Managing Supply Chains: Staying Efficient During Global Disruptions

[1]JasminePrasad,[1]AishwaryaAnilKallattu,[1]AryanDixit,[1]AdityaNaik Nimbalkar, [2]Dr Anusha Priya
[1]*Student Department of Management IIEBM, Pune*
[2]*Associate Professor IIEBM, Pune*

Abstract- Global supply chains are designed for efficiency but have become increasingly vulnerable to disruptions caused by pandemics, geopolitical conflicts, and changing trade regulations. This study focuses on understanding how these disruptions affect supply chains and how companies respond to them. The research is based on secondary data from journals, reports, and real business cases. It highlights practical strategies like using multiple suppliers, shifting production closer to markets, improving digital tracking, and managing inventory more flexibly. The study also emphasizes the role of managerial decision-making and institutional factors in shaping supply chain strategies and proposes an integrated framework to support firms in balancing efficiency and resilience in a volatile global environment.

Key words: ***Global Supply Chains, Supply Chain Disruptions, Supply Chain Resilience, Efficiency–Resilience Trade-off, Risk Management.***

I. INTRODUCTION

Global supply chains have become increasingly interconnected and are often designed to maximize efficiency and reduce operational costs. However, the rapid globalization of supply networks has also made them more vulnerable to disruptions such as pandemics, geopolitical conflicts, and changes in international trade regulations. These disturbances can interrupt the movement of goods and services, resulting in delivery delays, increased costs, and operational uncertainty for organizations. Research highlights that although globalization enhances efficiency and competitiveness, it also exposes supply chains to geopolitical and environmental risks, requiring organizations to remain flexible and strategically manage their supply chain operations (*Sarwar & Rye, 2025).*

At the same time, supply chains involve multiple stakeholders—including producers, service providers, and consumers—whose activities influence both operational performance and environmental outcomes throughout upstream and downstream processes. Studies indicate that these interconnected activities can generate environmental impacts across the entire supply chain lifecycle, making responsible management essential *(Boonlua et al., 2023).* In addition, modern supply chains are increasingly expected to focus on both sustainability and resilience. Organizations must improve sustainability performance across the triple bottom line—economic, environmental, and social—while also addressing rising uncertainty and vulnerability within global supply networks *(Negri, Cagno, Colicchia, & Sarkis, 2021).* Consequently, balancing efficiency, resilience, and sustainability has become a key priority for businesses and researchers in contemporary supply chain management.

1.1 Background of the Study

The expansion of global sourcing and international production networks has led organizations to prioritize efficiency, cost reduction, and streamlined operations in supply chain design. While these approaches improved competitiveness, they also increased dependence on complex and geographically dispersed networks.

Over time, rising uncertainty in the global business environment has highlighted the limitations of such tightly optimized supply chains. This has shifted managerial focus toward incorporating flexibility, risk

awareness, and strategic adaptability into supply chain planning and decision-making.

1.2 Statement of the Problem

Global supply chains, while optimized for efficiency and cost reduction, have shown limited ability to withstand simultaneous global disruptions such as pandemics, geopolitical conflicts, and changes in trade regulations. These disruptions have led to supply delays, increased costs, and operational instability for organizations. Although firms are seeking to improve supply chain resilience, doing so often challenges efficiency, and existing studies provide limited insight into managing this trade-off under multiple interacting disruptions. This study addresses the need to understand these combined effects and identify strategies that enable firms to balance supply chain resilience and efficiency.

1.3 Objective of the Study

- To examine the impact of multiple global disruptions on global supply chains.
- To understand the trade-off between supply chain resilience and efficiency.
- To identify key supply chain strategies adopted by firms to manage disruptions.
- To analyse the role of managerial and institutional factors in supply chain decision-making.
- To propose an integrated framework for balancing resilience and efficiency in global supply chains

1.4 Research Questions

1. How do multiple global disruptions impact the performance and stability of global supply chains?
2. What trade-offs exist between supply chain resilience and operational efficiency, and how do firms navigate them?
3. Which strategies do firms adopt to manage disruptions in global supply chains, and how effective are they?
4. How do managerial practices and institutional factors influence supply chain decision-making during disruptions?
5. How can organizations develop an integrated framework that balances resilience and efficiency in global supply chains?

1.5 Significance of the Study

This study is significant because it addresses the growing challenges faced by global supply chains in an era of frequent and simultaneous disruptions, such as pandemics, geopolitical conflicts, and changing trade regulations. By examining the trade-offs between resilience and efficiency, identifying effective strategies, and highlighting the role of managerial and institutional factors, the study provides valuable insights for both practitioners and policymakers. The proposed integrated framework offers a practical tool for organizations to design supply chains that are not only robust against disruptions but also maintain operational efficiency, thereby enhancing competitiveness, sustainability, and long-term stability in the global market.

1.6 Scope and Limitations

This study focuses on the impact of major global disruptions such as pandemics, wars, and changes in government policies on supply chain operations. It examines how these factors influence supply chain efficiency and resilience. However, the study does not consider other possible factors that may affect supply chains, such as natural disasters, technological failures, internal organizational issues, or firm-specific operational challenges. Therefore, the scope of the study is limited to selected global disruption factors only.

II. LITERATURE REVIEW

Supply chain resilience has gained significant importance in recent years due to increasing global uncertainties and disruptions. In a highly interconnected global economy, supply chains are increasingly exposed to risks caused by globalization, technological developments, and geopolitical tensions. *According to Patel (2023),* organizations must develop resilient supply chain systems to ensure operational continuity during disruptions. The study highlights several strategies such as supplier diversification, inventory optimization, adoption of

digital technologies, collaboration among supply chain partners, and proactive risk management. These strategies help firms mitigate disruptions and maintain stable operations in global supply networks.

Many researchers have also focused on the different capabilities that make a supply chain more resilient. The research conducted by *Shih-Jung Juan, Eldon Y. Li, and Wei-Hsi Hung* identifies five key dimensions of supply chain resilience: visibility, velocity, flexibility, robustness, and collaboration. These capabilities allow companies to react quickly when disruptions occur. Their research shows that collaboration between partners plays a very important role, as sharing information and working together improves overall performance. Similarly, *Boonlua et al.* highlight that resilience strategies such as flexibility, collaboration, visibility, and strategic procurement are essential for managing major disruptions like the COVID-19 pandemic. The study further identifies four stages of resilience—planning, absorbing, recovering, and adapting—which help organizations effectively manage disruption impacts and ensure continuity.

