International Business Research; Vol. 18, No. 2; 2025
ISSN 1913-9004 E-ISSN 1913-9012
Published by Canadian Center of Science and Education

SCRGD: Supply Chain Resilience in the Face of Global Disruptions

Anseguerema Bamia[1], Fanta Bamia[2]

[1] Jiangsu University, Jiangsu, China

[2] Jiangsu Ocean University, Jiangsu, China

Correspondence: Anseguerema Bamia, Jiangsu University, Jiangsu, China. E-mail: ansebamia@gmail.com

Received: February 10, 2025 Accepted: March 5, 2024 Online Published: March 26, 2025

doi:10.5539/ibr.v18n2p80 URL: https://doi.org/10.5539/ibr.v18n2p80

Abstract

Supply chain resilience (SCR) has emerged as a critical focus in response to the increasing frequency of global disruptions, including pandemics, geopolitical tensions, and climate change. This study explores the integration of resilience strategies with sustainability performance metrics to address these disruptions and enhance long-term supply chain performance. A conceptual framework is proposed, emphasizing resilience strategies such as flexibility, redundancy, and digital transformation, aligned with sustainability indicators like carbon footprint reduction, resource efficiency, and social responsibility. Case studies from disrupted supply chains, such as during the COVID-19 pandemic, are used to analyze the impact of resilience on sustainability. The findings reveal syner- gies between resilience strategies and sustainability metrics, demonstrating that collaborative and adaptive supply chain practices not only mitigate risks but also contribute to sustainable development goals. However, trade-offs, such as increased environmental costs due to redundancy, are noted, underscoring the need for energy-efficient practices. The study offers actionable insights for practitioners, advocating for digital transformation, multisourcing, and stakeholder collaboration as pathways to enhance resilience and achieve sustainability. Theoretical contributions include bridging the gap between resilience and sustainability while enriching systems theory and the triple bottom line framework. Future research directions are proposed to address gaps in sustainability measurement, focusing on advanced analytics and the social dimensions of supply chain management.

Keywords: Supply chain resilience, global disruptions, risk management, digital transformation

1. Introduction

In today's interconnected global economy, supply chains act as critical lifelines, enabling the smooth movement of goods and services across borders, industries, and continents (Altaf et al., 2025). As interconnected elements they contribute significantly to economic development and organizational effectiveness but at the same time make them progressively sensitive to disruption (Tortorella et al., 2025). These vulnerabilities are often revealed by external factors including natural disasters, geopolitical issues, pandemic as well as other events that are beyond the normal functioning and planning horizon of an organization (Adeleye et al., 2024). The current COVID-19 crisis, in particular, drew attention to the issues of supply chain vulnerability at the production, purchasing, and logistics levels on an unprecedented scale. They also disrupted the usual flow of goods and erode institutional capacity to restore disrupted operations and demonstrate the need for effective strategy to manage risk and bounce back (Adeleye et al., 2024). To overcome these challenges, there has been growing interest in supply chain resilience in OSCM literature. Best explained as the capacity of a system or organization to continue to operate and still recover from disturbances while continuing to fulfill core responsibilities, resilience has become an area of interest to organizations that seek to deal with volatility and guarantee sustained operations (Belhadi et al., 2024). In addition to being a condition for operational stability, resilience contributes to customer satisfaction, preserves the image, and becomes a competitive advantage in uncertain situations. Companies that are able to create buffer, as well as accommodate impact as well as reactions to interruptions are able to do well in unstable business environments (Belhadi et al., 2024). The growing recognition of sustainability as a key component of supply chain strategy further underscores the need for inte- grative approaches. Sustainability emphasizes balancing economic, environmental, and social objectives to achieve long-term value creation (Kashem et al. 2024). Linking resilience strategies to measurable sustainability performance metrics such as reducing carbon footprints, improving resource efficiency, and promoting social responsibility presents an opportunity to simultaneously address disruptions while advancing broader

sustainability goals. By fostering adaptable and sustainable supply chains, businesses can mitigate risks and strengthen their global competitiveness.

1.1 Objectives

This study aims to advance the understanding of supply chain resilience by addressing three core objectives:

- To evaluate the existing body of literature on supply chain resilience, focusing on key concepts, dimensions, and deter- minants, while synthesizing theoretical frameworks to explore foundational elements like flexibility, agility, redundancy, and collaboration.
- To analyze real-world case studies of supply chain disruptions, including natural disasters, pandemics, and geopolitical tensions, to understand their impact on operations and assess the effectiveness of resilience strategies employed by organizations.
- To identify and explore best practices and innovative strategies such as multisourcing, digital technologies, and collab- oration for enhancing supply chain resilience and enabling actionable recommendations for practitioners navigating global disruptions.

In this way, this work meets the following objectives: To fill the gap between the academic and the practical supply chain management, which can provide useful recommendations for the supply chain performance management in the context of increasing uncertainty and risk (Sundarakani et al., 2021). Combining resilience with sustainability offers organizations the necessary instruments and approaches required to prevent adverse impacts, maintain business operations, and build sustainable development Adeleye *et al.* (2024). Given the ongoing global disruptions that disrupt conventional supply chain paradigms, embracing innovative, ro- bust and sustainable strategies will remain characteristic for organisations willing to manage risk and protect their competitive advantage.

2. Literature Review

2.1 Resilience in Supply Chains

Supply chain agility and supply chain resilience have emerged as significant fields of study as organizations endeavour to build capabilities for managing shocks or changes (Sundarakani et al., 2021). Modern strategies describing resilience underline certain features like flexibility, adaptivity, and appropriate management of threats. On the other hand, agility is a supply chain's capacity to rapidly execute changes while adaptability corresponds to permanent alterations of supply chain structures and strategies to fit the new market environment requirements (Adeleye *et al.*, 2024). Risk management, on the other hand, relates to an organization's efforts to identify some risks, and make changes to ensure that those risks will not cause significant harm (Um & Han, 2021). Case studies are also presented to illustrate how resilience strategies has been adopted in other parts of the world. For instance, the automobile and electronics industries have applied multisourcing and flexible logistics in order to overcome challenges resulting from calamities or political instability.

