



# Examining the Impact of Supply Chain Disruptions on Shipping Delays

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**Abstract** – Global supply chains have faced unprecedented challenges, resulting in severe shipping delays. This study adopts a mixed-method approach to investigate the key factors contributing to these disruptions, including labor shortages, port congestion, and geopolitical instability. Additional complications, such as trade restrictions and environmental uncertainties, further aggravate these issues, with container shortages and inefficiencies in logistics identified as primary causes. The research explores various strategies to mitigate these disruptions, including supply chain diversification, digitalization, and alternative transportation methods to enhance resilience. Furthermore, the study underscores the importance of investing in technology, infrastructure, and adaptive supply chain models to reduce delays and maintain trade stability. By integrating both qualitative and quantitative analysis, this research provides a comprehensive insight into supply chain vulnerabilities and potential solutions. The results suggest that effective risk mitigation strategies and advancements in technology are vital in managing disruptions within global trade. Ultimately, the study emphasizes the need for collaboration among governments, businesses, and logistics providers to develop a more resilient and efficient supply chain network capable of withstanding future uncertainties.

**Keywords** – Supply chain disruptions- Shipping delays, Port congestion, Logistics management, Trade disruptions, Transportation bottlenecks

## I. INTRODUCTION

Global corporate operations depend on efficient supply chains, yet shipping delays have increased due to natural disasters, labor shortages, economic instability, and geopolitical crises. These delays affect sectors like manufacturing, healthcare, and e-commerce by causing logistical bottlenecks, increased expenses, and disgruntled customers.

Events like COVID-19, trade disputes, and port congestion demonstrate how supply chain vulnerabilities have increased due to globalization and just-in-time (JIT) inventory strategies. The pandemic revealed flaws, leading to significant product shortages and shipment delays.

In order to improve supply chain resilience and guarantee company continuity, this study looks at the causes and consequences of shipment delays.

## II. PROBLEM STATEMENT

Globalization and complexity have caused supply chain disruptions, which have resulted in significant shipping delays all around the world. Businesses are impacted by dependence on foreign suppliers, traffic, and unanticipated circumstances, which raise expenses and decrease productivity. Delivery delays cost businesses like manufacturing and retail a lot of money. Proactive risk management is difficult due to uncertainty. This study looks at how supply chain interruptions affect shipment delays, pinpoints the main reasons, and suggests ways to improve logistics effectiveness.

## III. STATEMENT OF PROBLEM

- Determine the main reasons why supply chain interruptions result in shipping delays.
- Examine the connection between supply chain inefficiencies and delivery delays.
- Evaluate how delivery delays affect customer satisfaction and business operations.
- Investigate methods and technology to reduce shipment delays.
- Make suggestions to improve the resilience and flexibility of the supply chain.

## IV. Literature Review

### Supply Chain Disruption Causes

#### Globalization and the Complexity of Supply Chains

Supply networks are now more complicated and susceptible to disruptions as a result of globalization. According to Ivanov and Dolgui (2020), contemporary supply chains are extremely interconnected, with goods and materials traveling across several borders before being purchased by customers. Because of this, problems in one area may cause delays in other parts of the world's maritime networks.

Furthermore, Christopher (2016) highlights that although global supply networks save production costs, they also come with dangers, such as lengthier transit routes, dependency on outside logistics providers, and regulatory issues in many nations. Because of their intricacy, supply chains are now vulnerable to interruptions



from unanticipated natural disasters, trade barriers, and geopolitical crises.

### **Transportation Bottlenecks and Port Congestion**

One of the main causes of shipping delays has been port congestion. Increased demand for international trade combined with port labor shortages has resulted in congestion, which has delayed the unloading and transportation of products (Sheffi, 2015). This problem was made worse during the COVID-19 pandemic, when port operations were held down globally due to a shortage of workers.

Transportation constraints are another important factor contributing to supply chain interruptions, according to Craighead et al. (2007). These include a lack of truck drivers, inefficient railroads, and traffic jams on the roads, all of which lengthen shipment delays. According to studies, these delays may be lessened by making infrastructural investments and enhancing transportation coordination.