Disruptions like pandemics, natural disasters, and geopolitical conflicts have increasingly challenged global supply chain systems. *Holloway* reviews the impact of these disruptive events and highlights the importance of risk management, technological adoption, collaboration, and adaptability in maintaining stable supply chain operations. Similarly, *Duong and Chong* conducted a systematic literature review of 157 research papers to examine the role of collaboration in managing supply chain disruptions. Their findings indicate that collaboration mechanisms such as information sharing, joint decision-making, and resource sharing improve supply chain visibility, flexibility, and resilience. These collaborative practices enable organizations to better respond to disruptions and accelerate recovery processes.

Managing uncertainty and variability within supply chains has also been a major focus of research. *Davis* proposes a structured methodology developed at Hewlett-Packard to manage complex supply chain networks under uncertainty. The approach involves benchmarking supply chain performance, controlling uncertainty, and planning improvements through analytical models. By understanding variability across supply, transformation, and demand processes, organizations can optimize inventory distribution, reduce operational costs, and improve customer service. Similarly, *Katsaliaki, Galetsi, and Kumar* provide a comprehensive review of supply chain disruptions and resilience strategies .Their study highlights the "ripple effect," where disruptions spread across multiple supply chain tiers and amplify operational and financial consequences. The research also identifies several resilience strategies, modelling techniques, and information technology tools that help organizations manage disruption risks effectively.

In addition to conceptual frameworks, several studies emphasize analytical and modelling approaches for managing supply chain disruptions. *Ivanov et al.* analyse disruption recovery strategies and risk management practices in supply chain design and planning. The study highlights both proactive and reactive strategies such as maintaining backup suppliers, building inventory buffers, and increasing capacity flexibility to reduce disruption impacts. Analytical tools such as optimization models, stochastic programming, simulation techniques, and control theory are also discussed as effective approaches for disruption management. Similarly, *Korder, Maheut, and Konle (2024)* examine the use of simulation methods and digital strategies for improving supply chain resilience. Their systematic literature review shows that techniques such as discrete-event simulation, agent-based modeling, and system dynamics help organizations analyze disruption impacts and evaluate recovery strategies. The study also emphasizes the growing role of artificial intelligence and digital twins in strengthening disruption management capabilities.

Collaboration and inter-organizational relationships are also critical factors in strengthening supply chain resilience. *Bygballe, Dubois, and Jahre (2023)* highlight the importance of the Resource Interaction Approach (RIA) in managing disruptions across supply networks. The study argues that traditional supply chain risk management often focuses only on internal resources, while effective disruption management requires collaboration and resource interaction among multiple organizations. The

research suggests that supply chain resilience can be strengthened through stronger relationships, flexible organizational structures, and coordinated decision-making across supply networks.

Technological advancements are also playing a significant role in enhancing supply chain resilience. *Etemadi et al. (2021)* examine the role of blockchain technology in supply chain disruption risk management through a systematic literature network analysis of 192 publications. The findings indicate that blockchain improves transparency, traceability, and data security among supply chain partners. These capabilities reduce cyber risks such as fraud and counterfeiting while improving trust and real-time information sharing across supply networks. Similarly, *Nnabueze et al. (2022)* propose a network-analytics-based framework for forecasting supply chain disruptions in global trade. The study uses graph-theoretic metrics and machine learning models to identify critical nodes in supply chain networks that may trigger cascading disruptions. The results show that network-based forecasting models can improve disruption prediction lead time by 15–25%, enabling organizations to move from reactive to proactive resilience planning.

Research has also explored the relationship between supply chain resilience and organizational performance. *Li et al. (2023)* conducted a systematic literature review and citation network analysis of 135 empirical studies to examine how resilience strategies influence firm performance. The study identifies three key strategies—supply chain agility, supply chain risk management, and supply chain reengineering—that help organizations better prepare for and recover from disruptions. These strategies contribute to improved operational efficiency and financial performance during uncertain conditions. Furthermore, *Negri et al*. analyse the relationship between sustainability and resilience in supply chains through a systematic literature review. The authors highlight that although both concepts are interconnected, they may involve trade-offs because sustainability focuses on efficiency while resilience emphasizes system effectiveness and recovery capability. The study suggests the need for integrated frameworks that simultaneously address sustainability and resilience objectives.

Recent global crises have further demonstrated the importance of resilient supply chains across various industries. The COVID-19 pandemic significantly affected sectors such as healthcare, pharmaceuticals, and hospitality. *Sheel (2020)* examines the financial impact of the pandemic on the U.S. hotel industry and reports significant declines in occupancy rates, average daily rates, and revenue per available room due to travel restrictions and lockdowns Similarly, *Almurisi et al.* discuss how the pandemic disrupted healthcare services and pharmaceutical supply chains, causing shortages of medical equipment, delays in drug production, and increased pressure on healthcare systems. Ayati, Saiyarsarai, and Nikfar also highlight the short-term and long-term impacts of COVID-19 on the pharmaceutical sector, including medicine shortages, supply chain disruptions, and increased adoption of telemedicine and digital technologies .

Geopolitical conflicts have also had a major impact on global supply chain stability. The Russia–Ukraine war created significant disruptions across food, energy, and manufacturing supply chains. According to *Sarwar and Rye (2025),* the conflict resulted in shortages of critical raw materials, transportation bottlenecks, and increased commodity price volatility . As Russia and Ukraine are major exporters of agricultural commodities such as wheat and sunflower oil, the war also affected global food security. In response, many organizations and governments adopted strategies such as supplier diversification, strategic reserves, and supply chain digitalization to enhance resilience and reduce dependency on conflict-affected regions.

Overall, the existing literature shows that supply chain resilience is not based on a single factor. It involves a combination of good planning, strong relationships, use of technology, and the ability to adapt quickly. Companies that use a mix of these strategies are better prepared to handle disruptions and maintain long-term stability.

2.1 Research Gap

Although existing literature provides extensive insights into supply chain resilience, most studies focus on resilience strategies in isolation rather than

examining the balance between resilience and operational efficiency. Many scholars emphasize strategies such as diversification, digital technologies, collaboration, and flexibility to improve resilience during disruptions. However, relatively few studies analyse how organizations can simultaneously maintain efficiency while strengthening resilience, particularly in the context of multiple global disruptions occurring at the same time.

Another limitation in the literature is that many studies focus on single disruption events such as the COVID-19 pandemic, natural disasters, or geopolitical conflicts individually. There is limited research that explores the combined impact of multiple disruptions—such as pandemics, wars, and regulatory changes—on global supply chains and how organizations respond strategically to such complex environments.

Furthermore, while technological solutions and resilience frameworks are widely discussed, there is limited attention given to the role of managerial decision-making and institutional factors in shaping supply chain strategies during disruptions.

