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| **Relationship Between** **Supply Chain Flexibility and Supply Chain Resilience: A Review of Literature** |  |
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**Abstract**

**Aim:** In modern dynamic and uncertain business environment, firms' ability to maintain operational stability while responding quickly to shocks is becoming increasingly vital. This study investigates the relationship between supply chain flexibility and resilience, specifically how adaptive abilities contribute to the overall robustness and responsiveness of supply systems.

**Methods:** This study adopted a systematic literature review approach to explore and synthesize existing research relevant to supply chain flexibility and resilience. The review methodology was guided by the principles of transparency, replicability, and rigor, aiming to identify patterns, gaps, and insights from the body of scholarly work on the subject. A comprehensive search was conducted across multiple academic databases, including Scopus, Web of Science, Google Scholar, and ScienceDirect, to collect peer-reviewed journal articles, conference proceedings, and relevant grey literature published between 2010 and 2025. Keywords and search terms included combinations of supply chain flexibility, supply chain resilience and supply chain management. To ensure relevance and quality, the inclusion criteria used was articles published in English, peer-reviewed publications, and studies explicitly focused on supply chain.

**Results:** Supply chain flexibility was identified as a crucial enabler of resilience. According to a review of Dynamic Capabilities Theory and System Theory and emerging global concerns, flexible supply chains are better positioned to manage risks, reduce vulnerabilities, and ensure company continuity. It also examines current problems such as economic insecurity, regulatory complexity, sustainability demands, labor shortages, and cybersecurity dangers, emphasizing the importance of combining technology and collaborative strategies to promote flexibility and resilience.

**Conclusion:** Firms that intentionally adopt digital tools, foster strong relationships, and embrace agility will be better positioned to weather disruptions and achieve long-term growth.

**Recommendation:** The study recommend that businesses should use dynamic risk management frameworks and engage in smart technology and environmental sustainability practices to build future-ready supply chains that balance efficiency and resilience.

**Keywords:** *Supply chain flexibility, supply chain resilience, supply chain management, dynamic capabilities.*

**INTRODUCTION**

## Background to the Study

Supply chain flexibility is an organization’s capacity to quickly alter and reconfigure its supply chain processes, resources, and strategies in reaction to external or internal changes (Huo *et al.,* 2018). Um (2017) argues that supply chain flexibility is the ability to easily change production levels, raw material procurement, and transportation capacity. A company can adapt and respond effectively to changes in consumer demand, market conditions, disruptions, and any other events that may affect the flow of goods and services (Siagian *et al.,* 2021).

Supply chain resilience is defined by Drozdibob *et al.* (2023) as the supply chain’s ability to anticipate, adapt to, and recover from disruptions caused by natural disasters, pandemics, or other unexpected events. Similarly, Supply chain resilience refers to the ability to respond quickly to unexpected events while preventing and reducing supply chain disruptions (Shishodia *et al.,* 2023). Moreover, Pettit *et al.* (2019) claim that an organization can effectively adapt to change and recover from disruptions or unforeseen events in its supply chain network.

According to UNCTAD (2024), global supply chains are becoming more volatile due to a "polycrisis" a combination of geopolitical tensions, environmental disruptions, and economic instability. A Maersk survey of over 2,000 European shippers revealed that 80% consider geopolitical risks, especially conflicts like those involving Russia and Ukraine, the greatest threat. Environmental shocks and economic uncertainty exacerbate this, making supply chains more fragile. In 2024, global shipping schedule reliability dropped to 50-55%, down from 70-85% pre-COVID. Key trade routes, between China and Europe, have been impacted by vessel rerouting around the Cape of Good Hope due to unrest in the Red Sea, absorbing up to 9% of global capacity and extending sailing distances by 10% (Notteboom *et al.* 2024). Furthermore, U.S. tariffs on Chinese exports have increased freight rates, illustrating how national policies disrupt global trade (Fan *et al.,* 2022).

Global supply chains are becoming more flexible due to geopolitical tensions, environmental disruptions, and economic shifts (Johnson & Haug, 2021). Nearshoring is increasing, with U.S. companies’ reshoring over 350,000 jobs in 2022 and up to 40% of Asia-origin freight projected to shift by 2030. On-demand warehousing is expanding in the U.S., Germany, and the UK, supporting faster urban deliveries. Platforms like Silq, used in Southeast Asia, Europe, and the U.S., enhance supply chain agility with real-time tracking and freight rate comparisons (Radhakrishnan, 2024). In addition, Automation at ports in China, Singapore, and the Netherlands is improving turnaround times, while sustainability drives sourcing decisions (Notteboom, 2022). Geopolitical tensions and trade tariffs, like the EU’s levy on Chinese EVs, are reshaping freight flows and increasing air transport reliance (Gone, 2024).

Modern supply chain management requires high flexibility and resilience to navigate global complexity and rising consumer demands (Lai, 2024). Bosse (20190 argues that companies like Scoutbee and Sennder are digitizing procurement and logistics, while tools from NexxIoT and Ambrosus enhance real-time visibility and risk response through IoT. Automation in warehousing, AI-driven planning, and smart last-mile solutions enhance adaptability, creating agile, transparent, and disruption-ready supply chains (Yarlagadda, 2024).

## Supply Chain Flexibility

Siagian *et al.* (2021) define supply chain flexibility as a company’s ability to adapt and respond effectively to changes in consumer demand, market conditions, disruptions and any other events that may affect the flow of goods and services. Um and Han (2021) stressed the necessity of adaptability in dealing with supply chain risks such as material supply disruptions or labor shortages. Singh (2024) argued that firms can mitigate the impact of disruptions by practicing proactive flexibility, which includes anticipating potential risks and implementing adaptable solutions ahead of time.

Indicators of supply chain flexibility include lead time, fill rate, inventory turnover, responsiveness and resilience. Okyere *et al.* (2015) define lead time as the total time it takes from receiving a customer order to delivering the final product or service. It is a crucial indicator of supply chain flexibility because it reflects how quickly a supply chain can respond to customer demands. A flexible supply chain aims to reduce lead time by streamlining operations, improving communication with suppliers, and adopting efficient production methods (Kimwaki, 2024). Darko *et al.* (2018) claim that shorter lead times enhance customer satisfaction and allow companies to adapt faster to changes in demand.

The fill rate is the percentage of client orders that are filled completely and on time. It displays the supply chain’s ability to deliver the relevant products in the correct quantities and on time (Harbi *et al.,* 2018). A high fill rate indicates a flexible and efficient supply chain that can consistently meet customer expectations, even in the face of demand fluctuations or disruptions (Ivanov *et al.* 2018). Improving fill rates often demands more planning, real-time inventory tracking, and strong supplier connections (Kaul & Khurana, 2022).