### **Climate Change and Natural Disasters**

Natural disasters and extreme weather cause major supply chain disruptions. Tang (2006) emphasizes how important transportation infrastructure is harmed by hurricanes, earthquakes, and floods, which makes it challenging for cargo to arrive at their destinations on schedule.

Additionally, according to research by Waters (2011), supply chains may face long-term hazards as climate change is predicted to increase the frequency and severity of such occurrences. In order to reduce the effects of environmental disruptions, the study highlights the necessity for businesses to create backup plans, such as different shipping routes and diverse supply networks.

### **Impact of Supply Chain Disruptions on Shipping Delays**

#### **Economic and Business Implications**

Delays in shipping have a significant impact on economies and businesses. Global supply chain interruptions lead to financial losses because of increased transportation costs, late delivery fines, and lost revenue from unfulfilled demand, according to Zsidisin and Wagner (2010).

Industries, including manufacturing and retail, are more susceptible to delivery delays, according to Singh and Kumar (2019). According to their analysis of the Indian supply chain industry, production stops, inventory costs rise, and customer trust erodes when raw supplies are delayed.

#### **Effects on Customer Satisfaction**

The emergence of e-commerce has led to a huge increase in customer expectations for prompt and dependable deliveries. According to Blackhurst et al.

(2011), extended shipment delays lead to unhappy customers, more product returns, and a bad reputation for the brand.

According to Handfield and McCormack (2008), companies should concentrate on strengthening supply chain resilience in order to keep customers loyal. According to their analysis, businesses may lower interruptions and raise customer satisfaction by investing in cutting-edge logistics solutions like real-time cargo tracking and AI-based demand forecasting.

### **Mitigation Strategies for Reducing Shipping Delays Supply Chain Resilience and Risk Management**

Resilient supply chains are crucial for cutting down on shipment delays, according to several studies. Agile logistics planning, inventory buffers, and supplier diversification are all important tactics for reducing supply chain interruptions, according to Pettit et al. (2010)'s resilience theory.

In order to foresee disruptions before they happen, Sarkis and Talluri (2020) contend that companies must implement proactive risk management techniques like scenario planning and predictive analytics. According to their research, shipping delays are reduced for businesses that incorporate risk assessment tools into their logistics strategy.

### **Technological Innovations in Supply Chain Management**

New developments in digital supply chain technology present encouraging ways to reduce shipment delays. According to Ivanov (2020), a "digital twin" is a virtual supply chain model that enables businesses to model various scenarios and instantly optimize their logistics plans.

Parallel to this, Simchi-Levi et al. (2014) highlight how blockchain might increase supply chain transparency. Blockchain helps cut down on delays brought on by mistakes in documentation and problems with customs clearance by offering a safe and unchangeable record of transactions.

Additionally, Craighead et al. (2007) propose that by anticipating possible disruptions and streamlining delivery routes, artificial intelligence (AI) and machine learning might improve supply chain efficiency.

### **Gaps in Existing Research and Areas for Further Study**

#### **Integration of AI and IoT in Supply Chain Risk Management**

While studies highlight the benefits of AI and IoT in logistics, more empirical research is needed to measure their real-world effectiveness in reducing delays.



**Impact of Geopolitical Conflicts on Supply Chains**

Research on the effects of trade wars, sanctions, and regional conflicts on shipping delays remains limited. Future studies should explore how businesses can mitigate risks in politically unstable regions.

**Sustainability and Green Supply Chains**

The impact of sustainable logistics practices on reducing supply chain disruptions is an emerging area of interest. More research is required to determine how green supply chains can improve resilience.

**Post-Pandemic Supply Chain Adjustments**

While COVID-19 exposed vulnerabilities in global supply chains, further studies are needed to assess how businesses have adapted their logistics strategies to prevent similar disruptions in the future.

**V. HYPOTHESIS**

**Null Hypothesis (H0):**

Supply chain disruptions do not have a significant impact on shipping delays. Businesses experience minimal or no major operational setbacks due to these disruptions.

