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Emerging Trends in Supply Chain Resilience: A Systematic Literature Review

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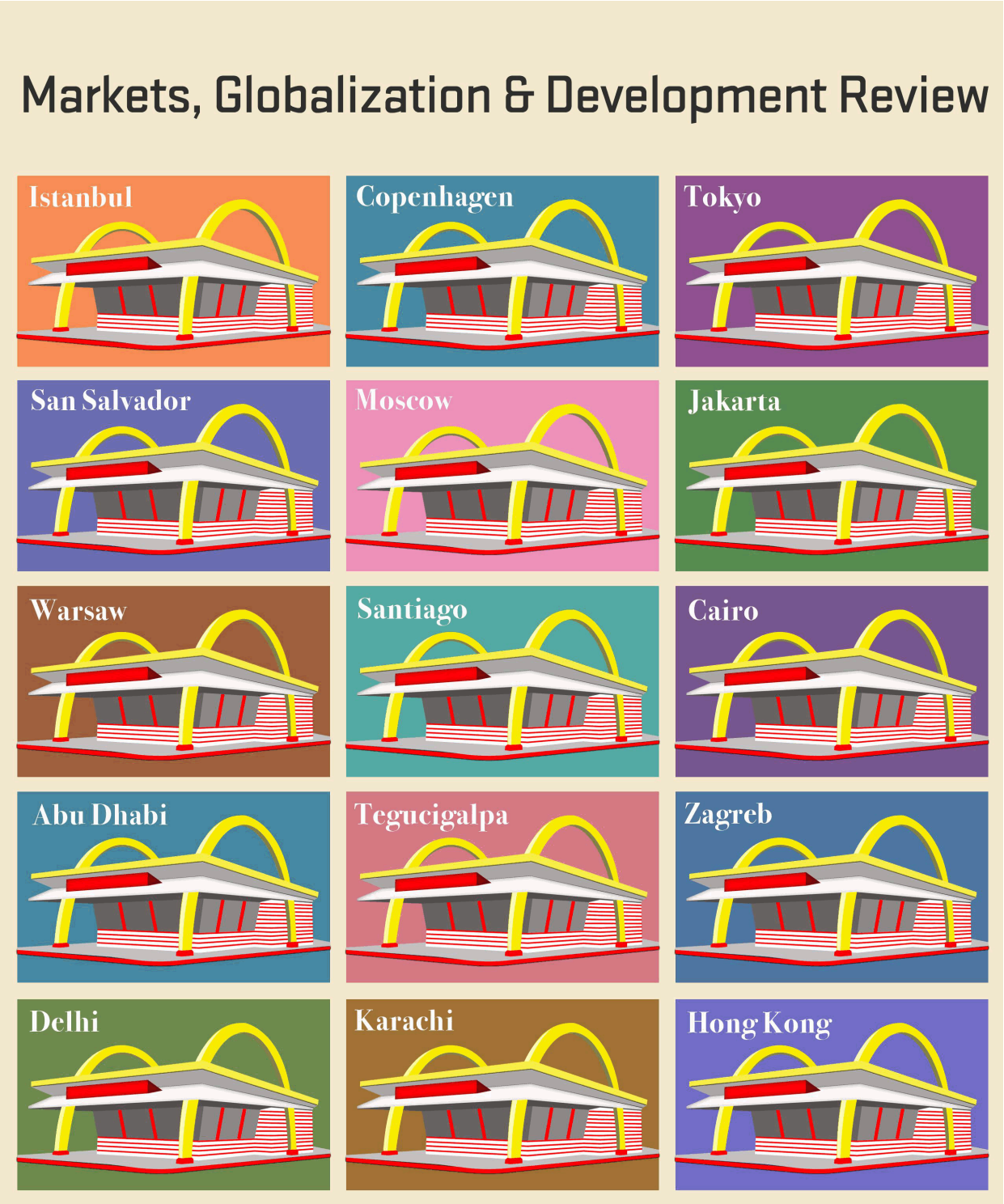

Emerging Trends in Global Supply Chain Resilience: A Systematic Literature Review

Introduction

In recent decades, global supply chains have been disrupted by some unpredictable events such as terrorist attacks (9/11 in 2001), earthquakes (Taiwan in 2010, Japan in 2011), tsunamis (Indian Ocean in 2004), hurricanes (US in 2005), wildfires (Australia in 2019), pandemic diseases (SARS in 2003, bird flu in 2005, swine flu in 2009 and COVID-19 in 2020) and geopolitical conflicts (US-China trade war, Russia-Ukraine war and Red Sea Crisis). Considering the severe outcomes of the COVID-19 pandemic on supply chains, with existing economic and financial obstacles, a substantial body of research focusing on the pandemic's effect on supply chain resilience has emerged since 2020. Nevertheless, following the COVID-19 pandemic, the increased geopolitical tensions and trade wars and increased frequency of extreme weather conditions due to climate change also revealed the importance of building resilience to mitigate the impact of such unforeseen challenges.

While such disruptive events can be considered major threats to human lives affecting all areas of society, they also test supply chains by the long-term impacts and high uncertainty risks (Sarkis et al. 2020). Due to the interconnection among supply chain members, the magnitude and scope of such disruptive events tragically showed that the actions of downstream and upstream actors of complex networks profoundly affected the other. It is essential to mitigate the risks within individual organizations and across the entire supply chain. Developing capabilities in supply chains is crucial for rapidly responding to and recovering from disruptions, potentially returning to a pre-disruptive state or even a better one (Ali et al. 2017; Chowdhury and Quaddus 2017; Ponomarov and Holcomb 2009). In this regard, considering the scope of the interconnections at the global level and the dynamic nature of the supply chains, the need for building a resilient supply chain has attracted attention from researchers and managers for a while. This need arises due to external factors such as natural disasters (Sáenz and Revilla 2014; Yang and Xu 2015), economic and financial crisis (Jüttner and Maklan, 2011), as well as internal factors such as terrorism (Sheffi 2001), and internally such as infrastructure issues and delivery disruptions (Ambulkar et al. 2015; Carvalho et al. 2012; Chowdhury and Quaddus 2017). A systematic literature review can consolidate our understanding of the supply chain capabilities developed to enhance resilience in the face of such disruptions (Tranfield et al. 2003). Moreover,

investigating how the capabilities designed to create resilient supply chains have evolved in the face of such disruptions can contribute to the existing body of knowledge. Accordingly, the research objectives of the study have been set as follows:

1. To view the range and scope of academic studies carried out on resilient supply chains through a systematic literature review (SLR)
2. To explore the resilience capabilities in supply chains

Theoretical Background

The dynamic capability theory (DCV) emphasizes the role of a firm's ability to adapt, integrate, and reconfigure internal and external organizational skills, resources, and functional competencies toward changing environments (Teece, Pisano and Shuen 1997). In the context of today's highly volatile and complex business environment, the dynamic capability theory is considered crucial for understanding how firms can achieve sustainable competitive advantage (Teece 2018), maintaining operational (Wu et al. 2006,) and financial performance (Zhou and Wu 2010). The dynamic capabilities can be disaggregated into the capacity (a) to *sense* the opportunities and threats, (b) to seize opportunities (mobilizing resources to address the changes), and (c) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, *reconfiguring* the business enterprise's intangible and tangible assets (Teece, Pisano and Shuen 1997).

