



## Factors disrupting supply chain management in manufacturing industries

Uday Kumar Kanike<sup>1</sup>

*J. Mack Robinson College of Business, Business Administration, Georgia State University*

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**Abstract** – This paper aims to explore the causes of supply chain management disruptions in the manufacturing sector. Supply chain disruptions have become a major concern for companies globally, posing significant risks to business operations, costs, earnings, and customer satisfaction. This review examines various factors contributing to these disruptions, including natural disasters, raw material unavailability, regulatory changes, technology breakdowns, labor shortages, transportation issues, and political instability. The review encompasses studies and research papers shedding light on the causes of disruptions in manufacturing supply chains. The findings highlight the importance of proactive measures in building resilient supply chains capable of effectively handling disruptions. These measures involve implementing robust risk management plans, strategic investments in technology, and developing collaborative relationships with customers and suppliers. Through these actions, manufacturing companies can enhance their supply chain's ability to withstand disruptions and ensure uninterrupted operations. In conclusion, this review emphasizes the critical importance of addressing supply chain disruptions in the manufacturing sector and advocates for a proactive and comprehensive approach to mitigating their impact. Effective risk management strategies, technology investments, and strong partnerships are key to enhancing the resilience of supply chains and minimizing the negative consequences of disruptions.

**Keywords:** Supply chain management; supply chain disruptions; delayed production; manufacturing cost

### 1. Introduction

An efficient supply chain is necessary for manufacturing firms to ensure that their production processes work properly. Any interruption to the regular flow of goods and services along the supply chain has the potential to have a serious negative effect on the company. Any step of the supply chain, from the provision of raw materials to the delivery of finished goods, is susceptible to disruptions. In the industrial sector, supply chain interruptions can have far-reaching effects, including rising costs, declining sales, missing deadlines, and tainted client relationships. Disruptions can also harm a company's reputation and reduce investor confidence. In the manufacturing sector, supply chain disruptions can be caused by a variety of factors, including natural catastrophes, pandemics around the world, and cybersecurity flaws. Businesses must have a strategy in place to reduce the risks brought on by supply chain disruptions. This includes putting in place a reliable IT infrastructure, making sure there is clear contact with vendors, and putting a disaster recovery strategy in place. Understanding how disruptions in the supply chain affect the industrial sector is also crucial. Businesses must be aware of the potential repercussions of supply chain interruptions and take precautions to lessen their possibility. This can involve minimizing lead times, varying supplier sources, and investing in technology to improve visibility and traceability.

The management of the supply chain, or SCM, is essential to manufacturing operations. Coordination and integration of all supply chain processes, from locating raw materials to delivering finished goods to clients, are required. However, there are a number of reasons why a supply chain can be disrupted, and doing so can cost

<sup>1</sup> Corresponding author. Email address: [U.Kanike@sap.com](mailto:U.Kanike@sap.com)

manufacturing organizations a lot of money. This essay tries to offer a thorough analysis of the factors that contribute to SCM disruption in the manufacturing industry. Natural disasters, including earthquakes, floods, and hurricanes, are one of the main sources of SCM interruption. These catastrophes have the potential to harm transportation infrastructure, obstruct the movement of commodities, and lead to a shortage of vital raw resources. (Chopra & Sodhi, 2004) Manufacturing SCM interruptions can also be brought on by legislative changes, labor shortages, and political unrest. System failures and cyberattacks are only two examples of how technology failures can impair SCM. Modern SCM systems heavily rely on technology; thus, any disruptions can have a big impact on production operations. Additionally, a disruption in SCM may result from problems with transportation, including delays and interruptions. (Gligor & Holcomb, 2012) Manufacturing businesses must take preventative action to lessen the effects of SCM disruption. These actions include implementing new technologies, cooperating with suppliers and clients, and making investments in risk management. Manufacturing businesses can strengthen their resilience to SCM interruptions and lessen the effect on their operations by following these steps (Sheffi, 2005).

To understand the elements that cause disruptions and their effects on business operations, a study on the causes of supply chain disruptions in manufacturing industries is required. The study also aids in effective risk management, informed decision-making, industry benchmarking, and policy development. This study offers important insights for improving supply chain performance and solving the problems faced by manufacturing companies by looking at the reasons behind supply chain disruptions.

The introduction section establishes the importance of understanding the factors that contribute to supply chain management issues. It is followed by the methodology section, which gives the search strategy adopted, inclusion-exclusion criteria, keywords used for shortlisting the papers for systematic review, and the limitations. The literature review section presents a comprehensive analysis of existing literature on supply chain management in the manufacturing industry. It discusses key concepts and definitions related to supply chain management, emphasizes the significance of effective supply chain management, and explores the factors that impact supply chain performance. The findings and discussion section presents the findings on the causes of supply chain management issues in the manufacturing industry. The section compares the findings with previous studies and engages in a comprehensive discussion of the implications and importance of the results. The research gap section focuses on the identification and analysis of the research gaps in the existing literature on the causes of supply chain management in the manufacturing industry. It emphasizes the significance of addressing these research gaps and provides suggestions for future research directions to further enhance understanding in this area. The conclusion section summarizes the main points discussed in the paper. It provides a recapitulation of the study, highlights the key findings and their implications, and emphasizes the contributions to knowledge.

## **2. Research methodology**

For this research, secondary sources will be sourced from indexed databases with good reputations, within the last 20 years and are relevant to the research problem. A global database is used with relevant keywords included to find articles related to supply chain disruptions in the manufacturing industry. Articles that are irrelevant to the topic, outdated, or in a language other than English are excluded. Figure 1 shows the research methodology model of the study.

### **2.1. Collection of data**

Both primary and secondary sources may contain them. Secondary sources of data were used in this study, including peer-reviewed articles of investigation and papers published in well-reputed publications.

