easy adaptability to disruptions, enabling rapid recovery and resumption of normal operations	1.708	0.807		
We have the capacity to successfully cope with changes induced by supply chain disruptions, facilitating efficient recovery and restoration of stability.	1.379	0.721		
SC Agility	1.286	0.879	0.790	0.508
Adapting manufacturing/operational lead times	1.528	0.851		
Adapting customer service level	1.614	0.658		
Adapting delivery reliability	1.958	0.864		
Adapting responsiveness to changing market needs	1.231	0.629		
SC Survivability	1.365	0.722	0.880	0.647
Our supply chain and logistics networks can remain effective and adapt to internal/external disruptions for long-term survivability and sustainability	1.779	0.830		
Our supply chain and logistics networks can effectively respond and adapt to anticipated risks for long-term survivability and resilience	1.533	0.784		
Our supply chain and logistics networks can consistently absorb and recover from negative business impacts for long-term survivability and adaptability	1.595	0.801		
Our supply chain and logistics networks can make timely and effective decisions to respond to disruptions for long-term survivability and agility.	1.705	0.796		

Table III-OA: HTMT Values

	1	2	3	4	5	6	7	8	9	10
1. Agility										
2. Dynamic Complexity	0.569									
3. INCMN	0.811	0.551								
4. INCOOD	0.684	0.565	0.774							
5. PKNOW	0.649	0.468	0.712	0.628						
6. Relationship Skills	0.618	0.580	0.697	0.794	0.735					
7. Survivability	0.623	0.609	0.657	0.552	0.565	0.677				
8. Resilience	0.626	0.667	0.673	0.546	0.538	0.583	0.757			
9. Strategic Inf Flow	0.591	0.485	0.641	0.551	0.803	0.771	0.483	0.467		
10. Structural Complexity	0.528	0.553	0.529	0.506	0.450	0.474	0.463	0.665	0.472	

Table V-OA**.** Endogeneity Test Results

Variable	Model 1 (endogenous variable: NC)		Model 2 (endogenous variable: SCC)		Model 3 (endogenous variable: SIF)		Model 4 (endogenous variable: NC, SCC)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
NC	0.281	0.361	0.373	0.002	0.364	0.003	0.289	0.331
SCC	0.311	0.001	0.064	0.847	0.313	0.002	0.066	0.839
SIF	0.072	0.621	0.084	0.567	0.020	0.938	0.082	0.576
Cnc	0.089	0.762					0.087	0.760
Cscc			0.260	0.417			0.259	0.415
Csif					0.048	0.794		

Variable	Model 5 (endogenous variable: NC, SIF)		Model 6 (endogenous variable: SCC, SIF)		Model 7 (endogenous variable: NC, SCC, SIF)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
NC	0.276	0.374	0.371	0.002	0.285	0.343
SCC	0.316	0.001	0.072	0.834	0.075	0.826
SIF	0.016	0.950	0.042	0.869	0.039	0.882
Cnc	0.092	0.757			0.090	0.757

Cscc			0.255	0.441	0.254	0.439
Csif	0.049	0.788	0.036	0.844	0.038	0.839

Cnc: Gaussian Copula term for NC; Cscc: Gaussian Copula term for SCC; Csif: Gaussian Copula term for SIF

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