Inventory turnover is a financial metric that measures the rate at which a company sells and replaces its inventory over a specified period. It reflects the efficiency of inventory management and indicates how effectively a firm is converting its inventory into sales within a given timeframe (Addo, 2020). According to Pandey *et al.* (2023), a high inventory turnover rate implies that products move swiftly through the supply chain, signaling that the company can efficiently respond to market demands. It also demonstrates that the supply chain avoids overstocking, which can lead to obsolescence or waste. Inventory management flexibility allows businesses to adapt to changing customer demands while lowering holding costs (Akinlab, 2021).

Responsiveness is how quickly and precisely a supply chain responds to customer requests, complaints, or changes in order specifications (Asamoah *et al.,* 2021). A responsive supply chain can quickly adjust its methods to deal with unexpected events, such as last-minute orders or delivery changes (Richey *et al.,* 2022). This flexibility is typically achieved by real-time data analysis, automation, and close communication across multiple supply chain partners (Dolgui & Ivanov, 2022).

Resilience in the context of supply chain management refers to the system's capacity to anticipate, absorb, adapt to, and recover from disruptions - such as supplier failures, natural disasters, or global crises like pandemics - while maintaining continuity of operations and minimizing adverse impacts (Han *et al.,* 2022). A strong supply chain is also adaptable it can adjust operations, change suppliers, or reroute supplies in the face of unexpected events (Ivanov, 2022). Namdar *et al.* (2018) argue that building resilience requires investing in risk management strategies, developing backup plans, and diversifying the supplier base to reduce reliance on a single source. According to Adobor and McMullen (2018), supply chain resilience is the ability of a system to return to its original or move to a new, more desirable state after being disturbed. They stress the importance of visibility, adaptability, and a risk management culture as critical enablers of resilience. Similarly, Adobor (2020) defines supply chain resilience as the supply chain's adaptive capability to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function.

Flexibility in supply chain systems is critical because it allows organizations to respond quickly to changing market demands and external interruptions, ensuring that operations continue with minimal downtime (Kamalahmadi *et al.,* 2022). A flexible supply chain enables more efficient resource management, resulting in streamlined processes, lower costs, and faster delivery times (Um, 2017). Ivanov *et al.* (2018) add that this adaptability not only improves operational efficiency but also enables a company to adopt new technologies and automation, thereby boosting innovation. Furthermore, flexibility increases a company's resilience to economic volatility, promoting scalability and long-term growth (Settembre-Blundo *et al.,* 2021). Finally, it increases a company's worth by displaying dependability, responsiveness, and a forward-thinking attitude in a competitive market (Mutambik, 2024).

A flexible supply chain optimizes resources by leveraging advanced technologies such as artificial intelligence and data analytics to improve forecasts, automate procedures, and provide real-time insight across the supply chain (Adeniran *et al.,* 2024). Flexibility necessitates tight collaboration with suppliers and stakeholders to make timely, coordinated decisions (Üstündağ & Ungan, 2020). It also allows for product and service customization while remaining efficient (R. Novais *et al.,* 2019).

## Supply Chain Resilience

Ivanov (2022) introduced the concept of viable supply chains, which is based on resilience but prioritizes long-term survival in highly turbulent and uncertain environments. He argued that in a world of frequent shocks, resilient supply chains must also be viable and capable of changing business models and supply chain structures as needed to adapt to prolonged or repeated disruptions. Baah *et al.* (2022) claim that indicators of supply chain resilience include, collaboration, flexibility, visibility, information sharing, and agility.

Collaboration is where all parties within the supply chain work together towards common goals, especially during disruptions (Duong & Chong, 2022). When organizations collaborate through joint planning, decision-making, and resource sharing they are better equipped to anticipate risks and respond effectively (Song *et al.,* 2024). A high level of collaboration allows for faster communication, shared risk management strategies, and collective problem-solving, which can prevent the breakdown of operations during crises (Umar & Wilson, 2021). Effective collaboration also enhances trust and alignment across the network, making it easier to implement contingency plans and adapt to unforeseen challenges (Elvegård *et al.,* 2024).

Fayezi *et al.* (2019) argue that flexibility is the ability of a supply chain to adapt quickly to changes in demand, supply conditions, or other environmental factors. It is one of the most vital attributes for building resilience because it enables firms to shift operations, adjust sourcing strategies, and reallocate resources with minimal disruption. According to Ivanov *et al.* (2018), flexible supply chains can respond faster to emergencies by using alternate suppliers, transportation methods, or workforce arrangements. This ensures continuity and supports rapid recovery, ultimately reducing downtime and financial losses during adverse events.

According to Dey (2023), visibility in the supply chain means having a clear, real-time understanding of the entire network’s operations, including inventory levels, supplier status, and transportation flows. It is essential for the early detection of disruptions and timely decision-making. da Costa (2024) claims that, when supply chain managers can trace issues back to their source and understand the flow of goods and information, they are better positioned to act quickly and mitigate negative impacts. da Costa (2024) adds that high visibility also promotes transparency and accountability, which are necessary for coordinating response strategies and maintaining stability during crises.

Information sharing is crucial for resilience as it enables accurate, timely communication across all nodes of the supply chain (Johnson, 2025). Holloway (2025) argues that leveraging IT systems and digital tools to distribute relevant data helps supply chain partners stay informed, align their actions, and coordinate more efficiently during disruptions. Proper IT infrastructure ensures that real-time updates are shared, risks are communicated, and decisions are based on reliable information (Ghorbanian *et al.,* 2019). It also reduces uncertainty and facilitates proactive responses, allowing organizations to manage threats collaboratively and reduce the bullwhip effect (Reynolds, 2024).

Gligor *et al.* (2019) define agility as the ability of a supply chain to respond rapidly and efficiently to unexpected changes in the environment. It goes hand in hand with resilience by emphasizing speed and adaptability. According to Mishra *et al.* (2025), an agile supply chain can quickly shift production, reroute shipments, or scale operations in response to sudden demand surges or supply shortages. This quick responsiveness helps minimize the impact of disruptions and maintain service levels. Agility also allows companies to seize new opportunities in volatile markets, turning potential risks into strategic advantages (Hsieh *et al.,* 2023).

Supply chain resilience is essential in modern supply chain systems because it enables businesses to successfully foresee, respond to, and recover from disruptions while ensuring operational continuity and stability (Katsaliaki *et al.,* 2022). Building resilience enables firms to significantly reduce financial losses caused by supply chain disruptions while maintaining high levels of customer satisfaction through timely deliveries and consistent product availability (Das *et al.,* 2022). Furthermore, resilience enhances a company's ability to remain competitive by allowing it to respond to market developments and unexpected challenges faster than less prepared competitors (Alberti *et al.,* 2018). It also supports long-term sustainability by proactively addressing vulnerabilities and establishing robust supply networks that can withstand future uncertainties, so protecting the company's reputation and operational performance (Negri *et al.,* 2021).