**Alternative Hypothesis (H1):**

Supply chain disruptions significantly impact shipping delays, leading to increased costs, operational inefficiencies, and customer dissatisfaction.

**VI. RESEARCH METHODOLOGY**

**Research Design:-**

The research employs a quantitative approach to analyze the impact of supply chain disruptions on shipment delays. A quantitative research design allows for the testing of cause-and-effect relationships related to disruptions in the supply chain. This design enables the study to quantify the economic and operational impacts of shipment delays and evaluate the effectiveness of existing mitigation strategies.

**Source/s of Data:**

Primary Data: Primary data collection involves the use of questionnaires administered to supply chain professionals and stakeholders. The primary data collected through surveys provide direct insights into the causes, consequences, and mitigation strategies related to supply chain disruptions and shipment delays.

**Data Collection Method:**

The data collection method involves the administration of questionnaires to a sample of supply chain professionals and stakeholders. The questionnaires are designed to gather information on the primary causes of supply chain disruptions, the economic and operational impacts of shipment delays, the effectiveness of mitigation strategies,

and recommendations for enhancing supply chain resilience.

**Population:**

This survey targets supply chain professionals to obtain diverse insights into disruptions and shipping delays. A probability sampling approach is employed to ensure that all individuals in the population have an equal likelihood of selection. This method enhances the reliability of the findings and allows for broader applicability across various supply chain stakeholders.

**Sampling Method:**

This study utilizes stratified random sampling, segmenting the population into subgroups based on sector, company scale, and location. A random selection from each group ensures diverse representation, reducing bias while analyzing the effects of supply chain disruptions on shipping delays.

**Sampling Frame:**

The sampling frame for this study will include companies engaged in supply chain management across various industries such as manufacturing, retail, and pharmaceuticals. It will be compiled from industry databases like Dun & Bradstreet and membership directories of professional associations such as the Council of Supply Chain Management Professionals (CSCMP). This approach ensures a diverse and representative pool of participants for the research.

**Date Collection Instrument:**

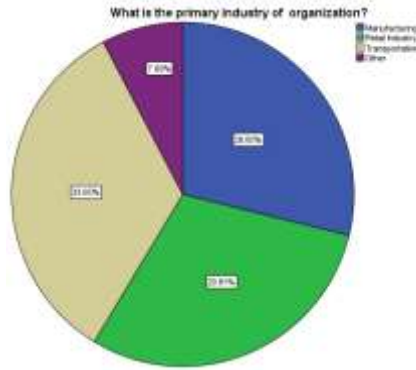
Questionnaire Design The research develops a structured questionnaire with closed-ended questions to gather quantitative data on supply chain disruptions, shipment delays, and mitigation strategies. The questionnaire is designed to be clear, concise, and relevant to the research objectives.

Survey Administration the questionnaires are distributed electronically to the sample of supply chain professionals and stakeholders identified for the study. The survey administration process includes reminders and follow-ups to ensure a high response rate and data quality.

**VII. DATA ANALYSIS & INTERPRETATION**

What is the primary industry of organization?

What is the primary industry of organization?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	30	28.8	28.8	28.8
	Retail Industry	31	29.8	29.8	58.7
	Transportation	35	33.7	33.7	92.3
	Other	8	7.7	7.7	100.0
	Total	104	100.0	100.0	



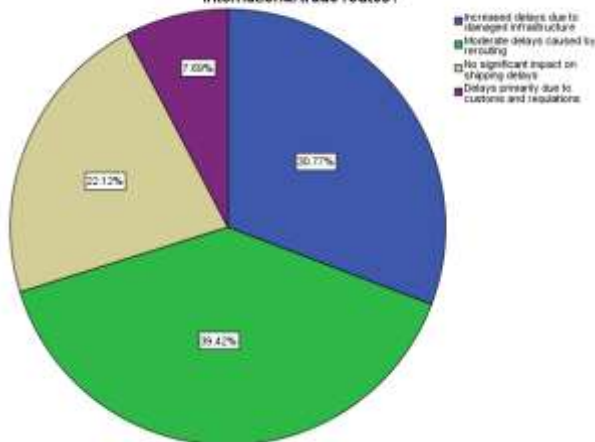
**Interpretation**

The table and graph show that among 104 respondents, 28.85% work in manufacturing, 29.81% in retail, 33.65% in transportation, and 7.69% in other industries.