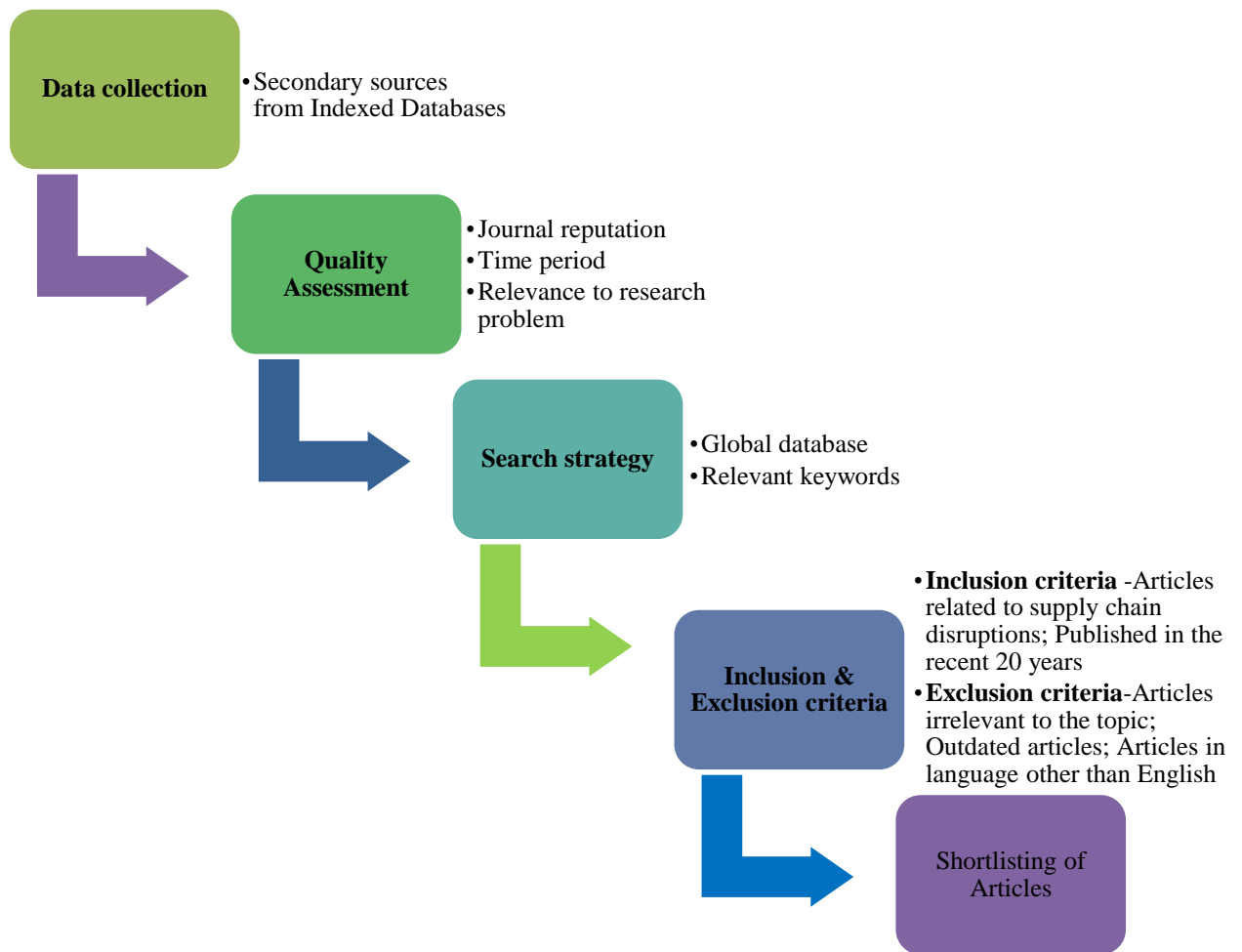


Figure 1. Research methodology.

## 2.2. Assessment of quality

Investigators examined the collected papers and determined whether they qualified for inclusion in the literature review. According to the criteria established for the study, journals, and publications were sorted. The authors conducted a quality assessment to determine the elements examined, the variables used, and the study's overall importance. The categories "yes, can't decide, maybe, no" were used to group papers. Also, a few papers are ranked as highly recommended, averagely appropriate, and not applicable. The study only considered articles that are both highly recommended and generally applicable. Other articles were excluded. The review presents the results of the research made during the period of December 2022 to April 2023. The search string included is relevant to the review topic, such as supply chain disruptions, causes for supply chain disruptions, and so on. Outdated papers are omitted in this study.

## 2.3. Search strategy

The search for relevant studies was conducted using high-end indexed databases such as Scopus, Web of Science, and ABDC journals. The focus was on articles published in esteemed publishers such as SAGE, Wiley, Elsevier, and Springer over the past decade. The keywords adopted to find relevant studies included supply chain disruptions, natural disasters, unavailability of raw materials, changes in regulations, technology breakdown, labor

shortage, transport issues, and political instability. Moreover, the search was restricted to recent publications within the past 20 years (Between 2003 and 2023). Figure 2 shows the search strategy model.

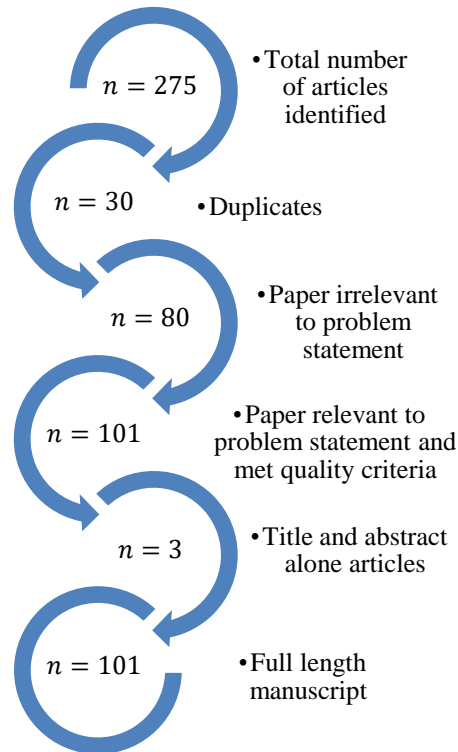


Figure 2. Search strategy.

It can be understood from Figure 2 that initially, 275 articles were identified, in that 30 articles were duplicates, 80 articles were irrelevant to the problem statement, 101 articles were relevant to the problem statement and met quality criteria, and 3 papers were used for introduction and abstract. Totally 104 articles were used in the whole manuscript.

#### 2.4. Inclusion criteria

- Articles and papers published in peer-reviewed journals and conference proceedings.
- Articles that specifically discuss the causes of supply chain management disruption in the manufacturing sector.
- Only recent studies were included.

#### 2.5. Exclusion criteria

- Articles that do not specifically focus on the causes of supply chain management disruption in the manufacturing sector.
- Articles that are not published in peer-reviewed journals or conference proceedings.
- Articles published in languages other than English.
- Duplicate articles or multiple versions of the same article.
- Articles that are not available in a full-text form for thorough analysis.

### **3. Factors disrupting supply chain management in manufacturing industries**

#### **3.1 Natural disasters**

Several scientific studies have examined the detrimental consequences of natural catastrophes on the supply chain management of manufacturing enterprises. Kim and Kim (2018) found that natural catastrophes can cause major supply chain disruptions, including higher prices, manufacturing delays, decreased efficiency, and lower customer satisfaction. A study by Srinivasan et al. (2014) found that natural catastrophes, including floods, hurricanes, and other calamities, can seriously disrupt supply chains, making it difficult to meet customer requests and resulting in lower sales. Authors Cagliano et al. (2012) looked at the effects of the 2010 Chilean earthquake on supply chain management in manufacturing businesses in their study. According to the authors, the earthquake had a substantial impact on the supply chain, causing a number of interruptions, such as production delays, decreased efficiency, and higher prices. In addition, Kotzé et al. (2017) found that supply chain interruptions brought on by natural catastrophes might result in longer lead times and worse customer satisfaction. Ye et al. (2012) conducted a case study on the Japan earthquake and Thailand floods. The findings show that natural disasters can significantly harm firms by destroying tangible assets, interfering with production, and cutting back on employment. Disasters can also harm a company's financial position by increasing unforeseen costs and making it more challenging to obtain outside financing. Natural catastrophes can also have an indirect impact because supply interruptions in one nation can have an impact on the entire global supply chain, resulting in output losses and price changes. Finally, disasters in emerging nations can reduce their ability to compete internationally and frighten away possible foreign investment.

Ivanov and Wendler (2017) studied natural disasters and supply chain disruption management. The authors made a case study on the Haiti earthquake in 2010, the Somalia flood in 1997, and the Myanmar cyclone in 2008. The study results show that mitigation and recovery were not sufficiently developed during the periods of crisis. According to a 2018 study by Uetake, Fukuda, and Iwanaga, supply networks and production schedules can be affected by natural catastrophes like earthquakes and tsunamis. The disaster had a major influence on the production schedules of the companies evaluated, according to a study that examined how the 2011 Tohoku earthquake and tsunami affected Japanese manufacturers. The authors came to the conclusion that major supply chain interruptions brought on by natural catastrophes can result in significant financial losses for firms. In a 2017 study, D'Souza, Maguire, and Pitt investigated how an Indian cyclone affected supply chain management in the automobile sector. The cyclone, according to the authors, disrupted the supply chain, which led to lower production levels, delayed delivery, and higher expenses. According to the study's findings, natural disasters can seriously disrupt supply networks in the manufacturing sector, leading to significant financial losses. Hüsigg et al. (2020) looked at how floods affected China's supply chain management. The authors found that the floods significantly disrupted the supply networks of the enterprises under investigation, which led to lower production levels and higher expenses. The study came to the conclusion that natural disasters can seriously impair supply networks in the manufacturing sector, causing considerable financial losses.

The supply chain management of manufacturing businesses may be immediately impacted by the direct devastation brought on by natural disasters, such as the loss of buildings and damaged infrastructure. For instance, Japan's manufacturing industry was severely disrupted by the 2011 Great East Japan Earthquake and Tsunami, which resulted in a 0.5% decline in industrial output (Nakamura & Murata, 2013). Production facilities were destroyed, the supply chain was stymied by a scarcity of raw materials and components, and transportation services were interfered with as a result of the infrastructure damage. Natural disasters can also have indirect consequences on industrial sectors' supply systems, such as disruptions to global marketplaces and supply chains, in addition to the direct harm they inflict. For instance, the 2004 Indian Ocean tsunami severely disrupted the world's supply chain, which decreased the supply of components and raw materials and increased prices as a result of increased competition for the scarce supply of goods and services (Tan & Gunasekaran, 2007). The 2011 Tohoku earthquake in Japan had a considerable impact on the supply chains of the nation's manufacturing industries, according to a study by Chang et al. (2013). Roads, bridges, and ports all sustained considerable damage as a result of the earthquake, making it challenging for businesses to get the required raw materials and transport their finished goods. Also, the supply chain disruption resulted in a major drop in the output of Japan's manufacturing sectors.

