Linking Supply Chain Resilience Strategies for Surviving Major Disruptions

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ABSTRACT

Supply chain disruptions, arising from the onset of the Coronavirus Disease 2019 pandemic over the preceding three years, have engendered a notable inflexibility within the supply chain. These disruptions, occurring concomitantly at the global network level, have led to the failure of individual connections and nodes inherent to the supply chain. Furthermore, a spectrum of events encompassing operational risks, natural disasters, pandemics, transportation disruptions, cyber insecurity, and financial crises is anticipated to precipitate significant disruptions in the future. This prospective scenario bears profound consequences for the resilience of supply chains. In academic spheres, there is a burgeoning interest in allocating resources towards enhancing supply chain flexibility. Such strategic investments are deemed instrumental in mitigating the risk associated with the non-attainment of project management objectives, thereby ensuring the sustenance of a competitive advantage in the market. Additionally, within each business's supply chain network, there exists the potential for adept individuals capable of navigating the current situation and adapting to various contingencies. Consequently, this adept management holds the promise of safeguarding supply chains, enhancing their resilience. This scholarly exposition systematically examined the extant literature pertaining to supply chain resilience, with a particular emphasis on the strategies and operational directives employed by diverse organizations. The inquiry discerned that the enhancement of supply chain resilience hinges on the implementation of a thorough assessment of mitigation scenarios within the supply chain. Additionally, resilience indicators emerged as valuable tools for evaluating the prevailing mitigation conditions within the supply chain.

KEYWORDS: Supply Chain Resilience (SCR), Supply Chain Management (SCM), Supply Chain Mitigation Scenarios, COVID-19.

1. INTRODUCTION

In early 2020, the COVID-19 pandemic caused a significant supply chain slowdown, sparking increased scholarly focus on supply chain flexibility. Organizations responded by adopting proactive protocols to build resilient supply chains capable of withstanding future disruptions like new epidemics or cyberattacks. Over the past three years, organizations have addressed vulnerabilities in their complex, global supply networks. As per McKinsey (2022),

organizations responded to disruptions by increasing inventory, completing projects, and decentralizing production to enhance supply chain flexibility, thereby bolstering their resilience (Piprani et al., 2022). Furthermore, decentralization mitigated risks and enhanced proximity to customers. Nevertheless, the supply chain challenge revealed that multiple facilities incurred higher costs, necessitating increased inventory to sustain service levels (Brown, 2022). Therefore, the process of decentralization sustained the manifold challenges experienced during the pandemic and facilitated the continued governance of the supply chain (Deloitte, 2022). Illustratively, numerous enterprises implemented alterations to their supply network configuration through the adoption of dual sourcing strategies. These modifications encompassed transitioning from a global network to a regional one and enhancing both demand and supply planning. However, this transition precipitated a scarcity of skilled personnel. Consequently, diverse organizations recommenced initiatives to expedite digitalization and incorporate sophisticated planning systems (McKinsey, 2022).

The deceleration in the supply chain transpired due to a multitude of factors. Brown (2022) anticipating the next significant disruption as a potential cyberattack or labor strike causing production loss, a strategic plan is imperative for rebuilding core competencies. Flexibility is crucial, as organizations with global networks are susceptible to broader impacts from local disruptions (Agostini et al., 2023). Incorporated into the supply chain strategy, procurement plays a pivotal role in guaranteeing an uninterrupted supply in circumstances where the primary source is unavailable (SGS, 2023).

Successfully managing an organization necessitates adaptability to changing circumstances. Awareness of the pivotal roles played by producers, service providers, and consumers in every supply chain activity is crucial, considering potential environmental impacts from upstream to downstream processes (Supachaiwat, 2021). Similarly, a company's learning and continuous improvement-oriented capabilities encompass the significance of both supply chain management (SCM) and supply chain disruption orientation (SCDO) (Yu et al., 2019). This involves considerations of disruptions stemming from market changes or environmental influences. Therefore, it becomes imperative to evaluate the value and efficacy of the organization's current resources and capabilities (Helfat & Winter, 2011). As per Deloitte (2022), a firm's resilience is intricately linked to its flexibility, agility, collaboration, predictability, and emphasis on network-centric approaches. Moreover, the National Research Council (2012) defines supply chain resilience (SCR) as a process encompassing four key stages: planning, absorbing, recovering, and adapting..

Planning entails organizations anticipating disruptions and devising strategies to address them proactively. This involves implementing diverse approaches like standardizing procedures, utilizing failure mode and effects analysis (FMEA), obtaining insurance coverage, maintaining safety stock, and diversifying production locations. **Absorbing,** within the context of supply chains, frequently witnesses the most significant adverse effects. The system aims to efficiently mitigate shock to minimize the peril presented. This involves evaluating the supply chain and gauging the degradation in performance due to the disruption, aiding in the assessment of absorptive capacity. **Recovery** is characterized as the stage subsequent to the initial shock, with a subsequent phase dedicated to reinstating normalcy. The aim is to expedite and optimize the system's recuperative process. **Adaptation** is delineated as a phase where organizations derive valuable insights from challenging experiences, leading to a transformative process enhancing their flexibility and resilience.