How has the ongoing war in Ukraine - Russia affected shipping delays across international trade routes?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increased delays due to damaged infrastructure	32	30.8	30.8	30.8
	Moderate delays caused by rerouting	41	39.4	39.4	70.2
	No significant impact on shipping delays	23	22.1	22.1	92.3
	Delays primarily due to customs and regulations	8	7.7	7.7	100.0
	Total	104	100.0	100.0	

How has the ongoing war in Ukraine -Russia affected shipping delays across international trade routes?



**Interpretation**

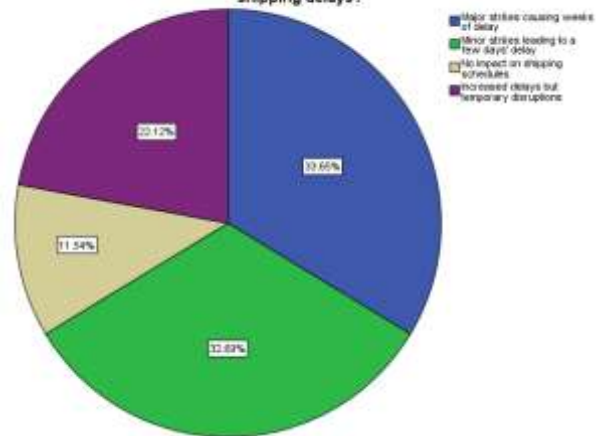
The table and graph show that among 104 respondents, 30.77% reported increased delays due to damaged infrastructure, 39.42% experienced moderate delays from

rerouting, 22.12% saw no significant impact, and 7.69% attributed delays to customs and regulations.

What role do labor strikes at key ports play in the frequency and duration of shipping delays?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major strikes causing weeks of delay	35	33.7	33.7	33.7
	Minor strikes leading to a few days' delay	34	32.7	32.7	66.3
	No impact on shipping schedules	12	11.5	11.5	77.9
	Increased delays but temporary disruptions	23	22.1	22.1	100.0
	Total	104	100.0	100.0	

What role do labor strikes at key ports play in the frequency and duration of shipping delays?



**Interpretation**

The table and pie chart show that among 104 respondents, 33.65% reported major strikes causing weeks of delay, 32.69% experienced minor strikes leading to short delays, 11.54% saw no impact on schedules, and 22.12% noted temporary disruptions. Overall, 66.4% believe labor strikes significantly affect shipping delays.

In what ways have shipping companies adjusted their logistics and scheduling strategies in response to labor strikes at major ports?

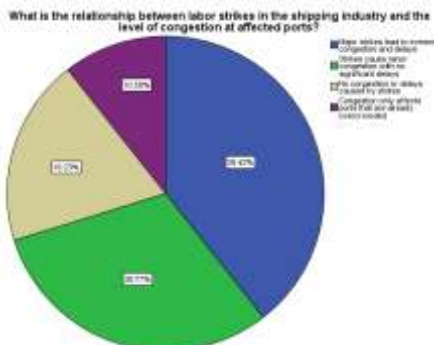


In what ways have shipping companies adjusted their logistics and scheduling strategies in response to labor strikes at major ports?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Shifted to alternate ports or routes	36	34.6	34.6	34.6
	Increased buffer times for shipping schedules	36	34.6	34.6	69.2
	Reduced shipping volume temporarily	26	25.0	25.0	94.2
	Maintained existing schedules without changes	6	5.8	5.8	100.0
	Total	104	100.0	100.0	

**Interpretation**

The table and pie chart show that among 104 respondents, 34.62% shifted to alternate ports or routes, 34.62% increased buffer times, 25.00% temporarily reduced shipping volume, and 5.77% made no changes. Overall, 69.2% adopted proactive strategies to mitigate labor strike impacts.