According to Ivanov (2021), a resilient supply chain is characterized by end-to-end (E2E) visibility, allowing organizations to monitor risks across the entire value chain, from suppliers to customers. This transparency aids in early threat detection and timely decision-making. Additionally, Khan *et al.* (2022), claim that digital tools like predictive analytics and AI-driven automation help reduce vulnerabilities and improve response to disruptions. Regular stress testing and reassessment ensure the supply chain remains adaptable to evolving risks (Ivanov & Dolgui, 2022).

Another distinguishing trait is that resilience is incorporated into the primary strategic goal, with CEOs balancing efficiency and resilience to construct future-ready supply networks (Siddiqui *et al.,* 2025). According to Ramezankhani *et al.* (2018), resilience measurements are used with growth and cost indicators to demonstrate a holistic approach to success in performance management systems. To supplement this, firms invest in new technology and worker capabilities that boost resilience and efficiency. Furthermore, solid governance structures and long-term processes are established to manage resilience beyond short-term goals (Andersen, 2024).

## Dynamic Capabilities Theory

Teece *et al.* (1997) developed the Dynamic Capabilities Theory (DCT), which provides a strategic framework for comprehending how businesses use internal competencies to design and deploy responses to external changes. DCT places more emphasis on an organization's capacity to adapt to changing and turbulent conditions than traditional resource-based perspectives, which concentrate on static resources. It asserts that to respond to quickly changing market conditions, businesses need to have the flexibility to integrate, develop, and reorganize both internal and external resources (Teece, 2007).

DCT is based on three fundamental concepts, perceiving, grasping, and reconfiguring. Sensing is a company's ability to recognize changes, threats, or opportunities in its external environment (Song *et al.,* 2022). Seizing implies organizing resources effectively to respond to observed developments. Reconfiguration, or transformation, is the ability to restructure and realign organizational resources and processes to maintain relevance and performance (Teece, 2014). These three tenets form the basis of an organization's ability to dynamically adjust its strategy and operations, particularly during supply chain volatility.

In this study, which examines the relationship between supply chain flexibility and supply chain resilience, DCT provides a useful lens for understanding how firms modify their supply chains to withstand and recover from disruptions. According to Aslam *et al.* (2018), supply chain flexibility, helped by sensing and seizing capabilities, allows firms to react quickly to changes by adjusting sourcing strategy, production schedules, and distribution channels. This agility is critical for predicting disruptions and providing effective remedies. On the other hand, grabbing and reconfiguring capabilities have a significant impact on supply chain resilience, which requires not only responding to disruptions but also rebuilding supply chain activities to recover swiftly and continue generating value (Roh & Xiao, 2024).

As a result, DCT offers a theoretical framework for examining the relationship between supply chain flexibility and resilience. Organizations with excellent dynamic capabilities are more likely to have adaptive supply networks capable of detecting disruptions and responding appropriately (Irfan *et al.,* 2022). This boosts resilience by enabling quick recovery and continued value delivery in challenging conditions (Sinha & Ola, 2021). This study, which focuses on DCT, underlines the strategic importance of dynamic capabilities in establishing robust and responsive supply chains.

## Systems Theory

Systems theory developed by von Bertalanffy (1950) views organizations and processes as systems composed of interconnected components that work together to achieve a common purpose and changes in one element can affect the entire system. Systems theory explains how various supply chain management operations, including procurement, production, logistics, and distribution, interact with and influence one another (Caddy & Helou, 2007).

The principles of systems theory provide an excellent foundation for investigating the link between supply chain flexibility and resilience. Harney (2019) argues that key tenets include component interdependence, in which each part of the system influences and is influenced by the others holism, which shows the importance of understanding the system as a whole rather than isolated parts and the input-throughput-output model, in which the system receives inputs, processes them through various parts of the system, and produces outputs. The theory also highlights feedback loops, which allow the system to react and learn from disruptions, and dynamic equilibrium, which happens when the system responds to internal and external demands to maintain balance (Cordon, 2013).

The study is based on systems theory, which gives a comprehensive lens through which to investigate how flexibility affects supply chain resilience. The theory claims that by viewing the supply chain as an interconnected system, flexibility across multiple components, such as procurement and logistics, is crucial to increasing the supply chain’s overall resilience (Tukamuhabwa *et al.,* 2015). The concept of feedback supports the idea that flexibility enables continuous adaptation and recovery during disruptions (Butler & Brooks, 2021). Furthermore, the concept of dynamic equilibrium underlines how supply chains can sustain performance despite continuing adjustments, emphasizing the importance of flexibility in long-term resilience. This theoretical framework is crucial for understanding how flexibility in one part of the supply chain can improve overall system resilience.

## Supply Chain Flexibility and Supply Chain Resilience

The connection between supply chain flexibility and resilience is becoming increasingly important for firms managing the challenges of current business settings (Singh, 2024). Adaptation and reconfiguration processes enabled by flexibility are critical for increasing resilience (Szemző et la., 2022). Settembre-Blundo *et al.* (2021 argue that flexible systems enhance an organization’s organic potential by enabling it to confront and respond to unexpected environmental and operational crises. This organic ability is important because it enables firms to adjust quickly to changes in both internal and external contexts, which is essential for maintaining a competitive advantage.

Logistics flexibility is significant as it represents an organization’s ability to handle various receipts and delivery requirements with precision and efficiency (Jafari, 2015). According to Sandberg (2021), the interconnection of production, logistics, and other flexibility aspects is crucial such that combining production and logistics flexibility helps speed up product development flexibility. Without the support of these services, an organization's competitive edge in introducing new goods or updating old ones may erode. Therefore, firms must foster collaboration with suppliers and adapt swiftly to enhance their agility and responsiveness (Narayanan *et al.,* 2015).

Supply chain resilience, on the other hand, is defined as an organization's ability to anticipate, respond to, and recover from disturbances (Duchek, 2022). Supply chains’ complexity and dynamism require them to adapt to changes in their environments continually to survive and prosper in the global market (Aslam *et al.,* 2018). Dynamic skills are critical for creating supply chain resilience because they allow organizations to respond effectively to changes in their operational environment (Irfan *et al.,* 2022).

Resilient supply chains can rapidly merge and rearrange existing resources in response to unexpected events, thereby minimizing the negative impacts of such disruptions (Katsaliaki *et al.,* 2022). Pu *et al.* (2023) argue that this ability not only allows for quicker recovery but also provides a competitive advantage over less resilient firms. Thus, the integration of flexibility into supply chain operations is essential for enhancing resilience. A flexible supply chain allows organizations to quickly rearrange and realign resources in reaction to disruptions (Enrique *et al.,* 2022).

