

## The Supply Chain: Before, During, and After COVID-19

Terry L. Howard  
University of Detroit Mercy

Gregory W. Ulferts  
University of Detroit Mercy

### ABSTRACT

The complex supply and demand relationship is partly due to the globalization and internet availability that has connected millions of individuals in commerce and trade geographical distance. As a result of the interconnectedness, an interruption in the supply chain impacts many business entities. This study examines the supply chain management methods in the pre-COVID-19, the issues that emerged during the pandemic, such as distribution failure and the second section's ripple effect, and finally emerging changes post COVID-19. The COVID-19 pandemic was not the only challenge facing the supply chain networks. Instead, it amplified and exacerbated the existing challenges, and thus the industry experienced an interruption of product deliveries forcing some business entities to shut down. In spite of the challenges experienced in the pre-COVID-19 and throughout the pandemic, the future looks promising, with significant changes and opportunities in policy reforms, big data analytics, and intelligent logistics. Leaders can refine the lessons discovered during the pandemic through prescriptive analytics to support decision-making processes in future related challenges. In short, the magnitude of COVID-19's effect on SCM is undeniable the largest source of data that will shape policy reform debates and re-define international collaboration in research and development like witnessed during the manufacturing of the COVID-19 vaccines. The present study recommends that further studies establish the actual extent of the impact caused by COVID-19 on SCM.

Keywords: Pandemic, Covid-19, Supply Chain, Supply Chain Management, Commerce

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## INTRODUCTION

The movement of products from the producers to the consumers occurs through a complex “supply and demand” relationship. The complexity is partly due to the globalization and internet availability that has connected millions of individuals in commerce and trade geographical distance (Queiroz et al., 2020). As a result of the interconnectedness, an interruption in the supply chain impacts many business entities worldwide. For instance, the novice COVID-19 in late 2019 in Hebei Province of the Wuhan region in China caused significant damage to the global supply chain. From healthcare, food, medical supplies to microchips, the interruption of the distribution chain occurred because of the stringent health measures and travel advisories banning most international flights (Okeagu et al., 2021).

Additionally, the outbreak of COVID-19 also triggered a high demand for essential goods and commodities such as personal protective equipment (PPE), face masks, and body bags. The market quickly outweighed supply, thus leading to hoarding of these goods due to anxiety (Queiroz et al., 2020). No one had anticipated the outbreak and the speed of spread. Therefore, most societies were unsure how to respond to this global pandemic. Consequently, the widespread panic led people to buy essential commodities such as face masks, hand sanitizers, toiletries, and bottled water in bulk for fear of not knowing when the pandemic would end. Local suppliers also hoarded and inflated the prices of medical supplies, and these actions and events worsened the situation in many parts of the world (Micheli et al., 2021). The hospitals also experienced many patient admissions in the ICU on the same breadth who required ventilators for respiratory support. The high number of patients quickly outweighed most healthcare facilities’ supplies. In short, the outbreak of COVID-19 exposed the inadequacies in supply chain systems in healthcare and a host of other industries. The world, as it is, lacks the complete supply chain management to face a global pandemic (Okeagu et al., 2020).

This current study sets out to examine the supply chain management methods in the pre-COVID-19 in part one. Next, the paper shall also discuss the issues that emerged during the pandemic, such as distribution failure and the second section’s ripple effect. Finally, the article shall summarize the emerging changes post COVID-19.

## SUPPLY CHAIN MANAGEMENT PRACTICES PRE-COVID-19

Supply chain management (SCM) represents a vital segment of a business process that supports the movement of goods and other services across geographical locations. Without it, it becomes difficult for the goods to move from production to the point of sale that may occur thousands of miles away (Okeagu et al., 2021). Therefore, supply chain management is a broad area that encompasses many independent business entities in logistics, transport, warehousing and storage, and insurance. Additionally, it also incorporates security both physically and in cyberspace. According to Freund et al. (2020), these business processes that constitute SCM have inherent risks and face multiple threats. Therefore, SCM in the pre-COVID-19 already faced several challenges, as discussed below:

### Poor Seaport Management

Delays in the delivery of goods are among the greatest significant challenges in supply chain operations before the outbreak of COVID-19. Many organizations experienced delays in

delivering the ordered products or raw materials due to the long lead times caused by congestion of the seaports and poor clearance systems in most ports worldwide (Okeagu et al., 2021). These delays have negative ramifications on the business. More specifically, such delays increase production costs and loss of clients in some extreme cases. According to many authors, seaport challenges include but are not limited to physical congestion due to high volumes of imports and exports Khan & Yu (2019). Plus, there is also limited capacity in terms of human resources, a significant presence of heavy-duty vehicles in some specific ports such as Apapa seaport in Nigeria, and a lack of modern technologies to facilitate quick clearance in most developing countries Khan & Yu (2019).

Furthermore, some seaports also lack adequate equipment like ship-to-shore container cranes, which makes handling containers difficult, especially among the large ship vessels that cannot dock in shallow waters. According to Khan & Yu (2019), most countries have poorly developed seaport infrastructure network that accounts for the delays of sea cargo. As a result, there is a ripple effect of these inefficiencies. For example, in most cases, the suppliers were unable to meet the demands of the buyers in good time, subsequently leading to trade defaults, increased logistics costs, and other consequences that negatively affect businesses (See Figure 1 in Appendix A).

### **Poor Transport Infrastructure**

Poor roads, railways, and inland water transport remained among the issues impacting the supply chain operations (SCM) in the pre-COVID-19 period. Most countries have poor roads and rail networks that lack coordination. Damaged roads with sizeable potholes across distribution networks, worn out, and faulty distribution trucks are some of the challenges and issues that plagued the supply chain operations in the pre-COVID-19 (Khan & Yu, 2019). Additionally, there was a lack of proper cold storage facilities and trucks for the perishable agricultural products in some parts of the world. These challenges impeded the supply chain system operation. Furthermore, most countries had poor coordination of transportation networks featuring cargo rail and inland water transport. More specifically, these issues impacted the delivery and lead time in SCM.