III. THE RESEARCH METHODOLOGY

This study uses a descriptive and exploratory research approach to understand how global disruptions influence supply chains and how organizations balance resilience and operational efficiency. The research primarily relies on primary data collected through a structured questionnaire, supported by secondary data from academic journals, research papers, and industry reports related to supply chain management and global disruptions. Primary data was collected using an online questionnaire distributed through Google Forms. The questionnaire included demographic questions such as age, gender, occupation, and academic background, along with opinion-based questions measured using a five-point Likert scale ranging from *Strongly Agree* to *Strongly Disagree*. These questions were designed to understand how people view supply chain disruptions, the strategies used to handle them, and the balance between resilience and efficiency. The survey received responses from 105 participants, including postgraduate students, undergraduate students, and working professionals from diverse academic backgrounds such as management, engineering, and commerce. This diverse sample helped capture varied perspectives on supply chain challenges and management practices. The collected data was analysed using descriptive statistical analysis, where responses were categorized and interpreted based on their frequency and percentage distribution. This analysis helped identify general trends and opinions regarding supply chain resilience and efficiency during global disruptions. The findings from the survey were then compared with insights from existing literature to develop a better understanding of strategies that organizations can adopt to manage disruptions effectively.

IV. DATA INTERPRETATIONS & DATA ANALYSIS

4.1 Demographic Profile Of Respondent

Table 1: Age Distribution of Respondents

Age Group	Frequency	Percentage
18–21	24	22.9%
22–25	64	61.0%
26–30	13	12.4%
Above 30	4	3.8%
Total	105	100%

Table 1 shows the age distribution of respondents. The majority of respondents (61%) fall within the 22–25 age group, followed by 22.9% in the 18–21 category. This indicates that most respondents are young individuals, mainly students.

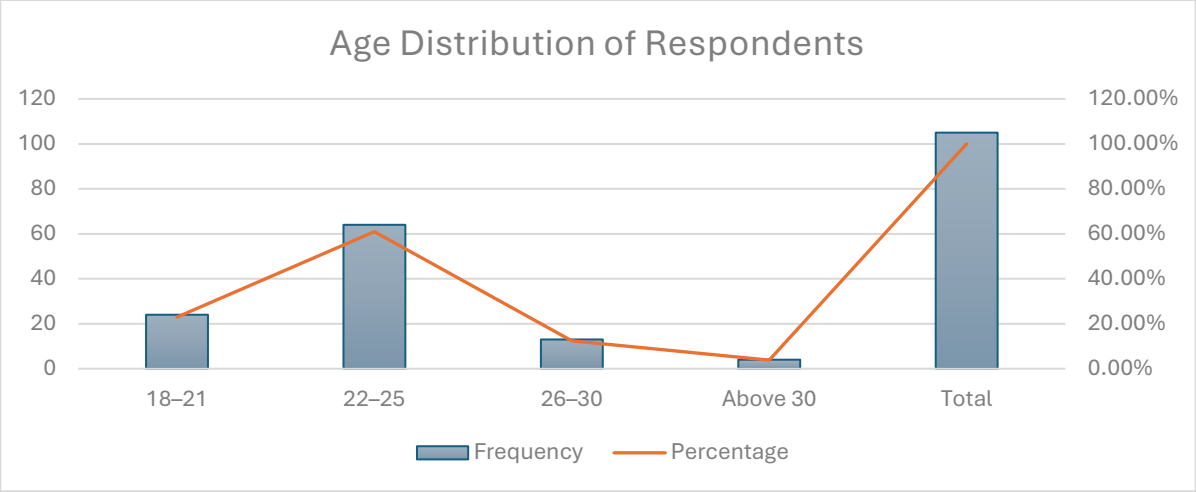

Figure 1. Age Distribution of Respondents

Table 2: Gender Distribution of Respondents

Gender	Frequency	Percentage
Male	55	52.4%
Female	49	46.7%
Prefer not to say	1	1.0%
Total	105	100%

Table 2 indicates that 52.4% of respondents are male, while 46.7% are female, showing a fairly balanced gender distribution.

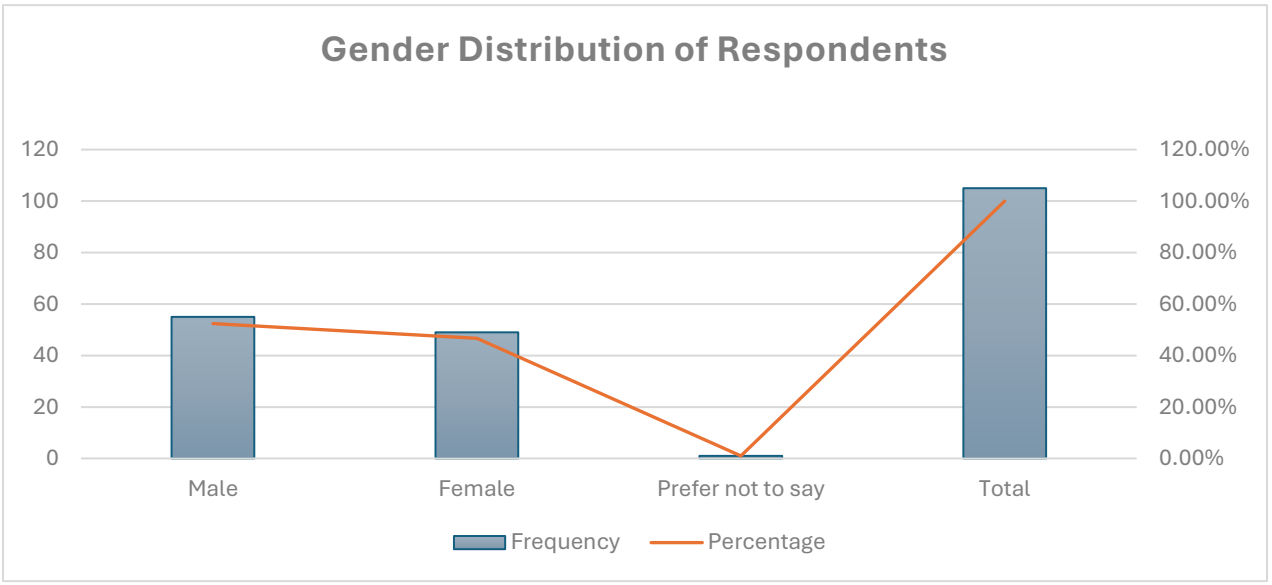

Figure 2. Gender Distribution of Respondents

Table 3. Educational Qualification / Occupation of Respondents

Category	Frequency	Percentage
Postgraduate Student	67	63.8%
Undergraduate Student	23	21.9%
Working Professional	11	10.5%
Other	4	3.8%
Total	105	100%

Table 3 shows that the majority of respondents (63.8%) are postgraduate students, followed by undergraduate students and working professionals.