Dynamic capabilities are essential for enhancing supply chain resilience, especially in disruptions (Ponomarov and Holcomb 2009; Ivanov and Dolgui 2020). Pettit, Fiksel, and Croxton (2010) also emphasized that these capabilities, including agility and adaptability, allow firms to manage uncertainties in supply and demand effectively and recover more quickly from supply chain disruptions. In more recent studies, DCV has been increasingly recognized as a pivotal framework in understanding and enhancing supply chain resilience, especially in the face of global disruptions such as the COVID-19 pandemic. Dubey et al. (2023) and Kähkönen et al. (2023) both highlight the importance of digital adaptability and agility in supply chains, demonstrating how government effectiveness and the ability to reconfigure resources swiftly during disruptions can fortify supply chain resilience. This reflects a growing understanding of the interplay between macro-environmental factors, such as government policies, and micro-organizational capabilities.

Research Methodology: Systematic Literature Review

Conducting a systematic literature review on the supply chain resilience context provides a comprehensive understanding of the existing body of work and helps to identify the gaps to explore in the relevant topic (Xiao and Watson, 2019). Unlike traditional reviews, a systematic literature review has a set of protocols that prevents bias against the selection of the articles while providing validity, transparency, and reliability of the findings (Tranfield et al., 2003; Thomé et al. 2016). Using frameworks developed by Fisch and Block (2018), Petticrew and Roberts (2008), and Tranfield et al. (2003) and the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), a systematic literature review on supply chain resilience was conducted first. The review comprises the steps of (1) identification of relevant research, (2) checking eligibility, (3) screening of articles, and (4) inclusion of articles that are provided by PRISMA. For greater quality of the search results, inclusion and exclusion criteria were integrated following the guidelines of Newbert (2007);

1. Articles published in peer-reviewed scientific journals in English,
2. The most relevant journals in the business management discipline particularly in the area of logistics, operations management, and supply chain management in particular,
3. Empirical research articles, qualitative or quantitative, and theoretical articles,
4. Articles published in the last 20 year, were included.

The year 2003 was selected as the initial point of the search since Rice and Caniato's article is the first study that mentions supply chain resilience and is considered the foundation of the term, which is followed by Christopher and Peck's 2004 and Sheffi and Rice's 2005 articles. Since then, their work on supply chain resilience has been a motivation to researchers in the field. Because it plays an important role in screening and analyzing the data, in line with previous systematic literature reviews on supply chain resilience (Ali et al. 2017; Hohenstein et al. 2015; Pereira et al. 2014), the most relevant keyword strings were selected which are "supply chain" and "resilien*". Using these search strings on electronic databases; Web of Science and Scopus, a total of 2143 articles were identified. Following the PRISMA guideline, duplicate articles were removed first. Then, the remaining 1477 articles were screened and 982 were removed via title and abstract screening since they did not meet the inclusion criteria (Newbert 2007). Following, the introduction and conclusion sections were reviewed among the remaining 495 articles in the second selection, and 129 articles were removed resulting in a total of 366 candidate articles. A further 24

articles were identified through cross-referencing citations leading to a literature sample of 390 eligible journal articles. In total, a literature sample consisting of 390 journal articles was fully read, and 55 were excluded since they did not provide related information regarding the purposes of this study. Finally, 335 articles on supply chain resilience were considered as eligible as a result of this process. A graphical representation of the selection and evaluation process is illustrated within the flow chart diagram of PRISMA in Figure 1.

The publication year, academic journal, country, methodological approaches, applied theories, and focused supply chain resilience antecedents of the articles selected from 2003 to the first half of 2023 were reviewed and further discussed in detail in the following subsections. For this purpose, a descriptive analysis was conducted to review the development and current situation of the supply chain resilience literature. Our coding is based on the following classification scheme:

1. the distribution of articles over the years,
2. the distribution of articles across journals,
3. the distribution of articles by methodology,
4. the distribution of articles by theory
5. the distribution of articles by supply chain resilience capabilities (e.g., flexibility, collaboration, agility, etc.)

After the descriptive analysis of the literature, a thematic analysis (Seuring and Gold 2012) was carried out to classify themes within the collected articles. During this process, each co-author independently reviewed the full text of all articles and manually coded the data using an Excel spreadsheet. This approach led to the identification of key themes within the context of supply chain resilience. The identified themes also helped highlight research gaps and suggest potential avenues for future research.