### **High Taxation and Unstable Foreign Exchange Rate**

Supply chain systems have also faced the challenge of high taxation rates in some countries. The high import taxation on some products increases the cost of these products when they reach the final consumers (Zijm et al., 2019). As a result, this lowers the demand for this product, which negatively affects the SCM. Additionally, the instability of foreign exchange in some countries due to high inflation rates raises the cost of production of the suppliers. In other words, fluctuation in foreign exchange rates causes cost-push inflation.

## **OTHER SUPPLY CHAIN ISSUES OF CONCERN IN THE PRE-COVID-19**

### **Sustainability Focus**

Supply chain leaders have grappled with the issue of sustainability for quite some time. Some challenges had existed before the outbreak of the COVID-19. More specifically, many

scholars and practitioners have expressed interest in establishing factors that can enhance sustainability in supply chain operations. According to Cankaya & Sezen (2019), sustainable supply chain management (SSCM) begins with an organization or company's awareness of its economic, environmental, and social impact. Next, it involves designing strategies and making the required changes to reduce these mentioned business environments. In other words, sustainability encompasses all the efforts from production, storage, transportation of goods, and other services to the final consumers (Sarkis et al., 2020). Reducing power consumption or reducing carbon dioxide emissions are all strategies involved in sustainability efforts.

The significance of sustainability in supply chain operations supersedes the ability to embrace green technology. In other words, it is not all about reducing carbon print in the atmosphere. Instead, it is a holistic concept that ensures the supply chain system does not cause harm to the economic, environmental, and social impact aspects of business operation. Therefore, Cankaya & Sezen (2019) argued that sustainability is perhaps the most critical aspect of SCM. It supports resilience and ensures that business enjoys continuity of service and operation.

Moreover, a supply chain operation anchored on sustainable and resilient platforms encourages more business collaboration and partnerships. Furthermore, many business entities and government agencies are more interested in conserving the environment upon which organizations operate. Therefore embracing eco-awareness strategies in all aspects of operations from production to transportation and logistics towards delivering goods to the final consumer enhances an organization's reputation (Sarkis et al., 2020).

At the foundation for supply chain operations, sustainability is more interested in enhancing productivity and efficiency. For instance, some of the best-managed companies, such as Nike, have embraced sustainability by using advanced technologies and innovative principles to manufacture their shoes. More specifically, when Nike changed how it made some of its boots, labor production decreased by 50% and the material cost by 20%. These changes in the price of production lead to a significant increase in margin level by 0.25%. Against this background, it is critical to note that sustainability can enhance the efficiency of supply chain operations and result in profit maximization. Sarkis et al. (2020) cited that supply chain systems typically focus on technology and viability. In other words, a successful supply chain should achieve a balance between viability and a balanced ecosystem featuring economic, environmental, and social impact harmony. However, for this to work, especially in the globular economy, there is a need for business entities to act on constructive and destructive feedbacks (Sarkis et al., 2020).

The sustainability concept thus is broad and encompasses the interaction between the supply chain system and the environment. For instance, when business entities utilize natural resources to produce products, there is a negative impact of the emission of harmful gases to the environment, which subsequently has a ripple effect on climate change (Queiroz et al., 2020). Therefore, scholars in SCM have expressed immense interest in establishing the correlation between resource utilization, negative impacts, and innovative solutions to manage negative feedback. More recently, sustainability has also evolved to include the aspects of social responsibility. According to Khan & Yu (2019), business entities involved in the SCM are responsible for the societies they serve. Therefore, protecting the environment and improving the livelihood of the communities through corporate social responsibilities is a central theme in sustainability efforts. Finally, the SCM in the pre-COVID-19 had many issues and concerns that directly or indirectly affected its operations.

## Cybersecurity

Over the past few decades, supply chain systems have evolved and developed into a complex network of business operations. While many factors, such as increased demand due to population change, may have increased the demand for supply chain operation services, technology has remained the leading growth factor (Zijm et al., 2019). As a result, organizations of all sizes have quickly embraced technology and innovation in many business processes. Similarly, several business entities have digitized their strategies and operations and are gradually adopting cybersecurity measures. However, despite these initiatives and technological migration in most business entities, many authors believe cyberbullies have shifted their focus to suppliers, manufacturers, and other relevant third-party global partners. For example, Cheung et al. (2021) argued that targeting this group of business entities within a supply chain system happens because most have weak cybersecurity systems to prevent an attack.

Cybersecurity threats remain an area of concern for most players in SCM. The need to protect the system's integrity and ensure that the clients receive quality products and services is an area of interest that has attracted considerable research studies. According to Cheung et al. (2021), supply chain systems should embrace the latest technologies in cybersecurity to thwart efforts by cyberbullies to compromise the system. Moreover, the increased use of disruptive technology such as robotic process automation is beneficial in many ways. First, they are helpful in warehousing and factory floors. Second, the digitization of many business operations provides an opportunity for cybercriminals to attack the supply chain system. Figure 2 (Appendix B) shows the cybersecurity distribution of risk.

In many cases, supply chain risks may include but are not limited to denial of service (DoS) attacks, crucial theft of customer data, disruption of business, and data leaks (Choi, 2020). Additionally, supply chain systems may also suffer from malware and ransomware attacks. Based on these insights, business leaders in SCM must review their operations and assess cybersecurity risks through technology, processes, and people. In other words, cybersecurity compromise may be due to technological issues, process failures, or intentional/unintentional actions of the people within an organization (Choi, 2020).