Moreover, the capability to reconfigure supply chains effectively allows firms to utilize their existing assets and structures more efficiently, facilitating a faster return to an optimal state after a disruption (Chopra *et al.,* 2021). For instance, following the Tōhoku Great East Japan Earthquake, companies with flexible supply chain capabilities were reported to recover more swiftly than those lacking such flexibility (Siawsh *et al.,* 2023). This illustrates the importance of flexibility as a resilience measure, which is emphasized in contemporary supply chain research (Piprani *et al.,* 2022).

Flexibility in various aspects, such as distribution, production facilities, supply bases, and workforce skills, significantly contributes to the overall resilience of supply chains (Piprani *et al.,* 2022). This flexibility allows organizations to respond quickly and effectively during turbulent times, facilitating resource reconfiguration and enhancing their ability to adapt to unforeseen challenges (Agrawal *et al.,* 2023). Ultimately, the integration of flexibility within supply chains reinforces resilience, enabling organizations to maintain operational continuity and competitiveness in dynamic environments (Chunsheng *et al.,* 2020).

The interplay between supply chain flexibility and resilience is crucial for firms seeking to negotiate the intricacies of today's business landscape (Gunasekaran *et al.,* 2015). Flexibility is a core factor that improves resilience, allowing firms to survive disturbances and adapt to changing market conditions (Karman, 2020). According to Tarigan *et al.* (2021), companies that efficiently incorporate flexibility into their supply chain operations are better able to manage risks, respond to unanticipated problems, and preserve a competitive advantage. As a result, organizations must consider flexibility not only as a desirable asset but also as a crucial component of their resilience strategy, which will ultimately lead to more resilient supply chains capable of prospering in an unpredictable future (Purvis *et al.,* 2016).

## Emerging Issues in Supply Chain Resilience

Several emerging concerns are affecting the resilience of supply systems. According to Mamasoliev (2024), economic instability, induced by unforeseen factors such as rising oil costs, inflation, and trade policy shifts, continues to endanger supply chain stability. Geopolitical upheavals, notably upcoming changes in global leadership and trade agreements, exacerbate the complexity (Roscoe *et al.,* 2022).

Sulkowski (2018) argues that, as regulatory frameworks become more complicated across markets, firms have the problem of being compliant with changing laws and regulations. Automated tools for tracking and managing compliance data, as well as solid collaborations with legal professionals, are critical to tackling this issue. Furthermore, the growing demand for sustainability and ESG goals compels businesses to reconsider their supply chain operations, with a focus on techniques such as lowering fuel usage and incorporating renewable energy (Lewis & MacGregor, 2023). Embracing technology and streamlining transportation routes can help businesses achieve sustainability goals while being efficient (Kazancoglu *et al.,* 2023).

Labor shortages and cybersecurity threats are also major challenges for supply chains. The persistent lack of crucial workers, forces businesses to rely more on automation and artificial intelligence (AI), while also improving employment conditions to retain competent labor (Attah *et al.,* 2024). The digitization of supply networks increases the risk of cyberattacks, acquiring advanced cybersecurity defenses necessary (Singh, 2025).

## CONCLUSION

In today’s volatile business environment, the integration of supply chain flexibility and resilience is vital for sustaining competitive advantage and operational continuity. Flexibility enhances resilience by enabling firms to swiftly adapt to disruptions, market changes, and consumer demands. As shown by Gunasekaran *et al.* (2015) and Karman (2020), flexibility is not merely a desirable trait but a strategic necessity that empowers organizations to manage risks, maintain performance, and remain agile. Companies that adopt adaptive strategies, embrace digital tools, and foster collaborative networks are better positioned to recover from shocks and create long-term value. Flexibility, therefore, acts as both a preventative and enabling mechanism within broader resilience frameworks.

At the same time, emerging global challenges such as economic instability, shifting regulations, labor shortages, and cybersecurity threats demand stronger resilience strategies. Mamasoliev (2024) and Singh (2025) show the growing need for digital integration, automation, and sustainability practices to address these pressures. Regulatory complexity and ESG expectations also require firms to rethink operations, streamline compliance, and innovate towards greener, more efficient supply chains. Finally, the combination of flexibility and resilience enables firms to foresee disruptions, put in place strong contingency plans, and prosper in the face of uncertainty. Firms that prioritize these talents will be better able to handle the intricacies of modern supply chains and establish long-term, future-ready operations.

## RECOMMENDATIONS

The study recommends that organizations prioritize the integration of digital technologies such as artificial intelligence, machine learning, and real-time analytics to enhance both supply chain flexibility and resilience. These technologies offer improved visibility, faster response times, and proactive risk identification, enabling firms to quickly adapt to disruptions and evolving market demands. Additionally, investing in automation can help counteract labor shortages and increase operational efficiency. The study also recommends fostering collaborative relationships with suppliers and other stakeholders to promote transparency, knowledge sharing, and coordinated contingency planning during uncertain times.

Furthermore, the study recommends that firms adopt dynamic risk management frameworks that incorporate regular assessments of regulatory changes, geopolitical developments, and sustainability goals. Embracing environmentally friendly practices, such as optimizing transportation routes and reducing fuel consumption, not only strengthens resilience but also aligns operations with global ESG expectations. Enhancing cybersecurity infrastructure is equally crucial in an era of digitized supply chains. Finally, the study urges organizations to build a culture of adaptability and continuous improvement through training, scenario planning, and strategic foresight to ensure sustained competitiveness in an unpredictable global environment.

## REFERENCES

Addo, S. K. (2020). Inventory Turnover as Indicator of Health of Inventory and Business. *Dama Academic Scholarly Journal of Researcher*, *5*(4), 69-77. <https://www.academia.edu/download/62992850/DASJR-04-020-00620200417-125931-uwve4n.pdf>

Adeniran, I. A., Efunniyi, C. P., Osundare, O. S., & Abhulimen, A. O. (2024). Optimizing logistics and supply chain management through advanced analytics: Insights from industries. *Engineering Science & Technology Journal*, *5*(8). <https://doi.org/10.56781/ijsret.2024.4.1.0020>

Adobor, H. (2020). Supply chain resilience: an adaptive cycle approach. *The International Journal of Logistics Management*, *31*(3), 443-463. <https://doi.org/10.1108/IJLM-01-2020-0019>

Adobor, H., & McMullen, R. S. (2018). Supply chain resilience: a dynamic and multidimensional approach. *The International Journal of Logistics Management*, *29*(4), 1451-1471. <https://doi.org/10.1108/IJLM-04-2017-0093>