Consequently, stakeholders within the supply chain must formulate and implement diverse strategies for absorption, recovery, and adaptation in response to disruptions, characterized by varying magnitudes. While the concept of flexibility has garnered increased attention in recent times, scholars underscore the significance of supply chain flexibility through innovative methodologies. This signifies an augmented comprehension of how to adeptly manage and alleviate the impacts on SCR. Accordingly, this article initiates with an examination of the adaptation cycle and its implications on SCR within a dynamic global milieu. Subsequently, it delves into a discourse on the principal drivers enhancing SCR, elucidates the initiation and repercussions of supply chain disruptions, explores real-time alert monitoring, and explicates inferencing within a collaborative, interconnected supply chain. Consequently, a compendium of resilience indicators emerges as a resource to address or counteract disruptions and ensure the sustainability of the supply chain.

2. LITERATURE REVIEW

2.1 From Supply Chain Resilience Enablers to Supply Chain Resilience

Dynamic organizational capabilities, termed as strategic supply chain resilience capabilities, have the potential to foster the establishment of resilient supply networks. Extant literature underscores the significance of flexibility as a valuable competitive advantage (Birkie, Trucco, & Fernandez Campos, 2017). Strategic Capability Resource Environments (SCREs) form an integral component of the Resource-Based View (RBV), providing a framework for attaining competitive advantages through the strategic amalgamation of resources and capabilities within distinct organizations (Barney, 1991; Teece, 2007). Additionally, Teece (2007) concentrates on the scrutiny of autonomous renewable energy systems within the context of a critical disruption framework to comprehend their efficacy and resilience potential . Consequently, in conjunction with the previously delineated, Son et al. (2014) contributed insights into the dimension of flexibility within the supply chain. This encompasses agility, collaborative endeavours among partners, information dissemination, visibility across the supply chain, sustainability considerations, risk and revenue sharing, trust among partners, the cultural aspect of supply chain risk management, and adaptive capability.

Moreover, Deloitte (2022) delineates that resilience and efficacy in a supply chain network are bolstered by attributes such as agility, flexibility, predictability, network-centricity, visibility, and control. Agility involves structuring a supply chain based on geographical diversity, diversified sourcing, and the capacity to navigate market and supply chain disruptions. Flexibility denotes the ability to promptly adapt without incurring additional costs, achieved through fostering symbiotic relationships and trust with supply chain partners. Predictability involves anticipating issues across the supply chain and initiating concurrent planning and execution. Network-centricity emphasizes synchronization by optimizing the end-to-end (multi-tier) procurement network to facilitate coordination and risk mitigation. Visibility entails illuminating the entire supply chain, essential for pre-empting risks. Control pertains to enhancing decision-making capabilities in the supply chain under key performance indicator (KPI) standards by sourcing operations, thereby increasing control over the entire supply chain. Strategic Capability Resource Environments (SCREs) represent a dynamic array of capabilities crucial in constructing strategic capability resources. Furthermore, the literature posits that no single capacity, in isolation, would suffice to attain a state of adaptation. Deloitte (2022) asserts that Industry 4.0's manufacturing landscape has propelled the prominence of smart devices, exemplified by the operation of autonomous vehicles. These devices facilitate effective

performance monitoring through data analysis, enabling precise measurement of numerous operations in terms of time and efficiency. The heightened utilization of smart devices further enhances the capacity to analyse delays or disruptions in operational processes, promoting streamlined information flow. Despite the automation's advantages, the requirement for competent maintenance personnel is acknowledged. Nevertheless, smart devices emerge as pivotal tools for fortifying resilience in tandem with routine organizational activities. The participants were denoted as entities within the commodities, consumer goods, and chemical sectors. It was verified that prevailing geopolitical disruptions were not presently impeding critical supply chains. Consequently, the significance of the commodity, consumer goods, and chemical sectors lies in their relevance to structural alterations, such as nearshoring or network redesign, aimed at mitigating potential challenges (McKinsey, 2022).

2.2 Adaptive Cycles and Supply Chain Resilience in A Constantly Changing World

Enhancing flexibility in supply chain management has garnered significant scholarly attention. Scholars have contributed valuable insights through the examination of historical data analysis, assessing performance in flexibility within SCM (Vanpoucke & Ellis, 2020; Wieland & Durach, 2021). Supply chain resilience entails the capacity of a supply chain to recover or improve post-disruption, supported by adept navigation and mitigation of dynamic situations (Gao, Barzel, & Barabási, 2016). In contrast to conventional SCM approaches, resilience focuses on the systemic nature of risk rather than its source in assessments. Additionally, numerous studies have distinctly elucidated the characteristics of flexibility (Davoudi et al., 2012). Traditionally, scholars have predominantly construed flexibility in the realm of engineering, often synonymous with robustness. Consequently, the conceptualization of SCR has evolved in response to disruptions arising from the ever-changing global landscape. This evolution has been instrumental in achieving sustainability through the effective and timely dissemination of information.