## ISSUES THAT AROSE THROUGHOUT THE PANDEMIC

The outbreak of COVID-19 interrupted the supply chain, causing a loss of business worldwide. This section thus discusses the specific issues that emerged during the pandemic within supply chain operations.

### Distribution Failure

The outbreak of COVID-19 in late 2019 in the Wuhan region in China and spread globally paralyzed socio-economic activities. More specifically, the COVID-19 degenerated into a global pandemic that continues to cause havoc to many business entities, individuals, and society. According to Freund et al. (2020), the pandemic has disrupted the social order, with the health sector imposing strict policies like social distancing, physical distancing, voluntary, and health isolation. In addition, the government has also imposed further restrictions such as travel restrictions and travel advisories, negatively impacting economic activities. Consequently, the



world has experienced the worst global recession since the 1930s Great Depression (Wheelock, 2020). Figure 3 (Appendix C) shows the effect of COVID-19.

Besides disrupting social and economic order, the epidemic of COVID-19 mainly affected supply chain management (SCM), leading to distribution failure. The abrupt high demand for certain products such as the PPE, face masks, and medical supplies quickly surpassed the supply, thus causing distribution failure. Moreover, the COVID-19 outbreak also triggered travel restrictions and other health measures like social distancing that significantly decreased the number of employees per shift. In general, according to Reuters (2020), 48.8% of respondents indicated that Covid-19 was very disruptive to their supply chain business. On the same note, 41.5% cited that Covid-19 was somewhat disruptive to their supply chain business. These changes in business operations not only affected production capacity but also led to distribution failure. Businesses still find it challenging to handle the high demand for some goods with limited workforce capacity. Choi (2020) has noted that companies are trying to cope with the new challenges they face during this pandemic and will probably face difficulties in the post-pandemic. These challenges have caused an uproar in many quarters of management. Scholars and practitioners in the SCM are already expressing interest in studying the epidemic and its implication on business distribution and SCM in a broader context. However, there currently is limited scientific evidence about the relationship between SCM and COVID-19.

Moreover, scholars have failed to keep abreast of the global pandemic spread and the current economic status. In other words, there is limited empirical evidence to show the exact extent of damage that COVID-19 has impacted on SCM (Queiroz et al., 2020). Low production levels and restricted international movements primarily caused the distribution failure.

### **Scarcity Due to High Demand**

The second issue that emerged during the current pandemic is the scarcity of some products. As discussed, the COVID-19 outbreak triggered a mismatch between supply and demand for certain goods. For instance, the need for PPE, face masks, and hand disinfectants remained high beyond the suppliers' production. As a result, this caused scarcity of these products. On the same note, the governments' travel restrictions also caused scarcity of some goods in many segments of the world. More specifically, the ban on international travel to areas like China and Asia affected the supply of several goods. Queiroz et al. (2020) noted that China and most Asian countries such as Taiwan and Hong Kong produce many products ranging from household commodities to microchips used in electronics and automobiles. Therefore, international trade restrictions to these countries and many other countries with active industrial production impact the global economies negatively. Furthermore, the misalignment of demand and supply resulted in shortages, with the shortage of PPE and medical supplies getting high media coverage in many countries worldwide, including the U.S. (Micheli et al., 2021).

Previous studies showed that the high demand for these goods created a hyper-competitive market condition where buyers and sellers openly expressed self-interest, thus causing prices to shoot more than a hundredfold. For example, the U.K.'s spending on PPE increased from £146 million in 2019 to £15 billion in 2020. Based on these significant increases in prices of these goods, some scholars have argued that the governments partly contributed to these misfortunes. They failed to put in place the necessary good policies and decentralized procurement system. Additionally, most countries had no adequate capacity to produce the PPE kits and other essential medical supplies. As a result, many nations failed to secure an adequate

supply of these vital goods from the few suppliers, causing acute shortages (Micheli et al., 2021). The scarcity of these essential goods, typically classified as low-value goods yet essential, have taught the world and business leaders an important lesson. It is unwise to neglect the production of critical products perceived to be of low value. Depending on other countries for such products can result in acute shortages like the one witnessed during this global pandemic. Therefore, there is a requirement for capacity building to empower local business entities to produce these essential goods.

## **IMPORTANCE OF COMMUNICATION**

Communication and open flow of information between suppliers, buyers, government agencies, and the people is imperative during a pandemic. Lack of proper communication causes anxiety, panic, and in most cases, disrupts supply chain systems. For instance, Freund et al. (2020) noted that the COVID-19 outbreak sparked a high demand for some goods such as PPE kits, face masks, and ventilators. Consequently, the suppliers were hard-pressed to produce additional goods because of limited capacity and capabilities, increasing prices. Additionally, the supply chain suppliers and intermediaries also engaged in unethical business practices such as hoarding these essential goods to inflate their prices (Wang et al., 2021). Unfortunately, some of these challenges caused a lack of timely communication among key stakeholders such as government agencies, manufacturers, manufacturers, and healthcare professionals. According to Abrams & Greenhawt (2020), timely communication among the relevant authorities and stakeholders is vital during a pandemic. The author argued that proper communication could prevent overstocking and also reduce shortages.

Inter-communication among several parties from government agencies, business entities, and the general public proved beneficial during the pandemic. It influenced international collaboration and thus supported SCM. Different government agencies were able to work closely with their counterparts from other countries to ensure that the essential goods and services occurred with the least resistance (Wang et al., 2021). For example, the U.S., China, and other nations collaborated to ensure timely supply and distribution of essential goods such as PPE kits and face masks that have effectively managed the COVID-19 pandemic. Inter-communication between parties has also led to joint standardization and regulation of these products (Ketchen & Craighead, 2020).