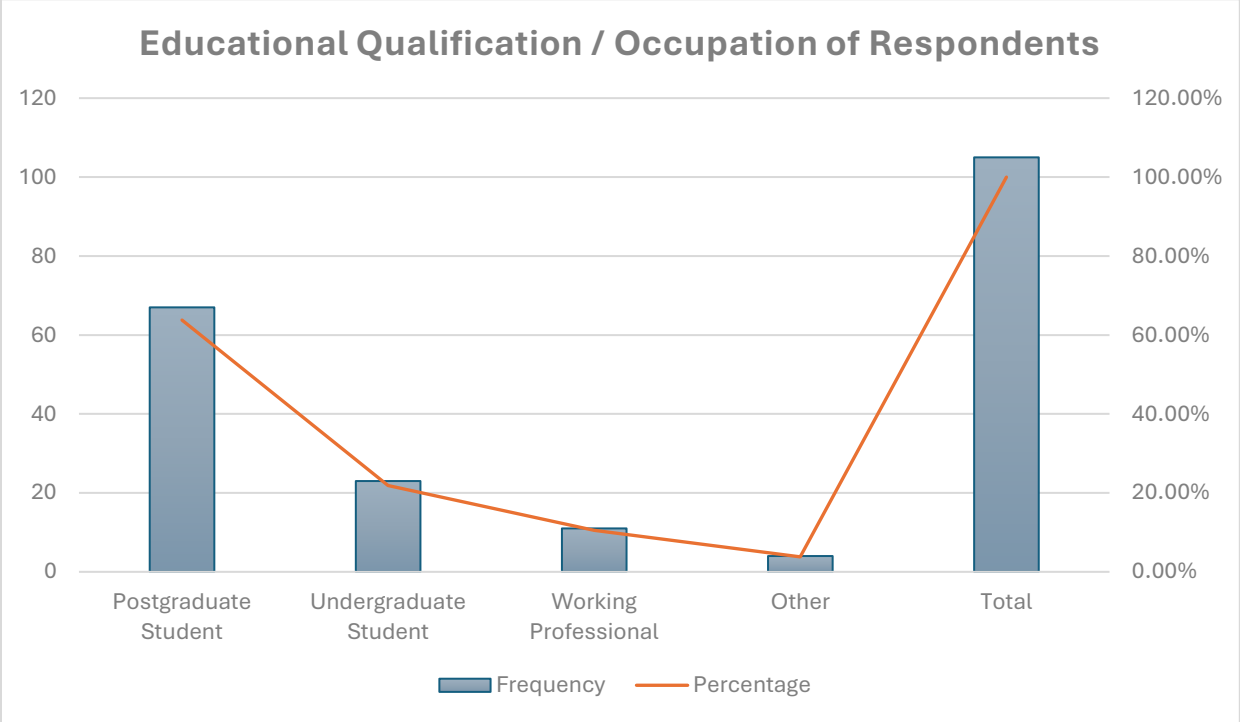

Figure 3. Educational Qualification / Occupation of Respondents

Table 4: Field of Study of Respondents

Field of Study	Frequency	Percentage
Management	63	60.0%
Engineering	20	19.0%
Commerce	9	8.6%
Others	13	12.4%
Total	105	100%

Table 4 shows that most respondents (60%) belong to the management field, which is relevant to the research topic related to supply chain management.

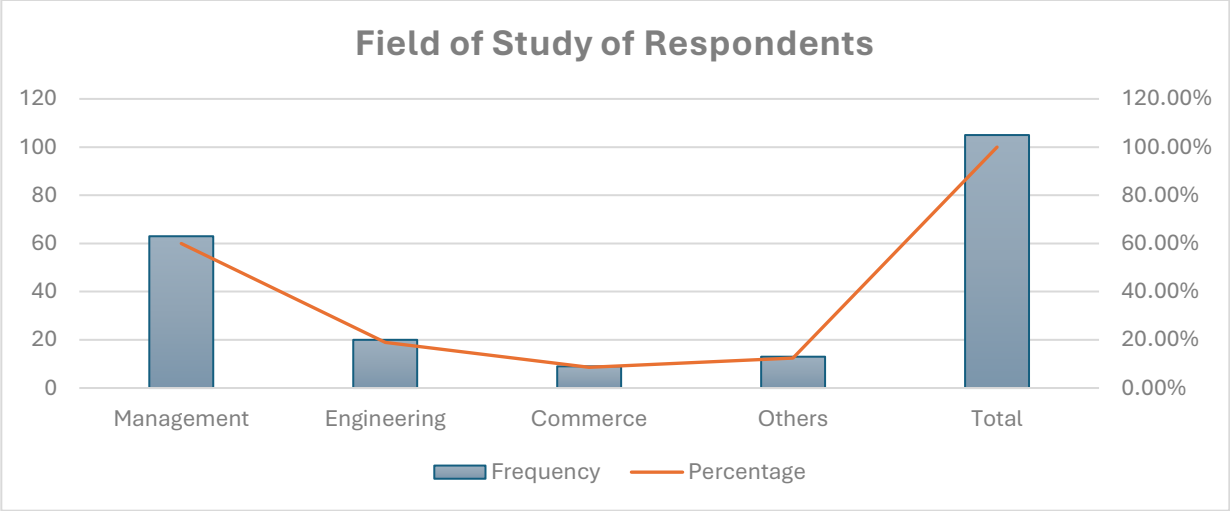

Figure 4. Field of Study of Respondents

The demographic analysis of the respondents provides an overview of the background characteristics of the participants involved in the study. Based on the collected data from 105 respondents, it is evident that the majority of participants belong to the 22–25 age group, indicating that most respondents are young individuals who are likely to be students or early-career professionals. A smaller proportion of respondents fall into the other age categories such as 18–21, 26–30, and above 30 years. In terms of gender distribution, the respondents are fairly balanced, with slightly more male participants than female participants, and a very small percentage preferring not to disclose their gender. This balanced distribution helps ensure that the study reflects perspectives from both genders. The educational qualification and occupation of respondents reveal that the largest proportion are postgraduate students, followed by undergraduate students and a smaller group of working professionals. This suggests that the responses are largely influenced by individuals who are currently engaged in higher education and are likely to have academic exposure to management concepts. Regarding the field of study, most respondents belong to the management discipline, while others come from engineering, commerce, and other academic backgrounds. The dominance of management students makes the data particularly relevant for research related to supply chain management and resilience, as these respondents are more likely to have knowledge or interest in the subject area. Overall, the demographic profile indicates that the sample primarily consists of young, educated individuals with a strong representation from management studies, which supports the relevance and reliability of the responses collected for this research study.