This article, drawing from the literature review, explores two resilience perspectives: engineering resilience and social-ecological resilience. Engineering flexibility, denoting an organization's adeptness in recognizing and addressing disturbances, encompasses the capacity to absorb and endure disruptions. This entails the ability to recover when absorption is not feasible, fostering opportunities and optimal learning. The establishment of resilient social-ecological systems, informed by knowledge and experience, involves interconnected natural and biological systems alongside social and human subsystems (Blackhurst, Dunn, & Craighead, 2011; Jüttner & Maklan, 2011).

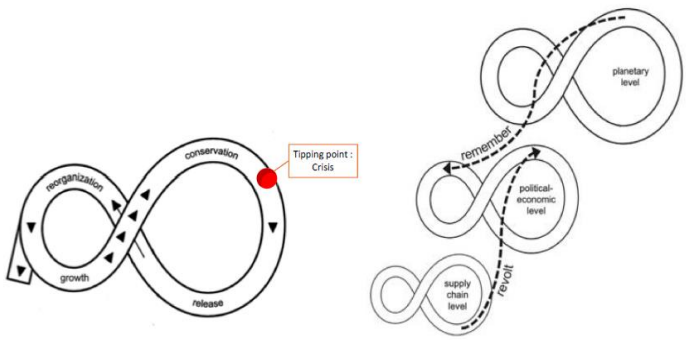
Folke (2006) posits that a system, within an adaptive cycle, undergoes reorganization and expansion without altering its fundamental nature or reverting to a previous state (Figure 1). In the adaptation process, when faced with an unresponsive shock, the current retention level deteriorates, prompting reorganization. Consequently, the built environment develops to enhance functionality and convenience, ensuring continuous and efficient resource utilization during expansion and improvement. Successful adaptation necessitates an adjustment cycle. This study evaluates performance and innovation across the adaptation cycle stages, including potential, connectedness, and adaptive capacity.

Potential signifies the existing resources within the system. Organizations can harness social capital as an asset, cultivated through shared network relationships. Trust, a component of social capital, has the potential to enhance supply chain efficiency. Nevertheless, an excess of

trust could diminish flexibility (Jüttner & Maklan, 2011). Concurrently, economic capital stands out as a facet of capital with the capacity to facilitate adaptation. Moreover, the organization must possess the capability to endure fluctuations in cash flow and market position (Walker, 2020).

Connectedness plays a crucial role in augmenting the overall resilience of the system and enabling dynamic management within the supply chain. Interconnectedness acts as a mediator in the relationship between the number of firms engaged with suppliers, exerting influence on various dynamics within this network (Wagner, Park, & Leydesdorff, 2015). However, networks with loose connections tend to be more flexible, despite their inherent rigidity. This affirms that a highly connected network could potentially undermine the resilience of individual network members by introducing risks (Pettit, Fiksel, & Croxton, 2010; Tukamuhabwa et al., 2015).

Adaptive capacity, within the context of SCR, denotes the ability of the supply chain to effectively respond to and recover from disruptions (Pettit et al., 2010). Enhancing adaptability within the supply chain contributes to the resilience of the ecosystem. Originally conceived for comprehending ecosystem dynamics, the adaptive cycle framework has been expanded and applied to elucidate the dynamics of resilience and change across diverse systems, encompassing social, ecological, economic, and other domains (Adobor & McMullen, 2018; Eltantawy, 2016). Adaptation cycles harbour the potential to foster collaborative interactions through alternative frameworks involving dynamic cross-scale interactions or segmentation (Figure 1). These interactions are linked by a sequence of gradual and regular events. Establishing an adaptive cycle that promotes stability in swift, minor events is termed as "remembering." Conversely, hyperlinks wield significant influence over gradual and momentary events, often termed as "revolutions." The amalgamation of these two formats serves to attain the goal of enduring substantial turbulence and achieving sustainability (Fath, Dean, & Katzmair, 2015; Simmie & Martin, 2010).



Adaptive cycles of resilience. **Cross-scale linkages of the adaptive. cycles.**

Figure 1. Adaptive cycles from Gunderson and Holling (2002)

2.3 Drivers to Improve Supply Chain Resilience

Supply networks in many industries are sometimes affected by unexpected disruptions (Munoz & Dunbar, 2015). Katsaliaki, Galetsi, and Kumar (2022) investigated the influence of climate-related and human-induced risks on disruptions in the supply chains. Ensuring the swift restoration of supply chains is crucial for the uninterrupted continuity of operations. Proactively integrating resilience can also function as a strategic approach for adapting organizational

structures to evolving conditions (Cavalcante et al., 2019; Gunderson & Holling, 2002). Achieving successful restoration involves ensuring the continuous continuation of activities at the required level of interconnection and control over the structure and function. Furthermore, disruptions within the supply chain can occur at various stages, including Plan, Source, Make, Deliver, and Return, as delineated in the Supply Chain Operations Reference (SCOR) model (Table 1).