Moreover, advanced information and communication systems in SCM have come in handy during the pandemic. Dissemination of quality, authentic and reliable information among stakeholders in SCM has proven vital in an era of a pandemic where misinformation can fuel conspiracy theories and cause unprecedented damage (Wang et al., 2021). Therefore, most business entities and government agencies have relied upon proper communication channels to ensure quality information flows throughout the supply chain system. In short, communication is among the issues that arose throughout the pandemic and shall remain crucial even in the post-pandemic Abrams & Greenhawt (2020). It will continue to influence supply chain systems and cooperation between business entities into the future. In other words, prompt communication helped business entities fast-track their orders and place new ones in record time.

## **SUPPLIER ENGAGEMENT**

Contemporary society has faced several challenges, ranging from wars to natural disasters like earthquakes and tsunamis. However, in recent decades, the world has not witnessed a pandemic of this magnitude since the Spanish flu (Sarkis, 2020). Therefore, supplier engagement has been a critical issue of interest to many scholars and practitioners. Whereas in the past, supplier management has focused more on business requirement issues such as proper documentation, insurance, and information security, the current challenges throughout the pandemic have shifted the interest to more holistic and fundamental issues relating to human resources management (Meyer et al., 2021). The pandemic turned the discussion about supplier engagement to labor relation practices, sustainability strategies, and environmental management issues. For instance, suppliers in some critical segments of the economy needed to explain their preparedness to handle COVID-19 and its impacts on society (Sarkis, 2020). Plus, various government agencies are also interested in knowing how these suppliers protect their workers during this pandemic. In other words, maintaining supply chain systems open is critical during a pandemic. However, business entities must protect their workers from avoiding casualties that may paralyze the entire operation. Okeagu et al. (2020) also noted that understanding how businesses have planned for the future is vital. Most have reduced workforce capacities due to health directives of maintaining physical and social distancing.

The supplier engagement during COVID-19 also has the open debate about the level of preparedness of business entities and independent organizations such as government bodies to communicate and engage with the suppliers quickly in times of a crisis to address the emerging supply chain challenges. Meyer et al. (2021) cited that effective supplier engagement can help to support the smooth flow of goods within the supply chain leading to few interruptions. Moreover, a close work relationship between suppliers intermediates such as transportation and logistics companies and relevant government agencies can minimize interruptions caused by travel restrictions, lockdown, and other stringent regulatory measures. Figure 4 (Appendix D) shows the biggest impact. More specifically, lack of visibility of events and possible alternatives was the biggest challenge facing most supply chain businesses at 33.3%. The shortfall of suppliers took the second slot at 26.7%, followed closely by closed borders that restricted movement at 23.3%. Finally, supply chain also felt the Covid-19 impact due to delay or lack of government support.

## **SUPPLIER DIVERSIFICATION**

The COVID-19 outbreak has also brought to light the vulnerabilities in supply chain operations that rely on a single source/supplier. The government directives such as lockdowns and travel restrictions have triggered a debate about the practicality of a single supplier. As a result, many business entities had to get back to the drawing table to map out their supply chain system. The lockdown in most countries worldwide led to shutting down businesses and reducing supplies to many business entities worldwide. Therefore, many organizations have appreciated the need for more supplier diversification to spread the risk throughout the supply chain (Choi, 2020). For example, having two different suppliers from geographically diverse locations could save many businesses the headache of shut down due to a shortage of raw materials. This outcome is because, in times of pandemics, some regions could be affected more than others. For example, European countries such as Italy got impacted severely than most



African countries (See Figure 5 in Appendix E). Therefore, an organization with a supplier of products from Italy would suffer more significant losses if there was no backup supplier from a different location. Consumer buying patterns thus shifted significantly to online shopping in Italy and France. This new trend is perhaps taking shape because online shopping is deemed safer and has less contact.

Previous studies have indicated that a dual supply system is more beneficial in situations like a pandemic that may impact one region or country severely than others. On the same breadth, multiple suppliers can provide the needed resilience in times of stress and save the supply chain of many organizations (Li & Zobel, 2020). However, many scholars have argued that multiple suppliers have underlying risks that can compromise resilience and efficiency. While the current study agrees with these assertions, it is also true that the level of technology, digitization of processes, and quality data can empower business organizations to find a balance concerning efficiency and resilience for profit and cost (Chain, 2020).

## **EMERGING CHANGES POST-COVID-19**

Supply chain systems during the COVID-19 experienced several challenges. As discussed, many supply chain operations faced distribution failures, scarcity of some products, and logistic issues because of the lockdown and travel restrictions. For these reasons, it is imperative to analyze the SCM emerging changes post-COVID-19. More specifically, different countries' measures in dealing with the COVID-19 spread are diverse. These measures include social distancing, restriction of movements for ground and freight cargoes, curfew, lockdown, and border closure, which significantly impacted the SCM processes. Queiroz et al. (2020) argued that these measures affected the supply chain operations in many ways. For example, many supply chain organizations experienced staff shortages, restrictions in delivery routes in many segments of the world, and significant changes in consumer behavior that directly influenced their purchasing power decisions (Chowdhury et al., 2021; Micheli et al., 2021).

### **Supply Chain Transparency**

As discussed, the COVID-19 pandemic caused several challenges to global supply chain systems. Additionally, it also exposed the interconnectedness that exists among business entities worldwide. Against this background, business leaders must embrace some changes and develop new enterprise models in the post-COVID-19. For instance, supply chain systems and business leaders will have to adopt supply chain transparency to survive the business terrain in the post-ear of COVID-19. During the COVID-19, many suppliers, SCM players, and world leaders collaborated to ensure a prompt supply of essential goods and services. The collaboration, synergistic energy, and transparency acted as a facilitator for the common good. For example, many authors agreed that collaboration by different suppliers and stakeholders boosted the sustainability and resilience inside the supply chain system (Li & Zobel, 2020). Though not an entirely new concept, leaders can leverage supply chain transparency in post-COVID-19, enhancing efficiency and reducing lead times (Chain, 2020). Furthermore, timely delivery of goods with fewer restrictions is beneficial to many business entities because it lowers production costs and enhances customer satisfaction. Figure 6 (Appendix F) shows the emerging strategic priorities.