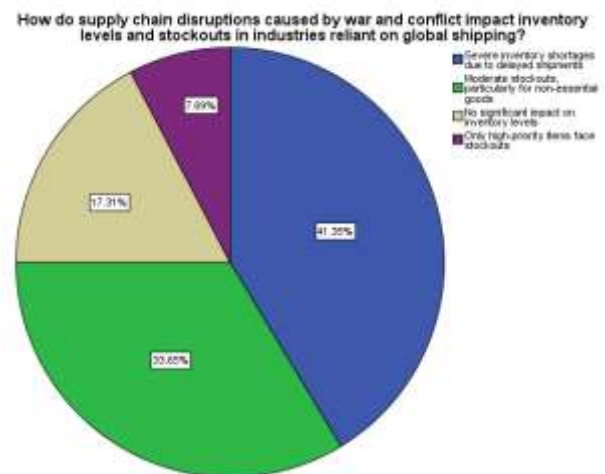
What is the relationship between labor strikes in the shipping industry and the level of congestion at affected ports?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major strikes lead to extreme congestion and delays	41	39.4	39.4	39.4
	Strikes cause minor congestion with no significant delays	32	30.8	30.8	70.2
	No congestion or delays caused by strikes	20	19.2	19.2	89.4
	Congestion only affects ports that are already overcrowded	11	10.6	10.6	100.0
	Total	104	100.0	100.0	



**Interpretation**

The table and pie chart show that among 104 respondents, 39.42% reported major strikes causing extreme congestion, 30.77% noted minor congestion with no significant delays, 19.23% saw no impact, and 10.58% stated congestion occurs only at already overcrowded ports. Overall, 70.2% believe labor strikes contribute to port congestion at varying levels.

How do supply chain disruptions caused by war and conflict impact inventory levels and stockouts in industries reliant on global shipping?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Severe inventory shortages due to delayed shipments	43	41.3	41.3	41.3
	Moderate stockouts, particularly for non-essential goods	35	33.7	33.7	75.0
	No significant impact on inventory levels	18	17.3	17.3	92.3
	Only high-priority items face stockouts	8	7.7	7.7	100.0
	Total	104	100.0	100.0	



**Interpretation**

The table and pie chart show that among 104 respondents, 41.35% reported severe inventory shortages due to delayed shipments, 33.65% experienced moderate stockouts of non-essential goods, 17.31% saw no significant impact, and 7.69% noted stockouts only for high-priority items. Overall, 75% experienced moderate to severe disruptions, highlighting the impact of global shipping delays on inventory levels.



How do companies in the shipping industry predict and manage delays caused by labor strikes during times of geopolitical instability?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use real-time data and predictive analytics for route planning	40	38.5	38.5	38.5
	Rely on government notifications and adjust schedules accordingly	43	41.3	41.3	79.8
	Implement contingency plans but cannot predict accurately	14	13.5	13.5	93.3
	Adapt only after the strike begins, with limited proactive management	7	6.7	6.7	100.0
	<b>Total</b>	<b>104</b>	<b>100.0</b>	<b>100.0</b>	

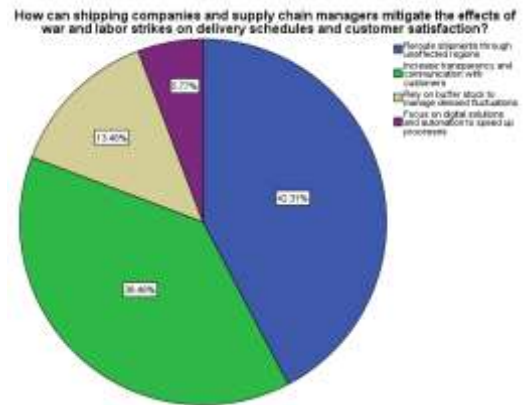
How can shipping companies and supply chain managers mitigate the effects of war and labor strikes on delivery schedules and customer satisfaction?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Reroute shipments through unaffected regions	44	42.3	42.3	42.3
	Increase transparency and communication with customers	40	38.5	38.5	80.8
	Rely on buffer stock to manage demand fluctuations	14	13.5	13.5	94.2
	Focus on digital solutions and automation to speed up processes	6	5.8	5.8	100.0
	<b>Total</b>	<b>104</b>	<b>100.0</b>	<b>100.0</b>	