Agrawal, N., Sharma, M., Raut, R. D., Mangla, S. K., & Arisian, S. (2023). Supply chain flexibility and post-pandemic resilience. *Global Journal of Flexible Systems Management*, *24*(Suppl 1), 119-138. <https://doi.org/10.1007/s40171-024-00375-2>

Akinlabi, B. H. (2021). Effect of inventory management practices on operational performance of flour milling companies in Nigeria. *International Academy Journal of Management, Marketing and Entrepreneurial Studies*, *8*(2), 137-174. <https://www.arcnjournals.org/images/ASA-IAJMMES-8-3-77.pdf>

Alberti, F. G., Ferrario, S., & Pizzurno, E. (2018). Resilience: resources and strategies of SMEs in a new theoretical framework. *International journal of learning and intellectual capital*, *15*(2), 165-188. <https://doi.org/10.1504/IJLIC.2018.091969>

Andersen, T. J. (2024). Adaptive Strategy-making Processes for Long-term Resilience and Sustainable Solutions. In *Sustainable and Resilient Global Practices: Advances in Responsiveness and Adaptation* (pp. 1-15). Emerald Publishing Limited. <https://doi.org/10.1108/978-1-83797-611-920241001>

Asamoah, D., Nuertey, D., Agyei-Owusu, B., & Akyeh, J. (2021). The effect of supply chain responsiveness on customer development. *The International Journal of Logistics Management*, *32*(4), 1190-1213. <https://doi.org/10.1108/IJLM-03-2020-0133>

Aslam, H., Blome, C., Roscoe, S., & Azhar, T. M. (2018). Dynamic supply chain capabilities: How market sensing, supply chain agility and adaptability affect supply chain ambidexterity. *International Journal of Operations & Production Management*, *38*(12), 2266-2285. <https://doi.org/10.1108/IJOPM-09-2017-0555>

Attah, R. U., Garba, B. M. P., Gil-Ozoudeh, I., & Iwuanyanwu, O. (2024). Enhancing supply chain resilience through artificial intelligence: Analyzing problem-solving approaches in logistics management. *International Journal of Management & Entrepreneurship Research*, *5*(12), 3248-3265. <https://www.researchgate.net/profile/Ifechukwu-Gil-Ozoudeh/publication/386384926_Enhancing_supply_chain_resilience_through_artificial_intelligence_Analyzing_problem-solving_approaches_in_logistics_management/links/674ff170359dcb4d9d50cd00/Enhancing-supply-chain-resilience-through-artificial-intelligence-Analyzing-problem-solving-approaches-in-logistics-management.pdf>

Baah, C., Opoku Agyeman, D., Acquah, I. S. K., Agyabeng-Mensah, Y., Afum, E., Issau, K., ... & Faibil, D. (2022). Effect of information sharing in supply chains: understanding the roles of supply chain visibility, agility, collaboration on supply chain performance. *Benchmarking: An International Journal*, *29*(2), 434-455. <https://doi.org/10.1108/BIJ-08-2020-0453>

Bosse, M. (2019, August 1). The need for flexibility & resilience in supply chains: The current landscape of Supply-Chain-Management startups in Europe. LinkedIn. <https://www.linkedin.com/pulse/need-flexibility-resilience-supply-chains-current-landscape-bosse>

Butler, T., & Brooks, R. (2021). Achieving operational resilience in the financial industry: Insights from complex adaptive systems theory and implications for risk management. *Journal of Risk Management in Financial Institutions*, *14*(4), 395-407. <https://www.ingentaconnect.com/content/hsp/jrmfi/2021/00000014/00000004/art00007>

Caddy, I. N., & Helou, M. M. (2007). Supply chains and their management: Application of general systems theory. *Journal of Retailing and Consumer Services*, *14*(5), 319-327. <https://doi.org/10.1016/j.jretconser.2006.12.001>

Chopra, S., Sodhi, M., & Lücker, F. (2021). Achieving supply chain efficiency and resilience by using multi‐level commons. *Decision Sciences*, *52*(4), 817-832. <https://doi.org/10.1111/deci.12526>

Chunsheng, L., Wong, C. W., Yang, C. C., Shang, K. C., & Lirn, T. C. (2020). Value of supply chain resilience: roles of culture, flexibility, and integration. *International Journal of Physical Distribution & Logistics Management*, *50*(1), 80-100. <https://doi.org/10.1108/IJPDLM-02-2019-0041>

Cordon, C. P. (2013). System theories: An overview of various system theories and its application in healthcare. *American Journal of Systems Science*, *2*(1), 13-22. <https://www.academia.edu/download/93711121/showpaperpdf.pdf>

da Costa, G. L. T. M. (2024). *Strengthening Resilience by Means of Supply Chain Visibility* (Master's thesis, Universidade do Porto (Portugal)).

Darko, S., Terkper, V. D., Novixoxo, J. D., & Anning, L. (2018). Assessing the effect of lead time management on customer satisfaction. *International Journal of Developing and Emerging Economies*, *6*(1), 1-22.

Das, D., Datta, A., Kumar, P., Kazancoglu, Y., & Ram, M. (2022). Building supply chain resilience in the era of COVID-19: An AHP-DEMATEL approach. *Operations Management Research*, *15*(1), 249-267. <https://doi.org/10.1007/s12063-021-00200-4>

Dey, S. (2023). Surviving major disruptions: Building supply chain resilience and visibility through rapid information flow and real-time insights at the “edge”. *Sustainable Manufacturing and Service Economics*, *2*, 100008. <https://doi.org/10.1016/j.smse.2022.100008>

Dolgui, A., & Ivanov, D. (2022). 5G in digital supply chain and operations management: fostering flexibility, end-to-end connectivity and real-time visibility through internet-of-everything. *International Journal of Production Research*, *60*(2), 442-451. <https://doi.org/10.1080/00207543.2021.2002969>

Drozdibob, A., Sohal, A., Nyland, C., & Fayezi, S. (2023). Supply chain resilience in relation to natural disasters: Framework development. *Production Planning & Control*, *34*(16), 1603-1617. <https://doi.org/10.1080/09537287.2022.2035446>

Duchek, S. (2020). Organizational resilience: a capability-based conceptualization. *Business research*, *13*(1), 215-246. <https://doi.org/10.1007/s40685-019-0085-7>

Duong, L. N. K., & Chong, J. (2020). Supply chain collaboration in the presence of disruptions: a literature review. *International Journal of Production Research*, *58*(11), 3488-3507. <https://doi.org/10.1080/00207543.2020.1712491>

Elvegård, R., Andreassen, N., & Badu, J. (2024). Building collaboration and trust in emergency preparedness: a model for planning collaboration exercises. *Safety in Extreme Environments*, *6*(4), 319-331. <https://doi.org/10.1007/s42797-024-00107-w>