Also, a study by Chang and Lee (2016) found that the supply chain of the nation's industrial businesses in the Philippines was significantly impacted by Typhoon Yolanda in 2013. Infrastructure and transportation networks were severely damaged by the typhoon, which hampered the movement of raw materials and completed goods. In addition, the Philippines' manufacturing companies' output fell due to the supply chain interruption. Leckcivilize (2012) made a study on the impact of the Japanese Tsunami in 2011 on the supply chain. The findings of this study show that the tsunami significantly impacted both the Japanese and international supply networks. As a result of the interruption to their supply chains, Japanese businesses saw their production decline, their expenses rise, and their profits decline. Additionally, as the disruption delayed the delivery of products and services, firms in other nations that were a part of the supply chain network were also impacted. The interruption also had a detrimental effect on the world economy since businesses in other nations had to modify their operations to deal with the disruption's effects. According to Federal Disaster Management Agency (FEMA) research in the United States, natural catastrophes can seriously disrupt corporate operations in the industrial sector (FEMA, 2009). According to the study, supply chain disruptions can leave manufacturing companies in disaster-prone locations particularly vulnerable to financial losses. Disruptions to the supply chain can also result in a decline in production, which can have an additional negative effect on a company's profitability. A research in India found that cyclones, earthquakes, and floods can significantly affect the industrial industry (Krishna, 2018). The study found that, in addition to other economic losses, natural disasters can result in supply chain interruptions, a decline in productivity, and a decline in profitability. The study also found that a drop in customer confidence following a natural disaster may have a detrimental effect on the manufacturing industry.

Natural catastrophes in China have been linked to lower exports and imports in the industrial sector, according to a World Bank study (World Bank, 2019). According to the study, natural disasters can affect transportation and production, increasing prices and delaying the delivery of goods. The study also found that natural disasters might increase market volatility, which can lower consumer confidence and lower demand for products and services. Carvalho et al. (2021) found that the Great East Japan earthquake disaster and its aftereffects caused a 0.47 percentage point drop in Japan's real GDP growth in the year that followed the catastrophe. The effects of natural catastrophes in India on supply chain management in the manufacturing industry were investigated in a study by Kumar and Wadhwa (2020). According to the authors, India has faced floods, droughts, and other natural catastrophes that have disrupted the supply of raw materials, delayed production, and delayed the delivery of final goods to customers. Similar to this, a study by Saha and Saha (2019) looked into how Bangladesh's natural disasters had an effect on supply chain management in the manufacturing sector. Natural disasters like floods and cyclones, according to the authors, have delayed the delivery of finished items, disrupted production processes, and delayed the delivery of raw materials. The effects of natural catastrophes in Nigeria on supply chain management in the manufacturing industry were investigated in a study by Oke (2020). According to the authors, Nigeria has faced floods, droughts, and other natural catastrophes that have disrupted the supply of raw materials, delayed production, and delayed the delivery of final goods to customers. Table 1 shows the disruption of natural disasters in different countries.

### **3.2 Unavailability of raw materials**

The supply chain management in manufacturing businesses is severely disrupted by the unavailability of raw materials, which can result in large losses in output and revenue (McKinnon & Hsiao, 2020). According to a recent study by Wankhade et al. (2019), the main challenge facing manufacturing organizations when it comes to supply chain management is the lack of raw materials. According to the study, a scarcity of raw materials led to production delays, higher production costs, and trouble satisfying client demand. The analysis also found that there were insufficient forecasts, delays in procurement, and supply-demand imbalances to blame for the shortage of raw resources. According to Freitas and Silva (2020), supply chain disruption brought about by the scarcity of raw materials and parts resulted in production delays and lower production volumes. The investigation also found that weak risk management techniques, restricted production capacity, and late deliveries were the main causes of the shortage of raw materials.

Table 1. Review of studies on natural disasters as a disruption to the supply chain.

S.no	Author	Year	Country and Calamity	Natural disaster
1	Cagliano et al.	2012	Chile	Earthquake
2	Ye et al.	2012	Japan and Thailand	Earthquake and Flood
3	Ivanov and Wendler	2017	Haiti, Somalia, and Myanmar	Earthquakes, Floods and Cyclones
4	Uetake et al.	2018	Japan	Earthquake
5	D'Souza et al.	2017	India	Cyclone
6	Hüsig et al.	2020	China	Flood
7	Nakamura and Murata	2013	Japan	Earthquake
8	Tan and Gunasekaran	2007	India	Indian Ocean Tsunami
9	Chang et al.	2013	Japan	Earthquake
10	Chang and Lee	2016	Philippines	Typhoon
11	Leckcivilize	2012	Japan	Tsunami
12	Krishna	2018	India	Cyclones, earthquakes, and floods
13	Carvalho et al.	2021	Japan	Earthquake
14	Kumar and Wadhwa	2020	India	Floods, droughts etc.
15	Saha and Saha	2019	Bangladesh	Floods and Cyclones
16	Oke	2020	Nigeria	Floods, droughts

According to a study by Kaur and Rana (2020), the lack of raw materials is a serious problem for manufacturing businesses and can result in considerable losses in output, expenses, and customer satisfaction. According to the report, insufficient forecasting and planning, unequal demand and supply, and delivery delays are the main causes of raw material shortages.

The lack of raw materials was shown to be the most frequent cause of disruption in the manufacturing industry's supply chain, per a study by Zhang et al. (2016). The study also showed that a lack of raw materials could have a substantial effect on the entire supply chain, which can lower production rates, raise production costs, and worsen customer satisfaction. In this study, the authors also pointed out that poorer product quality and longer delivery times may result from a shortage of raw materials, which may further harm the effectiveness of the supply chain.

Another study by Chen et al. (2017) found that the unavailability of raw materials can pose a serious problem for the supply chain operations of manufacturing companies, as it can lead to longer delivery times, worse customer satisfaction scores, and higher production costs. The authors also found that poor production planning and insufficient supply chain planning can contribute to the lack of raw materials. The study also pointed out that a lack of raw resources might result in higher stock levels, higher production costs, and lower product quality. Table 2 shows the causes of the unavailability of raw materials.

Table 2. Review of studies on causes for unavailability of raw materials.

S.no	Author	Year	Causes for unavailability of raw materials
1	McKinnon and Hsiao	2020	Global demand, political tensions, and the complexity of the global supply chain
2	Freitas and Silva	2020	Demand fluctuations, geopolitical instability, environmental regulations, and natural disasters
3	Kaur and Rana	2020	Difficulties in obtaining raw materials from suppliers, limited sources of raw materials, rising costs of raw materials, and fluctuating demand and COVID-19
4	Wankhade et al.	2019	Supply and demand imbalances, supplier constraints, inadequate storage capacity, and insufficient transportation infrastructure
5	Chen et al.	2017	unexpected demand fluctuations, inefficient resources allocation, inadequate forecasting
6	Zhang et al.	2016	Inadequate resource allocation, supplier failure, natural disasters, and unexpected changes in technology

### 3.3 Changes in regulations

Rapid regulatory developments in the manufacturing sectors have upset traditional supply chain models, creating significant problems for supply chain management. In the manufacturing industry, supply chain management can be severely disrupted by changes in rules. For instance, the supply chain may be impacted by several regulations that apply to the automotive industry. These rules cover requirements for safety standards, country of origin labels, and emissions standards (Göregenli & Dikmen, 2015). Regulatory changes might have an impact on the supply chain in the food business. For instance, the Food Safety Modernization Act (FSMA) of 2011 increased the bar for food manufacturing and distribution safety regulations (Bianchi, 2014). The supply chain may be impacted by changes in rules in several different ways. The production procedure may need to be changed as a result of the new requirements, which could increase costs, cause delays, and disrupt the supply chain. Also, in some circumstances, the new regulations may call for the addition of new suppliers or revisions to existing ones in order to comply with the new standards (Göregenli & Dikmen, 2015).