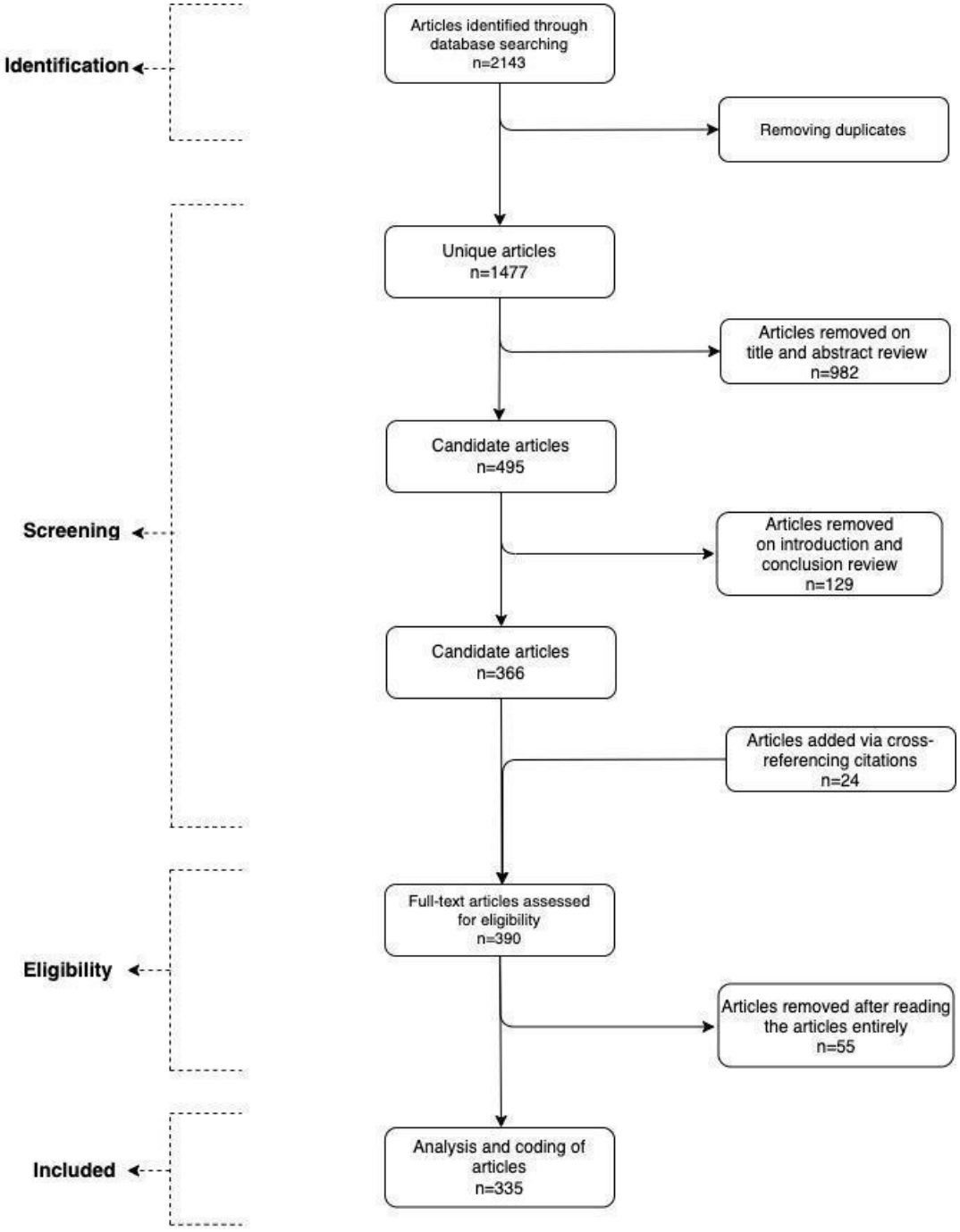

Figure 1. Review Process for Study Selection in Supply Chain Resilience

Findings

Descriptive Analysis of the Findings

Figure 2 shows the number of publications per year where the growth in the number of articles published over the year 2020 is significant reflecting the outcomes of the recent Covid-19 pandemic outbreak. Furthermore, since the articles from the first half of 2023 were included in this study, the number of articles for the year 2023 in the figure appears to be low in comparison to the increase in previous years. Consistent with the existing studies in the field, the increasing number of publications through the years on supply chain resilience also indicates the fact that supply chain resilience is a trending research agenda. However, compared to supply chain management, publications in the field of supply chain resilience remain scarce (Blackhurst et al. 2011; Hohenstein et al. 2015; Pereira et al. 2014; Ponomarov and Holcomb 2009).

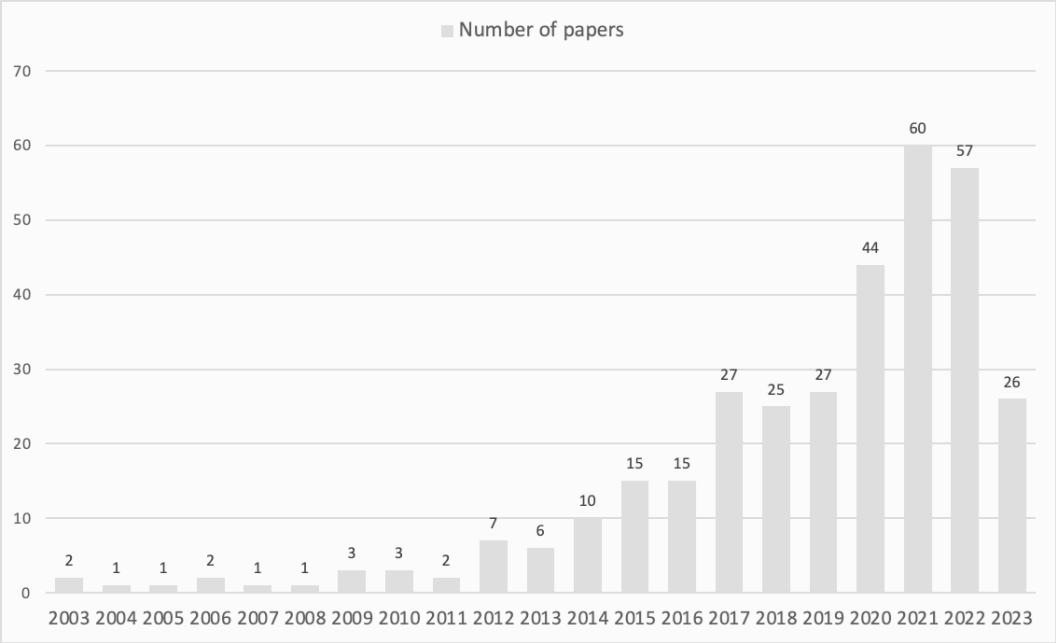

Figure 2. Year-wise distribution of publications

Table 1. Distribution of Articles Across Journals

Journal	Number of papers
International Journal of Production Research	24
International Journal of Production Economics	22
International Journal of Logistics Management	15
Supply Chain Management	13
Benchmarking: An International Journal	12
Sustainability	12
Computers & Industrial Engineering	11
Supply Chain Management: An International Journal	11
Transportation Research Part E: Logistics and Transportation Review	11
International Journal of Logistics Research and Applications	10
Annals of Operations Research	9
International Journal of Operations and Production Management	9
International Journal of Physical Distribution and Logistics Management	9
International Journal of Supply Chain Management	9
Journal of Business Logistics	9
Production Planning & Control	7
Omega	6
Operations Management Research	6
Journal of Enterprise Information Management	5
The International Journal of Logistics Management	5
International Journal of Disaster Resilience in the Built Environment	4
Journal of Purchasing and Supply Management	4
Sustainable Production and Consumption	4
Environmental Science and Technology	3
Frontiers of Engineering Management	3
International Journal of Agile Systems and Management	3
International Journal of Integrated Supply Management	3
International Journal of Logistics Systems and Management	3
Journal of Operations Management	3
Logistics Research	3
Operations and Supply Chain Management: An International Journal	3
Supply Chain Forum	3
Technological Forecasting and Social Change	3
European Journal of Operational Research	2
Global Business Review	2
International Journal of Services and Operations Management	2
Journal of Business & Industrial Marketing	2
Journal of Cleaner Production	2
Journal of Global Operations and Strategic Sourcing	2
Journal of Manufacturing Technology Management	2
Journal of Operations and Supply Chain Management	2
Journal of Risk Research	2
MIT Sloan Management Review	2
Technology in Society	2
Others	67
TOTAL	335

