Supply Chain Recovery Research: A Systematic Literature Review of Focus Areas, Strategies, Methods and Emerging Sustainability Insights

[1]Ali Shuaibu Abdulrahman, [2]Norhayati Zakuan, [3]Teh Zaharah Yaacob, [4]Marta Nowakowska

[1]*Faculty of Management, Federal University Dutse, Nigeria and Faculty of Management, Universiti Teknologi Malaysia, Malaysia, [2,3]Faculty of Management, Universiti Teknologi Malaysia, Malaysia, 4Faculty of Management, Wroclaw University of Science and Technology, Poland

Abstract

Supply chain recovery is an essential component of supply chain management as the increasing interconnectedness of supply chains has increased both the likelihood and impact of disruptions. This study conducts a systematic literature review to synthesize existing empirical research on supply chain recovery, focusing on recovery strategies, methods, and sustainability insights. Adopting the PRISMA framework, the review utilized SCOPUS and Web of Science databases, and selected articles published between 2015 and 2024 to ensure a contemporary perspective. Findings reveal that research focus in this area focuses on enhancing recovery efficiency, identifying and proposing recovery strategies, and also a focus on balancing recovery with sustainability practices. Additionally, the study found a predominant use of simulation methods and mathematical model over empirical methods that uses subjective decisions or statistical models. Similarly, a dominance of manufacturing sector focus was found, with limited attention to sectors such as agriculture, services, and energy. Furthermore, significant gaps in the literature shows inadequate exploration of integrating technology, and environmental sustainability into recovery strategies, despite growing calls for alignment with industry 5.0 propositions. An underexplored role of behavioral and managerial factors in shaping recovery outcomes was also found. Therefore, this review highlights the need for managers to adopt sustainable recovery strategies and leveraging emerging technologies such as AI, machine learning, and big data analytics to optimize recovery and balance resilience with environmental impact. Addressing these gaps could advance research by providing empirical insights and practical applicability of recovery strategies across diverse contexts.

Keywords: Recovery Strategies, Sustainability, Supply Chain Disruptions Supply Chain Recovery, Supply Chain Resilience, Supply Chain Risk Management

Introduction

In recent years, there has been an increasing interconnectedness of supply chains locally and globally, leading to heightened complexity, which has amplified both the likelihood and impact of supply chain disruptions. Disruptions in supply chains represent the manifestation or realization of supply chain risks, thereby necessitating strategies to address them (Duhadway et al., 2019). Supply chain disruptions are inevitable, making it a matter of *when*, not *if*, they will occur (Blom & Nieman, 2022). This reality highlights the need for effective recovery plans and strategies to reduce average time to recovery and ensure continuity of supply chain operations. Once a disruption occurs, recovery strategies are deployed using either preparedness-based backup plans (proactive in nature) or ad hoc situational responses (reactive in nature) to restore disrupted supply chains (Ivanov, 2023).

Beyond operational challenges, supply chain disruptions have significant economic and societal implications, including loss of productivity, obstructed services, increased operational costs, customer dissatisfaction, reputational damage, and revenue loss (Katsaliaki et al., 2022). Large-scale disruptions such as pandemics, geopolitical conflicts, and climate-related events can further threaten access to essential goods, healthcare delivery, and broader economic stability, underscoring the societal relevance of effective recovery strategies. The COVID-19 pandemic, as one of the most severe recent global disruptions, exposed the vulnerability of interconnected supply chains and adversely affected organizations and economies worldwide. These developments have reinforced the need for recovery from disruptions to be recognized as a critical component of supply chain risk management (SCRM).

Traditionally, SCRM research has focused on risk identification, assessment, mitigation, and monitoring. However, recovery has increasingly been recognized as an essential element that enables supply chains to return to stable operations following disruption (Ho et al., 2015). In this regard, Munir et al. (2020) argue that SCRM should be holistic, encompassing risk detection, prevention, response, and recovery. Recovery, in the context of supply chain disruption management, refers to the actions and strategies implemented to mitigate the impact of disruptions and restore supply chain operations to normal or acceptable performance levels (Ivanov et al., 2017). While some studies conceptualize supply chain recovery as a component of disruption management, involving disruption discovery, recovery, and redesign (Messina et al., 2020), others situate recovery within the broader concept of supply chain resilience, where supply chains are considered resilient when they are able to absorb, respond to, and recover from disruptions. In this perspective, recovery is understood as a capability that supports continuity and performance under conditions of uncertainty.

From a theoretical standpoint, recovery aligns closely with resilience perspectives and Dynamic Capabilities Theory, which emphasize organizations' abilities to sense threats, reconfigure resources, and restore operations in volatile environments (Teece, 2007; Bahrami & Shokouhyar, 2021). Recovery practices such as contingency planning, backup supply channels, and collaborative coordination exemplify the reconfiguration of organizational resources in response to disruption (Ivanov et al., 2017; Zhang et al., 2024). Despite this theoretical relevance, recovery remains inconsistently conceptualized and insufficiently synthesized within the SCRM and resilience literature, limiting cumulative knowledge development.

Extant literature reports a wide range of recovery strategies, reflecting both proactive approaches aimed at facilitating resilience and reactive approaches focused on managing disruptions after they occur. For example, Ivanov (2023) identifies commonly reported recovery strategies such as backup suppliers, factories, and warehouses, alternative transportation modes, inventory buffers, capacity reservations, and synergistic combinations of these strategies. Similarly, Rahman et al. (2021) document recovery strategies across multiple disruption contexts, including strategic stock management, supply chain collaboration, and government policy interventions for macro-level disruptions; demand forecasting, purchase rationing, and preemptive procurement for demand disruptions; capacity expansion, labor shifts, and collaboration with local manufacturers for manufacturing disruptions; buffer stock strategies for supply disruptions; blockchain-enabled information security and open communication channels for information disruptions; collaborative transportation management and backup depot facilities for transportation disruptions; and blockchain integration across supply chain actors for financial disruptions. While these studies demonstrate the multidimensional nature of recovery, they also reveal considerable diversity and fragmentation in how recovery strategies are classified, analyzed, and evaluated.