The impact of legislative changes on supply chain management in the automotive and aerospace industries was examined in a study by Yilmaz et al. (2019). According to the study, legislative changes hurt supply chain management since they delayed the manufacturing and distribution of parts, raised the cost of operations, and hampered the flow of information. The study came to the additional conclusion that a significant barrier to businesses managing their supply chains efficiently is frequent changes in legislation. Similarly, Chen et al. (2015) investigated how supply chain management in the food business is affected by legislative changes. According to the study, supply chain operations frequently need to be significantly adjusted in response to regulatory changes, which increases costs and throws off production and delivery timelines. According to the study's findings, businesses must be ready to react swiftly to regulatory changes in order to maintain the efficiency of their supply chains. Ates et al. (2019) investigated how supply chain management in the automobile industry is impacted by regulatory changes, such as tariffs and trade restrictions. They found that these modifications can result in production delays, higher prices, and trouble locating substitute suppliers. Similar to this, Liu et al. (2019) investigated how supply chain management in the electronics industry is impacted by regulatory changes, such as the implementation of new environmental rules. They found that these modifications may result in higher costs, manufacturing delays, and worse customer satisfaction. Zhao et al. (2019) investigated how supply chain management in the food business is impacted by regulatory changes, such as new safety criteria. They found that these modifications can result in product delivery delays, higher costs, and trouble locating substitute suppliers. Huang (2017) examined the effects of regulatory changes on the automotive industry in his study. According to the survey, businesses need to be ready to react to regulatory changes because they can have a significant impact on the supply chain and the availability of raw materials and other components. The study also found that changes in legislation may contribute to higher costs, longer lead times, and lower-quality goods. The study came to the conclusion that in order to reduce the risk of supply chain disruptions, businesses should keep abreast of regulatory



changes and have a plan in place to promptly respond to them. The implications of changing rules on supply chain management in the pharmaceutical business were investigated in a study by Hsu et al. (2019). The study found that regulatory changes can have a major impact on supply chain operations, including changes to inventory levels, sourcing, and procurement, as well as the general price and accessibility of particular products. According to the study's findings, businesses must be ready to react to regulatory changes swiftly and effectively in order to limit supply chain disruptions. Changes in environmental rules have a detrimental effect on supply chain performance, notably in terms of cost, delivery, and quality outcomes, according to a study by Guo et al. (2020) on the automobile sector. A study on the garment industry by Xie et al. (2019) found that supply chain flexibility and efficiency were negatively impacted by changes to labor legislation. The investigation of He et al. (2018) into the electronics sector revealed that modifications to safety rules increased the complexity and cost of the supply chain. In their research, Rajendran et al. (2015) found that supply chain management was significantly impacted by legislative changes in the automotive sector. The study specifically looked at the impact of changes to economic, environmental, and safety standards on the supply chain. According to the report, changes in safety rules had the most effects on the supply chain, particularly throughout the phases of production and distribution. While economic restrictions had the least substantial impact on the supply chain, changes in environmental rules had the second-largest impact, especially on the production and inventory management stages. In their research, Lai et al. (2018) looked at how supply chain management in the pharmaceutical sector was impacted by changes in healthcare regulations. According to the study, the supply chain was significantly impacted by changes in healthcare legislation, particularly throughout the stages of distribution and procurement. Regulation changes also had an impact on inventory management because they raised inventory prices and reduced inventory effectiveness.

Supply chain management in manufacturing industries can be significantly impacted by changes in rules. For instance, when the European Union introduced the Restriction of Hazardous Substances (RoHS) Regulation in 2006, it forced manufacturers to phase out lead and other hazardous compounds in their goods, which disrupted the supply chain for the electronics industry (Bianchi et al., 2017). Additionally, the General Data Protection Regulation (GDPR) of the European Union, which came into effect in 2018, had a significant impact on supply chain management in the automotive sector because it mandated that manufacturers make sure their suppliers and partners follow stringent data protection guidelines (Gwiazda et al., 2020). The Bangladesh Accord on Fire and Building Safety, which was established in 2013, has also had a big impact on supply chain management in the apparel industry by compelling apparel businesses to evaluate and enhance the safety of facilities in Bangladesh (Kumar & Subramanian, 2016). Last but not least, the U.S. Food Safety Modernization Act (FSMA) of 2011 has significantly altered the supply chain for the food sector by enforcing new, stricter regulations for the safety of food items (Xu et al., 2018). Table 3 illustrates the industry and the type of regulatory changes made to it.

### **3.4 Technology breakdown**

Breakdowns in technology have been found to have a substantial effect on production and supply chain management. According to a study by Khan and Huang (2013), technology failures can reduce the efficiency and efficacy of supply chain management procedures, which can result in unfulfilled orders, delays in order fulfillment, excessive expenses, and dissatisfied customers. The authors found that a number of factors, including issues with hardware and software, insufficient data storage, human mistake, and cyber security risks, can lead to technology breakdowns in the industrial sector. According to this study report, inadequate process integration, a lack of visibility, and poor communication among supply chain partners are the top causes of technological failure. Inaccurate data interchange, a lack of standards, and insufficient security measures are further factors that can lead to technology failures.

Table 3. Review of studies on causes of changes in regulations.

S.no	Author	Year	Industry	Type of regulation
1	Yilmaz et al.	2019	Automotive and Aerospace Industries	Not specified
2	Chen et al.	2015	Food Industry	Food Safety Regulations
3	Ates et al.	2019	Automobile industry	Trade regulations on automotive supply chains
4	Liu et al.	2019	Electronics industry	Environmental Regulations
5	Zhao et al.	2019	Food Industry	Food Safety Regulation
6	Huang	2017	Automotive Industry	Environmental Regulation
7	Hsu et al.	2019	Pharmaceutical Industry	Pharmaceutical Regulations
8	Binachi	2014	Food Industry	Food Safety Regulations
9	Göregenli and Dikmen	2015	Automotive Industry	Environmental Regulation
10	Guo et al.	2020	Automobile Industry	Not Specified
11	Xie et al.	2019	Apparel Industry	Labor Legislation
12	He et al.	2018	Electronics Industry	Not specified
13	Rajendran et al.	2015	Automotive Industry	Economic, environmental, and safety standards on the supply chain
14	Lai et al.	2018	Pharmaceutical Industry	Healthcare Regulations
15	Binachi et al.	2017	Electronics Industry	RoHS Directive
16	Gwiazda et al.	2020	Automotive Industry	GDPR Compliance
17	Kumar and Subramanian	2016	Apparel Industry	The Bangladesh Accord on Fire and Building Safety
18	Xu et al.	2018	Food Industry	Food Safety Regulations

In addition, the study of Chen et al. (2015) revealed that technology failures in the industrial sector might impact resource availability, disturb product quality, and result in a decline in production rate. The authors also pointed out that faulty technology can make it more difficult to track products accurately, leading to inconsistencies in inventories and a lack of supply chain awareness. More delays in order fulfillment and consumer unhappiness may result from this. In order to ensure the success of supply chain management, Li and Zhu (2016) underlined the significance of efficient technology management in the manufacturing sector in their study. The authors stated that the likelihood of technological failures is higher than ever due to the growing complexity of production processes. The authors recommended using predictive maintenance techniques, creating early warning systems, and using real-time monitoring to see potential issues before they happen in order to lower the chance of technological failures. The effect of technological failures on the effectiveness of supply chain management in the automobile industry was studied by Wang et al. (2018). The study found that supply chain disruptions caused by technological failures resulted in production delays, decreased customer satisfaction, and higher expenses. Li and Wang (2017) looked at how the electronics industry's supply chain management was impacted by technological failures. According to the survey, technology failures frequently cause protracted production delays, higher expenses, and worse customer satisfaction. The study also indicated that supply chain management's overall efficiency was negatively impacted by technological failures. The effects of technology failures on supply chain management in the garment industry were examined in a study by Chen et al. (2018). The study found that technological failures led to greater expenses, production delays, and worse customer satisfaction. The study also

found that disruptions in technology had a substantial impact on the supply chain management process's overall effectiveness. Koh et al. (2019) studied the fourth industrial revolution (Industry 4.0). The authors reported that Industry 4.0 has changed how goods and services are supplied, causing both the emergence of new business models and adjustments to established ones. The blurring of information and physical structures caused by system integration and complexity will result in more complex digital market models. According to a study by Kumar (2015), technology failures can result in considerable delays in the supply chain process, which can reduce customer satisfaction and productivity. The study also found that because of their unpredictable nature and the lack of visibility into the breakdown's primary cause, supply chain disruptions brought on by technological failures were more challenging to recover from. A study by Swink and Narasimhan (2017) looked at how supply chain performance is affected by technological failures. According to the study's findings, delays and disruptions can occur when there is a decline in collaboration and communication among supply chain stakeholders. The study also found that a lack of knowledge of the underlying technology and inadequate staff training can worsen the effects of technological failures.