In addition, the journal-wise distribution of the articles (*Table 1*) showed that most of the contributions were published in the *International Journal of Production Research* (24), the *International Journal of Production Economics* (22), and the *International Journal of Logistics Management* (15). Moreover, the published journals are in a variety of ranges regarding research areas such as operations management, supply chain management, logistics, and production research. This diversity of the journal research areas also emphasizes the interdisciplinary nature of the supply chain resilience topic (Bier et al. 2020).

As shown in Figure 3, in the literature several methodologies have been used to address the topic of supply chain resilience. The analysis indicated that modeling, case studies, and surveys were often used across the selected 335 articles on supply chain resilience context. Interviews were found to be the most popular form of primary data collection among the empirical articles. Another finding from the analysis is that quantitative research on supply chain resilience in pandemic and epidemic diseases such as the recent Covid-19 pandemic outbreak, remains scarce (Queiroz et al. 2022).

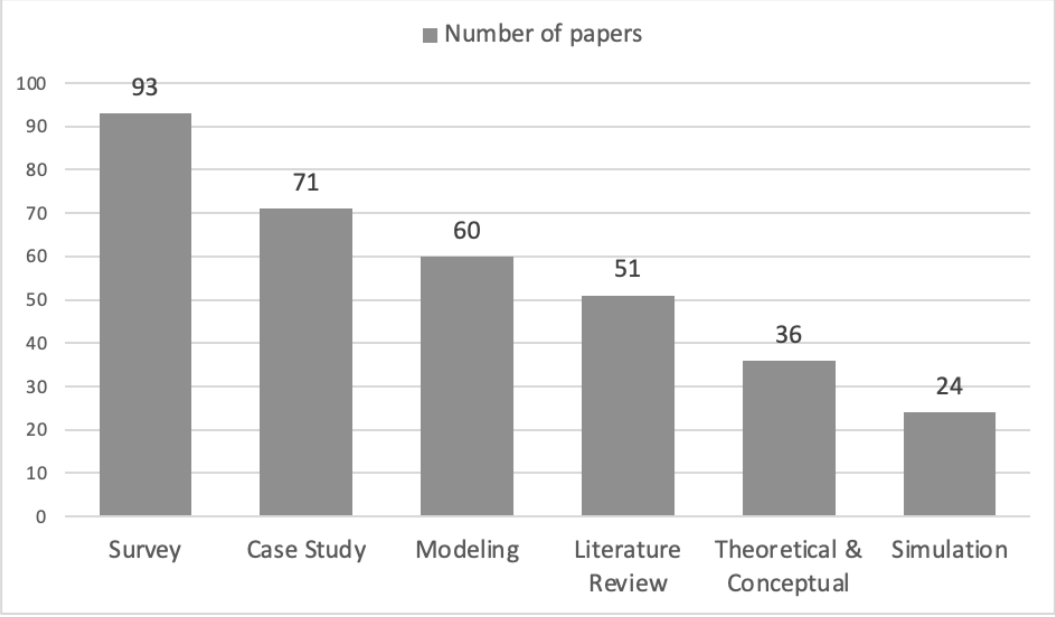

Figure 3. Distribution of Methodologies

Regarding the empirical theories adapted in the literature, various theories have been used to address the topic of supply chain resilience. *Table 2* demonstrates that Dynamic Capabilities (Chowdhury and Quaddus 2017; Golgeci and Ponomarov 2013; Ponomarov and Holcomb 2009) and Resource Based View (Blackhurst et al. 2011; Brandon-Jones et al. 2014; Ponomarov and Holcomb 2009) are by far the most employed theories in the field. Although there exists an increase in the number of theories used in supply chain resilience research, according to Ali et al. (2017), there still exists a lack of theory grounding in the supply chain resilience context which eventually restricts defining supply chain resilience from a theoretical perspective.

Thematic Analysis of the Findings

The thematic analysis has revealed key themes in the supply chain resilience concept: the transformation of supply chain resilience definition, supply chain disruptions, supply chain vulnerabilities, and supply chain capabilities.

Key Theme 1: The Transformation of Supply Chain Resilience Definition

Resilience in the supply chain management field has been described and is still being described by various researchers through the years, which are chronologically listed in Table 3. Despite the growing research, there is still no consensus on the supply chain resilience definition (Adobor 2019; Sahu, Datta and Mahapatra 2017; Spiegler, Naim and Wikner 2012; Tukamuhabwa et al. 2015). On the other hand, Kaviani et al. (2020) argued the fact that there is no need to develop a universal description since resilience depends on situations that are unique to themselves. Furthermore, Wieland and Durach (2021) argued that supply chain resilience needs to move beyond engineering resilience and incorporate social-ecological resilience. More recently, Ivanov (2023) explored the shift in supply chain resilience from a stability-based view (SBV) focused on returning to a pre-disruption state, to an adaptation-based view (ABV) emphasizing proactive adaptation and long-term viability. He argued that recent years have seen a transition towards designing supply chains with inherent flexibility and redundancy to handle both known and unknown uncertainties, highlighting the importance of resilience as an ongoing quality rather than just a reactive measure. This shift represents a significant improvement in ensuring continuous health and viability of supply chains.