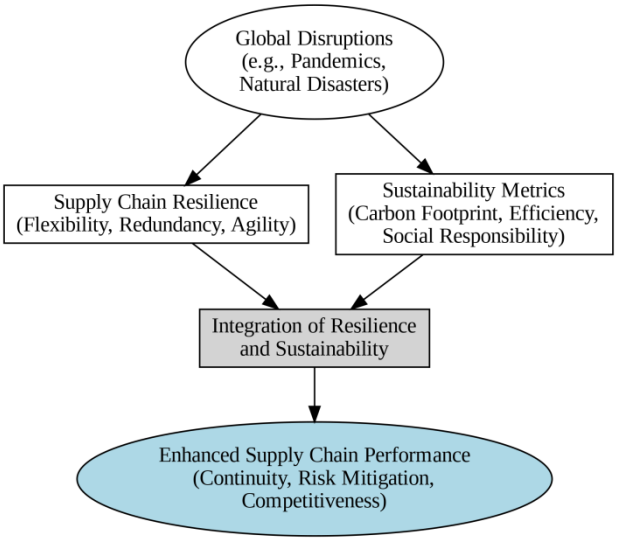

Figure 1. Flow Diagram

The illustration depicts the alignment between global disruptions with supply chain resilience and sustainability metrics that enhances supply chain performance measures. Supply chain disruptions resulting from pandemics and natural events compel organizations to require flexibility alongside agility together with redundancy as resilience measures while sustainability measures include carbon footprint reduction and social responsibility practices. Improved supply chain performance results from the integration of resilience and sustainability measures which delivers continuous operations and risk reduction abilities and competitive marketplace success in our volatile worldwide setting.

2.2 Sustainability Metrics in Supply Chains

Sustainability indexes are therefore becoming essential indicators for assessing, as well as enhancing the environmental, social, and economic impacts and footprints of supply chains (Belhadi *et al.*, 2024). Evaluation technologies used by most organizations adopt both the qualitative and the quantitative models of sustainable measurements. The sustainability aspects that have formed the basis of some of these measures include; carbon footprint, resource use efficiency, and social responsibility. Carbon footprinting supports evaluation of greenhouse gas emissions encouraging the strategies for decrease, whereas the resource efficiency focuses on effective utilization of energy and materials (Sarkis, 2021). The Social responsibility indicators address issues concerning labor and conformity and public welfare and right conducts for procurement (Altaf et al., 2025). Not only do these metrics show the statistical performance of organisations but also help businesses to satisfy international sustainable standards and expectations of stakeholders Belhadi *et al.* (2024). Based on the COVID 19, geopolitical instabilities and climate changes, organizations have been forced to include resilience and sustainability into their supply chain management strategies. A recent and clear instance is COVID 19 that brought to light severe risks that arise from the issue of supply chain risks, affecting production and supply across the value chain in myriad sectors. Likewise, political rivalries like the trade war between US and China, Brexit are having created a risk, which have made companies to redesign their supply chain networks (Sarkis, 2021). These disruptions have also increased sustainability issues, as organisations are pushed to decrease their environmental impact in addition to maintaining functionality Kashem *et al.* (2024). In this paper, it has been suggested that using resilience strategies in parallel with sustainable measures will aid business organizations in managing these disruptions (Belhadi et al., 2024). Although digital technology and supply chain integration have been shown to improve the supply chain resilience and sustainability performance concurrently and hence competitiveness in the ever-growing uncertain world.

Since the existing literature review on supply chain resilience and sustainability is built on a strong scholastic stand on supply chain resilience, the research effort is directed to fill the gap of understanding social sustainability aspect like labor rights, ethical sourcing and community impact (Um & Han, 2021). These are elements which must be addressed as modern supply chains, especially under scrutiny for fair labor practices, responsible sourcing, and primarily because transparency must be built into the supply chain. In other words, the worker exploitation, unsafe conditions, and supply chain transparency are problems faced by industries like the fashion, electronics and agriculture industry (Rashid et al., 2025). Research suggests that companies that follow fair wages, fair procurement policy and community engagement programmes improve resilience as well as the brand reputation (Kashem et al., 2024). Moreover, frameworks on the international level, such as the United Nations Global Compact, promote worker well being, diversity, as well as social equity in supply chain operations. Future research should explore the role of quantitative measures of social sustainability by examining factors that relate to employee welfare, stakeholder engagement, and supplier audits and their contribution to long term supply chain resilience and sustainability goals.

3. Methodology

This section outlines the methodology used to evaluate sustainability metrics and resilience frameworks, describes the data collection methods, and justifies the selection of research tools for measuring value-added outcomes in supply chain sustain- ability (Belhadi et al., 2024). A mixed research approach was adopted to compare sustainability measures and resilience strategies. To evaluate the sustainability criteria, the measures in the form of KPIs involved, inter alia, the carbon footprint, energy consumption, and social impact. These KPIs were selected based on the current models of sustainable supply chain management, mainly, quantitative and pertinent. Frameworks for resilience were assessed based on dimensions such as flexibility, redundancy and collaboration, which are among the most agreed-upon predictors for improving supply chain performance during disruptions (Christiano et al., 2025). A scoring system was further established for purposes of systematic comparisons of supply chain's performance according to these dimensions. Data collection was conducted through a combination of surveys, case studies, and secondary data analysis. Surveys were distributed to supply chain managers in industries heavily affected by disruptions, such as manufacturing, logistics, and healthcare

(Altaf et al., 2025). The surveys aimed to gather insights into the adoption of resilience strategies and their impact on sustainability outcomes. Case studies focused on disrupted supply chains in China, where external shocks such as the COVID-19 pandemic and geopolitical tensions had significant effects. Secondary data from industry reports and academic publications provided additional context and validation of findings, ensuring a robust foundation for analysis.

3.1 Conceptual Framework

This section presents a comprehensive conceptual framework that integrates resilience strategies with measurable sustainabil- ity performance metrics.