Recent empirical and practitioner-oriented studies further highlight this fragmentation. The BCI Supply Chain Resilience Report (2024) indicates that nearly 80% of organizations experienced supply chain disruptions in the past year, yet recovery strategies were applied inconsistently across industries. Similarly, the McKinsey Global Supply Chain Leader Survey (2024) reports persistent instability driven by geopolitical tensions, climate-related disruptions, and trade uncertainties, underscoring the absence of structured and consolidated recovery frameworks. Academic scholarship echoes these concerns. Madzík et al. (2024) argue that resilience research requires reorientation to explicitly integrate recovery as a core dimension of SCRM, while Lücker et al. (2024) demonstrate that although resilience–efficiency trade-offs are well examined, recovery strategies are rarely systematically categorized or critically evaluated. Collectively, these findings suggest that recovery-focused research remains underdeveloped and insufficiently synthesized in both theory and practice.

The foregoing discussion highlights supply chain recovery as a multidimensional yet fragmented research domain, underscoring the need for greater conceptual clarity and systematic synthesis. Therefore, this paper undertakes a systematic literature review to examine the state of the art in supply chain recovery research over the past decade. The aim of this study is to provide a comprehensive and structured understanding of recovery-focused supply chain research. Specifically, the objectives are to:
 i.   To classify the main focus areas of supply chain recovery research over the last decade.
 ii. To analyze the recovery strategies proposed in literature
 iii. To categorize, analyze, and evaluate the analytical methods and models employed in supply chain recovery research, focusing on their applications, strengths, and limitations across diverse contexts

Materials and Methods
This section outlines the comprehensive procedures utilized in conducting the systematic literature review on supply chain recovery. This include a detailed description of the search strategy, entailing the sources of literature or articles reviewed, the search strings used to

query the databases (SCOPUS & WOS), as well as the filtering, screening, and selection processes. In addition, clearly defined is the inclusion and exclusion criteria to ensure that articles reviewed in the study were relevant and of good quality. The process is presented utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework and checklist (2020), which provides a structured and transparent approach to reporting systematic reviews and meta-analyses. Consequently, this review is organized under the following sections: Title, Abstract, Introduction, Materials and Methods, Results, Discussion, conclusions, research gap and area for future studies.

Study Design

This study utilized a systematic approach to conduct a comprehensive literature review on the subject of "supply chain recovery" synthesizing existing empirical studies from peer-reviewed journal rather than generating new primary data. The Search Strategy involved SCOPUS and WOS databases as its source for extant research papers. The choice of these two databases was influenced by their established roles in academic research as evidenced by their extensive use by researchers. The value of these databases lies in their relevance in conducting systematic reviews, meta-analyses and Bibliometric analysis, their coverage in terms of their global reach and across various disciplines, their high-quality peer-reviewed content and advanced search capabilities which enhance the accuracy and efficiency of literature search (Emrouznejad et al., 2023; Senna et al., 2020). Moreover, SCOPUS is widely considered as one of the largest database with collections of high-quality academic research publications (Senna et al., 2020). Similarly, Fan and Stevenson (2018) opine that WOS provide arguably the best coverage of supply chain management and is commonly used in literature reviews.

Furthermore, the search string "TITLE-ABS-KEY ("supply chain disruption recovery" OR "supply chain risk recovery" OR "supply chain recovery")" for SCOPUS and "TS = ("supply chain disruption recovery" OR "supply chain risk recovery" OR "supply chain recovery")" for Web of Science was used. As suggested by Fan and Stevenson (2018), broad terms were used as search strings so that papers adopting alternative terminologies were identified. As a result, the initial search resulted in 62 identified records from SCOPUS and 44 from WOS.

Screening and Selection Process

For the purpose of screening and selection of relevant research papers, the Titles, abstracts, and keywords of the 74 remaining articles after removal of duplicates 32 identified duplicates to determine the relevance of the articles to the subject matter of supply chain recovery. In order to reduce subjective bias, multiple researchers were involved in the review as suggested by Tranfield et al., (2003). Therefore, the review was done independently by the researchers paying attention to the presence of the keyword "recovery", and the overall context of supply chain. As a result, 7 articles were further removed from the review because they were unrelated to recovery in the context of supply chain. Consequently, 67 documents were retrieved and assessed for eligibility. Furthermore, the remaining articles were filtered based on exclusion and inclusion criteria. The scope of this review is defined by the systematic nature of the search process, which inherently limits the included studies to those retrieved from SCOPUS and Web of Science databases. By adhering to predefined inclusion criteria and search filters, this SLR ensures a structured and replicable review process, though it may exclude certain sectors or emerging topics not yet fully represented in the peer-reviewed

literature. Therefore, The Exclusion criteria for this review include the removal of articles not published in English language to eliminate the risk of translation errors, articles published before 2015, as well as review papers and conference papers. The inclusion criteria encompass articles published from 2015 to 2024 to provide a contemporary perspective on supply chain recovery and ensure an even distribution of research articles pre- and post-COVID-19 (being the most recent disruption globally). Additionally, as a proxy for quality, only peer reviewed papers and articles written in English were included. These all resulted in 31 studies included in the review.

Results

Figure 1 presents the PRISMA flow diagram to visually represent the study selection process.
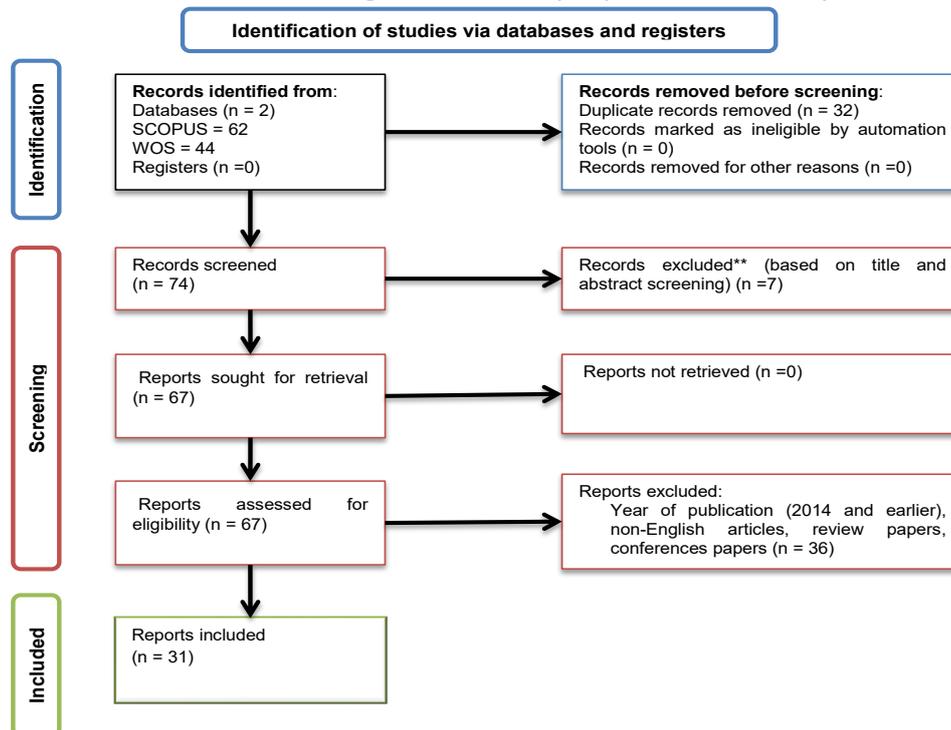