Table 2. Distribution of Theories

Theory	Number of papers
Dynamic Capabilities View	43
Resource Based View	25
Social Capital	11
Complex Adaptive Systems	8
Fuzzy Set Theory	8
Information Processing Theory	7
Contingency Theory	6
Graph Theory	5
Grey Theory	5
Systems Theory	5
Organizational Information Processing Theory	4
Complexity Theory	3
Contingent Resource-Based View	2
High Reliability Theory	2
Network Theory	2
Relational View	2
Resource Dependence theory	2
Resource Orchestration Theory	2
Social Exchange Theory	2
Absorptive Capacity Theory	1
Capital Based View	1
Competing Values Framework	1
Dependency Theory	1
Dynamic Managerial Capabilities Theory	1
Dynamic Systems Theory	1
Fitness Landscape Theory	1
Game Theory	1
Institutional Pressure theory	1
Institutional Theory	1
Item Approach	1
Knowledge-based view	1
Multilevel Theory	1
Normal Accident Theory	1
Organizational Culture Theory	1
Panarchy Theory	1
Quality Function Deployment	1
Resilience Theory	1
Social Network Theory	1
Stakeholder Theory	1
Stakeholders' Resource-Based View	1
Statistical Information Theory	1
Strategic Choice Theory	1
Theory of Bayesian Network	1
Theory of Diversity	1
Theory of Organizational Readiness for Change	1

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Table 3. Definition of Supply Chain Resilience through Years

Authors	Definition of Supply Chain Resilience
Christopher and Peck (2004, p. 2)	*"The ability of a system to return to its original state or move to a new, more desirable state after being disturbed"*
Datta et al. (2007, p. 189)	*"... not only the ability to maintain control over performance variability in the face of disturbance but also a property of being adaptive and capable of sustained response to sudden and significant shifts in the environment in the form of uncertain demands"*
Ponomarov and Holcomb (2009, p. 131)	*"The adaptive capability of the supply chain 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"*
Zsidisin and Wagner (2010, p. 3)	*"… the ability to return to normal performance levels following a supply chain disruption."*
Jüttner and Maklan (2011, p. 247)	*"… the supply chain's ability to cope with the consequences of unavoidable risk events to return to its original operations or move to a new, more desirable state after being disturbed"*
Ponis and Koronis (2012, p. 925)	*"The ability to proactively plan and design the supply chain network for anticipating unexpected* *disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operations, if possible, more favourable than the one prior to the event, thus gaining competitive advantage"*
Pettit et al. (2013, p. 46)	*"… the ability to survive, adapt, and grow in the face of turbulent change"*
Pereira et al. (2014, p. 627)	*"… the capability of supply chains to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one"*
Ambulkar et al. (2015, p. 112)	*"… the capability of the firm to be alert to, adapt to and quickly respond to changes brought by a supply chain disruption"*
Kamalahmadi and Mellat-Parast (2016, p.121)	*"The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations"*
Brusset and Teller (2017)	*"… is an operational capability that enables a disrupted or broken supply chain to reconstruct itself and be stronger than before"*
Pires Ribeiro and Barbosa-Povoa (2018, p.116)	*"A resilient supply chain should be able to prepare, respond and recover from disturbances and afterwards maintain a positive steady state operation in an acceptable cost and time."*
Hosseini et al. (2019, p.292)	*"SC capability to utilize the absorptive capacity of SC entities to repulse and withstand the impacts of perturbations, to minimize the consequences of disruptions and their propagation by utilizing adaptive capacity and to recover performance level to normal operations in a cost-efficient manner using restorative capacity when absorptive and adaptive capacities are not sufficient."*
Novak et al. (2020, p.10)	*"A supply chain is resilient to the extent that the system can maintain core functionality by continually adapting, evolving, and transforming in response to the dynamic multiscale feedbacks that occur between the multitude of interconnected organizations, institutions, and social and ecological systems that are all parts of the larger supply chain."*
Wieland and Durach (2021, p.2)	*"… the capacity of a supply chain to persist, adapt, or transform in the face of change."*
Dwaikat et al. (2022, p.290)	*"… the organizational ability to anticipate critical events related to emerging trends, constantly adapt to change and recover quickly after disasters and crises."*
Ivanov (2023, p. 4039)	*"… is both a process quality and a performance outcome. As a process quality, resilience characterizes the ability to adapt, survive, and exist. As an outcome, resilience quantifies performance deviations caused by disruptions and recovery actions."*

Key Theme 2: Supply Chain Disruptions

Global supply chains have been disrupted by several unpredictable events such as terrorist attacks (9/11 in 2001), earthquakes (Taiwan in 2010, Japan in 2011), tsunamis (Indian Ocean in 2004), hurricanes (US in 2005), wildfires (Australia in 2019) and pandemic diseases (SARS in 2003, bird flu in 2005, swine flu in 2009 and COVID-19 in 2020). While such disruptive events can be considered major threats to human lives affecting all areas of society, they also test supply chains by the long-term impacts and high uncertainty risks (Sarkis 2020).

Supply chain disruptions are unplanned and unanticipated events that stop or impede the normal flow of goods and materials within a supply chain (Craighead et al. 2007; Kleindorfer and Saad 2005; Stauffer 2003; Svensson 2000; Wagner and Bode 2008). There are several classifications of disruptions in the literature but generally disruptive events are classified under two sources: external, such as natural disasters (Sáenz and Revilla 2014; Yang and Xu 2015), economic and financial crises (Jüttner and Maklan 2011), and terrorism (Sheffi 2001), and internal, such as infrastructure issues and delivery disruptions (Ambulkar, Blackhurst and Grawe 2015; Carvalho, Azevedo and Cruz-Machado 2012; Chowdhury and Quaddus 2017) or a failure of any function in a supply chain or human error (Ponomarov and Holcomb 2009). Sheffi (2015) more specifically characterizes the scale of impact of such events as localized disruptions (natural disasters, industrial accidents, terrorist strikes) and global crises (pandemic diseases), where multiple countries and industries are affected at the same time. While disruption classifications of the previous studies showed that the categorization generally focused on how a disruptive event might occur or how it might impact the supply chain, from a different perspective, DuHadway, Carnovale, and Hazen (2019) distinguished disruptions as exogenous/endogenous disruptions and intentional/inadvertent disruptions, where they further conceptualized events in for subcategories as performance failures, force majeure, inside job and disruptive strikes.

Key Theme 3: Supply Chain Vulnerabilities

To avoid or mitigate supply chain disruptions, extant literature heavily focused on the risk sources that can lead to a disruption. Kleindorfer and Saad (2005) suggested two categories of risks that are operational and long-term, which are also introduced as low-impact high-frequency (LIHF) and high-impact low-frequency (HILF) risks. While operational risks manifest in various ways, such as supply-demand disparity, lead time uncertainties, machine breakdowns, etc., long-term risks are the ones that

are external to the network, such as natural hazards, terrorism, and political instabilities that have longer recovery periods. Supply chain risks are highly related to a supply chain's vulnerabilities since companies become more vulnerable as supply chains face disruptive events (Colicchia and Strozzi 2012).