## **SMART Logistics**

The COVID-19 outbreak disrupted many business processes and paralyzed the world economy. Consequently, the logistics industry was affected significantly through the several health and preventive measures initiated by government agencies and World Health Organization directives. Therefore, to rebuild and cope with the changes in post-COVID-19, the logistics industry must embrace smart logistics technology (Dantas et al., 2021). In some nations such as China, this is already being implemented and pursued. Pan et al. (2020) defined smart logistics as a set of disruptive new technologies that can conduct analysis, make decisions, and execute plans through intelligent devices. For example, the Unmanned Aerial Vehicle (UAV), a drone technology, has been deployed to help distribute essential goods such as face masks and hand disinfectants to buyers without physical contact. This capability is a positive step that reduces the chances of virus spread and may prove relevant in post-COVID-19. Moreover, these intelligent logistics technologies are cheaper over time due to their reduced labor costs and higher-margin revenues (Liu et al., 2020).

Innovative logistics technologies also provide an opportunity for supply chain management (SCM) to embrace disruptive technologies such as artificial intelligence, big data analytics, blockchain technologies, and machine learning. For example, China had invested in smart logistics that incorporate A.I. technologies with 90% automation rates. As a result, these intelligent logistics centers in China are more efficient than the traditional warehouses. Furthermore, China Smart Logistics Network has an aggressive plan of connecting over 100 million smart terminal devices that will significantly enhance domestic supply chain delivery within 24 hours and international express delivery within 72 hours (Liu et al., 2020). Additionally, predictive and prescriptive data analytics will help smart logistics centers forecast future demands and provide the best comprehensive and data-driven solutions.

## **Policy Reforms**

Reforms in international policies and relationships will be a significant emerging change for business and world leaders to enhance supply chain systems. Based on the level of collaboration witnessed during COVID-19 and the success achieved through partnership and relaxation of some restrictive policies, it is probable that the world can achieve much more by embracing policy reforms in supply chain management (Campbell, 2020). More specifically, business entities, supply chain players, and governments worked together to produce different COVID-19 vaccines that have boosted the fight against the pandemic (Del Pozo & Beletsky, 2020). Therefore, policy reforms in materials sourcing, technological transfer, and SCM can enhance product design, production, and delivery within record time. Subsequently, reduced lead times and prompt deliveries of goods and commodities shall help revitalize the world economy.

Furthermore, scholars can examine the descriptive data during the COVID-19 to identify significant trends and patterns to help policymakers improve SCM policy reforms. For instance, data on lockdown, partial and complete closure of borders, restriction of S.C. trade routes can correlate the rate of supply chain efficiency and these bottlenecks (Chowdhury et al., 2021). In other words, using the past data in these areas can help policymakers design the best legislation applicable in similar pandemics that may occur in the future (Campbell, 2020; Miroudot, 2020). Policy reforms could also allow more public and private partnerships to produce essential goods required during a pandemic.

Previous studies in policy reforms indicate that many countries are more prone to review their policies to align with evolving technologies such as intelligent logistics. For instance, in China, government policies are at the forefront of guiding the expansion of intelligent logistics (Liu et al. 2020). Changes in technology, such as the 5G technology, will also influence the success of smart logistics and other disruptive technologies (Fong et al., 2021). As a result, there is a requirement for policy reforms to capture the new technologies and define how practitioners should utilize them. At a global level, policy reforms will improve collaborations and joint partnerships in diverse business areas. For example, reduced tariffs on some raw materials required to manufacture essential products can lower the production costs and ensure that supply chain operations remain uninterrupted due to stringent rules (Del Pozo & Beletsky, 2020).

### **Big Data Analytics**

After the post-COVID-19, many business entities require a recovery strategy. One of the best ways to achieve this essential need is supply chain sustainability and resilience. Dantas et al. (2021) pointed out that data and analytics (descriptive, prescriptive, and predictive) can empower business owners and policymakers to make informed decisions. Moreover, several companies are currently deploying big data analytics to capture complete data and derive underlying relationships in ways that were never possible before. According to Sarkis (2020), big data analytics allow supply chain players to analyze raw material acquisition to deliver finished products and customer feedback. Companies that will have the capacity to analyze these data as described from raw material acquisition to the delivery of finished products to the consumers and share the insights with their supplier partners will significantly improve the supply chain resilience and efficiency (Javorcik, 2020).

Prescriptive analytics, which encompasses descriptive and predictive data, and comprehensive analysis of alternative solutions, is an area of interest that will define future supply chain relationships post-COVID-19. Asare et al. (2020) argued that access to the correct data is the initial step in attaining resilience and promoting sustainability. In other words, supply chain players can only improve service delivery and eliminate potential bottlenecks when they are aware of the challenges through the correct data (Sarkis, 2020). The post-COVID-19 thus shall bring into focus the role that big data and data analytics play in global business operations and collaborations. As discussed, companies that rely on SCM already have access to actual, extensive data. However, most are yet to fully integrate deep learning, machine learning, and artificial intelligence (Fong et al., 2021). Therefore, the present study recommends that in post-COVID-19, more companies involved in international trade should embrace these emerging technologies to develop supply chain transparency, intelligent technologies, and general SCM efficiency capabilities (Fong et al., 2021).