Identification of studies via databases and registers

Identification

Records identified from:
Databases (n = 2)
SCOPUS = 62
WOS = 44
Registers (n =0)

Records removed before screening:
Duplicate records removed (n = 32)
Records marked as ineligible by automation tools (n = 0)
Records removed for other reasons (n =0)

Screening

Records screened
(n = 74)

Records excluded** (based on title and abstract screening) (n =7)

Reports sought for retrieval
(n = 67)

Reports not retrieved (n =0)

Reports assessed for eligibility (n = 67)

Reports excluded:
Year of publication (2014 and earlier), non-English articles, review papers, conferences papers (n = 36)

Included

Reports included
(n = 31)

Fig1. PRISMA Flow Diagram for selection process of supply chain recovery research

Overview of Selected Articles
The list of reviewed articles presents a diverse set of themes and research focus areas in the field of supply chain recovery, focusing on several sectors or industries. Some articles focus on a single industry, others on multiple industries, while some are not industry-specific. Specifically, twenty articles focus on manufacturing sector constituting 64.5% of the total reviewed articles, four articles on agriculture, three on logistics and transportation, one on retail and wholesale, one on health care, and two unspecified. Additionally, based on publication year, the distribution of published articles skews to period's post-covid19. This was expected as the disruption resulting from the pandemic caused significant losses for companies worldwide. Perhaps, this attracted more research attention towards recovery studies. Specifically, 26 articles were published between 2020 and 2024 constituting 83% of the reviewed articles. Also, the years 2023, 2021, and 2022 had the highest number of publications of 8, 7 and 6 respectively.

Findings and Discussion

This section provides a general interpretation of the results and attempts to achieve the study objectives. Particularly, it discussed the focus-based classification of supply chain recovery literature, Proactive and Reactive Supply Chain Recovery Strategies, and analytical methods and models in recovery research.

Focus-Based Classification of Supply Chain Recovery Literature

This section aims to categorize the literature on recovery by reviewing articles based on their stated objectives so as to determine their general. Four categories identified comprises, enhancing recovery efficiency, recovery strategies, green supply chain recovery, and miscellaneous recovery insights. The first category include articles focused on optimizing supply chain recovery process by enhancing efficiency and effectiveness of recovery process in the event of a supply chain disruption. The second category groups articles with a focus on recovery strategies for a disrupted supply chain. The third category highlights articles with a focus on balancing supply chain recovery efforts with environmental sustainability, and the last category encompasses articles that provide unique perspectives and innovative approaches to supply chain recovery that do not fit neatly into the other categories (See table 2 for summary). Essentially, this section underscores the diverse focus of the reviewed literature on supply chain recovery based on their stated objective and this can facilitate the understanding of the overall landscape of research in this field. Out of 31 articles, 9 of them focus on enhancing recovery efficiency, 2 articles focus on balancing supply recovery efforts with environmental sustainability, 15 on recovery strategies, and 5 on other unique insights.

Table 1

Focus-based classification

SN	Key Focus	References	No. of articles
1	Enhancing Recovery Efficiency	Khamseh, et al. (2020); Sultana et al. (2022); Messina et al. (2020); Sawik (2019); Wolmarans, & Niemann (2023); Lei et al. (2023); Li & Yuan (2024); Fang, & Zhang, (2021); Tabatabaei et al., (2021)	9
2	Recovery Strategies	Chen et al. (2021); Rahman et al. (2021); Alvarenga et al. (2022); Chen et al. (2019); Magableh and Mistarihi (2024); Ermes and Niemann (2023); Yang and Xu (2015); Jain et al. (2023); Sudan and Taggar (2021); Zhao et al. (2022); Van der Westhuizen and Niemann (2022); Lee et al. (2023); Ju et al. (2022); Asafo-Adjei et al. (2023); Bo et al. (2021)	15
3	Green supply chain Recovery	Darom et al., (2018); Ivanov (2023)	2
4	Miscellaneous Recovery Insights	Paul et al. (2021); Ye et al. (2024); Blom, and Niemann (2022); Sheu (2016); Fan et al. (2023)	5

Optimizing recovery processes in supply chains is pivotal for enhancing resilience, efficiency and effectiveness in the event of a disruption. Research with this focus largely seeks to manage supply chain disruption or enhance supply chain resilience. For example, Sawik (2019) develops innovative portfolio approaches and stochastic mixed integer programming models to mitigate disruption risks and optimize recovery processes. Wolmarans and

Niemann (2023) identify strategies and management tools that organizations can employ to enhance their resilience and recovery capabilities during disruptions. This is quite similar to Messina et al., (2020) who underscore the significance of effective information management in enhancing supply chain resilience. Additionally, Khamseh et al. (2020) emphasize the importance of enhancing reactive measures to restore supply chains to their pre-disruption performance levels while minimizing associated costs. While Tabatabaei et al. (2021) focus on designing and validating a mathematical model to manage supply chain disruptions effectively. Others provide a focus on the use of industry 4.0 technologies, developing a framework for managing disruptions, and the role of digital financial inclusion in enhancing resilience and managing disruption (e.g. Sultana et al., 2022; Li & Yuan 2024; Fang & Zhang, 2021). The goals of these articles were to facilitate effective and efficient recovery of the supply chain.