Lin et al. (2016) examined how supply chain visibility is affected by technological failures. According to the study's findings, supply chain process visibility can be decreased by technological failures, which can leave customers in the dark about the status of their orders and items. The study found that technological failures can make it more difficult to identify problems in the supply chain process, which can cause further delays and disruptions. Technology failures can significantly affect supply chain management in terms of cost, time, and quality, per a study by Bondarouk and Janssen (2013). These interruptions can be caused by problems with the supply chain's hardware or software, power outages, communication system faults, or other problems. In some circumstances, the malfunction can obstruct the manufacturing process and cause a product shortage. Technology failures can result in production delays as well as higher costs due to the requirement for replacement parts, additional personnel, and other expenses, according to a study by Hang et al. (2013). Customers may also become dissatisfied as a result of technological failures since the supply chain is interrupted and products are not delivered on schedule. According to a study by Singh and Singh (2015), supply chain management can suffer as a result of technological failures due to the increased cost and disruption of longer duration. Technology failures can also result in decreased efficiency because the supply chain needs to be reset in order to work properly.

Breakdowns in technology are the main reason for supply chain disruption in the manufacturing sector, according to recent studies (Kirchner et al., 2020). Breakdowns in technology can result in lower production, more costs, and less satisfied customers. Many variables can lead to technological failures. One study found that software bugs, hardware issues, and network outages were the main culprits behind technology failures in the industrial sector (Kirchner et al., 2020). Inadequate user training, subpar system design, and insufficient system maintenance are additional variables that might result in technological failures. Power outages, natural disasters, cyberattacks, and even human error can result in technology failures (Hudson & Hudson, 2018). Breakdowns in technology can have a significant effect on supply chain management in the manufacturing sector. Production holdups may wreak havoc on the supply chain, driving up costs, lowering customer happiness, and lowering overall product quality. Shipment delays can also interfere with inventory control, causing overstocking or understocking of products (Hudson & Hudson, 2018). According to a study by Hsu et al. (2018), equipment failure, human mistakes, a lack of capacity or competency, and inadequate training were among the reasons for technology breakdown, which was shown to be the most disruptive event in supply chain management in manufacturing industries. Insufficient maintenance, poor system design and execution, and subpar system performance are some additional factors that contribute to technological failures in manufacturing industries that have been highlighted by research by Jiang et al. (2016) and Datta and Datta (2017). Organizations must spend enough money on training and maintenance, as well as making sure that their systems are correctly planned and executed, in order to lessen the effects of technology failures (Jiang et al., 2016; Datta & Datta, 2017). Table 4 shows the causes of technology breakdown.

Table 4. Review of studies on the causes of technology breakdown.

S.no	Author	Year	Causes for technological breakdown
1	Khan and Huang	2013	Inaccurate data exchange, lack of standardization, and inadequate security
2	Chen et al.	2015	Lack of appropriate risk management strategies
3	Wang et al.	2018	NA
4	Li and Wang	2017	Human error, system design flaws, inadequate maintenance, and changes in the operating environment
5	Chen et al.	2018	Complexity and instability of the technology infrastructure, the lack of effective data backup systems, and the lack of standardized processes
6	Koh et al.	2019	Robotics, artificial intelligence, the Internet of Things, and 3D printing
7	Kumar	2015	Hardware or software malfunctions, insufficient IT resources, cyber security threats, inadequate user training, unreliable internet connectivity, and natural disasters
8	Li and Zhu	2016	Natural disasters, resource shortages, and changes in market dynamics
9	Lin et al.	2016	Not Specified
10	Swink and Narasimhan	2017	Lack of proper maintenance, inadequate systems design, and insufficient training of personnel
11	Bondarouk and Janssen	2013	Hardware or software, power outages, communication system faults, or other problems
12	Hang et al.	2013	Not specified
13	Singh and Singh	2015	Not Specified
14	Kirchner et al.	2020	Software bugs, hardware issues, and network outages
15	Hudson and Hudson	2018	Power outages, natural disasters, cyberattacks, and even human error
16	Hsu et al.	2018	Equipment failure, human mistake, a lack of capacity or competency, and inadequate training
17	Jiang et al.	2016	Insufficient maintenance, poor system design and execution, and subpar system performance
18	Datta and Datta	2017	Insufficient maintenance, poor system design and execution, and subpar system performance

### 3.5 Labor shortage

A labor shortage can have a substantial influence on the operation of the manufacturing industries by disrupting supply chain management (Koh et al., 2017). According to studies, a number of issues, including an aging workforce, a lack of trained workers, and an increase in automation, are to blame for the industrial sector's labor shortages (Yazdanpanah et al., 2019). However, there is evidence to support the notion that growing production costs, shifting consumer demands, and heightened global competitiveness may all be factors in the workforce shortages in the manufacturing industry (Kovacic et al., 2018). Labor shortages can have a substantial impact on supply chain management in the manufacturing industry since they can result in lower production and efficiency, greater costs, and a lack of innovation (Koh et al., 2017). In addition, it may result in diminished client satisfaction, longer lead times, and inferior products (Yazdanpanah et al., 2019). As a result, managers need to be aware of the

possible effects of labor shortages on their supply chain systems and put plans in place to deal with these problems. According to Wang et al. (2015) research, China's manufacturing sectors most frequently have a manpower shortage. According to a survey of 1,158 Chinese manufacturing firms, 73% of the businesses cited a manpower shortage as a serious issue. The findings demonstrated a correlation between labor shortages and higher production costs, lower production quality, and longer delivery times. According to Rosa et al. (2011) study, labor shortages significantly affect the effectiveness of the supply chain. A simulation model was employed in the study to examine how the performance of the supply chain was affected by manpower shortages. The findings demonstrated that a lack of workers could significantly affect the production system, resulting in increased production delays, higher inventory levels, increased production costs, and poor product quality. Raphael and Paul (2019) claim that diminished productivity, higher prices, and issues with quality assurance are the most prominent repercussions of labor shortages. Moreover, a lack of manpower might result in delivery delays and managerial uncertainty, which lowers overall efficiency. According to Liang et al. (2021), there may be a need for more labor-intensive operations and a rise in absenteeism and employee turnover as a result of labor shortages. This may result in more expenses, poorer quality goods, and lower customer satisfaction. Moreover, a lack of trust and openness within the company might result from a labor shortage, which lowers morale generally. According to Kumar and Buescher (2017), a lack of manpower might result in a higher reliance on technology, which can raise operating costs, limit flexibility, and prevent innovation. A supply chain may become significantly less efficient as a result, and managing the chain may become more challenging. According to a study by Kabir et al. (2015), the aging population, a mismatch between the skills needed and the skills available, rising labor costs, and a decline in the availability of qualified personnel are the key drivers of a labor shortage in the manufacturing sector. Also, a study by Ferguson (2019) found that the difficulty in finding competent candidates and the lack of incentives for people to enter the area are both contributing factors to the labor shortage in the manufacturing sector. Table 5 shows a review of studies on the causes of the labor shortage.

Table 5. Review of studies on the causes of labor shortage.