Enrique, D. V., Lerman, L. V., de Sousa, P. R., Benitez, G. B., Santos, F. M. B. C., & Frank, A. G. (2022). Being digital and flexible to navigate the storm: How digital transformation enhances supply chain flexibility in turbulent environments. *International Journal of Production Economics*, *250*, 108668. <https://doi.org/10.1016/j.ijpe.2022.108668>

Fan, D., Zhou, Y., Yeung, A. C., Lo, C. K., & Tang, C. (2022). Impact of the US–China trade war on the operating performance of US firms: The role of outsourcing and supply base complexity. *Journal of Operations Management*, *68*(8), 928-962. <https://doi.org/10.1002/joom.1225>

Fayezi, S., Zutshi, A., & O'Loughlin, A. (2017). Understanding and development of supply chain agility and flexibility: a structured literature review. *International journal of management reviews*, *19*(4), 379-407. <https://doi.org/10.1111/ijmr.12096>

Ghorbanian, M., Dolatabadi, S. H., Masjedi, M., & Siano, P. (2019). Communication in smart grids: A comprehensive review on the existing and future communication and information infrastructures. *IEEE Systems Journal*, *13*(4), 4001-4014. <https://doi.org/10.1109/JSYST.2019.2928090>

Gligor, D., Gligor, N., Holcomb, M., & Bozkurt, S. (2019). Distinguishing between the concepts of supply chain agility and resilience: A multidisciplinary literature review. *The International Journal of Logistics Management*, *30*(2), 467-487. <https://doi.org/10.1108/IJLM-10-2017-0259>

Gone, M. A. D. (2024). American, European and Chinese Characteristics. <https://transatlanticrelations.org/wp-content/uploads/2024/03/Chapter-3.pdf>

Gunasekaran, A., Subramanian, N., & Rahman, S. (2015). Supply chain resilience: role of complexities and strategies. *International Journal of Production Research*, *53*(22), 6809-6819. <https://doi.org/10.1080/00207543.2015.1093667>

Han, Y., Chong, W. K., & Li, D. (2020). A systematic literature review of the capabilities and performance metrics of supply chain resilience. *International Journal of Production Research*, *58*(15), 4541-4566. <https://doi.org/10.1080/00207543.2020.1785034>

Harbi, S., Bahroun, M., & Bouchriha, H. (2018). How to Estimate the Supplier Fill Rate When the Supply Order and the Supply Lead-time Are Uncertain?. *International Journal of Supply and Operations Management*, *5*(3), 197-206.

Harney, B. (2019). Systems theory: forgotten legacy and future prospects. In *Elgar introduction to theories of human resources and employment relations* (pp. 112-127). Edward Elgar Publishing. <https://doi.org/10.4337/9781786439017.00014>

Holloway, S. (2025). Collaboration as a Driver for Supply Chain Resilience: Insights from Emerging Technology Integration. <https://www.preprints.org/frontend/manuscript/3843849861cecd5de1edf142faa48728/download_pub>

Hsieh, C. C., Chen, S. L., & Huang, C. C. (2023). Investigating the role of supply chain environmental risk in shaping the nexus of supply chain agility, resilience, and performance. *Sustainability*, *15*(20), 15003. <https://doi.org/10.3390/su152015003>

Huo, B., Gu, M., & Wang, Z. (2018). Supply chain flexibility concepts, dimensions and outcomes: an organisational capability perspective. *International Journal of Production Research*, *56*(17), 5883-5903. <https://doi.org/10.1080/00207543.2018.1456694>

Irfan, I., Sumbal, M. S. U. K., Khurshid, F., & Chan, F. T. (2022). Toward a resilient supply chain model: critical role of knowledge management and dynamic capabilities. *Industrial management & data systems*, *122*(5), 1153-1182. <https://doi.org/10.1108/IMDS-06-2021-0356>

Ivanov, D. (2021). Digital supply chain management and technology to enhance resilience by building and using end-to-end visibility during the COVID-19 pandemic. *IEEE Transactions on Engineering Management*. <https://doi.org/10.1109/TEM.2021.3095193>

Ivanov, D. (2022). Lean resilience: AURA (Active Usage of Resilience Assets) framework for post-COVID-19 supply chain management. *The International Journal of Logistics Management*, *33*(4), 1196-1217. <https://doi.org/10.1108/IJLM-11-2020-0448>

Ivanov, D. (2022). Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. *Annals of operations research*, *319*(1), 1411-1431. <https://doi.org/10.1007/s10479-020-03640-6>

Ivanov, D., & Dolgui, A. (2022). Stress testing supply chains and creating viable ecosystems. *Operations Management Research*, *15*(1), 475-486. <https://doi.org/10.1007/s12063-021-00194-z>

Ivanov, D., Das, A., & Choi, T. M. (2018). New flexibility drivers for manufacturing, supply chain and service operations. *International Journal of Production Research*, *56*(10), 3359-3368. <https://doi.org/10.1080/00207543.2018.1457813>

Ivanov, D., Das, A., & Choi, T. M. (2018). New flexibility drivers for manufacturing, supply chain and service operations. *International Journal of Production Research*, *56*(10), 3359-3368. <https://doi.org/10.1080/00207543.2018.1457813>

Jafari, H. (2015). Logistics flexibility: a systematic review. *International Journal of Productivity and Performance Management*, *64*(7), 947-970. <https://doi.org/10.1108/IJPPM-05-2014-0069>

Johnson, H. (2025). Assessing the Role of Communication and Information Sharing in Strengthening Supply Chain Resilience During Disruptions.

Johnson, J. E., & Haug, P. (2021). Modifications to global supply chain management strategies resulting from recent trade disruptions: an exploratory study. *Journal of Global Operations and Strategic Sourcing*, *14*(4), 701-722. <https://doi.org/10.1108/JGOSS-12-2020-0074>

Kamalahmadi, M., Shekarian, M., & Mellat Parast, M. (2022). The impact of flexibility and redundancy on improving supply chain resilience to disruptions. *International Journal of Production Research*, *60*(6), 1992-2020. <https://doi.org/10.1080/00207543.2021.1883759>

Karman, A. (2020). Flexibility, coping capacity and resilience of organizations: between synergy and support. *Journal of Organizational Change Management*, *33*(5), 883-907. <https://doi.org/10.1108/JOCM-10-2019-0305>

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/s10479-020-03912-1>

Kaul, D., & Khurana, R. (2022). Ai-driven optimization models for e-commerce supply chain operations: Demand prediction, inventory management, and delivery time reduction with cost efficiency considerations. *International Journal of Social Analytics*, *7*(12), 59-77.