Supply chain recovery strategies could be broad or tailored as well as proactive or reactive in nature. On the one hand, broad strategies encompass generic recovery strategies without focusing on specific aspects or contexts. On the other hand, tailored strategies are detailed, targeted strategies for recovery which are often tailored to particular contexts, or crises or otherwise specific. Overall, research in this classification focuses on providing a comprehensive understanding and recommendations for managing supply chain disruptions and/or enhancing supply chain resilience. For instance, studies by Chen et al. (2021), Rahman et al., (2021), and Alvarenga et al. (2022) focus on proposing broad supply chain disruption recovery strategies and plans to meet the growing demand for essential items, providing a comprehensive understanding of supply chain resilience and offer practical recommendations for building more resilient supply chains respectively, while Chen et al. (2019) aim to integrate and expand existing knowledge about post-disruption strategies into a comprehensive framework. Additionally, other studies focus on detailed, targeted strategies for recovery, often tailored to particular contexts or crises. Some studies focused on proposing crisis-specific recovery strategies, particularly COVID-19 Pandemic (Magableh & Mistarihi, 2024; Fan et al., 2023). These studies developed recovery strategies for supply chains and revised the current risk and recovery management model in the context of disruptions caused by the COVID-19 pandemic. Other studies with tailored recovery strategies include Jain et al. (2023), Ju, et al. (2022), Sheu (2016), Sudan and Taggar (2021), Bo, et al., (2021), Blom and Niemann, (2022), Van der Westhuizen and Niemann, (2022). These studies concentrate on diverse strategies and applications such as financing strategies, sourcing strategies, government intervention strategies for recovery, manufacturer's incentive strategy, contractual and relational governance strategies and strategies for grain processors. Balancing recovery and sustainability involves developing strategies that not only focus on immediate recovery but also consider long-term sustainability and environmental impact. Darom et al. (2018) develop a recovery model for a two-stage serial supply chain subject to disruptions, with considerations for balancing sustainability and recovery, particularly in transportation. Ivanov (2023) examines how sustainable recovery strategies can improve supply chain environmental and resilience performance compared to traditional ad-hoc recovery methods. Essentially, these articles seek to study recovery strategies with minimal adverse environmental impacts.

Articles that offer unique perspectives and innovative approaches to supply chain recovery, which do not fit neatly into the other categories were included in the miscellaneous category.

These studies provide a diverse range of insights, each contributing to a broader understanding of supply chain recovery. For instance, Paul et al. (2021) delved into recovery issues aiming to enhance awareness and understanding as well develops strategic policies to overcome these challenges. Ye et al., (2024) in their research provide data-driven insights into the losses incurred by supply chains due to the timing and speed of reopening emphasizing the critical role of timing in recovery efforts and aims to inform future policymaking for managing supply chain resilience during pandemics and other global disruptions. Blom and Niemann (2022) turn their attention to reputational risk management during supply chain disruption recovery. This is an entirely different dimension to the recovery focus of other studies. Particularly, they investigate how companies can effectively manage their reputation amidst disruptions, providing insights into strategies that can enhance corporate reputation. In a similar vein, Sheu (2016) explores the behavioral aspects of suppliers and the role of government interventions in post-disaster supply chain recovery thereby highlighting the importance of understanding the human and regulatory factors that influence recovery process. Lastly, Fan et al. (2023) challenge the conventional wisdom that rapid recovery from supply chain disruptions is always beneficial. As such, they propose a revision to the current risk and recovery management model, particularly in the context of evolving crises like COVID-19.

Overall, the focus-based classification of articles into enhancing recovery efficiency, recovery strategies, green recovery strategies, and miscellaneous insights reveals that recovery strategies dominate the reviewed literature comprising 15 articles reflecting an established focus on developing practical approaches to supply chain recovery. Conversely, recovery strategies with sustainability considerations remain significantly underexplored, with only two articles addressing this area suggesting an emerging area in recovery studies.

A consistent theme across recovery research is the role of collaboration, as emphasized by Alvarenga et al. (2022), Chen et al. (2019), Van der Westhuizen and Niemann (2022), Asafo-Adjei et al. (2023), and Ermes and Niemann (2023). Collaboration was discussed alongside flexibility and visibility in the manufacturing sector, as part of contingency planning in the ICT sector, as collaborative planning and transparent communication in the logistics and transport sector, and as collaborative relationships which is key to enhancing resilience in the manufacturing and fashion industries. Furthermore, while recovery efficiency and recovery strategies are well-documented, the integration of green recovery approaches and their alignment with broader sustainability goals remain fragmented.

Supply Chain Recovery Strategies: Proactive and Reactive Approach

The goal of recovery strategies is restoring the supply chain to its optimal state after a disruption. According to Messina et al. (2020), there are two types of strategies for managing supply chain disruption. The first is proactive, which entails countermeasures that need to be in place to face possible disruptive events, and the second is reactive, which entails actions applied during disruption for fast recovery. They emphasize that reactive strategies are only feasible if proactive strategies have been previously implemented. For example, supplier diversification as a proactive measure ensures that, during disruptions, an organization can swiftly activate resource sharing or emergency procurement as a reactive measure.

Furthermore, Ivanov et al. (2017) opined that proactive strategies to SC disruption management suggest approaches aimed at generating robust and resilient SC structures. In essence, the focus is on building capabilities that enable the supply chain to withstand and bounce back from disruptions. Supply chain resilience is about the ability to absorb, adapt, and recover, encompassing readiness capability, response capability, and recovery capabilities (Zhao et al., 2023). Because certain strategies are proactive in nature, it often begins with the identification of risk that enables prediction and the development of strategies for the identifiable risk, enabling the effective handling of those disruptions that have occurred earlier and can be expected (Chen et al., 2021).

