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Covid-19 Effect on Supply Chain a Case Study of Supply Chain Resilience Challenges and Learned Lessons from Pandemic

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Abstract: The global supply chain has been in crisis for two years, and there is no end. Ports are inundated with shipping containers, and freight rates have reached new highs. Unfortunately, not just one company or industry feels the impact: the supply chain crisis impacts everyone.

The COVID-19 pandemic has had a significant effect on supply chain management. The disruption of global trade will drastically impact companies' production, shipping, and economic well-being worldwide.

In terms of production, companies will need to find alternative sources of raw materials and components that are not affected by the pandemic. This may include sourcing from countries with less risk of contagion or finding new suppliers altogether. Many companies are already looking at ways to increase their domestic manufacturing operations to reduce their reliance on international shipping routes.

In terms of shipping, many companies have suspended all shipments or are limiting them to only essential items like food, medical supplies, and fuel for vehicles and generators. Other companies are using air travel as much as possible because it is less susceptible to disruption by roadblocks and other security measures put in place by governments trying to curb the spread of COVID-19 infection rates among civilians who may be traveling abroad while they still can before they are forced into quarantine at home instead (which will limit their ability to work remotely).

The effects of COVID-19 on the supply chain have been wide-ranging. Global economic growth and trade are both negatively impacted by the pandemic, which has resulted in plummeting global GDP and deflation.

The global economy is also affected by increased shipping costs and reduced demand for goods resulting from increased safety measures and travel restrictions. These factors have resulted in a decrease in transportation industry productivity, as well as a disruption to distribution channels and routes.

In addition, COVID-19 has caused an increase in production costs due to shortages of workers who can work on-site due to illness, travel restrictions, and other factors. As well as higher labor costs due to increased demand for workers.

Keywords: Covid-19, Supply Chain, Resilience, Transportation, Manufacturing, Demand Planning, Procurement, Challenges, Sustainability.

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1. Introduction

The COVID-19 outbreak and ensuing economic disruption exposed long-standing flaws in our supply systems. The pandemic's devastating effects on demand patterns for various medical items, including crucial

medications, caused havoc on the United States healthcare system. As the globe transitioned to working and learning from home, a global semiconductor chip shortage occurred, affecting the automotive, industrial, and communications industries, among others. Extreme weather events caused by climate change exacerbated these shortages. The robust U.S. economic recovery and shifting demand patterns have stressed supply chains in other critical items, such as lumber, and put further strain on U.S. transportation and shipping networks in recent months.

The pandemic has had an incredibly profound effect on countries that are already struggling economically. In Africa, the pandemic has led to disruptions in food supply and distribution systems and even though countries are working hard to correct these problems, they still have trouble keeping up with demand. The United States government has made it clear that it will continue to support its allies worldwide as they work to recover from this devastating outbreak.

The effects of the pandemic on world economics have been wide-ranging and far-reaching. In particular, this pandemic has been responsible for a significant decrease in global economic output and a reduction in international trade. The main impact that the pandemic has had on economies is its effect on productivity. As people become sick, they cannot make money or contribute to the economy. In addition, if people are unable to work due to illness, they may not be able to pay their bills or provide for themselves or their families. These changes can long-term affect an individual's ability to achieve financial stability and independence.

Executives from the supply chains involved in the COVID-19 situation are confronted with standard supply, demand, and control risks. They also notice a lack of readiness, flaws in present response strategies, and a need for increased supply chain resilience. Focus areas for enhancing resilience follow generic literature recommendations and offer a rich opportunity to bridge the gap between research results and business actions.

The COVID-19 problem has resulted in significant supply chain disruptions, which may be linked to fundamental vulnerabilities previously highlighted in the literature. This case study aims to provide a method for bridging the gap between supply chain resilience research and industry attempts to construct a more robust supply chain and help business managers to cope with any sudden change.

The unexpected and catastrophic COVID-19 flare-up created a severe crisis for all supply chain sectors, resulting in significant disruptions. The purpose of this dissertation is to dissect the existing situation and find answers to the following questions: (1) What supply chain issues have come to light due to the pandemic? What impact did these issues have on manufacturing, transportation, procurement, and demand planning? (2) What are the areas for development and decisions that must be made to establish a more responsive supply chain? (3) Do automation, innovations, and technology improvements substantially impact business stakeholders and the general public after the pandemic to prepare for any future crisis? Moreover, (4) How can we use the sustainability structure to make decisions about how to make the supply chain more resilient?

2. Literature Review

The coronavirus disease of 2019 (COVID-19) issue has focused on the supply chain's capabilities and its fragility in serving customers' requirements. Disruptions in the supply chain and abrupt shifts in customer behavior imply that the underlying systems involved in manufacturing and distribution operations require further attention.

According to a report released on 28 March by the Chartered Institute of Procurement and Supply, the COVID-19 epidemic affects 86% of supply chains (https://www.supplychainmovement.com/, 2020); in early March, more than 80% of respondents expected COVID-19 interruptions to have an impact on their firm. By March, this figure had risen to 95% of enterprises that will or have already been harmed by coronavirus supply chain disruptions (Management, 2020).

Panic buying would be classified as a demand risk in the literature on supply chain resilience. In contrast, the shutdown of facilities and warehouses that provide supplies would be classified as a typical supply risk. (Christopher, Building the resilient supply chain, 2004). However, it is possible that current research on supply chain resilience did not fully advance knowledge of supply chain hazards in business. 60% of responding procurement managers in a poll by Basware with over 700 respondents said their supply chain lacks transparency (Forde, 2020).

In the literature, there has been a persistent request for more excellent empirical and event-based research on supply chain risk and resilience. The roots of supply chain resilience can be found in literature dating back to the late 1950s. (Forrester, 1958) bullwhip effect is a fundamental principle for the operations and supply chain management discipline. It directly connects to demand risks and how they can disrupt the supply chain.

As early as 2007, for example, Kahn and Burnes advocated for more integrated research on supply chain risk management methodologies and tactics for boosting supply chain resilience (Khan). Scholten et al. provided an editorial perspective on how articles on supply chain resilience frequently have a poor empirical grounding and that a significant portion of the material is conceptual. Fortunately, multiple requests for special issues on COVID-19 and the supply chain have been issued, notably in JOM, SCMIJ, and IJPR. Consequently, we may expect a robust stream of research in the future term (Svholten). The time has come to respond to requests for more empirical and event-based research that is less conceptual. Furthermore, an extreme effect route for this study is the ability to reduce the gap between the literature's grasp of the issue and the industry's understanding of the subject. This might help with efforts toward improved supply chain resilience and recovery.

MANUFACTURING DURING COVID-19

When the pandemic hit, it was a shock to the manufacturing world. Businesses struggled to keep up with the demand for their products, and many were forced to close down or reduce their output. However, as the pandemic progressed, those same businesses began to see an increase in sales as people tried to stock up on essential items they would need once the pandemic ended.

This meant that many manufacturers were able to resume operations earlier than expected. However, some companies still struggle with manufacturing difficulties during Covid-19. Here are some common problems they face:

1. The lack of workers due to fear of contracting COVID-19 has caused many factories to close down early or reduce their operations. This means fewer employees are available for hire, thus making it difficult for companies that require more workforce than usual.
2. The lack of workers has also increased wages, which means the costs will go up if the manager decides not to hire temporary workers from agencies. This is because agencies often charge a premium for their services, which means that even if the manager hires them directly instead of through an agency, they still pay more since there are not enough.