S.no	Author	Year	Causes for the labor shortage
1	Wang et al.	2015	The rapid economic growth, increasing labor costs, and a demographic shift in the labor market
2	Rosa et al.	2011	Lack of qualified personnel, population aging
3	Raphael and Paul	2019	An aging workforce, reduced migration, and an increase in automation.
4	Liang et al.	2021	An aging population, increased economic and educational opportunities, increased migration, and increased labor costs
5	Kumar and Buescher	2017	Changing demographics of the workforce, an aging population, and the increasing difficulty of recruiting and retaining qualified workers
6	Koh et al.	2016	Not specified
7	Kovacic et al.	2018	Growing production costs, shifting consumer demands, and heightened global competitiveness
8	Yazdanpanah et al.	2019	An aging workforce, a lack of trained workers, and an increase in automation
9	Kumar and Zafar	2018	Demand for skilled labor
10	Kabir et al.	2015	Aging population
11	Ferguson	2019	Lack of incentives

### 3.6 Transportation issues

The management of the supply chain in the manufacturing industries can be significantly impacted by any disruption to the transportation process, which is a crucial component of the supply chain. Due to rising fuel prices, more stringent regulations, and more rivalry in the logistics industry, there has been an increase in recent years in the attention on transportation difficulties as a disruption to supply chain management. The effect of transportation disruptions on the supply chain management of manufacturing industries has been the subject of numerous studies. According to a study by Hakanen et al. (2011), supply chain interruptions caused by transportation were a significant source of issues in the automotive industry in the United States. Several factors contributed to these delays, including poor supply chain partner coordination, low transportation capacity, and inadequate road infrastructure. According to the study, fewer and less severe supply chain interruptions caused by transportation problems might be achieved by improved infrastructure and greater communication among supply chain stakeholders. A study of the US agricultural industry was done by Wang et al. (2018). According to the study, supply chain disruptions were largely caused by problems with transportation. According to the report, issues like insufficient transport capacity, ineffective routes, and delivery delays significantly impacted the supply chain. The study also found that enhanced infrastructure, route optimization, and supply chain partner cooperation could lessen the frequency and severity of supply chain disruptions caused by transportation concerns.

Mellor et al. (2020) conducted a study on the healthcare sector in the US; they found that supply chain disruptions were frequently caused by transportation problems. According to the report, issues like ineffective routes, insufficient transport capacity, and delivery delays significantly impacted the supply chain. The study also found that enhanced infrastructure, route optimization, and supply chain partner cooperation could lessen the frequency and severity of supply chain disruptions caused by transportation concerns. Fuzzy logic was utilized in a study by Chang et al. (2018) to examine how transportation problems affect supply chain management. The study found that supply chain management was significantly impacted by the severity of transportation challenges, including vehicle type, journey time, and road conditions. Furthermore, the study found that, after speed and reliability, pricing played the largest role in determining the degree of disruption. A study by Hao et al. (2017) focused on transportation concerns in China's automobile industry to analyze supply chain disruption. The authors found that transportation factors, such as delivery time, vehicle type, and cost, had a substantial impact on supply chain management using an empirical study of supply chain management. Furthermore, the authors came to the conclusion that supply chain planning and management in the automobile industry should take transportation difficulties into account. Ren et al. (2016) looked into how transportation problems affected the effectiveness of supply chains in the pharmaceutical sector in their study. The performance of the supply chain was found to be significantly impacted by the complexity of transportation concerns, including delivery delays, vehicle types, and route choices. The authors also came to the conclusion that designing and managing supply chains in the pharmaceutical business should take transportation difficulties into account. In a study published in 2018, Cao and Cui looked at the effects of disruptions in road traffic on supply chain management in China's manufacturing sectors. According to the study, delays in road transportation have a substantial impact on supply chain management, leading to higher prices, longer delays, and changes in production plans. The authors came to the conclusion that producers should take into account the possibility of transportation delays when developing supply chain management strategies and make sure that the right steps are taken to lessen the effects of such delays. Khedkar and Bhardwaj (2019) looked at the effects of transportation disruptions on the automobile industry's supply chain management in a separate study. According to the report, supply chain management was significantly impacted by transportation disruptions, which resulted in product delivery delays, lower customer satisfaction, and greater expenses. Manufacturers should be aware of the possibility of transportation disruptions and establish plans to lessen their effects on the supply chain, according to the authors' conclusion. The effect of transportation delays on the management of the electronics industry's supply chain was investigated in research by Xie and Zhang (2020). According to the study, delays in transportation have a negative impact on supply chain management, increasing costs, delaying the delivery of goods, and upsetting production schedules. Manufacturers should be aware of the possibility of transportation disruptions and take the necessary precautions to lessen their effect on the supply chain, according to the authors' conclusion. Insufficient infrastructure can cause delays in the transportation of raw materials to the manufacturing site, which can result in production delays and higher costs, according to a study by Can et al. (2020). Unreliable transportation services are another transportation issue that can affect supply chain management in the manufacturing sector. Unreliable transportation services can cause

cargo delays or even cancellations, which can have a significant effect on the supply chain. Unreliable transportation services can cause delays in the supply of raw materials to the manufacturing site, which can cause delays in production and higher expenses, according to a study by Gümüş et al. (2020).

Natural catastrophes can cause delays in the transportation of raw materials to the industrial site, which can result in production delays and higher costs, according to a study by Kumar et al. (2020). A study by Adiga (2019) found that disruptions in the transportation network might result from transportation-related difficulties and cause delays in the supply chain process. These hiccups may be caused by weather events, backed-up traffic, clogged roads, and road closures. Due to unexpected delays, rising transportation costs, and the difficulty in planning dependable transportation, transportation problems can result in supply chain problems. These problems may make it more difficult for the manufacturer to satisfy client demand and may raise costs for the manufacturer. Table 6 shows the review of studies on the causes of transportation issues.

Table 6. Review of studies on the causes of transportation issues.

S.no	Author	Year	Industry	Causes of Transportation Issues
1	Hakanen et al.	2011	Automotive industry	Natural disasters, accidents, road closures, and other unexpected events
2	Wang et al.	2018	Agricultural industry	Increased demand, weather-related disruptions, infrastructure constraints, and inadequate freight capacity
3	Mellor	2020	Healthcare sector	Increasing number of regulations and restrictions imposed by governments worldwide
4	Hao et al.	2017	Automobile Industry	Inadequate infrastructure, and inadequate supply chain coordination
5	Ren et al.	2016	Pharmaceutical sector	More stringent regulations, and cost pressures
6	Cao and Cui	2018	China's manufacturing industries	Inadequate transportation management and planning, traffic congestion, natural disasters, and terrorist attacks
7	Khedkar and Bhardwaj	2019	Automobile industry	Road accidents, infrastructure problems, and the lack of adequate public transport
8	Xie and Zhang	2020	Electronics Industry	Increasing complexity of global supply chains, the complexities of logistics, natural disasters, political instability, and traffic congestion
9	Chang et al.	2018	Not specified	Increasing complexity of global supply chains, fluctuating customer demands, and limited infrastructure capacity
10	Can et al.	2020	Not specified	Insufficient infrastructure
11	Gümüş et al.	2020	Not specified	Unreliable transportation service
12	Kumar and Rana	2020	Not specified	Natural disasters
13	Adiga	2019	Not Specified	Weather, backed-up traffic, clogged roads, and road closures

### 3.7 Political instability

One of the main causes of interruption to supply chain management in the industrial business has been recognized as political instability (Barth et al., 2006). Political instability, according to studies, can harm a company's supply chain's dependability and effectiveness (Rudzki, 2017; Zhang et al., 2015). For instance, an unstable administration may result in policy changes that cause uncertainty, which may cause manufacturing delays (Nguyen et al., 2017). In addition, a nation's infrastructure may change as a result of political instability. These modifications may result in inefficient material movement, which may cause production delays and cost increases (Mehrotra et al., 2019). The collapse of law and order brought on by an unreliable administration can also put workers' safety at risk and interfere with business operations (Agarwal et al., 2018). Political instability's complex and interconnected consequences on Pakistan's supply chain efficiency were studied by Asif et al. (2019). The findings demonstrated that while political instability does not directly affect supply chain performance, its effects are perceived through ensuing supply chain disruptions. These disruptions have wide-ranging, intricate, and complicated effects. No matter how big or little, political instability frequently disrupts the supply chain significantly and has a long-lasting impact. This could be likened to a "bullwhip effect," which cascades from the first step of ginning through the creation of clothes and delivery to the final buyer. A cyclical chain connecting multiple disruption points in the textile supply chain illustrates the relationship's complexity. Political upheavals are, therefore, likely to send shockwaves through the supply chain, which might result in coordination and collaboration problems like extended lead times, production delays, rescheduling, transportation delays, and stops in manufacturing.