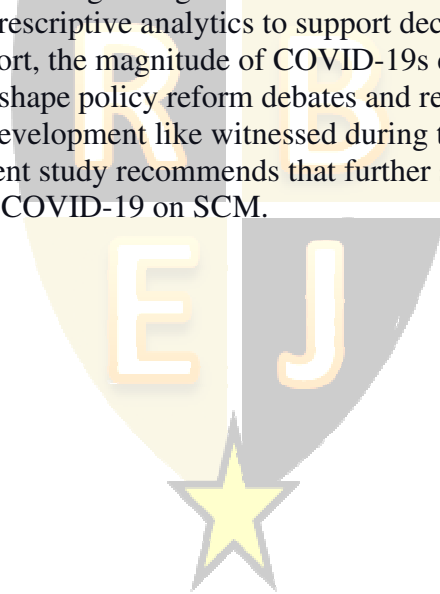
### **CONCLUSION**

In conclusion, the COVID-19 pandemic impacted SCM practices and operations worldwide. The preventive health measures, in particular, have affected how suppliers and companies operate. More specifically, there have been substantial changes in labor practices, with most supply chain players experiencing staff shortages, remote working, and restrictions on trade routes (Chowdhury et al., 2021). Consequently, these measures have led to delay in deliveries and long lead times. Therefore, the COVID-19 pandemic contributed significantly to

some products' distribution failure and scarcity in a spiral effect. However, it is equally important to note that the SCM had some issues of concern before the COVID-19 outbreak. For instance, the supply chain industry faced poor seaport development, high taxation, unstable foreign exchange rates, and poor transportation infrastructural development.

Furthermore, the supply chain industry also had concerns in fields such as cybersecurity and sustainability. Therefore, the COVID-19 pandemic was not the only challenge facing the supply chain networks. Instead, it amplified and exacerbated the existing challenges, and thus the industry experienced an interruption of product deliveries forcing some business entities to shut down.

Finally, SCM practices during COVID-19 underwent the worst disruption since the ending of the Spanish flu. The world economy went into stress, and in subsequent resilience, businesses and government operations shut down during lockdown. The initiation of restrictions for goods and people was a means to contain the contagion. Despite these stringent measures, the COVID-19 virus spread alarmingly, infecting millions of individuals, with millions of others losing their lives. In spite of the challenges experienced in the pre-COVID-19 and throughout the pandemic, the future looks promising, with significant changes and opportunities in policy reforms, big data analytics, and intelligent logistics. Leaders can refine the lessons discovered during the pandemic through prescriptive analytics to support decision-making processes in future related challenges. In short, the magnitude of COVID-19's effect on SCM is undeniable the largest source of data that will shape policy reform debates and re-define international collaboration in research and development like witnessed during the manufacturing of the COVID-19 vaccines. The present study recommends that further studies establish the actual extent of the impact caused by COVID-19 on SCM.



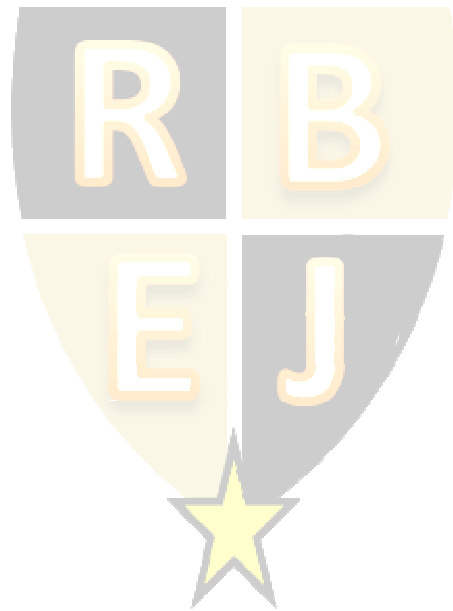
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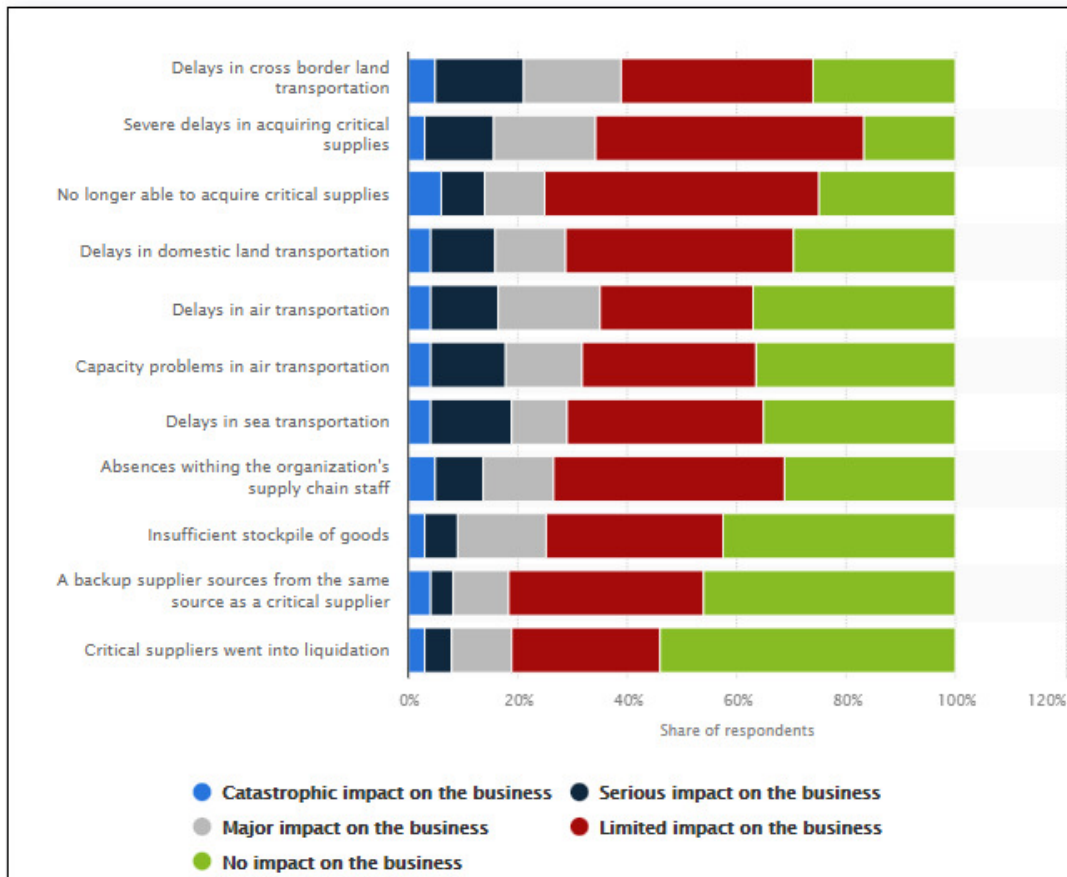
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Appendices