Western countries have focused in recent decades on producing low-volume, high-value, high-margin goods. As a result, manufacturing high-volume, low-margin items has relocated to low-cost nations, and extensive and complex supply chains have emerged. Using just-in-time methods and lean ideas throughout these networks has resulted in considerable cost savings. However, these networks are vulnerable to worldwide disruptions, with roughly 35% of manufacturers reporting difficulties caused by the global coronavirus (COVID-19) pandemic (National-Association-of-Manufacturers, 2020).

Face shields (medical visors), employed as Personal Protection Equipment (PPE), are one such mass-produced, low-margin product. Governments have been forced to impose strict quarantines due to the virus's widespread distribution, which has had the unintended consequence of suspending production and exports (F. Betti, 2020). These occurrences, combined with increased demand, resulted in a scarcity of PPE, which sparked a global race to source materials and export restrictions (Leonard, 2020). The European Commission's effort on joint PPE procurement is one such strategy.

National demands for the manufacturing of ventilators, PPE, and other critically needed medical equipment have been made public worldwide (Corera, 2020). Many mass production facilities have been converted to satisfy this need. These strategies take weeks to months to build but will solve the long-term, high production rates needed. Given that the COVID-19 pandemic's key time frame is in the range of days to weeks, it is now necessary to produce locally, quickly, and affordably.

Some manufacturing companies acquired responsibilities for delivering essential tools and equipment required by the entire public and healthcare facilities. Some manufacturers have successfully utilized repurposing and pivoting, which is the practice of quickly moving to a new product or process. Many others found it challenging to adapt.

Beyond pandemics and epidemics, environmental calamities and political concerns have significantly disrupted industry and supply systems. Sony, Toyota, and Nissan facilities in Japan and the UK were forced to close a reduce the tsunami's effects on the Japanese auto industry in 2011. With its most significant impact in 2019, the US-China "Trade War" forced several Chinese firms to relocate their production facilities to other regions of South East Asia (Y. Kajitani, 2013). In April 2020, auto sales in the U.K. plummeted by 97%, making it the lowest month for sales since 1946 (Campbell, 2020).

According to data, organizational disruptions are at their most excellent level. Unforeseen and catastrophic incidents increasingly bring them on. Service innovation, the conversion of a business model and rationale from product-centric to service-centric, has historically aided manufacturing companies in stabilizing their businesses in the face of distribution (C. Kowalkowski, 2012). Despite such solutions, manufacturing is anticipated to be among the industries with the most damaging economic effects (work, 2020). This result is a consequence of both the crisis' extraordinary extent and the harsh measures used to combat it.

PROCUREMENT DIFFICULTIES

The global outbreak of covid-19 has led to many challenges for businesses. One of these is an increase in purchasing difficulties. The main reason is that suppliers cannot deliver their products due to health concerns. This has made it difficult for companies to purchase raw materials and other necessary supplies. For example, some companies have had trouble getting hold of certain types of food because they fear the virus will contaminate them.

These risks increased due to globalizing supply chains, a focus on supplier reduction for better procurement negotiating leverage, and the establishment of specialist factories for higher economies of scale. Ellram (MANAGEMENT, 2020) expands on these results in a JSCM webinar on COVID-19 and supply chain, arguing that many resilience difficulties have evolved from a cost fixation and short-term cost emphasis in supply chain management. She claims the shift to low-cost country sourcing has resulted in long pipes and insufficient local backup supplies. Furthermore, Ellram says that the emphasis on financial statements has resulted in more extended payment periods and inventory being relocated to supplier balance sheets. In contrast, lean techniques may have been widely adopted, lowering supply chain agility.

The globalization of the supply chain can achieve a cost of products sold benefit through economies of scale and manufacturing placement in nations with lower factor costs. Conversely, globalization lengthens the logistical pipeline, introducing the danger of supply delays and reliance on distant sources (Harrison, 2014). A decrease in suppliers might provide power when negotiating payment terms and pricing. However, it also increases reliance on those suppliers for ongoing supplies. The most well-known supplier segmentation from Kraljic (Kraljic, 1983) includes dependence and supply risk as one of its two axes. Under this segmentation, firms should focus on assuring supply rather than cost reductions for critical bottleneck supplies and organizations take a more collaborative approach for more strategic supplies.

Inevitably, people will be unable to purchase goods and services because they cannot afford to do so. The difficulty of purchasing is exacerbated by the fact that many companies have closed their operations during the pandemic. The decision to close down a business or not is a difficult one. Still, it is often made based on how well the company has prepared for a pandemic and how much confidence it has in its employees' ability to stay healthy. Many companies have found that if they do not close down operations during the pandemic, they will lose staff members who cannot come to work due to illness or fear of exposure.

It is also essential for businesses to consider whether their employees will be able to access adequate transportation services before deciding whether or not to close down operations during Covid-19. In some areas, public transit may be limited or unavailable; this could leave many employees without reliable methods of getting to work each day until regular service resumes again after Covid-19 has passed through their residence or business location.

TRANSPORTATION DIFFICULTIES

Global transportation and shipping delays are causing significant problems for many companies and organizations. For example, the pandemic has forced some public transit systems to shut down, making it harder for people to get anywhere safely. Additionally, many countries have imposed travel bans on infected people entering their borders. At the same time, people are hesitant to leave their homes during this crisis, so

deliveries also suffer from a lack of demand. Some businesses have already closed their doors because they cannot afford these added expenses. Others are considering whether or not they will be able to stay in operation if they have fewer employees working remotely while maintaining high productivity levels.

Transportation-related studies on COVID-19 effects are divided into three categories: mobility trends, mode utilization, and equity consequences of transportation improvements. Several studies have looked at how people moved throughout the epidemic. In Colombian research, (J. Arellana, 2020) assessed the pandemic's short-term effects on aviation, freight, and urban transportation They discovered that government initiatives such as a restriction on air passenger travel lowered mobility, transit usage, and traffic congestion. Within the United States, (W. Riggs, Exploring the Implications Travel Behavior During COVID-19 for Transit: Potential for Ridesharing and Carsharing, 2020) evaluated changes in travel behavior caused by telework during the pandemic using survey data acquired during the outbreak's early months (March and April of 2020). Surprisingly, many of the increased leisure foot and bike journeys were caused by telework (i.e., additional trips generated while working from home).

Abouk and Heydari (R. Abouk, 2021), studied Google data on daily location trends over two time periods, a pre-pandemic period (3rd of January 2020- 6th of February 2020) and a post-pandemic period (15th of February 2020 - 25th of April 2020). They discovered that mobility in the following places decreased during the pandemic: transit stations, pharmacies, retail, grocery shops, and recreation. In a March 2020 Australian survey-based research, Hensher (D.A. Hensher, 2021) Based on the features of their employment and employers, it was estimated how many days people worked from home, and the effects on their commute trips were then examined. Their research revealed that while females and younger employees were more likely to be able to work from home, low-income group workers were less likely to be able to do so. Lou and Shen (J. Lou, 2020) The researchers compared the mobility of low-income and high-income groups after the introduction of stay-at-home orders using county-level data from the University of Maryland's COVID-19 Impact Analysis Platform. Their travel dataset contained data on the overall number of journeys, and trips for work and non-work activities. Based on these findings, the study discovered that stay-at-home directives had varying effects on the number of trips across socioeconomic categories. Stay-at-home orders, in particular, did not reduce trips for either work or non-work purposes for the study's lowest income group ($30,000). However, these directives dramatically reduced work and non-work travels (except of park visits) among the study's middle- and upper-income groups. Bian (Bian, 2021) explored the time lag impacts of pandemic-related regulations on transportation networks in the US cities of New York and Seattle from a policy standpoint. They observed that following the adoption of social separation rules, automobile traffic and transit use in both cities decreased dramatically. They also discovered a faster recovery in automobile traffic prior to reopening. Still, no recovery in transit system utilization, highlighting substantial disparities in the consequences of COVID-19 limitations based on transportation mode.