The model offers an exhaustive catalogue of potential disruptions and their associated impacts at each stage. Diverse factors could precipitate disruptions in the planning process. Consequently, suitable proactive and reactive measures need to be implemented both before and after the disturbance to adeptly anticipate and mitigate the ensuing impacts.

Table 1. Possible supply chain disruptions and their impact.

Key Components of Supply Chain Resilience	Event / Disruption	Impact on the Supply Chain
Plan	Shortage/price change of a basic commodity (e.g., toilet paper and food products during lockdown).	Increase in demand from all customers.
	New regulation that prohibits a product; brand scandal; sudden change in consumption patterns.	Reduction in customer demand.
Source	Explosion; strike; supplier bankruptcy.	Reduction in the production capacity of a supplier.
	Global lockdown.	Reduction in the production capacity of all suppliers.
	A supplier obtains a onopoly / is the only reachable one.	There has been an observed rise in the quantities procured from a specific supplier, whereas the quantities obtained from other suppliers have been reduced to zero.
Make	Explosion; strike; epidemic in a factory.	The factory saw an abrupt and substantial decline in its manufacturing capacity.
	Global lockdown.	Reduction in the production capacity of the factories.
Deliver/Return	The imposition of an embargo on a nation and the occurrence of a strike or explosion at a port.	The infeasibility of employing the conventional pathway.
	A transportation modality becomes inoperable, rendering planes incapable of flights and trucks unable to transport.	The impracticability associated with the utilization of a particular mode of transportation.

2.4 Supply Chain Resilience to Supply Chain Disruption Orientation

The transition from SCR to SCDO denotes the acknowledgment and comprehension of an imminent disruption (Ambulkar, Blackhurst, & Grawe, 2015). Enterprises would acquire valuable insights from such actions. Furthermore, past experiences related to disruptions would be synthesized to enhance the management of responses to future disruptions. According to Mubarik et al. (2021), flexibility operates in two directions. Firstly, it enables companies to

resume normal operations after disruptions, and secondly, it offers experiential learning opportunities to improve their capacity to handle future disruptions. Consequently, resilient firms can leverage their actions in managing disruptions to enhance their SAP Change Document Object. The encounter and response to disruptions motivate businesses to invest in fortifying their learning infrastructure.

Hence, the organization must adapt to emerging opportunities and the prevailing environment. Furthermore, the ambidextrous capability of companies is delineated as strategically manufacturing options, such as prioritizing management oversight to monitor the exploitation of the supply chain (Ocicka, Mierzejewska, & Brzeziński, 2022; Rojo, Llorens-Montes, & Perez-Arostegui, 2016). This strategy is essential to meet the transient demands encountered by businesses, adapting to dynamic markets for sustained success, and iterating within existing business models for immediate gains (Mubarik et al., 2023).

Likewise, the advent of digital transformation has been identified as a pivotal factor in supply chain disruptions, encompassing issues like inventory shortages and influencing the information flow within digital supply chains (Boute & Udenio, 2023). The literature review yielded the subsequent research questions:

(1) Can organizations with restricted resources and lacking substantial data analytics infrastructure achieve supply chain resilience as a business outcome through real-time information analytics?
(2) What are the determinants that impact the decision-making process in the utilization of real-time data mining?
(3) In what way can edge analytics facilitate swift real-time information flow while operating within computational resource constraints and ensuring visibility and resilience as business outcomes?

Hence, scholars within the field of supply chain management posit a logical argument that addressing such research inquiries necessitates more than the mere duplication of the ambidextrous theory, which focuses on maintaining a balance between exploration and exploitation. Consequently, conducting a literature review on strategies pertaining to SCR and strategic procurement becomes imperative. Safeguarding the supply chain and enhancing its flexibility would entail the following:

Supply chain disruption propagation and impact (Katsaliaki et al., 2022): A total of nine disruptive occurrences were identified as statistically significant. In terms of real-time monitoring and predictive capabilities, four elements were deemed relevant. Various factors may contribute to interruptions across different systems, with congestion on transportation routes being one such factor that can impede efficient system operation. Another potential disruptor is the breakdown of information systems, critical for the smooth functioning of numerous businesses. Additionally, the lack of precision in forecasting, particularly unforeseen shifts in demand patterns, can pose challenges and disruptions across multiple systems. However, comprehending the phenomena of disruption propagation within the intricate and interconnected supply chain systems is facilitated through the lenses of systemic risk and normal accident theory (Scheibe & Blackhurst, 2018). Similarly, the deployment of supply chain monitoring tools proves effective in averting the spread of interruptions within a tightly integrated supply chain, thereby mitigating disruptions and promptly issuing warnings that can significantly reduce their severity.