Vulnerability was first introduced to the supply chain context by Svensson's (2000) study, where he defined supply chain vulnerability as the "existence of random disturbances that lead to deviations in the supply chain of components and materials from normal, expected or planned schedules or activities, all of which cause negative effects or consequences for the involved manufacturer and its sub-contractors" (p.732). In another definition by Christopher and Peck (2004), supply chain vulnerability is considered as an exposure to a disturbance. Since most companies realize their vulnerabilities only when a disruption occurs in their supply chain (Bier et al. 2020), understanding supply chain vulnerabilities is crucial in improving supply chain resilience (Fiksel and Fiksel 2015). To mitigate disruption risks in a supply chain, Kleindorfer and Saad (2005) develop a conceptual framework where they identify sources of risks and vulnerabilities in a supply chain. They categorized the supply chain vulnerability sources into three categories: operational factors, natural hazards and terrorism or political instability. Blos et al. (2009) further categorized vulnerabilities into four categories; financial vulnerability, strategic vulnerability, hazard vulnerability and operations vulnerability.

Previous studies addressed various drivers of supply chain vulnerabilities, such as customer dependency (Svensson 2004), supplier dependency (Jüttner 2005; Svensson 2004), single sourcing (Zsidisin et al. 2004), and global sourcing (Jüttner 2005). As a pioneer in the supply chain vulnerability context, Svensson further contributed to the field by distinguishing the types of vulnerability into two: atomic vulnerability, which concerns a part of the supply chain and holistic vulnerability (Svensson 2004). In their study, Pettit, Fiksel, and Croxton (2010) discussed that supply chain resilience has two dimensions: vulnerabilities and capabilities. They presented supply chain vulnerabilities within three main categories: external vulnerabilities, such as financial or bureaucratic issues; internal vulnerabilities, like supplier and customer disruptions; and structural vulnerabilities, such as the supply chain design. On the other hand, in Chowdhury and Quaddus's (2015) study, where they developed a multi-objective optimization model, they gathered supply chain vulnerability factors that were previously addressed in the field under seven categories: hazard vulnerability, strategic vulnerability, financial vulnerability, operational vulnerability, infrastructure vulnerability, demand and supply

vulnerability.

Based on the literature, we created *Table 4* to summarize the supply chain vulnerabilities. Within the literature, supply chain vulnerabilities are generally categorized into two: unforeseeable disruption risks, such as natural and man-made disasters (Parast and Shekarian 2019), and operational risks that are mainly concerned with supply-demand errors due to failed coordination (Nooraie and Parast 2015; Yang, Pan and Ballot 2017), which makes operational risks relatively more manageable. Christopher and Peck (2004) further expanded this classification into three: internal, such as infrastructure failures; external to the firm; internal to the supply chain, such as demand or supply-related risks; and external, such as environmental disruptions. There are also various categorizations of supply chain risks in the literature, such as Ho et al.'s (2015) macro and micro risk perspective. Macro-risks refer to external or natural risks, whereas micro-risks consist of internal risks such as recurrent events. Micro-risks are further divided into four subcategories: demand risk, manufacturing risk, supply risk, and infrastructural risk.

Nonetheless, not all disruptive events happen at the same speed. For instance, the 9.0 magnitude earthquake in Japan, which is considered one of the largest disruptions to global supply chains, not only affected local businesses but also caused damage to various industries across the global supply chain because of the shortage of parts supplied from Japan (Lohr 2011). While sudden-onset disasters such as earthquakes and tsunamis unfold almost instantly creating physical impacts, slow-onset disasters can be predicted much further in advance and unfold over a longer period creating social and economic impacts such as famine and drought (Van Wassenhove 2006).

Epidemics and pandemics are considered unique disruptions that cause systematic threats to the supply chains, both internally and externally (Golan, Jernegan and Linkov 2020). Although COVID-19 is not the first disaster that has led to disruptions in supply chains, compared to other infectious diseases where the businesses recovered in a matter of weeks, even during the early stages of the COVID-19 pandemic, its impact on global supply chains was massive (Govindan, Mina and Alavi 2020; Ivanov 2020; Xu et al. 2020). Sodhi and Tang (2021) demonstrate the need for extreme supply chain management for extreme circumstances such as pandemics, geopolitics, war, climate change, or biodiversity collapse that simultaneously disrupt supply chains in multiple dimensions. Under such vulnerable situations, a resilient supply chain requires an ability to respond to those challenges, where supply chain capabilities play an instrumental role in mitigating risks (Hohenstein et al. 2015). Therefore, it

is also important for a company to investigate vulnerabilities and capabilities of the entire network, including all actors, to improve supply chain resilience (Christopher and Peck 2004).

Table 4. Classification of Supply Chain Vulnerabilities

<table>
<tr><td colspan="3">Supply Chain Vulnerabilities</td></tr>
<tr><td>Disruption Risks</td><td colspan="2">Operational Risks</td></tr>
<tr><td>External Risks</td><td>External to the firm but Internal to the supply chain</td><td>Internal to the firm</td></tr>
<tr><td>Natural Disasters</td><td>Supply Risks</td><td>Process Risks</td></tr>
<tr><td>Slow onset: climate change, famine, drought, deforestation, poverty</td><td rowspan="2">Quality issues, variability of replenishment lead time, capacity fluctuations, supplier bankruptcy, etc.</td><td rowspan="2">Bottlenecks, product quality issues, machine failure, IT infrastructure failure, labor strikes, etc.</td></tr>
<tr><td>Sudden onset: earthquakes, tsunamis, cyclones/storms/hurricanes, volcanic eruptions, floods, landslides, wildfires, floods</td></tr>
<tr><td>Man-made Disasters</td><td>Demand Risks</td><td>Control Risks</td></tr>
<tr><td>Slow onset: refugee crisis, economic crisis, environmental pollution, technology changes, political instability</td><td rowspan="2">Demand volatility, market changes, forecast errors, competitor’s moves, etc.</td><td rowspan="2">Poor visibility through the supply chain, safety stock policy, order quantity and batch size policy, lack of collaborative forecasting, and bullwhip effects</td></tr>
<tr><td>Sudden onset: Terrorism, Coup d’état, chemical leaks, war</td></tr>
</table>