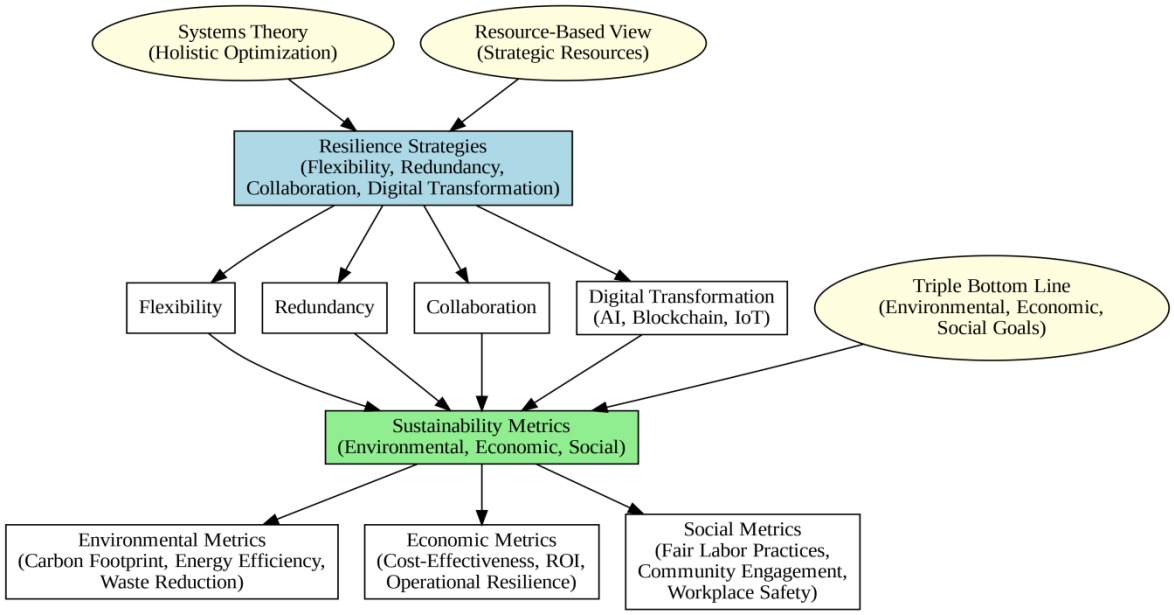

Figure 2. Conceptual Framework Connecting Resilience Strategies to Sustainability Metrics

Figure 2 illustrates the conceptual framework, highlighting the relationship between resilience strategies and sustainability metrics. The RBV argues that the resources like technology and partnerships are key enablers of resilience as strategic assets. Lastly, the sustainable strategic management or more known as TBL focuses on three key areas: environment, economy, and people. Therefore, the integration of these theoretical perspectives allows for a strong framework from which the drivers of resilience that support sustainability can be understood and developed in practice (Rahbari et al., 2024).

The model bridges theoretical constructs with practical implications, emphasizing the alignment of operational resilience with sustainable development goals Rahbari *et al.* (2024). The measures and their associations with the specific aspects of sustainability performance have been added to the model as follows. The ability to make changes easily is one of the valuable attributes of supply chain resilience because it allows adjusting operations to the shifts in supply and de- mand rapidly. Contingency management relies heavily on redundancy to construct other sources of supply such as the backup suppliers and inventory stocks. There is adoption by the members of the supply chain so that there may be closer and effective cooperation and coordination to accomplish the goal of increasing supply chain resilience (Christiano et al., 2025). Furthermore, digital transformation leverages advanced technologies, including artificial intelligence (AI), blockchain, and the Internet of Things (IoT), to improve visibility and predictive capabilities, ultimately enabling more adaptive and responsive supply chain operations. To ensure the alignment of resilience strategies with sustainability outcomes, the framework incorporates measurable performance metrics across three key dimensions.

Environmental metrics focus on reducing the carbon footprint, improving energy efficiency, and minimizing waste generation (Rahbari et al., 2024). Economic metrics emphasize cost-effectiveness, return on investment (ROI), and reduc- ing operational disruptions to maintain profitability and resilience. Social metrics prioritize fair labor practices, community engagement, and workplace safety, ensuring that supply chains contribute positively to societal well-being. The amalgamation of resilience strategies with sustainability metrics draws from on several theory frameworks. Systems theory focuses on the interdependency of supply chain sub-systems and argues that supply chain optimization can only be effective if it is a system-wide effort while considering both supply chain resilience and sustainability as goals to strive for.

3.2 Mathematical Framework

In this section, two equations are presented to quantify the relationship between resilience strategies and sustainability perfor- mance metric.

3.2.1 Sustainability Performance Metric (SPM)

The Sustainability Performance Metric (SPM) is calculated as a weighted sum of environmental, economic, and social metrics:

$$\text{SPM} = w_e E + w_c C + w_s S \quad (1)$$

Where:

- w_e, w_c, w_s: Weights assigned to environmental (E), economic (C), and social (S) metrics, respectively.
- E: Environmental performance (e.g., carbon footprint reduction).
- C: Economic performance (e.g., cost savings or ROI).
- S: Social performance (e.g., fair labor practices).

3.2.2 Resilience Index (RI)

The Resilience Index (RI) evaluates supply chain resilience based on flexibility (F), redundancy (R), and collaboration (C_o):

$$\text{RI} = \alpha F + \beta R + \gamma C_o \quad (2)$$

Where:

α, β, γ: Scaling factors representing the importance of each resilience factor.

F : Flexibility in adapting to demand and supply fluctuations.

R: Redundancy through backup resources and inventory buffers.

C_o: Collaboration across supply chain partners.

The decision about which research tools to use was based on their suitability in capturing practical changes in supply chain sustainability in terms of value added. Applying statistical analysis and modeling, correlations between the chosen resilience strategies and the measures of sustainability were defined (Queiroz et al., 2022). For example, whilst redundancy was found to have a small negative correlation with carbon footprint reduction, regression analysis facilitated the measurement of this correlation. Closed ended questions and case study analysis helped explain the socio-cultural factors eliciting resilience and sustainability in the system. The selection of these tools was done from several research and operation means that have been effective in supply chain risk management (Okoye *et al.,* 2024). This approach allowed for obtaining both a rich understanding of the relationships between resilience strategies and sustainability performance and, at the same time, maintaining reliability and validity of the conclusions. This way, the study caters for practical application of integration of resilience and sustainability into the management of supply chains. The theoretical implications of the study contribute to the overall understanding of the factors affecting opera- tional resilience and organization's ability to minimize negative outcomes while pursuing sustainable development objectives on practical level.