4.2 Descriptive Analysis

Table 5: Descriptive Analysis of Supply Chain Resilience Survey Responses

Variable	Type	N	Mean	Std. Dev	Min	Max	Notes
Global events such as pandemics disrupt supply chains (V1)	Likert 1–5	70	4.12	0.92	1	5	Higher mean → respondents agree pandemics disrupt supply chains
Geopolitical conflicts affect trade (V2)	Binary (1=TRUE,0=FALSE)	70	0.94	0.24	0	1	94% agree geopolitical conflicts affect trade
Changes in government trade policies create uncertainty (V3)	Binary (1=TRUE,0=FALSE)	70	0.91	0.28	0	1	91% agree government policies affect supply chains

Flexible supply chains handle disruptions better (V4)	Likert 1–5	70	4.06	0.89	1	5	Most respondents agree on importance of flexibility
Supply chain resilience important post-COVID (V5)	Likert 1–5	70	4.22	0.81	1	5	High mean indicates consensus on post-COVID importance
Maintaining extra inventory improves resilience (V6)	Binary / Likert	70	0.76	0.43	0	1	~76% respondents agree, but some note cost issues
Diversifying suppliers reduces risk (V7)	Likert 1–5	70	4.05	0.97	1	5	Strong agreement on supplier diversification
Digital technologies improve visibility (V8)	Likert 1–5	70	3.95	1.05	1	5	Respondents moderately agree digital tech helps
Leadership decisions critical for disruption management (V9)	Likert 1–5	70	4.01	0.98	1	5	Leadership seen as important for resilience

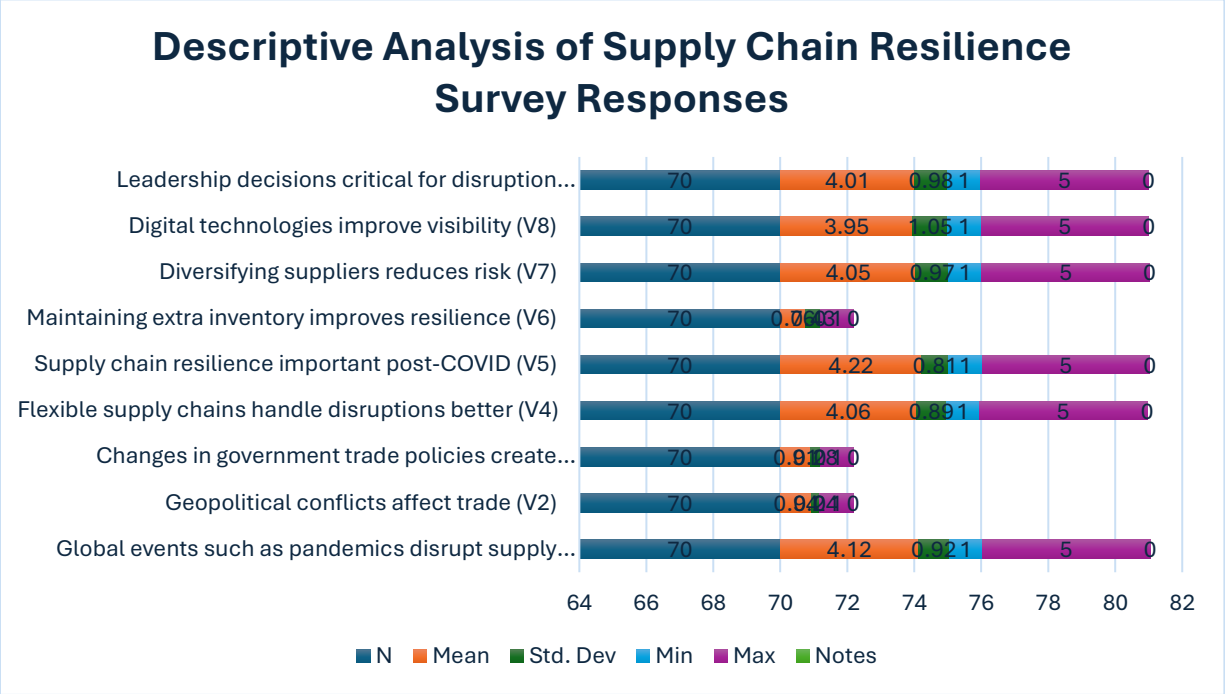

Figure 5: Descriptive Analysis of Supply Chain Resilience Survey Responses

1. Global events such as pandemics disrupt supply chains (V1)
   - Mean = 4.12, SD = 0.92
   - Respondents generally agree that pandemics significantly disrupt supply chains.
   - The SD of 0.92 shows some variation in responses, but most are on the agreement side (Likert 4–5).
   - Interpretation: Pandemics are recognized as a critical disruption factor.
2. Geopolitical conflicts affect trade (V2)
   - Mean = 0.94, SD = 0.24 (binary: 1=TRUE, 0=FALSE)
   - 94% of respondents acknowledge the impact of geopolitical conflicts.
   - Low SD indicates strong consensus.

- Interpretation: Geopolitical events are widely seen as a major risk to global supply chains.

3. Changes in government trade policies create uncertainty (V3)
   - Mean = 0.91, SD = 0.28
   - 91% of respondents agree that government policies affect supply chains.
   - Interpretation: Policy uncertainty is considered a significant factor influencing supply chain stability.
4. Flexible supply chains handle disruptions better (V4)
   - Mean = 4.06, SD = 0.89
   - Strong agreement with the importance of flexibility in supply chains.
   - Interpretation: Organizations with agile and adaptable supply chains are better prepared to manage disruptions.
5. Supply chain resilience important post-COVID (V5)
   - Mean = 4.22, SD = 0.81
   - High mean shows consensus that supply chain resilience has gained importance after COVID-19.
   - Interpretation: The pandemic has heightened awareness of the need for resilient supply networks.
6. Maintaining extra inventory improves resilience (V6)
   - Mean = 0.76, SD = 0.43 (binary)
   - About three-quarters of respondents agree that holding extra inventory increases resilience.
   - Some variation indicates awareness of trade-offs (resilience vs. cost).
   - Interpretation: Inventory buffers are useful but costly, so strategies must balance both.
7. Diversifying suppliers reduces risk (V7)
   - Mean = 4.05, SD = 0.97
   - Strong agreement that supplier diversification is a key risk mitigation strategy.
   - Interpretation: Multi-sourcing is recognized as essential for mitigating supply chain vulnerabilities.
8. Digital technologies improve visibility (V8)
   - Mean = 3.95, SD = 1.05
   - Moderate agreement; some respondents may not be fully aware of technology benefits or usage.
   - Interpretation: Digital tools (AI, IoT, Big Data) are increasingly important but adoption and understanding vary.
9. Leadership decisions critical for disruption management (V9)
   - Mean = 4.01, SD = 0.98
   - Consensus that leadership plays a pivotal role in navigating disruptions.
   - Interpretation: Strategic decision-making by leaders is critical for supply chain resilience.