Another aspect of the transportation study connected to the pandemic looked at patterns in mode usage. During the COVID-19 epidemic, air transportation was one of the most impacted industries, as evidenced by a significant decrease in air passengers and a huge number of flight cancellations globally. (P. Suau-Sanchez, 2020) Using information from Flightradar24, which tracked 150 airlines across 2,751 airports worldwide. Sun and Wandelt (X. Sun S. W., 2020) evaluated the variations in international passenger travel patterns between December 16, 2019, and May 15, 2020. They discovered that the number of serviced origin-destination airport pairings fell by around 75% in mid-March 2020, and the number of operational aircraft fell by roughly 2/3. In an associated study by Sun and Wandelt (X. Sun S. W., 2021) by evaluating 110 research publications, the researchers evaluated the impact of COVID-19 on air transportation systems, air passenger experience, and the long-term implications on aviation. This research found numerous significant changes that are projected to occur in the aviation business post-COVD, including the rise of hub-operation limiting super long-haul flights, the use of a global immunity license, and the growth of competing and replacement transportation modes (e.g., high-speed rail and connected and automated vehicles).

In terms of ridership and supply, the pandemic has significantly impacted transportation services. Rail and air transportation are two of the most critical segments of the transportation business (Kermanshachi, 2018). A significant drop in air traffic caused several airlines to become financially crippled (Albani, 2020). Because of the 'Work from Home policy, the overall number of persons traveling to work has decreased dramatically.

Ridership on New York's public transportation system has reached an all-time low. It is projected that ridership on the subway and commuter rail systems will drop by 90% (MTA., 2020). On a worldwide basis, passenger air travel was predicted to continue favorable growth rates in 2020, despite several issues confronting the sector, including high jet fuel prices and weak economic development. However, the emergence of the new coronavirus put everyone's preparations on wait. These challenging economic conditions are expected to counteract the aviation industry by another 59 percent decline in passenger numbers in 2021 compared to 2019, resulting in another poor financial performance for the airline sector. The global aviation sector is expected to lose an incredible 53.8 billion US dollars in net profit in 2021, following a 137.7 billion US dollar net profit loss in 2020. The industry's outlook is delicate. The increased affluence of developing market middle classes was expected to boost aviation demand. Air travel is expected to expand the greatest in Latin America and Africa. However, these regions are also the most likely to be affected by the outbreak's health catastrophe (2006-2022, Growth of global air traffic passenger demand, 2020).

Deutsche Bahn (Germany) and SNCF (France), Europe's two largest rail firms, both announced major passenger and financial losses for their train lines in the first half of 2020 (W. Rothengatter, 2021). Similarly, major intercity railway firms in Japan saw a 30% drop in either passengers or income (H. Ding, 2021). The International Union of Railways (UIC, 2020) produced an econometric model in July 2020 based on data from numerous sources, including railway income statistics and economic prediction scenarios. According to their forecast, the worldwide passenger railway sector will lose $22 billion in a delayed recovery scenario and $6.2 billion under a speedy recovery scenario in 2021 (UIC, 2020).

Different kinds of mobility on the road revealed diverse trends. Islam (Islam, 2020) discovered that automobile utilization in the United States decreased throughout the epidemic in terms of overall hours of use and total vehicle miles driven. According to one example study, taxi demand in Shenzhen, China fell by more than 85% during the lockdown period and had a delayed rebound when compared to overall vehicle traffic in the city (Zheng, 2021). Riggs and Appleyard (W. Riggs, Exploring the Implications Travel Behavior During COVID-19 for Transit: Potential for Ridesharing and Carsharing, 2020) discovered a decrease in car miles travelled but an increase in leisure foot and bike rides. According to Buehler and Pucher, riding increased by 8% on average across 11 European nations, with weekends seeing the biggest increases. During the pandemic, recreational riding dramatically grew in the United States and Canada (R. Buehler, 2021). Another research in the United States compared the usage of the bike sharing system with the subway system between February and March 2020 using information from New York City Bike Share and the Metro Transit Authority (João.F. Teixeira, 2020). Despite the fact that use of the bike sharing decreased by 71% and that of the subway declined by 90%, it was noted that this system may have served as a vital lifeline for low-income populations that needed access to public transportation. This result supports earlier research that showed bike sharing programmers are essential for low-income people as a form of transportation (K.H. Reilly, 2020).

The COVID-19 epidemic had a considerable impact on water transportation as well. using panel data for 14 important Chinese ports between January and October 2020, XU et al. (L. Xu, 2021) discovered that due to the widespread factory closures, the pandemic's severity—as determined by the total number of confirmed cases—had a considerable negative impact on both import and export cargo throughputs. According to an Australian research based on data from a variety of sources, including but not limited to Google, Apple, Moovit, and interviews with transportation industry stakeholders, the pandemic caused a 9.5% drop in water-based freight transportation (H.S. Munawar, 2021). According to Cullinane and Haralambides (Cullinane, 2021), several major ports with a strong gateway role had a sharp decline in container throughput in the first half of 2020, but they also saw a significant increase in activity in the second half of the year. Due to the rapid shift in demand, many ports experienced congestion and lengthy turnaround times as well as shortages of equipment, truck drivers, and dock workers.

Deliveries are delayed worldwide due to the impact of COVID-19. Three main factors cause the delays: people are afraid to travel, some countries have imposed travel bans, and many public transit systems have been shut down. These factors have increased the difficulty of delivering shipments on time, which has caused severe problems for companies and organizations that rely on timely deliveries.

Many countries have closed their borders in an attempt to prevent the spread of the virus. This means that most countries can only ship goods within their frames, which causes problems for those who need to import or export products from other countries.

In the United States, the government has passed regulations to reduce the spread of the virus and ensure that people can get their medication. These rules include: All packages must be sent via registered mail or UPS, the receiver's address must be visible on all packages, Packages must be sent from a verified sender's address, not from a P.O. box or hotel address, and Packages must only be shipped from within the United States (no international shipments).

Demand uncertainty can occur on a regular basis in container shipping operations. To deal with these scenarios when they arise, maritime corporations have devised a number of operational and strategic approaches, such as removing some ports from itineraries or blank sailing of all ports on itineraries and assigning ships to schedules on different routes (Notteboom, 2021). However, these approaches adopted as solutions by maritime businesses may result in empty containers failing to be positioned at the essential places (Song, 2015), resulting in duplicate storage of containers in regions with high importation and container shortages in regions with significant exportation (Braekers, 2011). This issue was addressed in a research undertaken by Ko (Ko, 2020), which revealed that in nations with large global trade volumes, there is a significant demand for empty containers, and when the demand cannot be met, the available-to-promise cargoes are detained in warehouses. Empty containers that are kept in warehouses or ports generate cost and time losses for maritime enterprises, as the storage cost of these containers is nearly equal to that of full containers. Furthermore, when operating equipment and human costs for shipping these containers are included in, the total cost can be significantly greater (Kuzmicz, 2019).