3.3 Quantitative Analysis in Supply Chain Resilience and Sustainability

The validation process for supply chain resilience (SCR) strategies required quantitative analysis of Healthcare, Technology, Manufacturing and Logistics industries to establish persuasive evidence. This research analyzed how SCR scores corresponded to sustainability measurements and financial output (ROI) using distinct data from each sector. The analysis through correlation matrix demonstrated that increases in resilience tend to produce superior sustainability results although these outcomes frequently include conflicting priorities. Healthcare together with Technology industries maintain the highest SCR scores because they effectively adapt to changes but Logistics stands out regarding financial returns although sustainability scores remain lower (Pourmohammadreza et al., 2025). The Retail and Manufacturing industries showed higher social responsibility performance than the Logistic sector. Considering these findings helps develop a method for evaluating resilience strategies together with their sustainability effects so we can improve supply chain systems in the future.

4. Case Studies of Supply Chain Disruption

This echo has been projected as a significant issue in present day integrated global market thereby causing

system losses and efficiency hiccups to different organizations' developmental and strategic plans. This section takes a look at actual examples of how major interruptions affect supply chain and the measures adopted to manage these interrupt ions while building supply chain resiliency.

4.1 Impact of the COVID-19 Pandemic

The COVID-19 outbreak has created unprecedented supply chain risks that affected production and distribution, and procure- ment links in almost every industry. For example, the automotive industry suffered heavy blows as factories closed and the inter-dependency on trade hiked up which stalled the supply of crucial components hence fetalizing assembly of vehicles Ivanov and Dolgui (2020). Likewise, in the health care industry, severe scarcity of personal protective equipment (PPE) and other medical necessities to combat adequately the mass spread of viruses Sarkis (2021). These disruptions highlighted the fact that organisations require proper extensive risk evaluation so that proper adaptive resilience measures can be bought in to ensure the continuity of business during crises.

4.2 Natural Disasters and Climate-Related Events

Haiyan, the typhoon that struck the Philippines in November 2013, caused widespread disruption to supply chains, while the catastrophic earthquakes and wildfires that occurred the following year in Nepal, Chile and Northern California, respectively, all had a major impact on global supply chains (Pourmohammadreza et al., 2025). The 2011 Japan earthquake that include a Tsunami affected the electronics industry and brought sharp cut off on semiconductor production and limited availability of essential components Ivanov, 2018. Similarly, hurricanes Harvey and Irma in 2017 impacted the transport and communication systems along with damaging several infrastructure and supply chain and its overall reverberation in economy such as retail and automotive industry domains Ponomarov and Holcomb, 2009. These events bring the fact that flexibility and redundancy should be incorporated into supply chain design and that technology should be used to enhance the visibility and response of the supply chain.

Table 1. Comparison of Literature Review Articles on Supply Chain Resilience

No.	Authors	Published Journals	Year Span	# Papers Reviewed	Primary Focus
1	Pereira et al. (2014)	Supply Chain Manage- ment: An International Journal	2000-2013	30	Investigated intra- and inter- organizational issues in pro- curement for supply chain resilience.
2	Tukamuhabwa et al. (2015)	Int. J. Production Re- search	-	91	Reviewed definitions of sup- ply chain resilience and inte- grated" cost-effectiveness" into frameworks.
3	Kamalahmadiand Parast (2016)	Int. J. Production Eco- nomics	2001-2015	100	Proposed a timeline and principles of resilience, focusing on enterprise re- silience.
4	Hosseini et al. (2019)	Transportation Research Part E	2002-2017	168	Developed quantitative models for resilience, focusing on drivers and capacity-building concepts.
5	Han et al. (2020)	Int. J. Production Re- search	2003-2019	153	Categorized resilience ca- pabilities and performance metrics, with emphasis on readiness and recovery.
6	Shekarian and Parast (2021)	International J. of Logis- tics Research	2000-2017	98	Analyzed organizational ca- pabilities and antecedents in mitigating disruptions.
7	Spieske and Birkel (2021)	Computers & Industrial Engineering	2011-2021	62	Explored Industry 4.0 en- abler technologies and sup- ply chain resilience.
8	Zamani et al. (2022)	Annals of Operations Research	2011-2021	23	Reviewed AI and Big Data Analytics applications for supply chain resilience.
9	Ergun et al. (2023)	IISE Transactions	-	-	Examined supply chain fail- ure models and strategies to enhance resilience.
10	This Work	-	2012-2022	992/146	Focused on challenges and opportunities in building re- silient supply chains.

4.3 Geopolitical Tensions and Trade Disputes

Trade wars are some of the current trends that have triggered topological risks and risks on the supply chain especially to industries that rely on complex relay chains (Ponomarov & Holcomb, 2009). A good example is the US-China trade war that began in 2018, which saw two major economies place tariffs and trade barriers to the products.. These measures put pressure on firms to confront additional costs, reorganise their global value chains and deal with the emergence of new regulations Gereffi, 2020. Like others, the United Kingdom's exit from the European Union (Brexit) created new levels of unpredictability to customs systems and border passages, leading to disruptions in product mobility and transportation costs Sarkis, 2021. The never-ending conflict between Ukraine and Russia also show us the danger of geopolitical risks.

This has affected transport outlooks, amplified the cost of logistics and made investments in affected areas unattractive (Christiano et al., 2025). Moreover, the restric- tions on the sectors including energy and defense by the western countries have also increased the prime objectives of the global supply chain and made it challenging for those companies that are linked with Russia and western counterparts Gereffi, 2020; Ivanov and Dolgui, 2020 (Ivanov, 2018). These cases make a clear point that sourcing strategies should be developed with an empha- sis on the diversification of supplier sources, collaboration where possible, and the creation of flexible contingency plans to cover for the interruptions from geopolitical activities. The lessons derived from the evaluation of these case studies highlight four major areas vital for reinforcing the supply chain. Reflected on the case of COVID-19 it is evident that being flexible and working with other stakeholders is critical as a result of external shocks (Gereffi, 2020). H firms that adopted technology, including blockchain and IoT, succeeded in managing the disruptive events within the supply chain system of their organizations. These technologies gave real time view of the supply chain, the potential problems that may arise, and necessary remedies taken (Patel, 2023). As such capacities were critical in managing change across demand volatility and disruption of logistics that emerged due to the pandemic.