Table 2

Summary of Supply Chain Recovery Strategies

Author(s)-Date	industry	Recovery strategy	Category
Chen et al. (2021)	Manufacturing	Product changes, Emergency Procurement, and Back Order Price Compensation	
Rahman et al. (2021).	Medical/ Healthcare	Emergency supply of raw materials, Increase production capacity	Reactive
Ju et al. (2022)		Government subsidy	
Bo et al. (2021).	Cloud manufacturing	Resource sharing amongst suppliers and manufacturers, Incentive mechanisms	
Alvarenga et al. (2022)	Manufacturing	*collaboration, flexibility, visibility, analytical orientation*	Proactive
Chen et al. (2019).		Contingency plans, Optimal alternatives for replacement, Collaboration Forming	
	ICT	emergency team, Establishing and following standardized procedures for reactive activities	
Magableh and Mistarihi (2024)	Cross industry	Digitization and Transparency, Utilization of Emerging Technology, Business Continuity Planning, Visibility and Monitoring, Adoption of Block-chain Technology	
Jain et al. (2023).	Manufacturing and Retail/Wholesale Sectors	Supplier diversification, Long-term Relationships, source from logistically efficient locations	
Sudan and Taggar (2021).	Logistics and transportation sector	Robust transportation and advanced logistic systems, Transport intelligence	
Zhao et al. (2022).	-	Mixed Recovery Strategy, Pure Penalty Strategy, Pure Investment Strategy	
Van der Westhuizen and Niemann. (2022).	Logistics and transport sector	Collaborative Planning, Transparent Communication Policies and Platforms, Performance Measurement, Supply Chain Visibility	
Asafo-Adjei et al. (2023).	Manufacturing	Collaboration, Flexibility, Redundancy (resilience)	

Ermes and Niemann (2023)	Fashion retail industry	Technology Implementation, Collaborative R/ships, Customized Policy Changes, Quality Insurance Inspections, Disruption-Specific Reverse Logistics Teams	Combination
Yang and Xu. (2015)	Agricultural	Contingent sourcing, Government aid	
Lee et al. (2023).	Manufacturing	Contractual governance, Relational governance	

For instance, Chen et al. (2019) in their study proposed proactive strategies in the ICT sector, including contingency plans, optimal alternatives for replacement, collaboration, forming emergency teams, and establishing standardized procedures for reactive activities. These strategies are preemptive and anticipatory in nature and they are meant to enhance readiness by ensuring that there are predefined actions and resources available to address disruptions, thereby minimizing downtime and facilitating operational continuity. Specifically, collaboration leverages the collective expertise and resources of various stakeholders to respond effectively in the event of disruptions. Similarly, Magableh and Mistarihi (2024) discuss proactive strategies such as digitization and transparency, utilization of emerging technology, business continuity planning, visibility and monitoring, and adoption of blockchain technology. Particularly, these strategies improve the supply chain's ability to anticipate and respond to disruptions through enhanced data visibility and real-time monitoring as such contributes to resilience.

However, reactive strategies relate to a response to unexpected disruptions, which are unpredictable. The primary difference between the two contexts lies in their respective focus. On the one hand, proactive strategies focus on resilience, emphasizing strategies and capabilities to prepare for and recover from disruptions. On the other hand, reactive strategies focus on the immediate actions and processes necessary for recovery after a disruption. For example, Chen et al. (2021) in the manufacturing sector discuss reactive strategies like product changes, emergency procurement, and back order price compensation. These strategies are crucial for quickly addressing the immediate impacts of a disruption, ensuring that production can resume as soon as possible. Additionally, Rahman et al. (2021) in the healthcare sector emphasize emergency supply of raw materials and increasing production capacity as reactive measures due disruptions caused by changes in demand. These actions are vital in sectors where timely availability of resources is critical to maintaining service levels and patient care.

Inherently, both proactive and reactive recovery strategies aim to ensure the supply chain returns to normal or even improved functioning after a disruption, but they tackle the problem from slightly different angles. Proactive strategies, such as supplier diversification and long-term relationships like collaboration as proposed by Jain et al. (2023), are designed to build a strong and resilient supply chain that can withstand disruptions. In contrast, reactive strategies such as resource sharing amongst suppliers and manufacturers, incentive mechanism as well as government subsidies are immediate actions and a response to disruption (Bo et al., 2021; Ju et al., 2022)

According to Magableh and Mistarihi (2024) recovery strategies are in immediate, short-term, and long-term phases such that the immediate phase entails the actions needed to be taken instantly once a disruption occurs (reactive) and long-term phases entail actions, plans, and strategies to be considered to achieve stability and responsiveness (proactive). To further illustrate the application of recovery strategies, Ermes and Niemann (2023) in the fashion retail industry highlight a combination of proactive and reactive measures, including technology implementation, collaborative relationships, customized policy changes, quality insurance inspections, and disruption-specific reverse logistics teams. These strategies enhance resilience by ensuring that the supply chain can quickly adapt to and recover from disruptions through both immediate and long-term actions. Similarly, Yang and Xu (2015) in the agricultural sector discuss the importance of contingent sourcing and government aid as a combination of proactive and reactive strategies. Contingent sourcing allows for flexibility in supplier selection during disruptions, while government aid provides necessary support to stabilize the supply chain. In the manufacturing sector, Lee et al. (2023) emphasize the role of contractual and relational governance as combined strategies. Contractual governance ensures clear agreements and responsibilities among supply chain partners, while relational governance fosters trust and collaboration, enhancing the overall resilience of the supply chain.

These examples demonstrate that a combination of proactive and reactive strategies can provide a comprehensive approach to supply chain recovery, addressing both immediate needs and long-term stability. By integrating measures such as technology implementation, collaborative relationships, and contingent sourcing, supply chains can build robust frameworks capable of withstanding and recovering from disruptions. Future research could explore the effectiveness of these combined strategies in different contexts, providing deeper insights into the dynamic nature of supply chain recovery and resilience. This holistic approach underscores the importance of both immediate reactive measures and long-term proactive planning in achieving a resilient supply chain. Essentially, a loop or interdependence is formed such that the initial reactive recovery provides insights further analysis of the disruption and its impacts which in turn informs the development and implementation of long-term strategies to enhance resilience and mitigate the effects of future disruptions. Thus, a continuous loop is created where each disruption informs and improves future resilience strategies, thereby strengthening the overall supply chain recovery process.