Resilience as a path to a quick recovery: Employing proactive and mitigating strategies prior to disruptions, along with the utilization of adaptive control, can effectively minimize the impacts in the aftermath (Munoz & Dunbar, 2015). Various tactics can be employed to bolster resilience in the supply chain. These strategies extend beyond merely maintaining resource slack and encompass measures such as sustaining elevated inventory levels, integrating built-in redundancy to ensure unutilized capacity, and fostering flexibility in the selection of alternative supply sources (Ivanov, 2018). As per Pettit et al. (2010), there is a positive correlation between resilience and enhanced capabilities coupled with reduced vulnerabilities. These capabilities include agility, the ability to respond promptly to unforeseen circumstances, and an elevated level of teamwork to effectively manage risks. According to Purvis et al. (2016) and Ivanov and Dolgui (2019), the spread and recovery of disruptions depend on the structural attributes of the interconnected supply chain, including the density, complexity, and criticality of its nodes.

Monitoring, real-time alerts, and inferencing in a collaborative, connected supply chain: Facilitating the improvement of resilience in the supply chain involves the efficient exchange of timely information, achieved through collaboration and heightened visibility. The deployment of this technology holds the potential to optimize the efficiency of real-time data transmission among multiple collaborating entities. Furthermore, it fosters cooperation among partners and facilitates collaborative planning within the supply chain network (Scholten & Schilder, 2015). The increasing significance of utilizing data and decision-driven analytics in the domain of responsive supply chains for risk management has become evident in enhancing resilience, notably through the adoption of real-time control mechanisms (Ivanov & Dolgui, 2019). According to Dubey et al. (2019), the impact of digital technology on agility and reactivity is of significant importance. Furthermore, a connected and collaborative supply chain would exhibit the following characteristics: The system would be equipped with sensors, a Global Positioning System (GPS), and radio-frequency identification (RFID) technology, enabling connections with either the Cloud or Edge network. This connectivity facilitates continuous data generation, aiding real-time decision-making processes designed for automated workflows and continuous tracking. Additionally, the system's transparency enables the continuous and immediate viewing of data, facilitating the conversion of this data into actionable insights. Proactive measures, leveraging predictive skills facilitated by the utilization of real-time data, can be employed to anticipate and act prior to the occurrence of problems. According to Rai et al. (2021), the connected and collaborative supply chain, there is a requisite for agility, denoting the system's capacity to adapt and self-configure in response to multiple changes. These diverse aspects collaborate synergistically to enable well-informed decision-making and underscore the importance of disseminating information and harmonizing supply chain procedures.

As previously mentioned, the adoption of this resolution aligns with Tang (2006) strategies for potential risk mitigation. In terms of preventive risk mitigation strategies, while solutions employing supply chain monitoring tools prove effective in preventing the propagation of disruptions within a highly integrated supply chain, occurrences of supply chain failures remain a possibility (Garay-Rondero et al., 2020). In safeguarding the supply chain against significant disruptions, the challenge lies in estimating the return on investment, as such disruptions may never materialize. Consequently, there exists a tradeoff between allocating funds for preparing for unforeseen disruptions and managing the consequences of such unpredicted events. Additionally, pre-disruption risk mitigation and reactive risk mitigation strategies may involve techniques that, while effective in addressing specific risks, could be incompatible with the broader strategic context. For instance, a company's strategy to increase orders through collaboration with a single supplier may require enhanced flexibility. Furthermore, the

utilization of data and decision-driven analytics within a responsive supply chain for risk management, primarily through real-time control mechanisms, introduces the challenge of integrating diverse mitigation strategies. The amalgamation of these strategies aims to cover a broad spectrum of risks and situations. Consequently, businesses need a systematic methodology for assessing supply chain mitigation scenarios, enabling them to effectively manage the risks associated with supply chain disruptions (Ivanov & Dolgui, 2019). Nevertheless, strategic procurement remains imperative for organizations to navigate risks and implement continuous improvement processes in procurement that may face disruptions. Consequently, procurement transforms into a strategically executed process, representing the essential avenue for enduring significant disruptions and achieving sustainable growth.