Key Theme 4: Supply Chain Resilience Capabilities

Supply chain capabilities are essential attributes for improving resilient supply chains which eventually lead to improved business performance (Christopher and Peck 2004; Jüttner and Maklan 2011; Liao and Kuo 2014; Pettit et al. 2010; Ponomarov and Holcomb 2009; Sheffi and Rice 2005). The extant literature suggested that effective implementation of supply chain capabilities leads to reducing vulnerabilities and preventing or being prepared for disruptions (Craighead et al. 2007). In their study, Ali et al. (2017) developed a conceptual mapping framework where they distinguished supply chain capabilities according to the phases of disruptions. Supply chain resilience elements were gathered under the categories of ability to anticipate, ability to adapt, ability to respond, ability

to recover and ability to learn. As shown in Figure 4, key components in building resilient supply chains that were discussed by the researchers in the field are flexibility, collaboration, visibility, agility and redundancy, which are also consistent with previous findings (Ali et al. 2017). A vast number of researchers have investigated that supply chain flexibility is a key to mitigating any major disruption (Agarwal et al. 2006; Das 2011; Gong 2008; Stevenson and Spring 2007), which is defined as the ability to respond and adapt to unforeseen changes (Sheffi and Rice 2005). In some studies, flexibility is also assumed as a dimension of agility (Chopra and Sodhi 2004; Ponis and Koronis 2012; Scholten et al. 2014). Wieland and Wallenburg (2013, p.302) defined agility as "the ability of a supply chain to rapidly respond to change by adapting its initial stable configuration". In their study, they investigate the relationship between supply chain capabilities, particularly agility and robustness, and supply chain customer value, where they consider robustness as a supply chain's resistance or anticipation to change.

In terms of supply chain capabilities, many studies pointed out different recommendations for building resilience; for instance; Fiksel and Fiksel (2015) focused on visibility which is the traceability of services from raw material to the end customer, whereas Christopher and Peck (2004) and Jüttner and Maklan (2011) considered velocity and visibility as an antecedent for agility. Existing studies have pointed out various capabilities that companies can adopt as resilience strategies, which enable a supply chain to bounce back from adverse events and adapt to uncertain future disruptions. All these strategic capabilities that comprise a resilient supply chain eventually provide improved performance, allowing firms to be more sustainable (Christopher and Peck 2004; Jüttner and Maklan 2011; Pettit et al. 2010; Sheffi and Rice 2005).

Considering the vulnerabilities exposed by COVID-19, numerous studies have suggested strategies for minimizing impacts, recovering, and preparing for future pandemics. These strategies are categorized into three main dimensions of supply chain resilience: preparedness, response, and recovery, following the framework by Chowdhury and Quaddus (2017) and Ponomarov and Holcomb (2009). To address the pandemic-related shortages in essential goods, studies have recommended increasing production capacity (Paul and Chowdhury 2020; Leite et al. 2020; Mehrotra et al. 2020; Veselovská 2020), optimizing timing for building up production, reallocating resources, and employing temporary staff. Others suggest expanding manufacturing facilities (Shokrani et al. 2020) and adapting product features to meet demand with existing resources (Paul and Chowdhury 2021).

The challenges of raw material shortages were highlighted by the case of an Australian hand sanitizer company that had to halt production (Paul and Chowdhury 2020). Studies proposed strategies for upstream resilience such as improving visibility in supply networks (Ivanov and Dolgui 2020) and diversifying suppliers (van Hoek 2020). Additionally, research suggests reconfiguring logistics and supply chains by suggesting nearshoring or backshoring production facilities (Cappelli and Cini 2020; Deaton and Deaton 2020; van Hoek 2020), improving IT capabilities (Ibn-Mohammed et al. 2021; van Hoek et al. 2020), and automation to reduce dependency on human labor (Ivanov and Das 2020). To address capital shortages, easing capital flow has been recommended (Deaton and Deaton 2020).

Partnerships are also essential for smoothing product and service flow (Veselovská 2020), as well as improving information sharing and collaboration (Jabbour et al. 2020; Sharma et al. 2020a). Strategies for dealing with reduced demand include price adjustments (Chiaramonti and Maniatis 2020), and sustainability practices are advocated for resilience (Rizou et al. 2020). Researchers stress the importance of holistic, resilient response plans integrating multiple strategies for a viable supply chain that is agile, resilient, and sustainable in the post-COVID era (Baveja et al. 2020; Ivanov 2020b; Jabbour et al. 2020; Leite et al. 2020).

A vast range of supply chain capabilities is considered by academicians and practitioners to develop a resilient mechanism such as agility, responsiveness, reengineering, velocity, visibility, flexibility, redundancy, collaboration, transparency, robustness etc. (Pettit et al. 2013). Although a wide range of capabilities have been discussed in the supply chain resilience domain; the main focus has been on flexibility as shown in Figure 4. Following flexibility, other capabilities such as visibility, collaboration, agility, and velocity also show a notable presence in the literature, indicating their recognized importance in building resilient supply chains. Additionally, the systematic review revealed an increasing focus on digital transformation capabilities in supply chain resilience literature. It is also observed that the following capabilities, which are mentioned less frequently, have been discussed in articles after 2020: Safety and Health, Supply Chain Alertness, Supply Chain Intelligence, Supply Chain Learning Orientation, Supply Chain Mapping, and Warning. Although less prevalent, these capabilities signify emerging areas of interest reflecting recent developments and shifting focus within the domain.

Conclusion

In this study, the systematic literature review on emerging trends in supply chain resilience highlights significant advancements and underscores the dynamic nature of supply chain management in response to various global disruptions. By analyzing the existing body of literature, this study has illuminated the multifaceted nature of supply chain capabilities, offering a comprehensive view of the current state of research and practice in supply chain resilience. The findings contribute to the field of supply chain resilience by synthesizing existing research on resilience, identifying key trends, and highlighting areas for future investigation. The insights from this review have significant implications for scholars and practitioners, providing a roadmap for developing more resilient supply chains that can withstand the uncertainties of the global business environment.

Theoretical Implications

By synthesizing existing research on resilience and identifying key trends, this study makes significant contributions to the theoretical understanding of supply chain capabilities within the framework of the DCV. The DCV emphasizes a firm's capacity to renew competencies, enabling it to sustain a competitive advantage in fluctuating business environments. This perspective provides a robust framework for understanding the development and enhancement of supply chain capabilities in response to global disruptions.

The dynamic capabilities framework underscores the importance of sensing, seizing, and reconfiguring as fundamental processes that enable firms to adapt to changing environments. The systematic review highlights that supply chain capabilities such as flexibility, agility, collaboration, and visibility are critical for resilience, aligning closely with the DCV's emphasis on adaptation and reconfiguration. For instance, the capability to reconfigure supply networks for greater modularity and diversification is akin to the DCV's notion of renewing and transforming resource bases. This theoretical alignment suggests that the dynamic capabilities of sensing opportunities, seizing them through strategic resource allocation, and reconfiguring organizational competencies are integral to building resilient supply chains.