China is home to seven of the world's ten largest container ports, and Chinese ports handle more than half of worldwide container shipping traffic, owing to China's status as both the world's largest exporter and second-largest importer. This global system guiding exports and imports necessitates the creation of a container placement cycle geared toward China in container transportation. Following the discharge of a full container in accordance with this placement cycle, the container must be swiftly positioned in China, whether empty or full, and then sent to various places once full. This cycle plan increases the number of containers exported from China while decreasing the number of containers imported. Furthermore, trade volumes of containerized cargoes increase significantly as China-based trade activity increases before the New Year (Group, 2020). The recent empty container scarcity can be ascribed to all business operations carried out in this procedure (Kuzmicz, 2019).

The development of COVID-19 in China, which is recognized as the world's export center, during the period of peak export volumes led to a quick decline in commercial activity in the country and a far more intense container scarcity crisis in the globe than before witnessed (Koyuncu, 2021). Xu (Xu, 2021) used a regression model to evaluate this topic using data from 14 distinct Chinese ports. Their analysis demonstrated that COVID-19 had a negative impact on the port operation operations for both export and import cargoes in China, accounting for a 20-50% decline in cargo volumes at Chinese ports (Berti, 2020).

DEMAND PLANNING DURING COVID-19

The world is in chaos, and it is hard to know what to expect from each country. The pandemic has created much uncertainty about how things will play out, and it can be hard to plan for the future when there are so many unknowns.

Demand Planning is a term that refers to the process of forecasting future demand for a product. Demand planning aims to determine how much of a product will be needed in the future and when it will be required. During the COVID-19 pandemic, demand planning has been complexed for several reasons:

- Due to the virus's uncertainty and spread, businesses have had trouble predicting the future.
- Businesses have had trouble finding reliable data on which to base their predictions.
- Businesses have had trouble communicating with suppliers and customers in different countries or continents.
- Businesses have had trouble getting credit from suppliers who are not convinced they will be paid back soon enough.

Because of this, many companies have had to rethink their demand planning strategies to manage demand risk during the Covid-19 pandemic. The global business environment has changed dramatically, and demand forecasting is no longer a straightforward process.

Aside from the necessity to manage the risk of demand signal amplification along the supply chain, Christopher and Peck (Christopher, "Building the resilient supply chain, 2004) and Mena et al. (Mena, 2018) are among the writers who identify a broader range of supply chain risks, such as supply, demand, and control risks. Pettit et al. (Pettit, 2010) extend this work by outlining frequent risk outcomes of typical supply chain management actions.

Food supply networks were subjected to a series of rapid, exogenous demand and supply shocks during the epidemic's early stages when many nations implemented lockdowns to halt the spread of the virus. Prior to the pandemic, food-away-from-home purchases made for a sizable part of total food sales. Food-away-from-home expenditures accounted for slightly more than half of consumer food expenditures in the United States (J. Luckstead, 2020); before the epidemic, they made up about a third of food spending in Canada (Goddard, 2020). Food-away-from-home purchases fell due to the temporary closure of restaurants and other food service establishments due to lockdown regulations. These food expenditures abruptly shifted to supermarkets and other food retail establishments. Consumers' panic purchasing and hoarding behaviors amplified the impact of the shift in food demand to retail outlets, resulting in short-term stockouts (J. Lusk, 2020).

In many nations, large-scale supermarket merchants predominate the retail food industry and use a just-in-time delivery model. Modern supply and demand planning and management procedures ensure that food shop shelves are consistently supplied by considering regular supply and demand trends. Under normal conditions, the system is functional and efficient. However, the unexpected demand shock puts it under much stress. Even though they were severe in certain areas, these symptoms during the initial pandemic wave were usually transient.

Food supply chains that provide food service outlets need time to adapt to serving the food retail sector. This included creating new contracts, adjusting container specifications, and adhering to labeling standards specific to the food retailing industry.

Consumer panic buying or hoarding has been a prominent demand-side shock in Canada and many other countries. One of the more dramatic sights from the early phases of the COVID-19 pandemic was grocery shelves being empty of important food and non-food products such as pasta, rice, canned goods, flour, frozen foods, bottled water, hand sanitizers, hand soap, and toilet paper (Post, 2020). Government authorities and food sector leaders have been eager to underline that there is plenty of food in the system, but short-term panic buying patterns have become self-perpetuating. As governments around the world tightened social distancing laws, many consumers engaged in stockpiling activities in anticipation of movement restrictions and interruptions to food distribution systems.

3. Research Methodology

The pandemic caused major supply chain interruptions, which could be traced back to fundamental weaknesses previously identified in the literature. This case study intends to bridge the gap between supply chain resilience research and industry efforts to build a more robust supply chain and assist business management in dealing with any rapid shift.

THE RESEARCH DESIGN

This dissertation was written after researching previously published works of literature, case study data, and data from various government/non-government associations from news reports and organization sites, as well as virtual roundtables with supply chain executives, which were supplemented by interviews. In the first step, published literature works were gathered non-ordered using electronic channels from the databases of Google Scholar, Science Direct, Springer, ISI Web of Knowledge, and Research Gate. The dissertation evaluated the available literature on different supply chain components through early August 2022, focusing on manufacturing, transportation, procurement, and demand planning during the COVID-19 pandemic.

In the Second step, based on the examination, the author produced research questions that serve the study's aim. The questions are written within the introductory part of the paper. This study assembles and displays information and data relevant to the ecological, economic, and social implications of COVID-19 and satisfies the study goals from an immense number of published literatures.

In a third step, videoconference interviews were done with executives and planners from various industries, including transportation, equipment manufacture, fast-moving consumer goods, food manufacturing, durable consumer product manufacturing, technology, and software services. These semi-structured interviews included high-level inquiries and queries regarding supply chain resilience issues and priority areas recommended in the literature. Interviews took place between 21 August and 8 November, 2022. Table 1 lists example interview questions. The interviews were taped to be transcribed, analyzed, and reviewed during the paper's development. Quotes from the interviews will be used to illustrate the conclusions and areas of research potential mentioned in the following sections. These statements were shared with the interviewed executives and planners to guarantee proper citation and that the interpretation and analysis of findings corresponded to the conversation during the interview and the perspective of the questioned management. Sharing the citations and draught conclusions with the supply chain executives created a good feedback loop that informed some of the debate and analysis. It also allowed for the confirmation and expansion of research possibilities highlighted by participants.

Finally, the author reviewed and advised significant supply chain activities and techniques to be done in order to establish a resilient supply chain based on the information collected and acquired in the literature study.

Table 1 Interviews questions

1-	Was your supply chain affected by COVID-19?
2-	What specific challenges does your supply chain face?
3-	What was the responding action taken by your company?
4-	Did you have a contingency plan to react against pandemics? If not, do you plan to have some after the pandemic lesson?
5-	What actions were taken during COVID-19 that would last after the pandemic?
6-	How may your company benefit from a c structure to make decisions to make the supply chain more resilient?
7-	What would primary change be applied to your supply chain after COVID-19?