Strategic Sourcing: Efficient supply chain management necessitates adept procurement strategies to address uncertainties in supply and demand. Typically, disruptions in the supply chain lead to the idling of surplus production resources, with consequential repercussions on both upstream and downstream supply chains, ultimately diminishing a company's market value. According to Saengkham (2022), the significance of organizational management strategies and procurement efficiency underscores the importance of these strategies and procurement in the functioning of the agency. Furthermore, Burke, Carrillo, and Vakharia (2007) recognized the singular supplier sourcing strategy as the predominant approach specifically when the supplier's capacity aligns significantly with product demand. Additionally, adopting multiple supplier sourcing strategies emerges as the most suitable approach. Hence, the selection of a specific procurement strategy becomes a pivotal decision in an environment characterized by risk. In a stable environment, the adoption of single-source procurement could be considered a pragmatic method, while uncertainty has the potential to exacerbate the risks faced by a company (Costantino & Pellegrino, 2010; Sampattikorn, Ussahawanitchakit, & Boonlua, 2012). Thus, the distinctive attributes would surpass those of rival wheelchair manufacturers, which are akin to a single supplier (Quain, 2018). Engaging in multiple procurements results in increased costs; nonetheless, the configuration of multiple suppliers necessitates a meticulous assessment from a risk management perspective. For instance, Coles maintains one or more suppliers for the majority of its products, particularly in the categories of food and hygiene. Similarly, small and medium-sized enterprises (SMEs) often opt for multiple supplier procurement. In terms of advantages, sourcing from a single source proves to be more beneficial.

Per the findings of Gaffney (2023), organizations that engage with multiple suppliers demonstrate an increased likelihood of achieving on-time deliveries, recording a success rate of 92%, in contrast to the 76% success rate observed in businesses reliant on a single supplier. Furthermore, as outlined in the Exiger (2023), a substantial 79% of large enterprises are projected to prioritize flexibility and risk management in the coming two years. It is recommended that organizations incorporate automation through contemporary technologies and foster collaboration with suppliers and stakeholders. According to Schroeck, Kwan, and Kawamura (2019), the implementation of new assistive technologies has brought about organizational, cultural, and operational transformations. Furthermore, the digital transformation of procurement necessitates a reassessment and reinvention of business practices. In an era where technology plays an increasingly dominant role, businesses must seek innovative procurement solutions to capitalize on variations in purchasing. According to ProcurePort (2022), a successful procurement strategy demands a thorough understanding of the organization's overarching strategy and long-term mission. This mission encompasses resources, market risks, and internal factors that could impede the attainment of objectives. Consequently, organizations should refine their SCM strategies to adeptly handle the logistics

of each company within the supply chain.

2.5 Methodology For the Assessment of Supply Chain Mitigation Scenarios

Various risks of diverse types can potentially disrupt the supply chain. Consequently, the challenge lies in selecting the most effective risk mitigation strategy to enhance the resilience of the supply chain. Optimization methods can be employed to evaluate the resilience of the supply chain. In this section, we put forth a five-step methodology (Figure 2) that could be employed to assist businesses in preparing for disruptive situations.

The initial step involves modelling the optimization of the overall supply chain network, configured to cater to the diverse requirements of various businesses. This entails constructing a model that supports multiple suppliers, manufacturers, warehouses, and retailers. Consequently, integer linear programming is essential to ascertain the optimal values for variables such as production, inventory, and shipments. These variables are optimized to minimize costs over the specified period while adhering to constraints, including production capacity at each level of the supply chain and flow conservation at each node (Ghavamifar, Makui, & Taleizadeh, 2018; Rezapour, Farahani, & Pourakbar, 2017; Yavari & Zaker, 2019; Zhao & You, 2019). The second phase entails formulating diverse disruption scenarios and adjusting the parameters of the supply chain model established in the initial step (refer to Table 1). Subsequently, the third stage involves the selection of a mitigation strategy aimed at mitigating disruptions that adversely affect performance, with corresponding modifications to the optimization model. The fourth stage encompasses simulating the scenario with the introduced disruption and selecting appropriate mitigation strategies. Finally, the fifth stage involves defining resilience indicators to compare simulation results and identify the mitigation strategy that yields the most resilient supply chain. Bret et al. (2021) suggested indicators capturing the supply chain's capacity to rebound from disruption include recovery time, supply chain performance assessed through the service rate for all customers across all periods, total costs encompassing transport, storage, and delivery delays, as well as inventory levels of raw materials and finished products at all stages.

Enhancing supply chain resilience may introduce conflicts with the traditional emphasis on bolstering the company's financial performance, despite both strategies addressing risk management. However, this approach also poses potential hazards, such as fluctuations in supply chain demand. Consequently, businesses must prioritize efficiency, leveraging the risk of changes to foster ongoing flexibility, even incurring additional expenses.

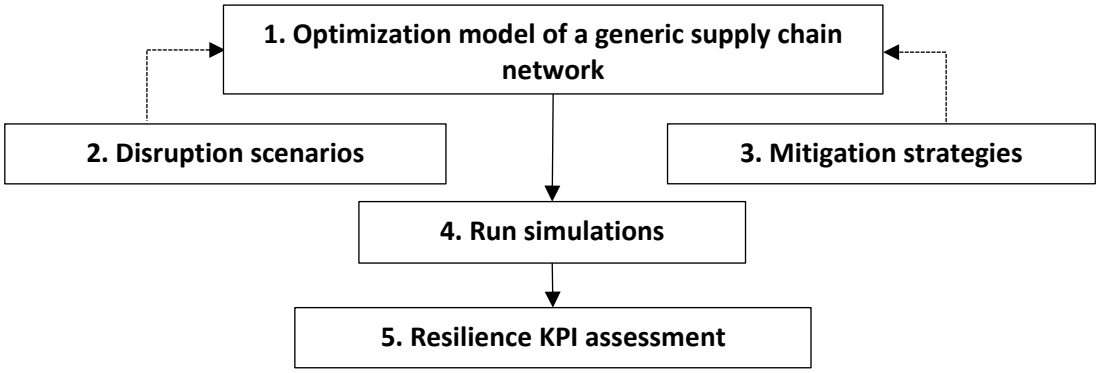


Figure 2. A five-step methodology for supply chain mitigation scenarios assessment from Bret et al. (2021).