Analytical Methods and Models in Recovery Research
This section provides an overview of the various analytical methods and models used in recovery research. The classification and groupings of methods and models are adopted from Vishnu et al. (2019), Supply Chain Risk Management: Models and Methods. The broad classification of these methods includes analytical methods, comprising mathematical models and simulation models, and empirical methods, comprising subjective decision models and statistical models. The distribution of articles based on the analytical methods and models includes 14 articles utilizing analytical methods, with 11 employing mathematical models and 3 using simulation models. Empirical methods constitute 14 articles, comprising 7 subjective models and 7 statistical models. Lastly, 3 articles utilized mixed methods. Overall, these represent the methods and models utilized by studies in supply chain recovery research across all the focus areas of enhancing recovery efficiency, recovery strategies, green recovery strategies in supply chain, and miscellaneous insights in recovery

Table 3

Summary of Methods and Models in Recovery Research

Methods		References	No. of articles	Analytical technique
Analytical methods	Mathematical models	Khamseh et al. (2020)	1	Quantitative model using optimal control theory
		Chen et al. (2021); Li and Yuan (2024).	2	Mixed integer linear programming model (MILP)
		Darom et al. (2018).	1	Nonlinear constrained optimization model
		Sawik (2019).	1	Stochastic mixed integer programming
		Yang and Xu (2015)	1	Profit function analysis within a mathematical model framework
		Zhao et al. (2022)	1	Game-theoretic and robust optimization approach
		Zhang et al. (2024)	1	Evolutionary economic-epidemiological modeling
		Ju et al. (2022)	1	System dynamics modeling and simulation
		Bo et al. (2021)	1	game-theoretic modeling and optimization-Stackelberg competition model
		Tabatabaei et al. (2021)	1	Metric LP technique and an NSGAII algorithm (Non-dominated Sorting Genetic Algorithm II)
	Simulation models	Rahman et al. (2021)	1	Agent-based simulation model ABSM
		Ivanov (2023)	1	Simulation analysis using any logistics
		Lei et al. (2020)	1	Hybrid simulation model combining discrete event modeling and agent-based modeling
Empirical methods	Subjective decision methods	Messina et al. (2020); Chen et al. (2019)	2	Case study analysis
		Wolmarans and Niemann (2023); Ermes and Niemann (2023); Blom and Niemann (2022); Van der Westhuizen and Niemann (2022)	4	Thematic analysis
		Paul et al. (2021).	1	Delphi-based grey decision-making trial and evaluation laboratory (DEMATEL)
	Statistical methods	Sultana et al. (2022)	1	Kruskal Wallis Test
		Alvarenga et al. (2022); Asafo-	2	Structural Equation Modeling (SEM)

	Adjei, et al. (2023)		
	Jain et al. (2023).	1	Robust approach combining time series analysis, econometric modeling, and statistical analysis
	Fan et al. (2023)	1	Heckman two-stage analysis
	Lee et al. (2023)	1	Hierarchical OLS Regression
	Fang et al. (2020)	1	Gravity Equation modeling with LL-FE (Log-Log regression model with fixed effects) and PPML (Poisson Pseudo-Maximum Likelihood) estimation.
Mixed method	Magableh and Mistarihi (2024)	1	combined fuzzy ANP–fuzzy TOPSIS
	Sudan, and Taggar (2021)	1	Triangulation and theoretical methods
	Sheu (2016)	1	Multi methodological approach: SEM and behavioral theory-grounded normative models

Literature on recovery has utilized Mathematical models and expressions (quantitative frameworks) to represent real-world scenarios. Basically, these models are used to optimize processes, predicting outcomes, and making informed decisions. The ability of mathematical models and expressions to handle complex variables and constraints systematically makes them a useful method for analysis. The range of mathematical models used by the reviewed articles includes mixed integer linear programming, optimal control theory, nonlinear constrained optimization model, stochastic mixed integer programming etc. A common method is the use of Mixed Integer Linear Programming (MILP). Chen et al. (2021) employed this model to propose a supply chain disruption recovery strategy. Similarly, Li and Yuan (2024) utilized the same model to provide decision support for managers to optimize recovery effectively by emphasizing the need for agility and coordination in supply chain networks. Another analytical method is the optimal control theory, as demonstrated by Khamseh et al. (2020). This method allows for the dynamic adjustment of control variables to optimize the performance of supply chain recovery processes over time. By applying this theory, the researchers were able to development of a dynamic optimization model that compares alternative supply chain recovery options taking into account time and cost, thereby balancing the effectiveness and efficiency of reactive measures for optimal recovery outcomes. Nonlinear constrained optimization was utilized by Darom et al. (2018) to Develope a recovery model of a two-stage serial supply chain subject to supply chain disruption with considerations for striking a balance between sustainability and recovery during the recovery cycle particularly on transportation. Furthermore, Stochastic mixed integer programming is used to incorporate uncertainty and variability in supply chain recovery planning. This model was used by Sawik (2019) to account for the unpredictable nature of disruptions. Specifically, the researcher used this model to develop innovative portfolio approaches that can be used to select primary and recovery suppliers and assembly plants, allocate order quantities for parts and products, and schedule production in a way that mitigates the impact of disruption risks and optimizes the recovery process. Other notable contributions include: Yang & Xu (2015), who focused on profit function analysis within a mathematical model framework, whereas Zhao et al. (2022) integrated game-theoretic and robust optimization approaches. Zhang et al. (2024) explored evolutionary economic-

epidemiological modeling, and Ju et al. (2022) used system dynamics modeling and simulation. Additionally, Bo et al. (2021) developed a game-theoretic modeling and optimization approach based on the Stackelberg competition model, and Tabatabaei et al. (2021) combined metric LP techniques with the NSGAII algorithm.

Simulation models essentially are used to replicate the behavior of a system using computational algorithms, which makes them particularly useful for analyzing complex systems where traditional analytical methods may fall short. Their ability of simulation models to model dynamic interactions and stochastic processes remains its strength area. Simulation model such as agent-based simulation model was utilized by Rahman et al. (2021) to propose a set of recovery strategies and plans that can minimize cost and maximize availability of product to respond to global supply chain disruption. Ivanov (2023) conducted simulation analysis using logistix digital supply chain model to examine different recovery strategies and their impact on both environmental and supply chain resilience performance. In furtherance, Lei et al. (2020) developed a hybrid simulation model that combines discrete event modeling and agent-based modeling to evaluate the effectiveness of different countermeasures in enhancing the resilience of the supply chain against counterfeit threats. These models showcase the versatility and robustness of simulation techniques in recovery research.