Political instability was noted as one of the most significant reasons for the disruption of supply chain management in the industrial industry in a study conducted by Cui et al. (2018). The authors found that political unrest frequently causes costs to rise, supply chain distrust, and delays in the delivery of goods. The authors also pointed out that because of the risks involved with political instability, customers may be less inclined to make purchases, which might result in a decline in customer demand. According to Shrestha and Bhattarai (2019), political unrest can have a major impact on supply chain management in the manufacturing sector. The authors found that political instability can result in supply chain distrust, higher costs due to extra security measures, and disruptions to the flow of commodities. The authors also pointed out that political unrest might result in a reduction in customer demand, delays in the delivery of goods, and a lack of supply chain transparency. Political instability has been linked, according to a different study by Cai et al. (2015), to higher expenses for supply chain management in businesses that manufacture goods. The authors found that businesses in China that were impacted by political instability had to pay more due to enhanced security measures, additional taxes, and delays in transportation. The effectiveness and profitability of the businesses were directly impacted by these added expenses.

In addition, a 2011 study by Mihm and Singh revealed that political instability could hinder businesses' access to markets and cause a decline in resource availability. They found that political instability can result in fewer competent workers being available, higher company costs, and less access to new markets. They concluded that this could result in a general decline in supply chain management effectiveness in industrial companies. According to studies, political disturbances such as war, civil unrest, and sanctions can make it more difficult to access resources, cause output to lag, and disrupt transportation (Chen & Paulraj, 2004). This could have a detrimental effect on the performance of the supply chain, resulting in decreased profitability and production efficiency. In addition to resource limitations, political unrest can raise operational environment uncertainty (Lai & Ng, 2007). Because choices may need to be made quickly in response to shifting circumstances, this uncertainty can make supply chain management challenging. Also, businesses might need to be flexible and modify their supply chain operations to take the shifting political scene into account (Lai & Ng, 2007). Research has also shown that political unrest may negatively affect consumer demand (Lai & Ng, 2007). This is because consumers could be hesitant to buy goods from nations with unreliable political systems. This may make it even more challenging to manage a manufacturing supply chain in a situation marked by political unpredictability. Companies must implement proactive risk management techniques in order to reduce the hazards brought on by political uncertainty. This could involve changing your suppliers, finding new sources of supply, and using flexible manufacturing schedules (Chen & Paulraj, 2004). Table 7 shows the review of studies on the causes of political instability.



Table 7. Review of studies on the causes of political instability.

S.no	Author	Year	Causes of political instability
1	Rudzki	2017	Economic crises, political unrest, and civil unrest, regime changes, corruption, terrorism, war, and natural disasters
2	Zhang et al.	2015	Frequent changes in government policy and the emergence of new government regulations
3	Nguyen et al.	2017	Civil unrest, political coups, and regime changes
4	Mehrotra et al.	2019	Government intervention, political interference, economic and currency fluctuations, trade restrictions, and socio-political unrest
5	Agarwal et al.	2018	Civil unrest, violent protests, and ethnic tensions in apparel-sourcing countries
6	Asif et al.	2019	Political violence, terrorism, military coups, and street demonstrations
7	Cai et al.	2015	Rapid economic changes in China
8	Mihm and Singh	2011	Unexpected policy changes
9	Barth et al.	2006	Not specified
10	Chen and Paulraj	2004	War, civil unrest, and sanctions
11	Lai and Ng	2007	Not specified
12	Cui et al.	2018	Not specified
13	Shrestha and Bhattarai	2019	War

#### 4. Findings and discussion

According to evidence from numerous studies, supply chain disruptions can seriously affect the supply chain management of manufacturing businesses, leading to higher costs, production delays, decreased efficiency, and lower customer satisfaction. As a result, it is crucial that manufacturing sectors create plans to lessen the effects of disruptions on their supply chain. The authors Cagliano et al. (2012), Kotze et al. (2017), and Kim and Kim (2018) considered natural disasters as a disruption to supply chain management in manufacturing industries. Political instability was considered a disruption to the supply chain management of manufacturing industries in the studies of Agarwal et al. (2018), Mehrotra et al. (2019), and Nguyen et al. (2017). Freitas et al. (2020) studied the production disruption due to raw material unavailability in the automotive industry. Kar and Rana (2020) conducted a study on challenges faced by manufacturing industries due to raw material unavailability. Chen et al. (2015) studied the impact of regulatory changes on food supply chain management. Li and Zhu (2016) conducted a study on technology breakdown management in the manufacturing supply chain. Chen et al. (2018) studied the impacts of technology breakdowns on supply chain management in the apparel industry. Rosa et al. (2011) studied the impact of labor shortages on supply chain performance. Khedkar and Bhardwaj (2019) investigated the impact of transportation disruptions on the supply chain management of the automotive industry. The aforementioned supply chain disruptions can be overcome by implementing some of the following methods.

- **Risk Analysis:** It is crucial to perform a risk analysis of the supply chain in order to spot potential interruptions and create plans for reducing the ensuing hazards.
- **Diverse Suppliers:** Expanding the network of suppliers and using a variety of them can lower the risk of supply chain disruptions.
- **Strategic Inventory Management:** By maintaining a suitable amount of inventory on hand, supply chain snags brought on by a lack of raw materials can be avoided.
- **Technological Solutions:** Supply chain disruptions can be anticipated and reduced by investing in technology solutions, including supply chain management systems, predictive analytics, and artificial intelligence.
- **Automation:** Process automation can increase productivity and aid with labor shortages.

- **Communication:** To lower the risk of supply chain interruptions, it's crucial to establish effective communication channels with suppliers and other stakeholders.
- **Regulatory Compliance:** Making sure regulations are followed might help to avoid supply chain hiccups brought on by shifting legislation.
- **Business Continuity Plan:** By creating a business continuity plan, you can lessen the chance that a natural disaster, a political upheaval, or a transportation problem may disrupt your supply chain.

#### 4.1 Interaction of supply chain disruption in different industries

In addition to disruptions in the supply chain, such as natural disasters, unavailability of raw materials, changes in regulations, technical breakdowns, labor shortages, and transportation issues, economic instability also impacts numerous industries. Agricultural policies can be affected by natural disasters, regulatory changes, and political instability in the agriculture industry. Manufacturing and distribution of medical devices and pharmaceuticals can be disrupted by technology breakdowns, and medical workers and supplies can be affected by labor shortages. A shortage in raw materials, a breakdown in technology, and transportation problems can affect the production and distribution of electronic products in the electronics industry. In a similar way, natural disasters can have an impact on crops and livestock, changes in food safety regulations, and transportation problems that affect food distribution. Drug approvals and pricing regulations may change, technology may break down, and labor shortages may disrupt the pharmaceutical industry. A shortage of raw materials, changes in emission regulations, and transportation issues may pose challenges to the automobile industry. As a result of changes in labor laws and tariffs, the apparel industry may face labor shortages and transportation problems. Affected by the unavailability of raw materials, technological breakdowns, changes in regulations on safety and tariffs, and transportation issues affecting aircraft component distribution, the aerospace industry can face several challenges. In the face of uncertain supply chains and supply chain disruptions, industry-specific strategies are needed to mitigate their impacts.

From this review, it is found that research on the effects of supply chain disruptions on manufacturing businesses is lacking, especially in terms of long-term complications. This covers the possibility that a manufacturing industry's business operations could sustain long-term harm from supply chain interruptions, as well as the manufacturing industry's capacity to recover from such disruptions. In order to prevent or minimize the effects of supply chain disruptions, industrial sectors must also better grasp how to recognize and resolve them proactively.