Disasters such as the earthquakes or hurricanes to the affected areas exposed the need to integrate multiple forms of redundancy and flexibility into supply chain models. For instance, measures such as multisourcing, whereby organizations deal with different suppliers and creating other transport channels played a big role in reducing the effects of such occurrences. These approaches allowed maintaining organizational continuity in the case of disruptions of the key suppliers or logistics chains Ponomarov and Holcomb, 2009 (Gereffi, 2020). The best lessons taken from these disasters reveal the fact that the integration of stocks or slack – within the supply chains can act as a means of protection against any unforeseeable disturbances. Disputes between successive administrations of the United States of America and the People's Republic of China as well as the Ukraine and the Russian Federation show the usefulness of strong risk management systems. Such disruptions underlined the value of orienting on geopolitical processes and developing strategies on how to respond to them. For instance, organizations implementing their operations in areas experiencing aggravated geopolitical risk managed to mitigate their risks by developing multiple tiers of suppliers and by building partnership with local stakeholders (Okoye *et al.* 2024). They eliminated disruptions and made the organizations less susceptible to barriers on trade and sanctions or abrupt shifts in regulation.

Hence, these case studies give a clear perspective of agility, collaboration, and redundancy and how risk can be managed effectively to develop a safer supply chain (Ozdemir et al., 2022). In light of the above, using technology in suppliers, expanding supplier base, and keeping abreast with geopolitical changes will strengthen organizational preparedness for disruptions. These strategies do not only address the risk issues but also contribute to long term sustainability and competitiveness of the business in the climate of increasing volatility (Ivanov & Dolgui, 2020). Together, these strategies can be used to strengthen organisations' ability to protect against volatility and risk, as well as to provide a foundation for sustainability that preserves the competitiveness of the organizations within and across industries.

5. Mitigation Strategies for Supply Chain Resilience

Building a sustainable supply chain management is crucialary important in today's environment for organisations that want to plan for a future with interruptions in the globe (Ozdemir et al., 2022). Business continuity refers to an organization's capacity to receive, consider, mobilize for, handle, and return to stability in the continuity of required products and services. Several measures have been adopted by organisations in their efforts to issue manage risks and ingrained supply chain resilience including diversification of supplier sources, use of alternative sourcing approaches as well as the incorporation of technologies in the management of the supply chain complexity Patel (2023). Relationships and knowledge exchange have also been also found to be important facilitators in building cooperation in dealing with the unexpected situation Orlando *et al.* (2022) McGregor et al,

(2016). Below is an exploration of key strategies that contribute to supply chain resilience: An extension of the procurement strategy known as multisourcing is the practice of sourcing from a variety of suppli- ers to reduce reliance on a lone seller. This approach brings added flexibility and cuts risks of supplier failure, geopolitical developments, or production problem (Wyrembek, 2025). As such distribution of supply chain risks of companies allows them to have better position for supply chain resilience, competitive pricing and newer innovations. Nevertheless, implementation of multi- sourcing strategy in supply chain comes along with challenges because the supplier has to be evaluated, the relationship maintained and the supplier integrated into the supply chain processes. Information systems of a higher evolutionary level can support this approach in terms of continuity and competitive advantage (Gereffi, 2020). Nearshoring is a concept of moving the supply chain activities to geographically closed locations, which makes it possible for firms to shorten lead times and transport cost(Ivanov & Dolgui, 2020). Depending on where an organization sources or manufactures, it becomes easier to adapt to market needs, and because of proximity cultural and regulatory barriers are eliminated. This approach also provides direct visibility and accountable access to supply chains, which can facilitate the flow of and assist in the timely modifications to the structure.

It is effective particularly in diversifying potential regional hazards such as calamities, political instabilities or economic volatilities by developing the production activities in several places (Owusu-Berko, 2025). A diversified manufacturing network demonstrates that when the ability of one particular facility is damaged, it cannot greatly affect that of the rest of the facilities. This strategy increases the resilience by enhancing cost efficiency, and using local advantages, including lower cost of labor and better access to markets, among others (Katsaliaki *et al.*, 2022). By so doing, these organizations can be able to enhance their operating standards, model, and flexibility in the prevailing uncertain and unpredictable environment. The reduction of the variability between processes, components and products across the supply chain makes work easier, eliminates complexities and increases the flexibility (Jane, 2025). This harmonization allows the company to shift resources within it according to various demands or the interruption of some product's demand. Therefore, through the implementation of common systems and procedures in the organization, there is always better organization of the involved players, and thus better flow of information between them and a better response to the changing market circumstances (Kashem et al., 2024). Keeping an inventory of buffers checklists along with emergency production capacity help in case of disruptions (Gereffi, 2020). These working capital buffers assist an organization to mitigate demand or supply shocks while maintaining End-User connectivity. Whilst it may increase the costs to hold excess stock or maintain idle capacity it provides protection during events that alter demand or the availability of suppliers, thereby protecting the customer experience and business resilience (Owusu-Berko, 2025). Forming a connection with other members in the supply chain environment promotes teamwork, sharing of risks and effective for solving problems. Supplier and logistics partners' engagement can enhance response readiness and response following disruptions Ozdemir *et al.* (2022). These relations create synergy in the hard times by supporting one another and optimizing resource use within supply chain, making it more durable and compacted.