4. Research Findings

This chapter presents the main findings of the research as derived from interview data with twelve supply chain executives and planners from various industries with roles across different industries. The interview sample comprised three General Managers, three Supply chain Planners, two Process Managers, one Manufacturing director, one Manufacturing Quality Manager, one Senior Procurement Specialist, and one Logistics Specialist. Those samples are representing nine different industries as following: Automotive, Oil & Gas, Durable consumers products, Construction & Transportation, Machinery Manufacturing, Container Service & Land Transport, Packaging Manufacturing, Fast-Moving Consumers Goods (FMCG), and Computer & Network Security.

The prime aim of this chapter's analysis is to supply chain executives and planners as actors in the responsibility of implementing the counter actions against Covid-19 challenges. Given that the main goal of this research is to investigate the challenges that occurred during the pandemic, the consequences of those challenges, the best practices taken during this period, the archived results by applying such actions, and what actions became permanent to the system. Together with key findings from the review of previously published works of literature, case study data, and data from various government/non-government associations. As a result, conclusions could be taken on a way for bridging the gap between supply chain resilience research and industry efforts to build a more robust supply chain and assist business management in dealing with any sudden change.

This chapter's interview data is mostly focused on answering the research questions which have been collected by conducting semi-structured interviews. This interview data is represented in qualitative data. Thus, the inductive narrative method has been used to analyze interview data.

COVID-19 CHALLENGES

Covid-19 pandemic had huge impacts on all industries which created major challenges to supply chains. 100% of the interviewee's samples confirmed that their business was influenced by the pandemic.

The pandemic introduced unexpected worldwide events as a follow-up of the fast virus spreading, creating a very high infection rate. The government had to enforce strict policies for public safety and enclose cities to minimize an epidemic outbreak. Safety precautions instructions were specified by the World Health Organization which have been forced by governments to be applied within any industrial facilities. Such instruction added more load meeting such requirements, maintaining social distance and supplying the PPE represented in masks, face shields and sanitizers made it very costly to achieve such measures. For example, interviewee #4 said:

"The high expense of achieving Covid-19 safety precautions and social distance was difficult; the corporation had to pay extra money to add more buses for labor transit to ensure social distance, in addition to purchasing the necessary masks, face shields, and sanitizers for labor safety. Those items were scarce during the epidemic, and their prices were significantly more than usual."

Countries also have implemented a partial lockdown with restricted hours and in some locations full lockdown to control the virus transfer to uninfected regions. Still, such measures had a significant impact on industries that had a limited time a day to move their raw materials, products, and transport employees. Also had limited available working hours per day. For example, interviewee #8 said:

"We had to shut down the production plant for a bit, and we had to reduce our production rates at times due to the limited working hours during the lockdown."

And interviewee #9 said:

"Lockdown had a significant impact on the transportation industry; several competitors were affected by restricted hours."

And interviewee #10 said:

"Due to the lockdown and travel restrictions, as many clients were unable to move freely to visit the service centers and many workers were trapped abroad and unable to return."

PANDEMIC CONSEQUENCES

Many challenges appeared as a consequence of the pandemic, which has a cross-correlations between each other's creating a complex chain of reaction. A diagram has been drawn based on the understanding of the literature review besides the analysis of the interview data. The following graph shows eleven consequences challenges as a result of the pandemic; Applying social distance, Lack of labor, Factories shutdown, decreased capacity, Slow ports processing, Lack of containers, Extended Leadtime, Unstable demand, and Cost increase. See Figure 1 Pandemic consequences challenges flow diagram

A radar chart has been created based on analysis of interviewees' statements. This chart shows the occurrence percentages of such challenges detected by our sample of interviewees. See Figure 2 Consequences challenges occurrence percentages.