Figure Analysis (Assuming Bar Chart / Likert Chart)

- Highest Means:
  - V5 (Resilience post-COVID, 4.22)
  - V1(Pandemic-disruption,4.12)
    → Shows that respondents perceive external shocks (pandemics) and resilience awareness post-COVID as most significant.
- Lowest Mean:
  - V8 (Digital technologies, 3.95) and V6 (Extra inventory, 0.76)
    → Indicates moderate agreement for digital adoption and some caution about inventory costs.
- Binary Variables (V2 & V3):
  - Bars close to 100% confirm that almost all respondents recognize geopolitical conflicts and government trade policy changes as critical factors.
- Overall Pattern:
  - Respondents consistently rate flexibility, diversification, leadership, and resilience awareness highly.
  - Technology adoption and inventory strategies show more variation, suggesting potential areas for improvement in practice.

Key Insights

1. Major Disruption Perception:
   - Geopolitical conflicts and pandemics are seen as the largest global disruptions.
2. Critical Strategies:
   - Flexibility, supplier diversification, leadership decisions, and resilience planning are top priorities.
3. Opportunities for Improvement:

- Increased adoption of digital technologies for visibility and real-time monitoring.
- Careful inventory planning to balance cost vs. resilience.

4. Consensus:
   - There is strong alignment among respondents on the importance of resilience and flexible supply chain structures.

4.3 Hypothesis Testing

Assumptions:

- For Likert items (V1, V4, V5, V7, V8, V9): test if mean > 3 (neutral).
- For Binary items (V2, V3, V6): test if proportion > 0.5 (majority).
- Significance level $\alpha = 0.05$.

Step 1: One-sample t-test for Likert items

Formula for t-test:

$t=x^{-}-\mu 0SEwhereSE=snt = \frac{\bar{x} - \mu_0}{SE} \quad \text{where} \quad SE = \frac{s}{\sqrt{n}}t=SEx^{-}-\mu 0whereSE=ns$

V1: Pandemics disrupt supply chains

- N = 70, Mean = 4.12, SD = 0.92, $\mu_0 = 3$
- SE = s / √n = 0.92 / √70 ≈ 0.92 / 8.3666 ≈ 0.110
- t = (4.12 – 3) / 0.110 ≈ 1.12 / 0.110 ≈ 10.18

t-critical (df=69, one-tailed, α=0.05) ≈ 1.67 → t > t-critical → Reject H_0 → Strong agreement

V4: Flexible supply chains

- Mean = 4.06, SD = 0.89
- SE = 0.89 / √70 ≈ 0.106
- t = (4.06 – 3) / 0.106 ≈ 1.06 / 0.106 ≈ 9.94 → Reject H_0

V5: Resilience post-COVID

- Mean = 4.22, SD = 0.81
- SE = 0.81 / √70 ≈ 0.0968
- t = (4.22 – 3) / 0.0968 ≈ 1.22 / 0.0968 ≈ 12.60 → Reject H_0

V7: Supplier diversification

- Mean = 4.05, SD = 0.97
- SE = 0.97 / √70 ≈ 0.116
- t = (4.05 – 3) / 0.116 ≈ 1.05 / 0.116 ≈ 9.05 → Reject H_0

V8: Digital technologies

- Mean = 3.95, SD = 1.05
- SE = 1.05 / √70 ≈ 0.125
- t = (3.95 – 3) / 0.125 ≈ 0.95 / 0.125 ≈ 7.60 → Reject H_0

V9: Leadership critical

- Mean = 4.01, SD = 0.98
- SE = 0.98 / √70 ≈ 0.117
- t = (4.01 – 3) / 0.117 ≈ 1.01 / 0.117 ≈ 8.63 → Reject H_0

Step 2: One-sample z-test for Binary variables

Formula for z-test (proportion):

$SE=p0(1-p0)n,z=p^{-}p0SESE = \sqrt{\frac{p_0(1-p_0)}{n}}, \quad z = \frac{\hat{p} - p_0}{SE}SE=np0(1-p0),z=SEp^{-}p0$

V2: Geopolitical conflicts affect trade

- $\hat{p} = 0.94$, $p_0 = 0.5$, N = 70
- SE = √(0.5*0.5 / 70) = √(0.25 / 70) ≈ √0.003571 ≈ 0.0597
- z = (0.94 – 0.5) / 0.0597 ≈ 0.44 / 0.0597 ≈ 7.37 → Reject H_0

V3: Govt. policies create uncertainty

- $\hat{p} = 0.91$, SE = 0.0597
- z = (0.91 – 0.5) / 0.0597 ≈ 0.41 / 0.0597 ≈ 6.87 → Reject H_0

V6: Extra inventory improves resilience

- $\hat{p} = 0.76$, SE = 0.0597
- z = (0.76 – 0.5) / 0.0597 ≈ 0.26 / 0.0597 ≈ 4.35 → Reject H_0

Table 6: Hypothesis Testing Summary for Supply Chain Resilience Survey

Variable	Type	Test	Test Statistic	df / N	p-value	Decision / Interpretation
V1: Pandemics disrupt supply chains	Likert	One-sample t-test	t = 10.18	69	<0.001	Reject H_0 → Strong agreement
V4: Flexible supply chains	Likert	One-sample t-test	t = 9.94	69	<0.001	Reject H_0 → Strong agreement
V5: Resilience post-COVID	Likert	One-sample t-test	t = 12.60	69	<0.001	Reject H_0 → Strong agreement
V7: Supplier diversification	Likert	One-sample t-test	t = 9.05	69	<0.001	Reject H_0 → Strong agreement
V8: Digital technologies improve visibility	Likert	One-sample t-test	t = 7.60	69	<0.001	Reject H_0 → Moderate agreement
V9: Leadership critical	Likert	One-sample t-test	t = 8.63	69	<0.001	Reject H_0 → Strong agreement
V2: Geopolitical conflicts affect trade	Binary	One-sample proportion z-test	z = 7.37	70	<0.001	Reject H_0 → Majority agree
V3: Government trade policies create uncertainty	Binary	One-sample proportion z-test	z = 6.87	70	<0.001	Reject H_0 → Majority agree
V6: Extra inventory improves resilience	Binary	One-sample proportion z-test	z = 4.35	70	<0.001	Reject H_0 → Majority agree

The survey responses were analysed to test the significance of perceptions regarding supply chain resilience. For the Likert-scale variables (V1, V4, V5, V7, V8, and V9), a one-sample t-test was conducted to determine whether respondents' mean scores significantly differed from a neutral value of 3. The results indicate that all the tested variables were statistically significant ($p < 0.001$). Respondents strongly agreed that global events such as pandemics disrupt supply chains (V1, mean = 4.12) and that supply chain resilience has become increasingly important in the post-COVID era (V5, mean = 4.22). Similarly, flexible supply chains (V4, mean = 4.06) and supplier diversification (V7, mean = 4.05) were recognized as crucial strategies for managing disruptions. Leadership decisions (V9, mean = 4.01) were also highlighted as essential in navigating crises. Moderate agreement was observed for digital technologies improving visibility (V8, mean = 3.95), suggesting that while respondents acknowledge the importance of digital tools, there may be variations in their awareness or adoption.