3. CONCLUSION AND DISCUSSION

The evolving global landscape, characterized by uncertainty stemming from both global disruptions and market trends, is exerting direct influence on operations, compelling a re-evaluation of supply chain responses. This shift is attributed to operational risk, natural disasters, pandemics, disruptions in logistics, geopolitical crises, cyber insecurity, and financial crises. Consequently, the reintroduction of SCR strategies becomes imperative for businesses. The proactive preparation for diverse scenarios not only anticipates potential disruptions but also fosters closer relationships with customers, yielding valuable resilience indicators. These indicators are discerned by comparing simulation results and selecting optimal mitigation strategies for SCR. Consequently, organizations must assess whether fortifying resilience may introduce internal barriers. Drawing from a survey conducted by Deloitte in 2022, respondents pinpointed noteworthy internal impediments to fortifying and augmenting resilience. These were delineated as organizational capabilities, change readiness, cost pressures, leadership capabilities, internal politics, time constraints, silo orientation, technological deficiencies, and competing priorities. Consequently, organizations must formulate strategies or protocols to pre-emptively mitigate risks, averting disruptive events such as cyberattacks and data breaches that pose threats to the supply chain. Additionally, a dearth of skilled personnel and personnel shortages emerge as prominent causes of disruptions in the supply chain.

Organizational resilience denotes the capacity to exhibit flexibility in the face of change, demonstrating an adaptability to novel circumstances through the integration of contemporary ideas and innovations. It signifies a preparedness to adjust strategies proactively to attain objectives and remain attuned to evolving dynamics within both internal and external organizational environments (Nasalee & Songsrirote, 2020). However, persistent challenges in supply chain operations pose ongoing issues for businesses, leading to unpredictable shifts in product demand. In certain scenarios, the adoption of local suppliers emerges as a viable solution to address these challenges. This approach involves ensuring a consistent material flow and optimizing both financial and non-financial performance aspects, including quality control and sales growth, within the organizational framework of supply chains (Cappelli & Cini, 2020; Huo et al., 2014). As a result, the researchers, drawing upon the literature review, articulated the following insightful observations: The supply chain cluster served as a manifestation of the amalgamation of SCM practices and cluster industries. The interconnection and collaboration among members of these supply chain clusters were deemed pivotal in enhancing productivity and addressing challenges, ultimately contributing to a more resilient local economy (Golicic, Flint, & Signori, 2017; Grimstad & Burgess, 2014). As a result, resource utilization could be maximized. Conversely, it is expected to bolster sustainability by reducing procurement and production expenses (Albuquerque et al., 2020; Ruiz-Benitez, López, & Real, 2019), and enduring disruptions, such as pandemics and natural disasters. This could harm organizations with extensively interlinked supply chains, leading to a domino effect of failures. To mitigate the impact of disruption and sustain the resilience of supply chain clusters, businesses must adapt to continual change. As a result, dynamic capabilities become imperative for enhancing and safeguarding the organization's tangible and intangible assets, fostering sustainability, and enhancing effectiveness in an evolving environment (Teece, 2007). Supply chain members should cultivate dynamic capabilities to help organizations fortify and safeguard their assets amid disruptions (Golicic et al., 2017).

Revisiting the foundational principles of the RBV perspective, the emphasis is on how companies can maintain competitiveness by leveraging internal resources and factors that enable them to outperform competitors in the same industry (Barney, 1991). This aligns with a resource-based perspective on the supply chain. Consequently, attention would be directed towards the resources necessary to enhance organizational performance, positioning the supply chain as a tool for competitive advantage (Loi, 2016).