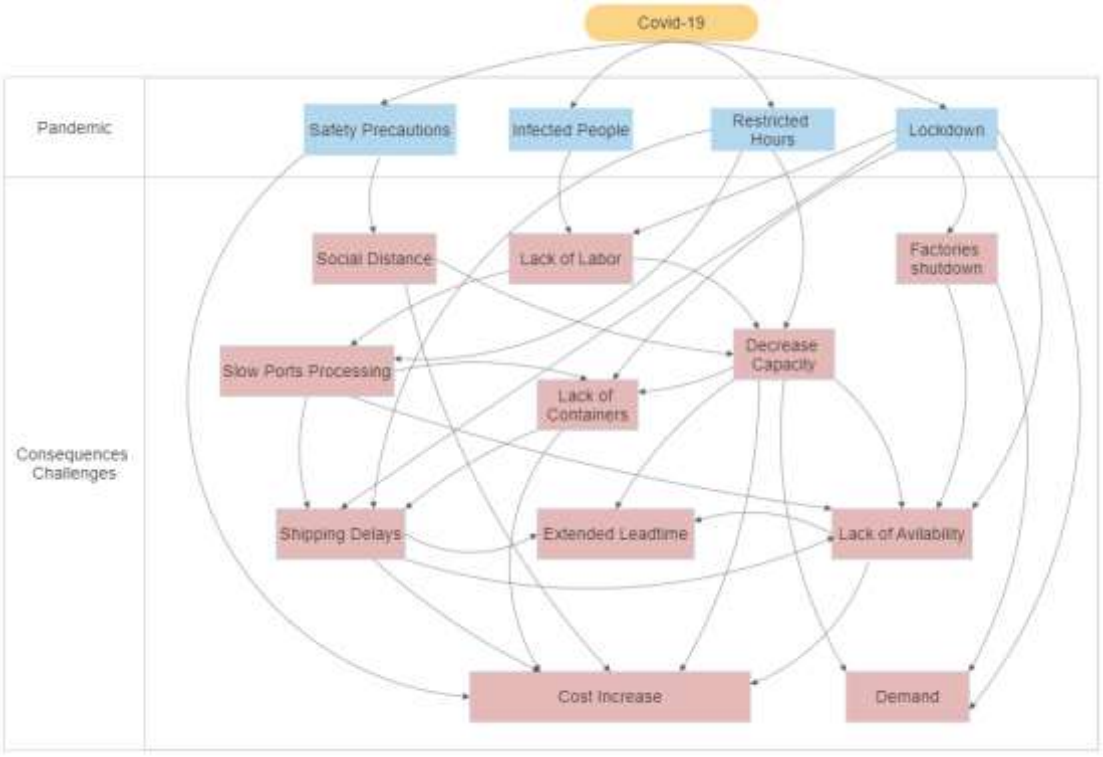

Figure 1 Pandemic consequences challenges flow diagram

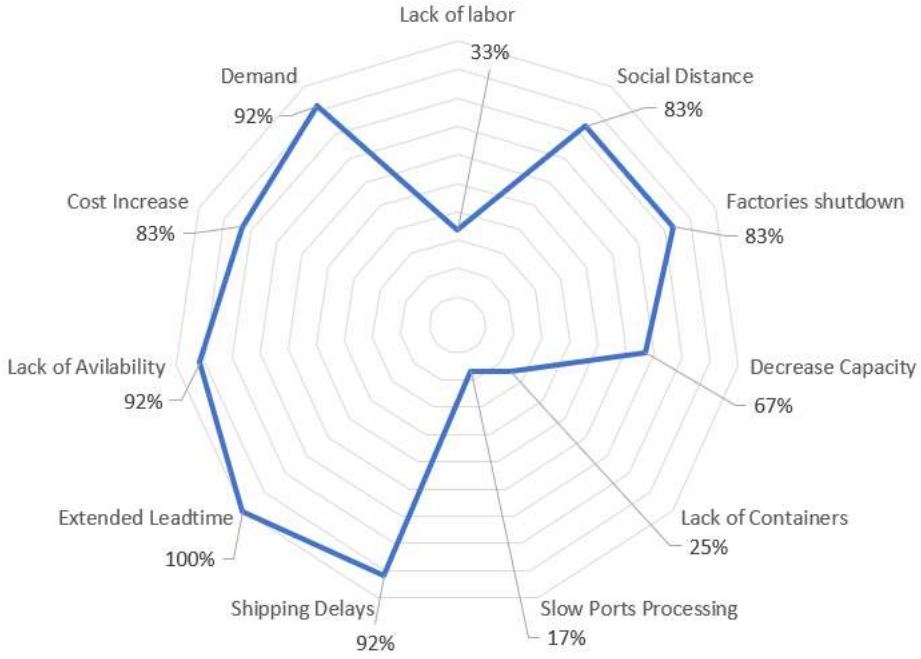

Figure 2 Consequences challenges occurrence percentages

Lack of labor

Lack of labor was one of the challenges that appeared as a consequence of the Covid-19 virus spreading with a very high infection rate. Infected employees with strong symptom went to emergency rooms, and some of them with severe symptoms were dead. With a big fear of the virus spreading, anyone experiencing any Covid-19 symptoms must stay home at for least two weeks. In addition to the government's lockdown, many laborers were trapped within their cities or abroad and could not return to working facilities even if they didn't have any symptoms. As a result, industries had a significant challenge of having less available labor to run the

business, some of the absent laborers with high experience were responsible for critical processes roles which led to the complete shutdown of such stages.

33% of the interviewees' sample stated that lack of labor was one of the challenges during the pandemic. For example, interviewee #1 said:

"As a result of the increased number of employees infected with Covid-19, manufacturing capacity was lowered, and some essential operations became a bottleneck of the total process due to the absence of experienced labors who used to perform such processes."

And interviewee #4 said:

"Some production labor became infected with Covid-19, resulting in less manpower available on site and lower production capacity; some processes were halted due to a lack of labor."

And interviewee #10 said:

"Due to the lockdown and travel restrictions, as many clients were unable to move freely to visit the service centers and many workers were trapped abroad and unable to return."

Applying social distance

Applying social distance was one of the pandemic safety precautions recommended by the World Health Organization and forced by some government polices to minimize the risk of the virus spreading. Industries had to apply these precautions to keep running without facing any penalties, ensuring their workforce won't infect each other's.

83% of the interviewees' sample confirmed that applying social distance was challenge and required applying new polices to achieve. For example, interviewee #2 said:

"Due to pandemic social distance was required adding to minimize the Covid-19 spreading."

And interviewee #4 said:

"The high expense of achieving Covid-19 safety precautions and social distance was a challenge; the corporation had to pay extra money to add more buses for labor transit to ensure social distance."

And interviewee #6 said:

"We worked two shifts but throughout the Covid-19 pandemic to ensure safety procedures and social distance."

And interviewee #10 said:

"Such policies forced the firm to lower the number of workers to ensure they had enough safe social distance."

Factories shutdown

As a consequence of the pandemic and lockdown many factories had to shut down worldwide, which directly related to the lack of supplies needed by industries as raw materials and created unstable demand levels.

83% of the interviewees' sample highlighted that factories shutdown was one of the challenges that had a high risk during the pandemic. For example, interviewee #1 said:

"Due to the Chinese lockdown, factories closed their doors, causing shipping delays and cost increases."

And interviewee #6 said:

"Raw materials were a significant challenge for our company as a number of our suppliers were closed."

And interviewee #11 said:

"During the Covid-19 pandemic many companies closed doors and declare bankruptcy which added many risks during purchasing processes."

Decrease capacity

Industries were forced to decrease their capacity as a result of; a lack of labor, applying social distance, and restriction hours. Restriction hours limited the available working time for facilities and minimized the available time to transport raw materials plus the finished goods to customers. Thus, companies had to decrease production capacity.

67% of the interviewees' sample noted that they had to decrease capacity. For example, interviewee #1 said:

“As a result of the increased number of employees infected with Covid-19, manufacturing capacity was lowered.”
And interviewee #3 said:
“As many cities and manufacturers shuttered their doors due to lockdown. As a result, partners' production capacity is reduced.”
And interviewee #6 said:
“We experienced a drop in sales as well as a reduction in production capacity as a result of the lockdown.”

Lack of containers

Finding a container for shipping was a big challenge, as many troubles occurred within the supply chain. Lack of containers issue showed up as a result of; the lockdown, reduced capacity of facilities, and slow port processing. Resulting in duplicate storage of containers in regions with high importation and container shortages in regions with significant exportation.
25% of the interviewees’ sample noted that they experienced troubles due to lack of containers. For example, interviewee #3 said:
“It becomes difficult to supply manufacturing facilities with raw materials, as well as worldwide shipping challenges, a lack of containers.”
And interviewee #8 said:
“We had numerous sourcing, shipping, and lack of containers issues.”
And interviewee #12 said:
“Finding a container was a big challenge during this period.”

Slow ports processing

Slow ports processing occurred due to the lack of available labor who performed many critical activities plus the restriction’s hours. Many of the employees were infected by Covid-19 creating more workload for others on site. In addition to some initial policies of keeping shipments for quarantine period. Slow processing leaded to; lack of available containers, many shipments delay as some shipments could miss its scheduled ship due to this slow processes, and lack of availability of goods.
17% of the interviewees’ sample noted that they experienced troubles due to slow ports processing. For example, interviewee #12 said:
“Shipping cost increased plus finding a container was a big challenge during this period. All operation in ports Leadtime extended as a result of pandemic precautions and lack of labor who was infected which added more work load and huge latency in processing.”

Shipping delays

Shipments delays was one of characteristics of the pandemic period, shipping was impacted by; restricted hours, lockdown, slow ports processing, and lack of containers. These delays had a direct effect on lack of raw materials availability, extended Leadtime, and dramatically cost increase for supplies plus shipping cost.
100% of the interviewees’ sample noted that they experienced many shipments delays. For example, interviewee #5 said:
“We were impacted by shipping disruptions and delays. During the epidemic, shipping costs climbed dramatically, often by 100%, which showed in product prices.”
And interviewee #6 said:
“Lockdown hours made it difficult for vehicles to dispatch and deliver our products or raw materials. As a result, all shipments had to be handled during the first shift, and any delays would result in a total shipment delay the following day.”
And interviewee #10 said:
“Some specific spare parts that we do not maintain in stock in our warehouses were subject to significant delays and extended lead times.”

Extended Lead-time

Leadtime kept increasing as a result of; shipping disruptions, suppliers and service providers capacity decrease, and lack of availability of supplies. All of these created long ques of orders with very limited supply flow which created very high prices increase according to the Law of Supply and Demand.

100% of the interviewees' sample mentioned that they faced extended Leadtime. For example, interviewee #2 said:

"Earlier company was tied by the capacity and Leadtime of the supplier. So, when the pandemic hits partners couldn't fulfill the company requirements."