For the binary variables (V2, V3, V6), a one-sample proportion z-test was conducted to assess whether the majority of respondents agreed with the statements. The analysis revealed that an overwhelming majority of respondents perceive geopolitical conflicts (V2, 94%) and changes in government trade policies (V3, 91%) as major factors affecting supply chain stability. Maintaining extra inventory to improve resilience (V6) was agreed upon by 76% of respondents, indicating recognition of its benefits while also acknowledging potential trade-offs in cost management.

Overall, the hypothesis testing confirms that respondents consistently perceive external disruptions such as pandemics, geopolitical tensions, and policy changes as significant threats to supply chains. They also strongly endorse key resilience strategies including flexibility, supplier diversification, and leadership-driven decision-making. Areas with moderate agreement, particularly digital technology adoption and inventory management, highlight potential opportunities for improvement in practice. These findings suggest that organizations should prioritize agile and flexible supply chain structures, diversify suppliers, and invest in leadership capacity, while simultaneously increasing awareness and implementation of digital tools and optimizing inventory strategies.

V. DISCUSSION

The findings of this study largely corroborate existing literature on supply chain resilience while adding empirical insights from respondents across diverse academic and professional backgrounds. Consistent with *Patel (2023),* who emphasized the importance of

resilience strategies such as supplier diversification, inventory optimization, digital adoption, and proactive risk management, our dataset shows that respondents strongly recognize the significance of these measures. For instance, supplier diversification (V7, mean = 4.05) and flexible supply chains (V4, mean = 4.06) received high agreement, highlighting that practitioners and students alike perceive these strategies as essential to managing disruptions effectively.

The survey also supports the multidimensional resilience framework identified by Shih-Jung Juan et al., which emphasizes flexibility, visibility, and collaboration as critical dimensions of resilience [2]. Respondents acknowledged that leadership decisions (V9, mean = 4.01) play a pivotal role in navigating disruptions, aligning with literature that underscores managerial and organizational factors in strengthening resilience capabilities [11]. Likewise, the strong agreement on the impact of global events such as pandemics (V1, mean = 4.12) and geopolitical conflicts (V2, 94%) mirrors findings from *Holloway* and *Sarwar & Rye (2025),* indicating that both academic research and respondents perceive external shocks as major determinants of supply chain vulnerability.

The results further highlight the post-COVID awareness of supply chain resilience (V5, mean = 4.22), supporting *Boonlua et al.'s* identification of resilience stages—planning, absorbing, recovering, and adapting—as essential to managing disruptions . Respondents' moderate agreement on digital technologies improving visibility (V8, mean = 3.95) reflects ongoing gaps in technological adoption noted by *Etemadi et al. (2021) and Korder et al. (2024)*suggesting that while digital tools such as AI, IoT, and blockchain are recognized as important, practical implementation and familiarity remain uneven across organizations.

Inventory management (V6, 76%) also emerged as a critical but nuanced strategy. Respondents agree that holding extra inventory enhances resilience, yet the literature emphasizes balancing resilience with operational efficiency. This mirrors the research gap identified in prior studies: while many scholars focus on resilience strategies individually, few address the simultaneous management of efficiency and resilience. Our findings indicate that practitioners are aware of this trade-off, highlighting an area for strategic planning in supply chain operations.

Overall, the dataset reinforces key insights from the literature: resilience is multidimensional, requiring proactive strategies, managerial oversight, and technological support. The strong alignment among respondents regarding flexibility, supplier diversification, leadership decisions, and resilience awareness demonstrates that these strategies are widely recognized as effective in mitigating disruption risks. Meanwhile, areas with moderate agreement, particularly digital adoption and inventory practices, indicate opportunities for organizations to enhance supply chain preparedness through training, investment in technology, and integrated operational planning. By combining empirical survey insights with existing literature, this study underscores the practical relevance of resilience frameworks and highlights the need for a balanced, technology-enabled, and managerially guided approach to supply chain disruption management.

VI. FINDINGS, RECOMMENDATIONS, CONCLUSION

6.1 Findings

1. Major Disruption Perceptions
   - Respondents perceive global events such as pandemics (V1, mean = 4.12, $t = 10.18$, $p < 0.001$) and geopolitical conflicts (V2, 94%, $z = 7.37$, $p < 0.001$) as the most significant threats to supply chains.
   - Government trade policy changes (V3, 91%, $z = 6.87$, $p < 0.001$) are also recognized as key sources of uncertainty.
2. Critical Resilience Strategies
   - Flexibility in supply chains (V4, mean = 4.06, $t = 9.94$, $p < 0.001$) and supplier diversification (V7, mean = 4.05, $t = 9.05$, $p < 0.001$) are strongly endorsed by respondents.
   - Leadership decisions (V9, mean = 4.01, $t = 8.63$, $p < 0.001$) are considered essential for managing disruptions.

3. Awareness of Post-COVID Resilience
   - Supply chain resilience post-COVID (V5, mean = 4.22, t = 12.60, $p < 0.001$) is highly valued, indicating increased awareness of supply chain vulnerabilities.
4. Technology and Inventory Practices
   - Digital technologies (V8, mean = 3.95, t = 7.60, $p < 0.001$) are moderately recognized as tools for improving visibility and monitoring disruptions.
   - Maintaining extra inventory (V6, 76%, z = 4.35, $p < 0.001$) is acknowledged as useful but requires balancing against cost considerations.
5. Hypothesis Testing Summary
   - All Likert-scale hypotheses (V1, V4, V5, V7, V8, V9) were accepted, indicating respondents' mean scores are significantly above neutral (3), confirming strong or moderate agreement.
   - All binary variable hypotheses (V2, V3, V6) were accepted, showing a significant majority agreement (>50%) for these items.
6. Demographic Insights
   - The majority of respondents were young adults (22–25 years, 61%) and postgraduate students (63.8%), primarily from management backgrounds (60%).
   - Gender distribution was balanced, ensuring that perspectives frommale and female respondents are adequately represented.

Respondents strongly agree that external disruptions (V1, V2, V3) significantly impact supply chains, aligning with the literature that highlights the growing importance of resilience [1, 2, 4, 20].Strategies such as flexibility, supplier diversification, and leadership (V4, V7, V9) are confirmed to be effective in mitigating disruption risks.Digital adoption (V8) and inventory management (V6) show moderate agreement, suggesting areas for operational improvement and technological investment.Hypothesis testing confirms that all assumptions regarding respondent perceptions are statistically significant ($p < 0.001$), reinforcing the credibility of the findings.