Appendix A

Figure 1: Graph illustrating the impact of COVID-19 on supply chain

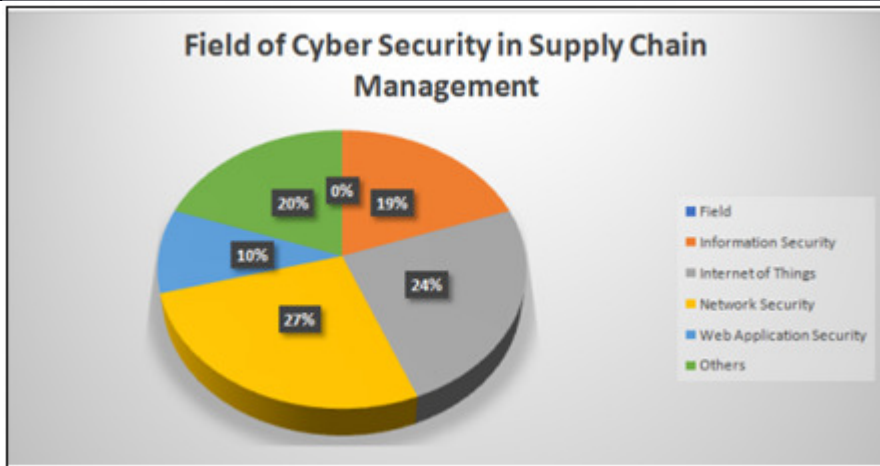


Source (Mazareanu, 2021)



**Appendix B**

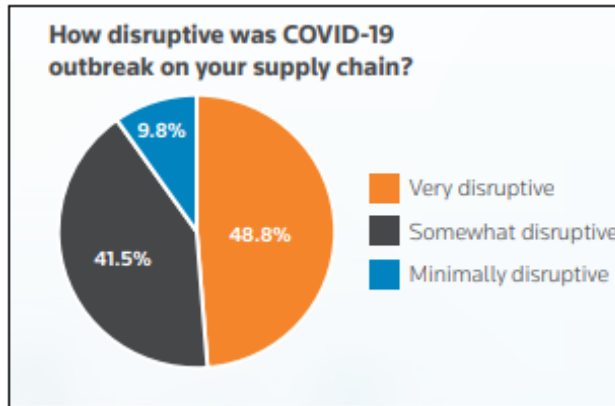
**Figure 2: Cybersecurity Distribution of Risk in Supply Chain Management**



Source (Latif et al., 2021).

**Appendix C**

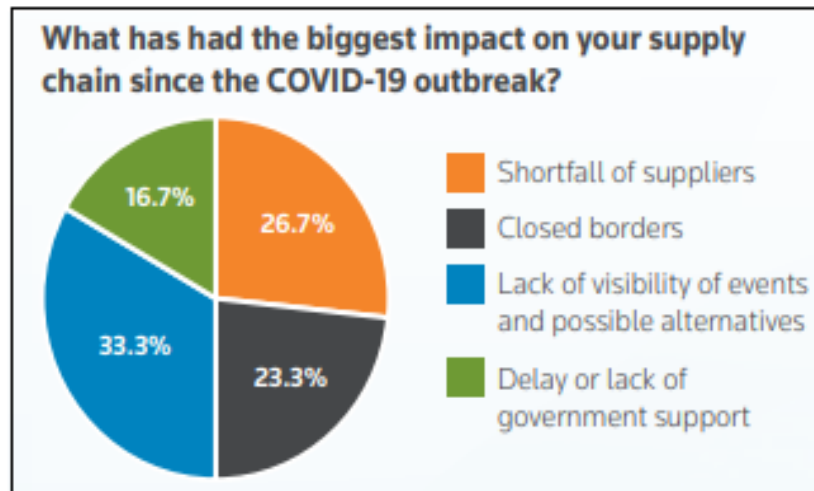
**Figure 3: Effect of Covid-19 on Global Supply Chain**



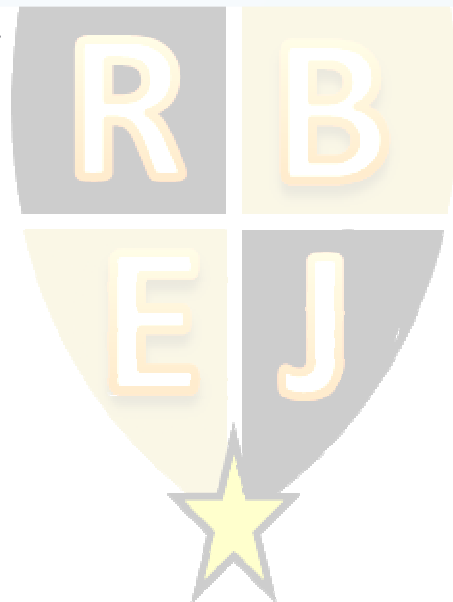
Source (Reuters, 2020)