Kazancoglu, I., Ozbiltekin-Pala, M., Mangla, S. K., Kumar, A., & Kazancoglu, Y. (2023). Using emerging technologies to improve the sustainability and resilience of supply chains in a fuzzy environment in the context of COVID-19. *Annals of Operations Research*, *322*(1), 217-240. <https://doi.org/10.1007/s10479-022-04775-4>

Khan, R. S., Sirazy, M. R. M., Das, R., & Rahman, S. (2022). An ai and ml-enabled framework for proactive risk mitigation and resilience optimization in global supply chains during national emergencies. *Sage Science Review of Applied Machine Learning*, *5*(2), 127-144.

Kimwaki, B. M. (2024). Supply Chain Performance in the Manufacturing Sector: The Role of Lead-Time Management Strategies. *Journal Integration of Social Studies and Business Development*, *2*(1), 1-12. <https://jurnal.integrasisainsmedia.co.id/index.php/JISSBD/article/download/142/139>

Lai, Y. (2024). Innovative Strategies in Logistics and Supply Chain Management: Navigating Modern Challenges. In *SHS Web of Conferences* (Vol. 183, p. 02020). EDP Sciences. <https://doi.org/10.1051/shsconf/202418302020>

Lewis, T., & MacGregor, A. (2023). *Future Ready: Your Organization's Guide to Rethinking Climate, Resilience, and Sustainability*. John Wiley & Sons.

Mamasoliev, S. (2024). Global Supply Chain Resilience: Implications for Us Trade Policy and National Security. *American Journal of Education and Learning*, *2*(4), 525-535. <https://advancedscienti.com/index.php/AJEL/article/view/177>

Mishra, A., Gupta, N., & Jha, G. K. (2024). Supply chain resilience: Adapting to global disruptions and uncertainty. *International Journal of Innovative Research in Engineering*, *5*(2), 189-96. <https://www.doi.org/10.59256/ijire.20240502025>

Mishra, N. K., Pande Sharma, P., & Chaudhary, S. K. (2025). Redefining agile supply chain practices in the disruptive era: A case study identifying vital dimensions and factors. *Journal of global operations and strategic sourcing*, *18*(1), 64-90. <https://doi.org/10.1108/JGOSS-04-2023-0031>

Mutambik, I. (2024). The Role of Strategic Partnerships and Digital Transformation in Enhancing Supply Chain Agility and Performance. *Systems*, *12*(11), 456. <https://doi.org/10.3390/systems12110456>

Namdar, J., Li, X., Sawhney, R., & Pradhan, N. (2018). Supply chain resilience for single and multiple sourcing in the presence of disruption risks. *International journal of production research*, *56*(6), 2339-2360. <https://doi.org/10.1080/00207543.2017.1370149>

Narayanan, S., Narasimhan, R., & Schoenherr, T. (2015). Assessing the contingent effects of collaboration on agility performance in buyer–supplier relationships. *Journal of Operations Management*, *33*, 140-154. <https://doi.org/10.1016/j.jom.2014.11.004>

Negri, M., Cagno, E., Colicchia, C., & Sarkis, J. (2021). Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. *Business Strategy and the environment*, *30*(7), 2858-2886. <https://doi.org/10.1002/bse.2776>

Notteboom, T. (2022). Global trends in maritime supply chains and ports in 2021. In *Annual Report of Valencia Containerized Freight Index (VCFI): balance of the year 2021* (pp. 10-15). [https://repository.uantwerpen.be/docstore/d:irua:15136](https://repository.uantwerpen.be/docstore/d%3Airua%3A15136)

Notteboom, T., Haralambides, H., & Cullinane, K. (2024). The Red Sea Crisis: ramifications for vessel operations, shipping networks, and maritime supply chains. *Maritime Economics & Logistics*, *26*(1), 1-20. <https://doi.org/10.1057/s41278-024-00287-z>

Okyere, S., Annan, J., & Anning, K. S. (2015). Evaluating the effect of lead time on quality service delivery in the banking industry in Kumasi Metropolis of Ghana. *Journal of Arts and Humanities*, *4*(7), 29-44. <https://doi.org/10.18533/journal.v4i7.760>

Pandey, R., Chatterjee, D., & Rungtusanatham, M. (2023). The effects of tie strength and data integration with supply base on supply disruption ambiguity and its impact on inventory turnover. *International Journal of Operations & Production Management*, *43*(3), 428-465. <https://doi.org/10.1108/IJOPM-03-2022-0199>

Pettit, T. J., Croxton, K. L., & Fiksel, J. (2019). The evolution of resilience in supply chain management: a retrospective on ensuring supply chain resilience. *Journal of business logistics*, *40*(1), 56-65. <https://doi.org/10.1111/jbl.12202>

Piprani, A. Z., Jaafar, N. I., Ali, S. M., Mubarik, M. S., & Shahbaz, M. (2022). Multi-dimensional supply chain flexibility and supply chain resilience: the role of supply chain risks exposure. *Operations Management Research*, *15*(1), 307-325. <https://doi.org/10.1007/s12063-021-00232-w>

Pu, G., Li, S., & Bai, J. (2023). Effect of supply chain resilience on firm’s sustainable competitive advantage: a dynamic capability perspective. *Environmental Science and Pollution Research*, *30*(2), 4881-4898. <https://doi.org/10.1007/s11356-022-22483-1>

Purvis, L., Spall, S., Naim, M., & Spiegler, V. (2016). Developing a resilient supply chain strategy during ‘boom’and ‘bust’. *Production planning & control*, *27*(7-8), 579-590. <https://doi.org/10.1080/09537287.2016.1165306>

R. Novais, L., Maqueira, J. M., & Bruque, S. (2019). Supply chain flexibility and mass personalization: a systematic literature review. *Journal of Business & Industrial Marketing*, *34*(8), 1791-1812. <https://doi.org/10.1108/JBIM-03-2019-0105>

Radhakrishnan, R. (2024, December 23). *Top supply chain trends shaping global trade in 2025*. Silq. <https://www.onesilq.com/blog/supply-chain-trends>

Ramezankhani, M. J., Torabi, S. A., & Vahidi, F. (2018). Supply chain performance measurement and evaluation: A mixed sustainability and resilience approach. *Computers & Industrial Engineering*, *126*, 531-548. <https://doi.org/10.1016/j.cie.2018.09.054>

Reynolds, S. (2024). Investigating the Impact of Information Sharing on Supply Chain Resilience. <https://www.preprints.org/manuscript/202406.0557/download/final_file>

Richey, R. G., Roath, A. S., Adams, F. G., & Wieland, A. (2022). A responsiveness view of logistics and supply chain management. *Journal of Business Logistics*, *43*(1), 62-91. <https://doi.org/10.1111/jbl.12290>