Empirical methods include subjective decision models and statistical models which rely on observed, surveyed and measured phenomena. These methods derive knowledge from actual experience and data rather than from theoretical constructs or beliefs which is in contrast to analytical methods which are based on mathematical and theoretical models to represent and solve problems. These methods are strong in providing real-world insights and validating theoretical models. The subjective models utilized by the reviewed articles include; case study analysis, thematic analysis and Delphi-based grey decision making and trial evolutionary laboratory (DEMATEL). For instance, Messina et al. (2020) and Chen et al. (2019) conducted case study analyses, providing detailed examinations of specific instances of supply chain recovery. Particularly, they utilized case study analysis gathering data through interviews and validation workshops to derive insights and design propositions on supply chain recovery problems. Another notable subjective decision technique is the thematic analysis. This analysis was utilized by a number of authors including Wolmarans and Niemann (2023), to uncover strategies and management tools organizations employ to enhance their resilience and recovery capabilities during disruption. Ermes & Niemann (2023) used the same method to provide insights and strategies for effectively managing various omni-channel reverse logistics risks encountered during supply chain disruptions to enhance recovery.

Blom & Niemann (2022), used semi structured interviews and thematic analysis to study management of reputational risk during the recovery phase of supply chain disruptions, particularly in the context of third-party logistics (3PL) providers, their upstream suppliers, and downstream customers. Van der Westhuizen & Niemann (2022) explore various aspects of recovery, particularly the role of third-party logistics service providers (3PLs) in strategic supply chain alignment during supply chain disruption recovery. Paul et al. (2021) used a Delphi-based grey decision-making trial and evaluation laboratory (DEMATEL) to generate knowledge on supply chain recovery challenges in the wake of COVID-19. These methods highlight the applicability of empirical methods particularly subjective decision in capturing expert opinions and consensus.

Statistical Methods

Statistical methods involve the collection, analysis, interpretation, and presentation of data, making them essential for identifying patterns, testing hypotheses, and making predictions. These methods are best suitable for handling large datasets thereby providing a robust and generalizable result. The reviewed studies utilized a diverse range of statistical techniques such as structural equation modeling (SEM), Kruskal wallis test, time series and econometric modeling, heckman two-stage analysis, hierarchical OLS regression etc. specifically, Sultana et al. (2022) utilized a structured questionnaire, which includes a Likert scale to assess supply chain recovery challenges and intentions to adopt Supply Chain 4.0 technologies and Kruskal-Wallis test to evaluate relationships among the variables. While Alvarenga et al. (2022) used SEM to Model the factors that contribute to supply chain resilience and providing insights into how organizations can enhance their capabilities to withstand and adapt to and recover from disruptions. While Asafo-Adjei et al. (2023) utilized structural equation modeling to examine how different dimensions of network complexity relate to resilience strategies and disruption in supply chains. Jain et al. (2023) combined time series analysis, econometric modeling, and statistical analysis in a robust approach, to provide empirical evidence on how different sourcing strategies impact the recovery time of supply chains after disruptions. Others include Fan et al. (2023) who employed the Heckman two-stage analysis, Lee et al. (2023) used hierarchical OLS regression, and Fang et al. (2020) applied gravity equation modeling with LL-FE and PPML estimation, demonstrating the diverse applications of statistical methods in recovery research.

Mixed methods combine different research techniques to provide a comprehensive analysis, leveraging the strengths of both approaches to offer deeper insights and more robust conclusions. Studies from the review that utilized this method include, Magableh and Mistarihi (2024). They combined fuzzy ANP with fuzzy TOPSIS to Develop and assess recovery strategies for supply chains in the context of crises, particularly in light of disruptions caused by the COVID-19 pandemic. Sudan & Taggar (2021) used triangulation and theoretical methods and Sheu (2016) adopted a multi-methodological approach, integrating SEM with behavioral theory-grounded normative models to analyze and propose strategies for effective supply chain recovery post-disaster, considering the behavioral aspects of suppliers and the role of government interventions.

Sustainability-Driven Supply Chain Recovery Approaches

Supply chains are vulnerable to various disruptions, often compromising sustainability as a consequence of quick recovery. Therefore, managing supply chain disruptions alongside maintaining environmental sustainability is a daunting task (Darom et al., 2018). While extant literature recognizes the importance of integrating supply chain resilience and sustainability, the environmental impact of recovery strategies remains underexplored. Although, recovery strategies should be both responsive and environmentally friendly (Ivanov, 2023), implementing them while meeting customer expectations and minimizing adverse environmental impact presents a complex optimization problem (Darom et al., 2018). As opined by Eskandarpour et al. (2015), discussion on environmental sustainability in supply chain literature is largely focused on facilities, transports and product design using carbon dioxide (CO_2) emission as measurement metric.

Ivanov (2023) in his article on the design and deployment of sustainable recovery strategies in the supply chain posit that when disruption occurs, both preparedness strategies (proactive) and ad-hoc recovery strategies or actions (reactive) deployed typically involves transportation methods that produces higher CO_2 emission. Thus, he proposed additive manufacturing, particularly preparedness based recovery through 3D-printing-based product substitution. This approach can be supplemented by low emission e-trucks as recovery strategies. These strategies better improve sustainability compared to ad-hoc reactions with high CO_2 emissions. In other words, the strategies reduce environmental impact of recovery efforts in supply chains. Therefore, the study provides evidence of digital technologies and transport innovations on both sustainability and resilience. Darom et al. (2018) studied supply chain disruption with a focus on safety stock and carbon emission. They developed a Recovery model of a two-stage serial supply chain subject to supply chain disruption with considerations for striking a balance between sustainability and recovery during the recovery cycle particularly on transportation using safety stock as the mitigation strategy. Their nonlinear constrained optimization model provided the optimal total recovery cost, the revised production and ordering quantity for manufacturer and retailer, the optimal safety stock quantity and carbon emission cost impact of these decisions during recovery.