And interviewee #6 said:

"The pandemic had an impact on our supply chain; global lockdown had an influence on our export items, and raw materials had extreme extended lead times."

And interviewee #7 said:

"Especially in light of the ongoing delivery delays and prolonged lead time."

And interviewee #8 said:

"Aluminum has a three-to-four-month lead time on normal, but during the pandemic, the lead time increased to five to six months."

Lack of availability

Supplies and raw materials were very rare during the pandemic as a result of; lockdown, factories shutdown, reduced capacity of suppliers, slow ports processing, and shipping delays. All of these created a huge gap between consumption and availability which led to increased Leadtime and a massive reflection on prices.

100% of the interviewees' sample said they had a short of supplies as a consequence of the pandemic. For example, interviewee #1 said:

"Late supply of raw materials from suppliers as a result of shipping delays led to a market shortage."

And interviewee #5 said:

"We encountered numerous obstacles during the pandemic. One of our biggest concerns is the global shortage of microchips, which has impacted our production processes."

And interviewee #6 said:

"All suppliers had shorts owing to Covid-19."

And interviewee #11 said:

"We had a massive shortage in raw material supply as many of suppliers reduced their capacity or stopped production at all."

Cost increase

Raw materials, supplies, services, manufacturing, and transportation costs increased during the pandemic period. Many factors affected cost increase as follows; applying the social distance, supplying the covid-19 safety precautions PPE, decreased capacity, lack of containers, and shipping delays.

83% of the interviewees' sample said that costs increased as a consequence of the pandemic. For example, interviewee #1 said:

"Shipping costs rose. Normally, a container would cost roughly 5,000 USD to ship before the pandemic, but the cost jumped to nearly 11,000 USD during the pandemic. Prior to the pandemic, the cost of air freight shipment was 5 USD per kilogram, but during the pandemic, the cost increased to 6.8 USD per kilogram."

And interviewee #4 said:

"Production costs increased since the company had to pay for overtime to make up for labor shortages, as well as pay extra to provide staff with safe meals throughout their shifts."

"The corporation had to pay extra money to hire more buses for labor transit to ensure social distance, in addition to purchasing the necessary masks, face shields, and sanitizers for labor safety. Those items were scarce during the epidemic, and its prices were significantly more than usual."

And interviewee #5 said:

"We were impacted by shipping disruptions and delays. During the epidemic, shipping costs climbed dramatically, often by 100%, which showed in product prices."

And interviewee #7 said:

"Also, shipping costs rose significantly, so the container we used to ship from China for 6.5K USD now cost more than 10K USD."

Unstable demand

Demand was also impacted by the epidemic. The Fluctuation in demand occurred based on the type of industry and its location within the supply chain. Raw materials suppliers who could survive had a massive demand as some of their competitors closed doors. On the other hand, some suppliers' demand went down due to customers shutdown or decreased their capacity. Plus, the lockdown had a huge impact in demand instability.

92% of the interviewees' sample noted that the pandemic impacted their demand. For example, interviewee #1 said:

"Egypt's demand was exceptionally high during the Covid-19 because national construction projects did not stop, therefore the strong demand and late supply of raw materials from suppliers as a result of shipping delays led to a market shortage."

And interviewee #2 said:

"Due to China lockdown and shipping difficulties in addition to long Leadtime company had more demand in local market."

And interviewee #3 said:

"Demand increased as many companies began to shift work from their physical offices to remote working, increasing the need to upgrade companies' smart solutions while somehow raising the risk of data leakage and identity theft."

And interviewee #4 said:

"During the pandemic, demand for food increased during the Covid-19 as people had to cook their food at home owing to lockdown and eateries closed their doors. Overall food market demand climbed roughly three times what was forecasted."

And interviewee #12 said:

"We had a decrease in demand locally and internationally due to lockdown and shipping disturbance."

RESPONSE ACTIONS

Within this section will represent the actions taken by the interviewees as a response to Covid-19 consequences challenges. These actions will be segmented into nine categories; manufacturing, procurement, transportation, demand planning, inventory management, warehousing, information management, and labor management.

Manufacturing

Table 2 Manufacturing Response Actions

No.	Response action	Interviewees %
1	Apply Safety precautions and social distance	83%
2	Local manufacturing	42%
3	Increase production capacity	25%
4	Introduce new processing capabilities	17%
5	Outsourcing	17%
6	Balance production rate with stocks	17%
7	Dynamic production planning	17%
8	Repair and recycle supplies	17%
9	Transform from hardware to software solutions	8%
10	Maintain production capacity	8%
11	Terminate manufacturing processes	8%
12	Terminate manufacturing branches	8%

Procurement

Table 3 Procurements Response Actions

No.	Response action	Interviewees %
1	Add more suppliers to system	67%
2	Domestic sourcing	50%
3	Suppliers with various geographical locations	42%
4	Local manufacturing	42%
5	Increase order quantities	33%
6	Look for alternatives	33%
7	New procurement policies	25%
8	Less purchasing orders	8%
9	Early order release	8%
10	Online sourcing	8%
11	Cost saving policy	8%
12	Consign stocking plan	8%

Transportation

Table 4 Transportation Response Actions

No.	Response action	Interviewees %
1	Monitoring shipping risks	42%
2	Use Air frights	25%
3	Shipping any ready quantities	17%

Demand planning

Table 5 Demand Planning Response Actions

No.	Response action	Interviewees %
1	Monitor Demand	42%
2	E-commerce selling	8%
3	Extend delivery time to customers	8%
4	Add more clients to system	8%
5	set acceptance criteria for clients	8%
6	more sales promotions	8%

Inventory

Table 6 Inventory Response Actions

No.	Response action	Interviewees %
1	Increase safety stocks	50%
2	Monitoring stocks	33%
3	Classification of raw materials	17%
4	Balance production rate with stocks	17%
5	Consume from safety stocks	8%
6	Consign stocking plan	8%

Warehousing

Table 7 Warehousing Response Actions

No.	Response action	Interviewees %
1	Increase warehouses capacity	17%
2	Reduce ports warehousing	8%
3	Build new warehouses	8%
4	Consign stocking plan	8%

Customer service

Table 8 Customer Service Response Actions

No.	Response action	Interviewees %
1	Extend delivery time to customers	8%
2	Balance end product supplies between customers	8%

Information management

Table 9 Information Management Response Actions

No.	Response action	Interviewees %
1	Digitalization	58%
2	Monitoring shipping risks	42%
3	Monitor Demand	42%
4	Monitoring stocks	33%
5	Transform from hardware to software solutions	8%

Labor management

Table 10 Labor Management Response Actions

No.	Response action	Interviewees %
1	Apply Safety precautions and social distance	83%
2	Working from home	75%
3	Workforce split plan into teams and shifts	67%
4	Labor management plan (ensure having substitutional)	33%

CONTINGENCY AND SUSTAINABILITY PLAN

Contingency plan

A contingency plan is a strategy meant to assist an organization in effectively responding to a large future crisis, event, or scenario that may or may not occur. A contingency plan is often known as "Plan B" or a backup plan since it can be used if expected results do not materialize.

33% of interviewees' confirmed that they already had a contingency plan to ensure business continuity. For example, interviewee #2 said:

"Company has contingency plans for any crisis occurred earlier, so as a one organization all factories support each other by providing raw materials to any factory who have shortage."