The review further identifies emerging capabilities such as digital transformation, supply chain alertness, and intelligence as vital for navigating complex and volatile environments. These capabilities reflect an evolution in the theoretical understanding of supply chain resilience, extending the DCV by incorporating modern technological advancements and the need for real-time decision-making. The integration of technologies

like AI, machine learning, and blockchain enhances sensing capabilities by improving predictive analytics and disruption forecasting, aligning with the DCV's focus on environmental scanning and interpretation. Grounding on the literature, we categorized the supply chain vulnerabilities in a way that can provide better sight both for buyers and suppliers. With this classification, we highlight various sources of risks and their potential impacts on supply chains.

Managerial Implications

This review has emphasized the critical role of supply chain capabilities in fostering resilience. Capabilities such as flexibility, agility, collaboration, and visibility have been identified as pivotal in enabling supply chains to anticipate, adapt to, and recover from disruptive events. The post-2020 literature indicates a growing emphasis on digital transformation and emerging capabilities like supply chain alertness and intelligence, which are vital for navigating the increasingly complex and volatile global supply chain environment. Digital tools have proven to be indispensable during disruptions, allowing for real-time decision-making, predictive analytics for disruption forecasting, and automation. Technologies such as AI, machine learning, and blockchain are being integrated to enhance various facets of resilience, such as predictive risk management, transparent and secure transactions, and improved supply chain visibility. Besides, managers should be aware that the emphasis on such capabilities underscores the shift from traditional risk management to a more holistic approach encompassing capabilities for building resilience.

Moreover, the findings of this study revealed that there's an increasing trend toward reconfiguring supply networks for greater modularity and diversification to handle disruptions more effectively, such as through nearshoring or multi-sourcing. With nearshoring and multi-sourcing, practitioners can diminish the vulnerabilities in the supply chain and gain more resilience. Furthermore, with the provided classification of supply chain vulnerabilities, it is possible to develop robust supply strategies and maintain operations in a resilient manner. By identifying these risks, better operational measures can be taken in supply management.

Future Research Agenda

This review has revealed an evolving landscape of supply chain resilience research, with a noticeable increase in publications following major global events such as the COVID-19 pandemic. This trend highlights the reactive nature of the field and the necessity for ongoing research to address new challenges as they arise. Future research should explore the dynamic

interplay between various supply chain capabilities and how they can be effectively leveraged to address current and future disruptions. This includes investigating how firms can enhance their adaptive capacity, not only to recover from disruptions but also to improve and evolve post-disruption.

Additionally, the impact of emerging technologies on supply chain resilience offers rich avenues for future research. Investigating how blockchain and AI reshape the landscape of supply chain management could provide valuable insights into the digitalization of supply chains. Furthermore, exploring the relationship between supply chain resilience and sustainability, especially in the context of climate change, presents a crucial area for theoretical and practical investigation. The role of digital tools in enabling real-time decision-making and predictive risk management warrants further exploration, as these technologies are critical for enhancing the DCV's sensing and seizing processes.

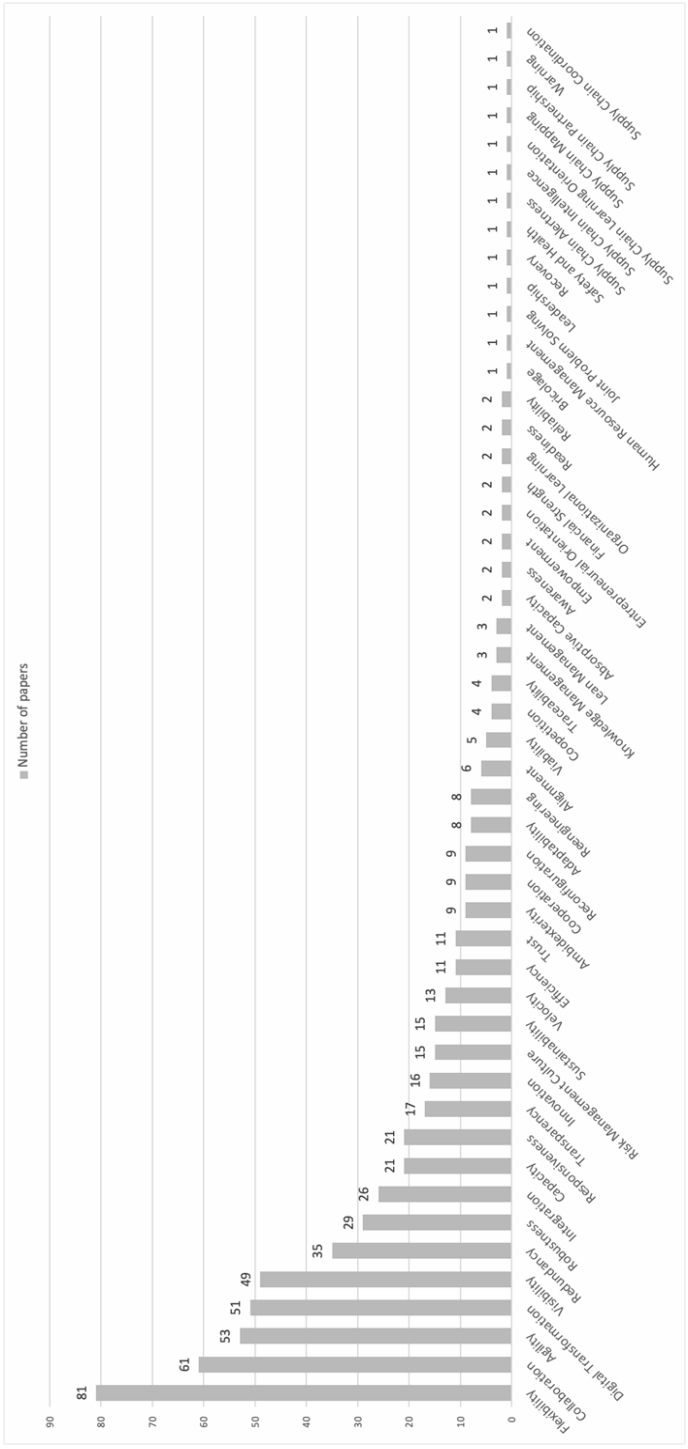

Figure 4. Distribution of Supply Chain Resilience Capabilities

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