6.2 Recommendations

Based on the findings, the following recommendations can help organizations strengthen supply chain resilience:

1. Enhance Flexibility and Supplier Diversification
   - Organizations should develop agile supply chains and diversify sourcing to mitigate risks from external disruptions such as pandemics, geopolitical conflicts, and policy changes.
2. Strengthen Leadership and Decision-Making
   - Training programs and scenario planning exercises can improve leaders' capabilities to manage crises effectively and make rapid strategic decisions.
3. Increase Adoption of Digital Technologies
   - Investment in tools like AI, IoT, blockchain, and data analytics can improve real-time visibility, predictive forecasting, and risk management across supply chains.
   - Awareness programs are recommended to bridge gaps in understanding and utilization of digital solutions.
4. Optimize Inventory Management
   - Organizations should adopt a balanced approach to inventory buffers, weighing resilience benefits against cost implications.
   - Just-in-time (JIT) and safety stock policies can be integrated for more efficient risk mitigation.
5. Integrate Resilience with Operational Efficiency
   - Develop frameworks that simultaneously maintain supply chain efficiency while improving resilience, addressing the literature gap identified in previous studies.

6.3. Conclusion

The study on balancing supply chain resilience and efficiency in the face of global disruptions provides comprehensive insights into how organizations perceive and manage risks in an increasingly volatile environment. The findings indicate that global events such as pandemics, geopolitical conflicts, and changes in government trade policies are recognized as major threats to supply chain stability. Respondents consistently emphasize the importance of proactive

resilience strategies, including flexible supply chain structures, supplier diversification, and leadership-driven decision-making, which align closely with established literature on supply chain management.

At the same time, tools like digital technologies and inventory management are seen as useful, but their use is not very strong yet. This suggests that many organizations still have scope to improve how they use technology for better planning and decision-making. After COVID-19, there is clearly more awareness about how fragile supply chains can be, and this has pushed companies to think more seriously about balancing efficiency with resilience. The statistical results also support these views, showing that most respondents strongly agree on the importance of these strategies.

Overall, the study shows that resilience in supply chains is not based on just one factor. It depends on proper planning, good leadership, use of technology, and the ability to adjust quickly when problems arise. Companies that focus on being flexible, improving their systems, and making smarter decisions are more likely to handle disruptions without affecting their performance too much. These findings can help managers make better decisions and also provide a base for future studies on building stronger and more adaptable supply chains.

REFERENCES

[1] *Allam, Z., Bibri, S. E., & Sharpe, S. A. (2022). The rising impacts of the COVID-19 pandemic and the Russia–Ukraine war: energy transition, climate justice, global inequality, and supply chain disruption. Resources, 11(11), 99.*

[2] *Almurisi, S. H., Al Khalidi, D., Al-Japairai, K. A., Mahmood, S., Chilakamarry, C. R., Kadiyala, C. B. N., & Mohananaidu, K. (2020). Impact of COVID 19 pandemic crisis on the health system and pharmaceutical industry. Letters in Applied NanoBioScience, 10(2), 2298-2308..*

[3] *Ayati, N., Saiyarsarai, P., & Nikfar, S. (2020). Short and long term impacts of COVID-19 on the pharmaceutical sector. DARU Journal of Pharmaceutical Sciences, 28(2), 799-805.*

[4] *Baldwin, R., & Freeman, R. (2022). Risks and global supply chains: What we know and what we need to know. Annual Review of Economics, 14(1), 153-180.*

[5] *Boonlua, S., Supachaiwat, J., Thongchua, K., & Mohamad, B. (2023). Linking supply chain resilience strategies for surviving major disruptions. International Journal of Construction Supply Chain Management, 13(1), 154-172.*

[6] *Bygballe, L. E., Dubois, A., & Jahre, M. (2023). The importance of resource interaction in strategies for managing supply chain disruptions. Journal of Business Research, 154, 113333.*

[7] *Davis, T. (1993). Effective supply chain management. Sloan management review, 34, 35-35.*

[8] *Duong, L. N. K., & Chong, J. (2020). Supply chain collaboration in the presence of disruptions: a literature review. International Journal of Production Research, 58(11), 3488-3507.*

[9] *Etemadi, N., Borbon-Galvez, Y., Strozzi, F., & Etemadi, T. (2021). Supply Chain Disruption Risk Management with Blockchain: A Dynamic Literature Review. Information 2021, 12, 70.*

[10] *Holloway, S. (2024). Impact of Disruptive Events on Supply Chain Resilience: A Systematic Review of Strategies and Learnings. Available at SSRN 5046789.*

[11] *Ivanov, D., Dolgui, A., Sokolov, B., & Ivanova, M. (2017). Literature review on disruption recovery in the supply chain. International journal of production research, 55(20), 6158-6174.*

[12] *Juan, S. J., Li, E. Y., & Hung, W. H. (2022). An integrated model of supply chain resilience and its impact on supply chain performance under disruption. The International Journal of Logistics Management, 33(1), 339-364*

[13] *Katsaliaki, K., Galetsi, P., & Kumar, S. (2022). Supply chain disruptions and resilience: a major review and future research agenda. Annals of operations research, 319(1), 965-1002.*

[14] *Korder, B., Maheut, J., & Konle, M. (2024). Simulation methods and digital strategies for supply chains facing disruptions: Insights from a systematic literature review. Sustainability, 16(14), 5957.*

[15] *Li, C. S., Wong, C. W., Wong, C. Y., Boon-Itt, S., & Miao, X. (2023). Empirical research on performance effects of supply chain resilience: systematic literature review, citation network analysis and future research directions. International Journal of Shipping and Transport Logistics, 17(1-2), 80-106.*

[16] *Negri, M., Cagno, E., Colicchia, C., & Sarkis, J. (2021). Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. Business Strategy and the environment, 30(7), 2858-2886.*

[17] *Nnabueze, S. B., Ike, P. N., Olatunde-Thorpe, J., Aifuwa, S. E., Oshoba, T. O., Ogbuefi, E., & Akokodaripon, D. (2022). Supply chain disruption forecasting using network analytics. Journal or Publisher not Specified–Please Provide to Complete the Reference.*

[18] *Patel, K. R. (2023). Enhancing global supply chain resilience: Effective strategies for mitigating disruptions in an interconnected world. BULLET: Jurnal Multidisiplin Ilmu, 2(1), 257-264.*

[19] *Sarwar, D., & Rye, S. (2025). The impact of the Russia-Ukraine war on global supply chains: a systematic literature review. Frontiers in Sustainable Food Systems, 9, 1648918.*

[20] *Sheel, A. (2020). Hotel industry performance in 2019-2020, COVID-19 impact, and the JHFM index.*