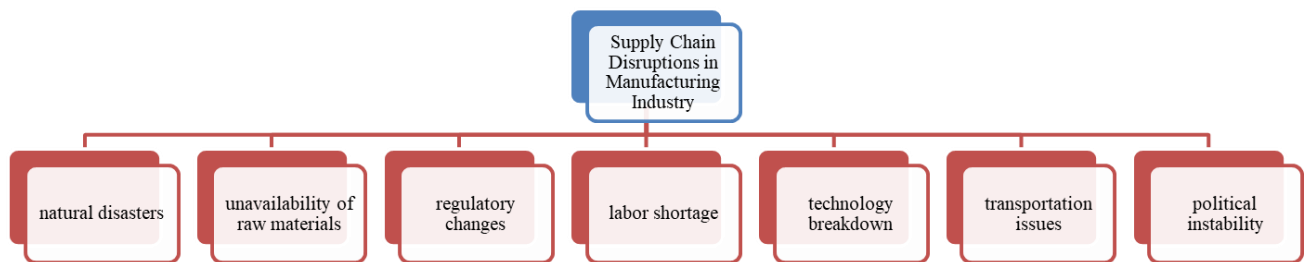


Figure 3. Conceptual framework.

From the above conceptual model (Figure 3), the following propositions can be derived:

- P1: Natural disaster creates a negative impact on supply chain disruption.*
- P2: Unavailability of raw materials negatively impacts supply chain disruption.*
- P3: Regulatory changes create a positive impact on supply chain disruption.*
- P4: Technology breakdown creates a negative impact on supply chain disruption.*
- P5: Labor shortage creates a negative impact on supply chain disruption.*
- P6: Transportation creates a positive impact on supply chain disruption.*
- P7: Political instability creates a negative impact on supply chain disruption.*

Figure 4 addresses the common impact of supply chain disruptions on manufacturing industries.

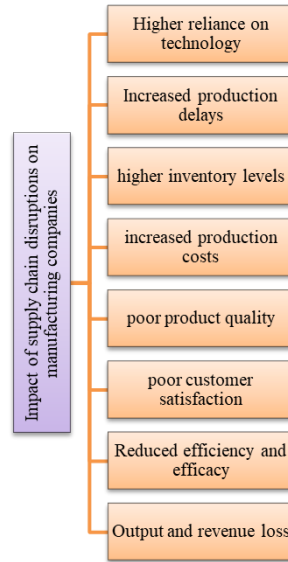


Figure 4. Common impact of supply chain disruption on manufacturing industries.

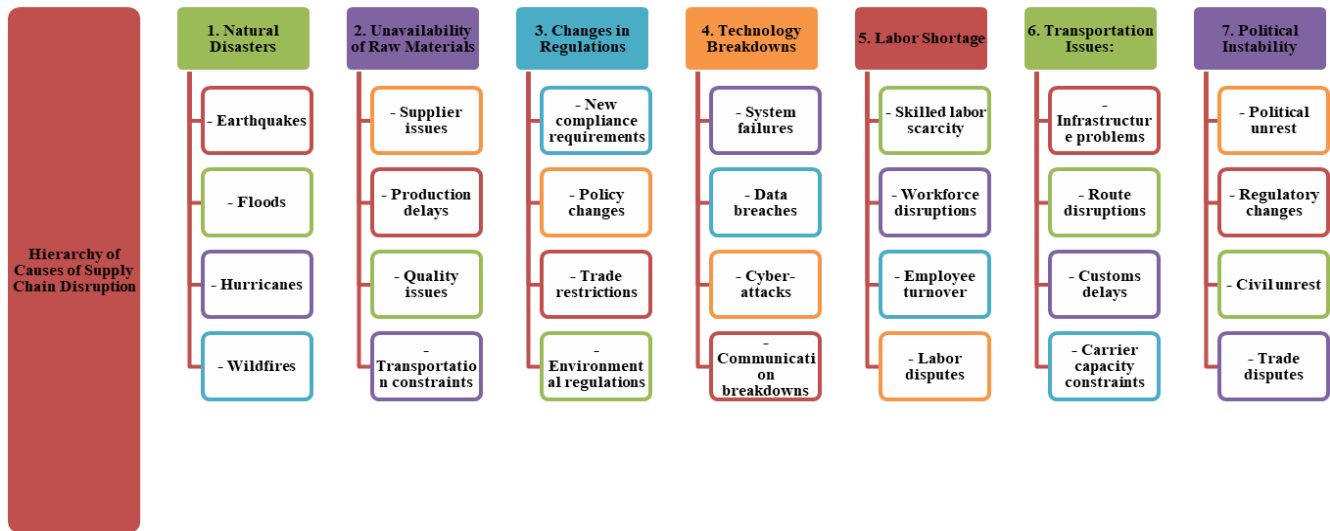


Figure 5. Major causes of supply chain disruption.

## 5. Research gaps identified from the review

Figure 4 has presented the common impact of supply chain disruption on manufacturing industries, and Figure 5 has hierarchically presented the major causes of Supply chain disruption. However, there is still a research gap that needs to be filled despite the considerable literature on the factors that disrupt supply chain management in manufacturing businesses. Further research is specifically required to comprehend the following topics more fully:

- Relationships between Disruption Factors: While the literature looks at different disruption factors separately, there is a lack of thorough research addressing how these factors are connected and can have cascade impacts. How, for instance, can natural calamities affect labor shortages or transportation problems? Organizations may create more effective and comprehensive supply chain disruption mitigation strategies by comprehending the intricate interactions between various disruption drivers.
- Research is lacking when it comes to efficient mitigation solutions for the unavailability of raw materials, despite studies that emphasize the effects of this problem. More investigation is required to pinpoint preventative

strategies that businesses can use, such as supplier diversity, smart inventory management, or alternate sourcing possibilities, to handle the problems brought on by a lack of raw materials.

- **Adaptation to Regulatory Changes:** Although the impact of regulatory changes on the manufacturing sector is acknowledged in the literature, there is little research on practical adaptation tactics. Manufacturers require direction on how to effectively track and respond to changing rules, maximize compliance initiatives, and overcome related difficulties without seriously disrupting their supply chain operations.
- **There is a research deficit in understanding how manufacturers may improve resilience in the face of technological disruptions,** despite studies addressing the effects of technical failures. In order to ensure minimal disruptions and prompt recovery in the event of technological failures, additional study is required to discover best practices in technology risk management, contingency planning, and investments in reliable IT infrastructure.
- **Addressing Labor Shortages in Supply Chains:** While there has been some research on the effects of labor shortages on supply chain operations, there hasn't been much done to identify practical solutions. Further research is required to examine cutting-edge solutions to labor shortages, including automation, reskilling initiatives, and strategic workforce planning to maintain manufacturing operations.
- **Sustainable alternatives for Transport Problems:** While it is acknowledged that transport problems are a substantial source of disruption, there is a lack of studies examining sustainable alternatives to lessen the effects. The development of techniques to reduce the carbon footprint of supply chain activities while guaranteeing effective and timely delivery of goods should be the main areas of future research. These areas include identifying environmentally friendly transportation modes, optimizing logistics networks, and designing such tactics.
- **Political Instability and Supply Chain Risk Management:** Although it is known that political instability can cause disruptions, further research is necessary to determine how manufacturers can successfully manage and reduce the risks that political instability poses to the supply chain. Examining methods to diversify sourcing locations, understand trade laws, and improve agility to react to geopolitical concerns are all included in this. By filling in these research gaps, manufacturing industries will get vital information that will help them improve the resilience of their supply chains and create practical mitigation plans for disruption factors.

## 6. Conclusion and future work

In conclusion, supply chain disruptions in the manufacturing sector have grown to be a serious worry for companies all over the world. Such hiccups can have disastrous effects on business operations, resulting in higher costs, lost earnings, and disgruntled clients. To make sure that their supply chains are resilient and prepared to handle disruptions when they happen, businesses need to take preemptive measures. This entails implementing a successful risk management plan, making technology investments, and forming cooperative relationships with clients and suppliers. By implementing these actions, companies can make sure that their supply chains can handle disruptions and continue to run at a high level. The current study does not involve any primary data analysis or interpretation. In the future, the model developed in this research could be tested through appropriate instrument development, primary data collection, and analysis in order to establish the relationships proposed in this research.

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