And interviewee #3 said:

"The company used to have a "Business continuity strategy", which ensured that the organization had two manufacturing locations ready. Previously, the corporation had two manufacturing facilities, one in the United States and one in Europe. Following the closure of the second location, the company began planning a disaster

recovery manufacturing facility. This facility must be prepared to begin production in the event of any disasters or hazards that may harm the original manufacturing site, such as natural or political calamities."
And interviewee #6 said:
"Our company has its own emergency plan. As a result, we keep many sources for each raw material to ensure that the company's demands are met."

And interviewee #12 said:
"We had a resilience system which could adapt, evaluate, and response to such risks. Plus, many departments had created its own contingency plan for any future similar cases for faster response and less impact."

Sustainability plan
The phrase "sustainability" refers to programmers', projects, and actions to preserve a specific resource. However, it relates to four distinct sectors known as the four pillars of sustainability: human, social, economic, and environmental.
The pandemic showed sustainability plans' importance in maintaining business continuity, survival, economic growth, human resources, and saving the environment. Of the continuous cost increase and lack of availability stated earlier as a result of the pandemic, many companies took a further step in taking more steps towards sustainability which in many cases helps in cost reduction and ensures business continuity, adding to its environmental value. In some cases, sticking to sustainable plan was extremely hard during the pandemic, especially for raw materials. 50% of interviewees already had or implemented some of the sustainability policies. For example, interviewee #2 said:
"To have more resilience and effective supply chain company took several approaches towards sustainability, those approaches were taken before the Covid-19 pandemic but the pandemic encourage the company to reduce its costs but investing more in sustainability plans."
"Recycling raw materials such as polyethylene, company made a feasibility study on getting new machine to recycle scraped polyethylene and reuse it in the process. Following this approach will minimize the new raw material consumption up to 30%. This way company would save money, transportation, and would have less material shortage risk due to reduction in lead."
And interviewee #4 said:
"Our organization's sustainability plan was stringent, therefore we struggled to implement these steps with the resources we had. We were having difficulty maintaining our position while adhering to the sustainable plan, which has an influence on our production expenses."
And interviewee #5 said:
"The company implemented a new policy called "REMAD," which stands for re-manufacturing and repairing valuable spare parts before reselling them to end customers as refurbished parts. This policy is one of the company's sustainability initiatives, and it helped reduce the reliance on new spare parts supplies, which were suffering from a pandemic."

And interviewee #6 said:
"The company implements a sustainability strategy to reduce electricity use by installing solar panels to generate clean, and sustainable energy. Also lowered the dependence on natural gas, the corporation required to utilize natural gas to heat up systems in the winter. As a result, it has been replaced by electrical coils. On the other hand, the corporation had a zero-waist plan, which means that all waste oil was recycled and repurposed in other goods."

And interviewee #8 said:
"Company has a sustainability plan in place to recycle raw materials. Following the corporate global sustainable strategy, our facility transitioned from diesel to hydropower, reducing CO2 emissions by more than 90%."
And interviewee #9 said:

“We had a plan for more efficient sustainability. We usually repair and renew old used tires before remounting them in our vehicles. Then we have a recycling strategy for different types of waste and scrap.”

5. Discussion and Conclusion

The Covid-19 outbreak has drawn attention to supply chain vulnerabilities at particular locations. However, it has also shown how adaptable these systems are overall. The disruption's unusual nature focused on supply chain resiliency and short-term instability in intermediate marketplaces. How resilience is defined and assessed is essential when addressing supply chain resilience over the medium to long term. There are intrinsic tradeoffs between supply chains that operate successfully and efficiently in "normal" times and their robustness and flexibility during "abnormal" times. Resiliency has multiple aspects. It is crucial to comprehend the underlying economic principles of the industry, mainly how to scale economies and productivity are influenced by industry structure and what this means for producer and customer welfare.

The epidemic has also brought attention to the interconnectedness of supply chains and the necessity for "systems thinking" when tackling resilience. Lower transaction costs and a tendency to be more flexible in uncertainty are characteristics of supply chains with higher levels of collaboration and good communication. The industry should be better equipped to handle significant disruptions after the Covid-19 outbreak, recognizing essential sources of supply chain risk and measures to manage these risks.

A resilient supply chain recovers swiftly after an unplanned occurrence. Our private sector and public policy approach to domestic manufacturing has resulted in the supply chain vulnerabilities described in this research, emphasizing efficiency and low prices over security, sustainability, and resilience for years. This approach has also jeopardized workers' prosperity, health, and ability to manage natural resources domestically and globally. As the Administration embarks on a path to reinvigorate our industrial base and safeguard global supply chains, national resilience demands a renewed emphasis on broad-based prosperity and sustainability.

A resilient supply chain strategy must use our unparalleled innovation ecosystem, people, broad ethnic, racial, and geographic diversity, small and medium-sized enterprises, and strong ties with allies and partners that share our values. The Administration must strengthen our innovation infrastructure by reinvesting in R&D and expediting our capacity to get inventions from the lab to the marketplace.

Workers must create the groundwork for resilience. Resilient production necessitates swift issue solving, fueled by manufacturing floor knowledge, leadership, and complete involvement. Decades of treating labor as a cost to be managed instead of an asset to be invested in resulted in lower actual salaries and union density for employees while also contributing to employers' difficulties in recruiting and retaining talented people. We must focus on building avenues for all people to access good-paying employment and the free and fair right to organize and bargain collectively.

We must guarantee that economic opportunities are available in all corners of the country, particularly for women, people of color, and those frequently left behind. Income, racial, and geographic inequality prevent millions of prospective employees, researchers, and entrepreneurs from fully contributing to development and innovation. Children with the potential to become innovators are less likely to become patent holders today if they are low-income, female, African American, Latino, or from disadvantaged areas. The Administration's strategy must give access and avenues for these employees, researchers, and company owners in the 21st century's burgeoning sectors.

A varied and healthy ecosystem of suppliers is required for a strong and resilient supply chain. As a result, we must restore our small and medium-sized firm manufacturing base, which the hollowing has decimated out of the domestic industry. We must also diversify our overseas suppliers and limit regional concentration risk. Domestic production of all essential items is neither feasible nor desired. However, for far too long, governments have accepted some aspects of global markets (particularly the concern that enterprises and money will be to where wages, taxes, and regulations are the lowest) as unavoidable.

In the face of similar challenges, other countries successfully engaged in policies that more evenly spread the benefits of globalization, especially to employees and small firms. We must advocate various of policies (taxation, environmental standards, and so on) that help shape globalization so that it benefits people as workers and families, not just consumers.

6. Limitations

More empirical, event-based, and less conceptual research into supply chain resilience has been asked for several times during the preceding two decades. COVID-19 provides an ideal opportunity for scholars to do the type of research that has been sought. This research might help to structurally de-risk supply networks. Decision models for supply chain design that incorporates the need for flexibility, quick response times, multiple sources, and methods for enriching supplier segmentation and assessment models to reduce a sole focus on savings and payment terms are research opportunities.

The sample size was recognized as a research disadvantage since obtaining a broad pool of individuals was difficult due to Covid 19. Due to the nature of the pandemic, not all organizations had a clear record of the pandemic period nor the confidentiality of such data, making it impossible to get exact impact numbers.

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