Appendix D

**Figure 4: Impact on the Supply Chain During Covid-19**



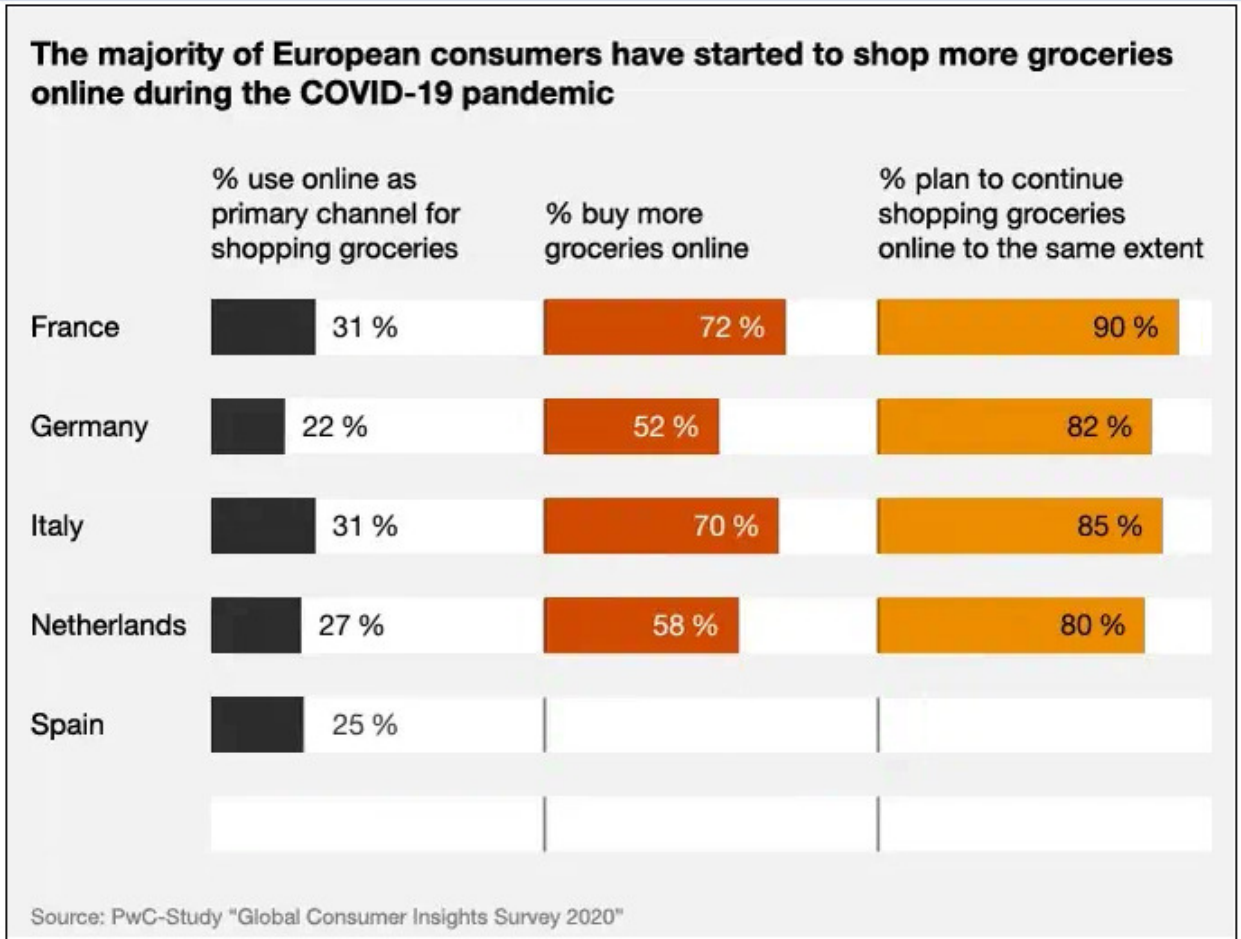
Source (Reuters, 2020).





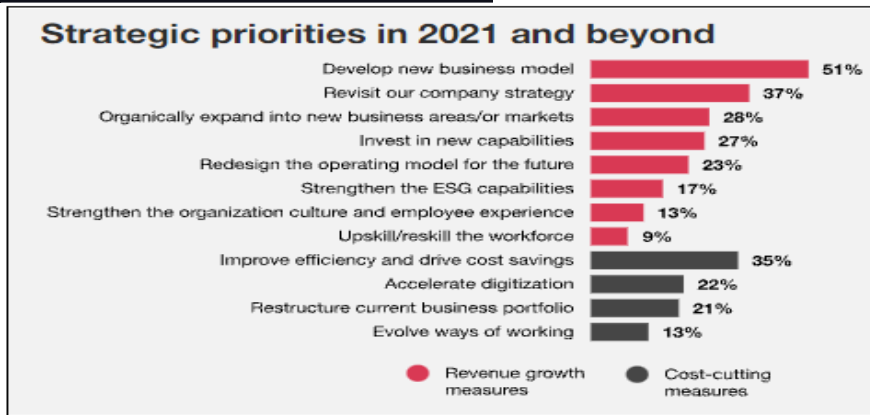
Appendix E

Figure 5: Illustration Of The Consumer Buying Patterns During The COVID-19 Pandemic, graphical illustration adopted from Source (PWC Report, 2020).



Appendix F

**Figure 6: Business Priorities in Post-Covid-19**



Source (PWC Strategy Report, 2021)