5.1 Supply Chain Flexibility

It entails such practices as modularity of products and manufacturing and logistics flexibility. All these strategies help the firm to adapt fast whenever there are changes in the market requirement or an event that affects the market. For instance, Nike enterprise has adopted automation and customization aspects in manufacturing therefore enhancing the company's re- sponsiveness of lead time. They make organizations adaptable in order to maintain competitiveness during the construction of the buffers against the unpredictable The use of digital technology has transformed supply chain management, and or- ganisations are now in a position to forecast disruptions, prevent them and any arising effects from occurring Um and Han (2021). Technologies such as blockchain, artificial intelligence (AI), and cloud computing provide innovative solutions that enhance transparency, decision-making, anadaptability. The paradigms of Blockchain technology result into traceability and transparency since the records are kept in a secure and decentralized manner (Kashem et al., 2024). As the product passes through different stages of a life cycle they facilitate identification of various associated hazards such as fraud, recalls or noncompliance to the set regulations. This transparency enhances confidence with partners within the supply chain and, in general, overall resilience.

Utilising technology through AI provides additional support to supply chain by giving better estimates of demand patterns and any dangers that may be present. AI makes it possible for industries and businesses to begin looking into big data since it can predict market trends and disturbances in advance and this enables the needed industrial changes to be implemented beforehand (Katsaliaki et al., 2022). This predictive capability enhances the robustness foundation for it lays groundwork for timely intervention on adversity. Cloud

computing provides timely data sharing and contribution between supply chain value chains. This way, organizations can benefit from access to the cloud services and enhance the applicability of analytical instruments, which will contribute to better efficiency of decision-making Um and Han (2021). It aids in improving supply chain transparency and enables various organizations to collaborate with one another in the face of disruptions; thus, they benefit from Improved globalization of supply chains and want implementation of these strategies to be a critical aspect to address supply chain challenges (Orlando et al., 2022). Through new approaches to sourcing materials, adapting to digital change and increasing cooperation, there are many ways that businesses can ensure that they are more resilient in the long-term given today's uncertainties.

6. Analysis and Discussion

A quantitative assessment was carried out regarding the connection between supply chain resilience (SCR) with sustainability performance indicators and financial measures across manufacturing, retail and healthcare services, logistic operations and technological fields. The analysis measured SCR scores and sustainability indices together with carbon footprint reduction as well as resource efficiency and social responsibility and ROI and cost savings and lead time stability. Table 2 below contains the summary of results before exploring them in detail.

Table 2. Summary of Supply Chain Resilience and Sustainability Performance Across Industries

Industry	SCR Score (0-100)	Sustainability Index	Carbon Footprint Reduction (%)	Resource Efficiency (%)	Social Responsibility Score (1-10)	ROI (%)	Cost Savings (%)	Lead Time Stability
Manufacturing	72.5	68.3	15.4	78.2	6.1	12.8	10.3	1.2
Retail	68.9	74.1	18.7	82.5	6.8	11.4	9.6	1.1
Healthcare	79.7	81.2	22.1	86.3	5.9	15.2	13.4	1.0
Logistics	66.3	62.7	12.3	71.5	4.9	17.5	15.1	0.9
Technology	74.1	78.9	25.3	88.4	5.7	14.9	11.7	1.0

This analysis shows that Healthcare industry (79.7) and Technology (74.1) reach the highest Supply Chain Resilience (SCR) scores because they are able to adapt to disruptions using redundancy strategy and risk reduction. On the contrary, Logistics (66.3) has the lowest SCR score indicating inefficiency of managing supply chain shocks. There is a great deal of discrepancy in terms of sustainability performance amongst industries, with Technology ranking highest for carbon footprint reduction (25.3%), resource efficiency (88.4%), which places the focus on adopting green technology. Retail and Healthcare have an important advantage being sustainable - they are rated high on social responsibility (6.8 and 5.9, respectively) because of the need to meet regulatory compliance requirements. While Sustainability scores lowest (62.7) and Social Responsibility (4.9) suggest there are doubts about ethical sourcing and environmental impact, Logistics ranks lowest. Trade offs are also seen in the financial performance as Logistics with the highest ROI being (17.5%) and cost savings (15.1%), however the sustainability score is lower. All factors that define lead time stability are critical: Logistics has the lowest variability (0.9), but with a negative impact on sustainability, whereas Logistics is an even stronger ideal due to high efficiency. For supply chains to organize these elements into the triumvirate, it needed digital transformation, regulatory compliance, and industry specific approaches.

7. Discussion

This section presents data-driven insights on the impact of resilience strategies on sustainability metrics, compares findings to existing literature, and discusses trade-offs, synergies, and gaps between resilience and sustainability in supply chains. The analysis reveals that resilience strategies have a significant influence on sustainability metrics. For example, imple- menting flexibility and redundancy not only enhances operational stability but also reduces environmental risks by minimizing supply chain disruptions that lead to resource wastage (Queiroz *et al.*, 2022). Similarly, collaboration fosters social sustain- ability by promoting fair labor practices and community engagement. However, the data also indicate a potential trade-off between redundancy and environmental performance, as maintaining higher inventory levels can increase carbon emissions unless offset by green logistics practices.

7.1 Comparison to Existing Literature

The findings align with the broader literature on supply chain resilience and sustainability. As highlighted by Sundarakani *et al.* (2021), resilience strategies such as redundancy and flexibility contribute to mitigating risks in uncertain environments. However, the study extends these insights by demonstrating how such strategies directly influence specific sustainability metrics, such as carbon footprint reduction and social responsibility (Mohammed, 2024). The study also identifies gaps in existing frameworks. While many frameworks focus on

the environmental and economic aspects of sustainability, they often overlook the social dimension, such as workforce well-being and community impacts, which this study incorporates Katsaliaki *et al.* (2022). A key trade-off observed is the conflict between redundancy and environmental performance. Maintaining higher inventory levels for resilience can increase storage-related emissions. However, these emissions can be minimized by adopting energy-efficient technologies. Synergies exist between collaboration and all three dimensions of sustainability environmental, economic, and social showcasing the potential for shared value creation. The study also identifies gaps in resilience strategies related to digital transformation, particularly the underutilization of advanced analytics in sustainability measurement.