**Interpretation**

The table and pie chart show that among 104 respondents, 41.35% rely on government notifications to adjust schedules, 38.46% use real-time data and predictive analytics, 13.46% implement contingency plans but struggle with accurate predictions, and 6.73% react only after disruptions occur. Overall, 79.8% manage delays proactively using government updates or predictive analytics.

How can shipping companies and supply chain managers mitigate the effects of war and labor strikes on delivery schedules and customer satisfaction?



**Interpretation**

The table and pie chart show that among 104 respondents, 42.31% prioritize rerouting shipments through unaffected regions, 38.46% focus on transparency and customer communication, 13.46% rely on buffer stock for demand fluctuations, and 5.77% use digital solutions and automation. Overall, 80.8% emphasize rerouting or communication to maintain delivery schedules and customer satisfaction during disruptions.

**VIII. FINDINGS**

- **Demographics:** Majority are male (53.8%), aged 26-35 (38.5%), with a Master's degree (45.2%).
- **Industry Sectors:** Respondents work in Manufacturing (28.8%), Retail (29.8%), and Transportation (33.7%).
- **Impact of Russia-Ukraine War:** 30.8% faced delays due to infrastructure damage, while 39.4% experienced moderate disruptions from rerouting.



- **Labor Strikes:** 33.7% encountered major strikes delaying shipments for weeks, and 32.7% had minor delays lasting days.
- **Shipping Adjustments:** 34.6% opted for alternate routes, and 34.6% built buffer times into schedules.
- **Inventory Disruptions:** 41.3% reported severe shortages, and 33.7% experienced moderate stockouts.
- **Managing Delays:** 41.3% relied on government updates, while 38.5% used predictive analytics for planning.
- **Mitigation Strategies:** 42.3% rerouted shipments, and 38.5% focused on transparent customer communication.
- **Technology Integration:** Exploring AI, IoT, and automation in minimizing delays.
- **Industry-Specific Risks:** Examining disruption management across different industries.
- **Sustainable Supply Chains:** Investigating eco-friendly logistics for efficiency and sustainability.
- **Post-Pandemic Adjustments:** Analyzing supply chain adaptations post-COVID-19 for resilience.

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## IX. LIMITATIONS OF STUDY

- **Restricted Sample & Coverage:** The study is based on certain regions and industries, limiting its broader applicability.
- **Short Data Collection Period:** The research captures a specific timeframe, missing long-term shifts in supply chain patterns.
- **Unpredictable External Factors:** Events like geopolitical conflicts, natural disasters, and pandemics are beyond control and may not be fully addressed.
- **Industry-Specific Variations:** Different industries face disruptions uniquely; a more detailed sector-based approach would offer deeper insights.

### Potential Biases in the Research

- **Interpretation Bias:** The study may emphasize findings that align with prior assumptions, potentially overstating disruptions.
- **Data Source Bias:** Reports from industries and governments may present a skewed view, downplaying inefficiencies.
- **Risk Perspective Bias:** Businesses have varied risk strategies, but the study may generalize its recommendations

## X. CONCLUSION

Supply chain disruptions—such as port congestion, transportation bottlenecks, and labor shortages—significantly affect shipping delays and global trade. The reliance on just-in-time (JIT) models increases vulnerability, leading to inventory shortages and higher costs. To address these challenges, businesses are leveraging AI, blockchain, and predictive analytics for better supply chain visibility. However, gaps in risk management and infrastructure still require stronger collaboration among businesses, governments, and logistics providers.

### Future Scope

- **Long-Term Impact:** Assessing lasting effects of supply chain disruptions on global trade.