This concept has further developed into an expanded RBV that centres on organizational operations. Moreover, organizations would need to broaden their resource base by forming alliances with suppliers (Chitmun, Ussahawanitchakit, & Boonlua, 2012; Miemczyk & Luzzini, 2019; Popli, Ladkani, & Gaur, 2017), and other governmental bodies and entities in the same geographic area or region, given the dynamic and uncertain market environment. Consequently, organizations would require assistance in sustaining their competitive edge, particularly in responding to unforeseen fluctuations in supply and demand. This underscores the application of dynamic capability theory within an extended RBV, representing a strategic deployment of dynamic capabilities. Organizations' resources could also be reconfigured (Teece, 2019) and redistributed by adapting to the market changes and quickly jumping ahead of the competitors (Mishra et al., 2019; Son et al., 2014). The need to adapt to environmental unpredictability and the influence of sustainability on survival and growth encourages organizations to enhance their sustainability (Chowdhury, Agarwal, & Quaddus, 2019; Teece, 2016) through dynamic capabilities (Di Stefano, Peteraf, & Verona, 2014; Teece, 2016), such as resilience and absorptive capacity (Shubham, Charan, & Murty, 2018). Leveraging sustainability necessitates a significant level of absorptive capacity for adaptation.

Furthermore, there is a requirement for the capability to understand stakeholder demands related to sustainability and customer expectations regarding services and products (Chowdhury et al., 2019). Furthermore, the theories of DC and AC empower organizations to effectively integrate information from external sources with existing knowledge. This integration aids businesses in leveraging the combined knowledge to improve sustainability. However, it has been posited that sustainability can be achieved through recovery practices (Ruiz-Benitez et al., 2019). Hence, supply chain flexibility is considered a capability inherent to the supply chain system. Consequently, organizations must proactively enhance and sustain their operations during disruptions, restore full operational capability afterward, and adapt to market changes. In essence, without such flexibility, the system remains fragile and lacks the ability to sustain itself over time. Thus, prioritizing the development of flexibility is imperative for organizations (Marchese et al., 2018). This is essential for enhancing strategic resilience to safeguard processes, activities, and resources that contribute to sustained operations during disruptions, thereby effectively maintaining the original production schedule at a reasonable cost.

Moreover, the organization would benefit from flexibility, including adaptable logistics. Additionally, flexible sourcing would enhance the robustness of the transportation network, leading to cost reduction (Stevenson & Spring, 2007). To establish a monitoring system that detects failure modes and issues near-real-time alerts for disruptions, it is advisable to connect the system through GPS and RFID to the Cloud or edge network. This continuous connection would facilitate the generation of data for making real-time decisions (Dubey et al., 2019; Ivanov & Dolgui, 2019). In alignment with the core principles of dynamic capability theory, it has been contended that elevating supply chain sustainability can be realized through the augmentation of resilience (Golicic et al., 2017).

4. FUTURE RESEARCH

Numerous scholarly investigations have delved into the strategies employed by resilient supply chains in navigating substantial disruptions. This research has culminated in an extensive review of literature elucidating methods to circumvent disruptions within the supply chain, encompassing aspects such as the adaptive cycle's influence on supply chain resilience within a dynamic global context. This comprehensive exploration encompasses pivotal factors driving the enhancement of supply chain resilience, elucidating the manifestation and repercussions of supply chain disruptions, and delving into strategic procurement coupled with a systematic approach for assessing scenarios conducive to supply chain mitigation (ProcurePort, 2022; SGS, 2023). The acquisition of resilience indicators serves as a mechanism for addressing disruptions and ensuring heightened sustainability within the supply chain. For scholars interested in delving into the nexus between supply chain resilience strategies and sustainability, further research is recommended based on the literature review. Moreover, there is potential for studying the cluster industry supply chain network and individual supply chain members (Golicic et al., 2017; Ruiz-Benitez et al., 2019). According to Bret et al. (2021), Resilience indicators play a pivotal role in sustaining a competitive edge. To validate their capacity for reflecting the ability to rebound from supply chain disruptions, these indicators can undergo rigorous scrutiny through statistical and quantitative models, including multiple regression models or SEM.

Supply chain disruptions persist as a challenge for enterprises, and market trends exert a direct impact on operations. This pressure on the supply chain to respond differently stems from various factors, including operational risk, natural disasters, pandemics, disruptions to logistics, geopolitical crises, cyber insecurity, financial crises, and transportation disruptions (Deloitte, 2022). Hence, forthcoming researchers in supply chain management should comprehensively explore all dimensions. This could be affirmed through qualitative research to garner diverse insights. Research queries should be straightforward, align with theoretical scrutiny, or align with the research question. The chosen research designs should be suitable for the research objectives, case study selection must align with the study's criteria, and the information gathered should be credible. Researchers should employ triangulation to assess the research's quality. Furthermore, reliability and validity should be expounded upon to ensure impartial and dependable research outcomes.

Nevertheless, to attain lucid and pertinent research outcomes, the researchers propose further exploration of the qualitative research design as detailed in the article by Yin (2013), “A (Very) Brief Refresher on the Case Study Method”. For additional insights into the qualitative research design, including case definition, distinctions between a case study and a teaching case, methods for selecting case studies, and fundamental types of case study designs. Finally, for research focused on surviving disruptions in the supply chain, involving quantitative or qualitative exploration of the correlation between supply chain resilience strategy and supply chain sustainability, addressing research gaps is imperative for establishing new intersections within critical areas of supply chain management or for generalizing research findings.

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