7.1.1 Balancing Trade-Offs Between Resilience and Sustainability

This represents a critical challenge of balancing a reduction in resilience and an increase in environmental costs brought on through strategies such as redundancy (i.e., stockpiling inventory or multisourcing). Quantitative trade-off model can aid firms in optimizing its sustainability goals and operational stability. For example, the usage of Lean-Agile frameworks with the help of AI driven predictive analytics can be used to minimize the excess inventory and maintain an agile supply chain solution (Orlando et al., 2022). Carbon emissions vs. operational redundancy can be statistically modeled such that threshold values of sustainability trade offs can be established for business use.

7.1.2 Regulatory Aspects in Supply Chain Resilience

The supply chain resilience and sustainability are directly impacted by government policies and international trade agreement. In the form of regulations, such as the European Green Deal and carbon tax policies, emission reductions are enforced; while trade agreements like USMCA and RCEP affect an organization's supplier diversification strategy (Okoye et al., 2024). Green logistics incentives, circular economy model and digital trade compliance can give rooms to both resilience and sustainability. Policy driven adaptations in global supply chain should be further researched in terms of case studies.

7.2 Implications for Theory and Practice

This section discusses the theoretical contributions of the study to the understanding of resilience and sustainability integration, as well as practical recommendations for supply chain managers seeking to implement resilience strategies while measuring sustainability performance.

7.2.1 Theoretical Contributions

The findings of this study provide valuable theoretical contributions to the field of supply chain management by bridging the gap between resilience and sustainability (Adeleye *et al*., 2024). While existing research often treats these concepts as separate domains, this study demonstrates their interconnectedness, emphasizing how resilience strategies can influence sustainability metrics across environmental, economic, and social dimensions. For instance, the above combinations of flexibility and redundancy, not only strengthen the robustness of the supply chain, but also promote sustainability by minimizing the rate of waste and providing services. Also, the study takes systems theory to another level by identifying what makes the nodes of the supply chain interdependent and coordinate so as to realize both resilience and sustainability. It enriches also the RBV by underlining that digital technologies and collaboration are two strategic enablers for connecting organizational resilience with sustainable objectives.

7.2.2 Practical Recommendations

To supply chain managers, this work presents findings to support the application of resilience strategies that also embrace sustainability (Oliveira et al., 2025). Managers should work closely with their supply chain partners to implement resource and information sharing that will increase supply chain resilience as well as Infuse the society with positive values such as humane labor practices and stakeholder engagement. Furthermore, solutions utilizing advanced information and communication technologies includ- ing artificial intelligence and block chain increase the visibility and forecasting function, which can help managers plan for disturbances and use resources more sparingly regarding environment. Responsive approach of flexibility should be integrated into the supply chain management processes so as to minimize disruption time and costs. However, managers need to ensure that redundancy does not result into increased energy consump- tion, water wastage and excessive use of materials by embracing environmentally friendly technologies and the right stock holding quantities respectively. Measurement of sustainability performance using parameters such as Carbon footprint, energy performance, and social responsibility metrics will give quantitative analysis on the effectiveness of the resilience strategies Therefore, this study establishes the need to take a systemic view on managing the supply chain by incorporating sustainabil- ity strategies with resilience initiatives. In this way, the organisations can work effectively and

efficiency, gain stakeholders' confidence, and support the chosen sustainable development goals.

Industry-Specific Recommendations for Practitioners

Therefore, industry specific strategy is required to enhance supply chain resilience and sustainability. To meet regulatory constraints, manufacturing should be based on circular economy models and low carbon production. To example, blockchain must be used by retail to have transparent sourcing and AI driven forecasting for demand to reduce waste. For crisis preparedness, healthcare should invest in multi tier supply network and supply management. Green transportation and real time tracking systems have to be adopted for logistics to adopt because they are able to optimize efficiency. Integration of resilience and sustainability is done through tailoring the strategies for industry particular challenges.

8. Conclusion

This study highlights the critical interplay between resilience strategies and sustainability performance in supply chain man- agement. This paper has shown that resilience concepts that include flexibility, redundancy and collaboration pose a positive impact on sustainability indicators, within environmental, economical and social context. Where flexibility increases organi- zational responsiveness, minimizes resources use and organizational disruption and where collaboration creates and maintain stakeholder confidence and fairness in labor relations. However, costs associated with redundancy for instance environmental costs are essential aspects that highlight that there have to be a balance between resilience techniques and sustainability goals. It is clear from the study that there is a need to measure sustainability performance along with resilience. Quantifiable goals include carbon footprint decrease, energy use optimization, and social relevance, which give others actionable information that analyzes the effectiveness of resilience management plans. A data-driven approach to integrating these metrics can help businesses align their operations with long-term sustainability goals while maintaining robust and adaptive supply chains. Future research should address gaps in the measurement of sustainability in disrupted supply chains. This includes explor- ing advanced analytics and digital transformation technologies, such as artificial intelligence and blockchain, to enhance the precision and scope of sustainability assessments. Additionally, further studies could investigate the social dimension of sus- tainability, particularly in relation to workforce well-being and community impacts, areas that are often underrepresented in existing frameworks. By addressing these gaps, future research can contribute to the development of comprehensive strategies that simultaneously enhance resilience and promote sustainability in increasingly volatile global markets.

Acknowledgments

We greatly appreciate the valuable contributions of our 广州巴洙亚贸易有限公司 and Mali-Chine Cargo workers. We would also like to thank our Young Brother Yalema Bamia and our Cousin Issa Ouologuem for their support and Encouragement.

Authors' contributions

Not applicable.