Roh, T., & Xiao, S. (2024). Extending the research agenda for supply chain management in the age of disruption: The multifaceted role and implications of dynamic capabilities. *Journal of General Management*, *50*(1), 5-15. <https://doi.org/10.1177/03063070241272373>

Roscoe, S., Aktas, E., Petersen, K. J., Skipworth, H. D., Handfield, R. B., & Habib, F. (2022). Redesigning global supply chains during compounding geopolitical disruptions: the role of supply chain logics. *International Journal of Operations & Production Management*, *42*(9), 1407-1434. <https://doi.org/10.1108/IJOPM-12-2021-0777>

Sandberg, E. (2021). Dynamic capabilities for the creation of logistics flexibility–a conceptual framework. *The international journal of logistics management*, *32*(2), 696-714. <https://doi.org/10.1108/IJLM-07-2020-0266>

Settembre-Blundo, D., González-Sánchez, R., Medina-Salgado, S., & García-Muiña, F. E. (2021). Flexibility and resilience in corporate decision making: a new sustainability-based risk management system in uncertain times. *Global Journal of Flexible Systems Management*, *22*(Suppl 2), 107-132. <https://doi.org/10.1007/s40171-021-00277-7>

Shishodia, A., Sharma, R., Rajesh, R., & Munim, Z. H. (2023). Supply chain resilience: A review, conceptual framework and future research. *The International Journal of Logistics Management*, *34*(4), 879-908. <https://doi.org/10.1108/IJLM-03-2021-0169>

Siagian, H., Tarigan, Z. J. H., & Jie, F. (2021). Supply chain integration enables resilience, flexibility, and innovation to improve business performance in COVID-19 era. *Sustainability*, *13*(9), 4669. <https://doi.org/10.3390/su13094669>

Siawsh, N., Peszynski, K., Vo-Tran, H., & Young, L. (2023). Toward the creation of disaster-resilient communities: the machizukuri initiative–the 2011 tōhoku great east Japan earthquake and tsunami. *International journal of disaster risk reduction*, *96*, 103961. <https://doi.org/10.1016/j.ijdrr.2023.103961>

Siddiqui, H. M. A., Azher, E., Ali, O., Khan, M. F. U., Salman, S., & Ahmed, O. (2025). Synergizing Resilience and Digitalization: A New Paradigm in Supply Chain Performance. *The Critical Review of Social Sciences Studies*, *3*(1), 3506-3526. <https://doi.org/10.59075/fw9yky89>

Singh, R. K. (2024). Strengthening resilience in supply chains: the role of multi-layer flexibility, supply chain risks and environmental dynamism. *The International Journal of Logistics Management*, *35*(6), 1807-1826. <https://doi.org/10.1108/IJLM-08-2023-0337>

Singh, T. (2025). *Digital Resilience, Cybersecurity and Supply Chains*. Taylor & Francis.

Sinha, R., & Ola, A. (2021). Enhancing business community disaster resilience. A structured literature review of the role of dynamic capabilities. *Continuity & Resilience Review*, *3*(2), 132-148. <https://doi.org/10.1108/CRR-03-2021-0009>

Song, J., Lee, K. B., Zhou, Z., Jia, L., Cegielski, C., & Shin, S. I. (2022). Enhancing supply chain sensing capability through social media: an environmental scanning perspective. *Information Technology & People*, *35*(1), 367-391. <https://doi.org/10.1108/ITP-11-2019-0609>

Song, M., Hwang, J., & Seo, I. (2024). Collaboration risk, vulnerability, and resource sharing in disaster management networks. *Australian Journal of Public Administration*. <https://doi.org/10.1111/1467-8500.12642>

Sulkowski, A. (2018). Blockchain, business supply chains, sustainability, and law: The future of governance, legal frameworks, and lawyers. *Del. J. Corp. L.*, *43*, 303.

Szemző, H., Mosquera, J., Polyák, L., & Hayes, L. (2022). Flexibility and adaptation: Creating a strategy for resilience. *Sustainability*, *14*(5), 2688. <https://doi.org/10.3390/su14052688>

Tarigan, Z. J. H., Siagian, H., & Jie, F. (2021). Impact of internal integration, supply chain partnership, supply chain agility, and supply chain resilience on sustainable advantage. *Sustainability*, *13*(10), 5460. <https://doi.org/10.3390/su13105460>

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic management journal*, *28*(13), 1319-1350. <https://doi.org/10.1002/smj.640>

Teece, D. J. (2014). The foundations of enterprise performance: Dynamic and ordinary capabilities in an (economic) theory of firms. *Academy of management perspectives*, *28*(4), 328-352. <https://doi.org/10.5465/amp.2013.0116>

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, *18*(7), 509-533. [https://doi.org/10.1002/(SICI)1097-0266(199708)18:7%3C509::AID-SMJ882%3E3.0.CO;2-Z](https://doi.org/10.1002/%28SICI%291097-0266%28199708%2918%3A7%3C509%3A%3AAID-SMJ882%3E3.0.CO;2-Z)

Tukamuhabwa, B. R., Stevenson, M., Busby, J., & Zorzini, M. (2015). Supply chain resilience: definition, review and theoretical foundations for further study. *International journal of production research*, *53*(18), 5592-5623. <https://doi.org/10.1080/00207543.2015.1037934>

Um, J. (2017). Improving supply chain flexibility and agility through variety management. *The International Journal of Logistics Management*, *28*(2), 464-487. <https://doi.org/10.1108/IJLM-07-2015-0113>

Um, J. (2017). Improving supply chain flexibility and agility through variety management. *The International Journal of Logistics Management*, *28*(2), 464-487. <https://doi.org/10.1108/IJLM-07-2015-0113>

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*(2), 240-255. <https://doi.org/10.1108/SCM-06-2020-0248>

Umar, M., & Wilson, M. (2021). Supply chain resilience: Unleashing the power of collaboration in disaster management. *Sustainability*, *13*(19), 10573. <https://doi.org/10.3390/su131910573>

UNCTAD. (2024, December 3). *Enhancing supply chain resilience amid rising global risks*. UNCTAD. <https://unctad.org/news/enhancing-supply-chain-resilience-amid-rising-global-risks>

Üstündağ, A., & Ungan, M. C. (2020). Supplier flexibility and performance: an empirical research. *Business Process Management Journal*, *26*(7), 1851-1870. <https://doi.org/10.1108/BPMJ-01-2019-0027>

Von Bertalanffy, L. (1950). An outline of general system theory. *The British Journal for the Philosophy of science*, *1*(2), 134-165. <http://www.jstor.org/stable/685808>

Yarlagadda, V. K. (2024). Cutting-edge developments in Robotics for Smart Warehousing and Logistics Optimization. *Robotics Xplore: USA Automation Digest*, *1*(1), 61-79. <https://hal.science/hal-04787280/>

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