Overall, these researches proposed additive manufacturing, use or e-truck for transportation, and buffer stock as sustainable recovery strategies to minimize carbon foot prints. These strategies not only enhance environmental sustainability but also contribute to the resilience of supply chains.

Research Gaps and future direction in Supply Chain Recovery
Several key research gaps have been identified in the literature on supply chain recovery, as summarized below. These gaps represent an agenda for future research and are derived from addressing the objectives of this systematic literature review.

Limited Focus on incorporating Environmental Sustainability into recovery efforts
The reviewed literature shows a limited focus on integrating environmental sustainability into supply chain recovery efforts. Only a small fraction of the articles address green recovery strategies underscoring a need for more research in this area. Future studies should explore how sustainable practices can be incorporated into recovery strategies to balance resilience and environmental impact and conform to the industry 5.0 propositions of sustainability.

Behavioral and Managerial Insights
There is a significant gap in understanding the role of behavioral and managerial aspects in supply chain recovery. Few studies focus on how management philosophies, practices, and organizational attitudes influence recovery efforts. Specifically, of the reviewed articles, only Sheu (2016) explored the behavioral aspects of suppliers and the role of government interventions in post-disaster supply chain recovery. However, it is important to highlight the human factors that influence recovery process. Research is needed to investigate the impact of these factors on the effectiveness of recovery strategies as well as frameworks that incorporate managerial insights.

Insufficient scope in empirical studies
There exists a notable gap in empirical research that quantitatively measures the effectiveness of recovery strategies across different industries. Most of the reviewed empirical literature relied on qualitative insights from few interviews or few case studies which restricts their generalizations accuracy. Future studies should increase their scope by utilizing surveys and questionnaires and quantitative methods to validate the impact of these strategies on other important variables such as supply chain resilience or even organizational performance. This approach can provide valuable insights for more robust statistical analysis and enhance the validity of research findings.

Integration of Emerging Technologies
The reviewed literature is insufficient in detailed exploration on how specific emerging technologies such as AI, machine learning and big data analytics can be integrated into both recovery strategies for optimization and better decision making. The limited exploration of emerging technologies within this review reflects the current state of research in the field. As the use of these technologies in supply chain recovery is still developing. Therefore, more focused research is needed to understand the practical applications and benefits of these technologies in enhancing supply chain recovery.

Sectorial bias towards manufacturing sector
The reviewed literature reveals a skew or bias towards the manufacturing sector. 64.5% of the articles were manufacturing sector focused. Specifically, out of 31 twenty articles focus on manufacturing, four on agriculture, three on logistics and transportation, one on retail and wholesale, one on health care, and two did not specify the industry. Other important sectors such agriculture sector, service sector, energy sector are underrepresented. In addition, comparative studies across different industries are needed to understand how the effectiveness of recovery strategies varies across different industries. This could help identify industry-specific best practices and tailor strategies to specific contexts. Addressing these gaps can ensure that future research contributes to comprehensive understanding of supply chain recovery thereby incorporating empirical validation, technological integration, behavioral insights, managerial aspects, sustainability considerations, and industry-specific best practice.

Conclusion
This study provides a comprehensive review of supply chain recovery literature by systematically analyzing 31 peer-reviewed articles from SCOPUS and Web of Science databases. The selected studies contributes to a deeper understanding of recovery strategies, with a focus on key areas such as recovery efficiency, green recovery, and the analytical methods used in recovery research. The thematic categorization reveals four main research areas: enhancing recovery efficiency, diverse recovery strategies, green recovery approaches, and unique perspectives such as reputational risk and behavioral aspects in relation to recovery efforts by organizations. These highlights the evolving nature of supply chain recovery research, with resilience and sustainability increasingly recognized as essential components in response to disruptions.

A critical finding of this review is the interplay between proactive and reactive recovery strategies. Proactive measures, such as supplier diversification and technology adoption, are

vital for building resilience, while reactive actions, like emergency procurement, address immediate disruptions. The interdependence of these strategies shows that effective reactive responses can inform future proactive planning thereby creating a continuous feedback loop that strengthens long-term resilience. Future research should further explore the combination of these strategies across different industries and disruption contexts, with particular attention to the evolving role of digital technologies and collaboration. Additionally, the review highlights the diverse methodologies employed in supply chain recovery research, ranging from mathematical models like Mixed Integer Linear Programming (MILP) and simulation models, to subjective decision-making tools and statistical techniques. The integration of mixed methods approaches further enriches the analysis of recovery strategies, particularly in the context of crises or disruptions like COVID-19. Another key insight is the growing emphasis on sustainability-driven recovery strategies, which address the challenge of balancing quick recovery with minimizing environmental impact. Strategies such as 3D printing for product substitution, low-emission transport, and safety stock management offer promising ways to enhance both sustainability and resilience.

Despite its contributions, this review identifies several gaps in the literature. The integration of environmental sustainability into recovery strategies remains limited, as does the exploration of behavioral and managerial factors. Additionally, the focus on manufacturing in much of the reviewed literature restricts insights into other critical sectors such as agriculture, services, and energy sectors. Finally, the applications of emerging technologies like AI, Machine learning, and Big Data Analytics in recovery processes is underexplored. Addressing these gaps will provide a more comprehensive understanding of how supply chains can recover efficiently and sustainably across various industries.

Managers should prioritize sustainability in recovery strategies by adopting technologies like 3D printing and low-emission transportation while balancing resilience and environmental impact. Additionally, they should recognize the importance of leadership and organizational practices in shaping recovery outcomes as well as embrace emerging technologies as they can further optimize decision-making and improve recovery processes. Additionally, by tailoring these strategies to sector-specific contexts, managers can enhance both operational efficiency and reputational benefits.

While this study offers a thorough review of supply chain recovery strategies, it has some limitations. The research focuses exclusively on peer-reviewed journal articles from SCOPUS and Web of Science, excluding other sources like conference papers and industry reports, which could provide additional insights. Moreover, the study's reliance on secondary literature limits empirical validation, which could be achieved through field studies or surveys. Additionally, dominance of articles focus on manufacturing sector leaves other industries underrepresented, limiting the generalizability of findings. Future research should address these gaps by incorporating broader data sources, conducting empirical studies, and exploring sector-specific recovery strategies in greater depth.

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