Funding

This work was supported by 广州巴洙亚贸易有限公司 and Mali-Chine Cargo.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data

are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

References

Adeleye, R. A., Oyeyemi, O. P., Asuzu, O. F., & Awonuga, K. F. (2024). Advanced analytics in supply chain resilience: A comparative review of African and USA practices. *International Journal of Management & Entrepreneurship Research, 6,* 296-306. https://doi.org/10.51594/ijmer.v6i2.771

Altaf, A., El Amraoui, A., & Delmotte, F. (2025). Robust cross-dock assignment problem with uncertain cost parameters. *International Journal of Production Research.* https://doi.org/10.1080/00207543.2025.2469164

Belhadi, A., Kamble, S., Subramanian, N., Singh, R. K., & Venkatesh, M. (2024). Digital capabilities to manage agri-food supply chain uncertainties and build supply chain resilience during compounding geopolitical disruptions. *International Journal of Operations & Production Management*. https://doi.org/10.1108/IJOPM-11-2022-0737

Christiano, T., Almeida, C., & Tabak, B. M. (2025). COVID-19 and supply chain disruptions: A novel perspective using a network of payments in Brazil. SSRN. https://doi.org/10.2139/ssrn.5137130

Gereffi, G. (2020). What does the COVID-19 pandemic teach us about global value chains? The case of medical supplies. *Journal of International Business Policy, 3,* 287-301. https://doi.org/10.1057/s42214-020-00062-w

Ivanov, D. (2018). Disruptive impact of COVID-19 pandemic on supply chains and its implications for recovery strategy: A simulation-based analysis. *Transportation Research Part E: Logistics and Transportation Review, 119*, 40-53. https://doi.org/10.1016/j.tre.2018.12.003

Ivanov, D., & Dolgui, A. (2020). Viable supply chain model: Integrating agility, resilience and sustainability perspectives—Lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research,* 1-21. https://doi.org/10.1007/s10479-020-03640-6

Jane, K. (2025). *Entrepreneurial marketing and firm resilience in Oman's logistics sector amid global supply chain disruptions.* ResearchGate. Retrieved from https://www.researchgate.net/publication/389420098

Kashem, M. A., Shamsuddoha, M., & Nasir, T. (2024). Digital-era resilience: Navigating logistics and supply chain operations after COVID-19. *Businesses, 4,* 1-17. https://doi.org/10.3390/businesses4010002

Katsaliaki, K., Galetsi, P., & Kumar, S. (2022). Supply chain disruptions and resilience: A major review and future research agenda. *Annals of Operations Research*, 1-38. https://doi.org/10.1007/s10479-022-04831-3

Mohammed, M. S. (2024). *Optimizing supply chain resilience in the face of disruptions: A study of strategies, risks, and recovery mechanisms in global supply chains*. ResearchGate. Retrieved from https://www.researchgate.net/publication/389211054

Okoye, C. C., Ofodile, O. C., Tula, S. T., Nifise, A. O. A., Falaiye, T., Ejairu, E., & Addy, W. A. (2024). Risk management in international supply chains: A review with USA and African cases. *Magna Scientia Advanced Research and Reviews, 10,* 256-264. https://doi.org/10.30574/msarr.2024.10.1.0024

Oliveira, J., Pereira, C., & Oliveira, A. (2025). The impact of exogenous shocks on strategy, business models and product development in the Portuguese footwear industry. *International Journal of Organizational Analysis.* https://doi.org/10.1108/IJOA-08-2024-4706

Orlando, B., Tortora, D., Pezzi, A., & Bitbol-Saba, N. (2022). The disruption of the international supply chain: Firm resilience and knowledge preparedness to tackle the COVID-19 outbreak. *Journal of International Management, 28,* 100876. https://doi.org/10.1016/j.intman.2022.100876

Owusu-Berko, L. (2025). *Advanced supply chain analytics: Leveraging digital twins, IoT, and blockchain for resilient, data-driven business operations.* ResearchGate. https://doi.org/10.30574/wjarr.2025.25.2.0572

Ozdemir, D., Sharma, M., Dhir, A., & Daim, T. (2022). Supply chain resilience during the COVID-19 pandemic.

Technology in Society, 68, 101847. https://doi.org/10.1016/j.techsoc.2022.101847

Patel, K. R. (2023). Enhancing global supply chain resilience: Effective strategies for mitigating disruptions in an interconnected world. *BULLET: Jurnal Multidisiplin Ilmu, 2*, 257-264.

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management, 20*, 124-143. https://doi.org/10.1108/09574090910954873

Pourmohammadreza, N., Jesri, Z. S. H., & Kamran, M. A. (2025). *A review of discount policies in supplier selection: Trends, opportunities, and challenges*. IEEE Access. https://doi.org/10.1109/ACCESS.2025.3547051

Queiroz, M. M., Wamba, S. F., Jabbour, C. J. C., & Machado, M. C. (2022). Supply chain resilience in the UK during the coronavirus pandemic: A resource orchestration perspective. *International Journal of Production Economics, 245*, 108405. https://doi.org/10.1016/j.ijpe.2021.108405

Rahbari, M., Arshadi Khamseh, A., & Sadati-Keneti, Y. (2024). Resilience strategies in coping with disruptions of the wheat supply chain caused by the Russia–Ukraine war crisis: A case study from an emerging economy. *Kybernetes, 53*, 2984-3018. https://doi.org/10.1108/K-12-2022-1728

Rashid, A., Rasheed, R., & Rahi, S. (2025). Impact of supplier trust and integrated technology on supply chain resilience for sustainable supply chain in the FMCG sector. *Journal of Science & Technology Policy Management.* https://doi.org/10.1108/JSTPM-04-2024-0134

Sarkis, J. (2021). Supply chain sustainability: Learning from the COVID-19 pandemic. *International Journal of Operations & Production Management, 41*, 63-73. https://doi.org/10.1108/IJOPM-08-2020-0568

Sundarakani, B., Pereira, V., & Ishizaka, A. (2021). Robust facility location decisions for resilient sustainable supply chain performance in the face of disruptions. *The International Journal of Logistics Management, 32*, 357-385. https://doi.org/10.1108/IJLM-12-2019-0333

Tortorella, G. L., Saurin, T. A., & Godinho Filho, M. (2025). Are we truly ready for what is coming? A reflection on supply chain resilience in face of megatrends. *International Journal of Production Economics.* https://doi.org/10.1016/j.ijpe.2025.109585

Um, J., & Han, N. (2021). Understanding the relationships between global supply chain risk and supply chain resilience: The role of mitigating strategies. *Supply Chain Management: An International Journal, 26*, 240-255. https://doi.org/10.1108/SCM-06-2020-0248

Wyrembek, M. (2025). *Machine learning as a foundation for resilient supply chains against delays: A stakeholder-centric approach*. Retrieved from https://www.ceeol.com/content-files/document-1375821.pdf