The Effects of Pandemics on Supply Chains

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Introduction

Beginning in March 2020 and beyond, there has been an increasing amount of attention focused onto supply chain management and how it operates through a global pandemic like COVID-19. As shortages in stores around the world became more commonplace, and the general public stocked up on necessary items to prepare to face the pandemic, supply chains were forced to work overtime to keep up with the increasing demand and provide consumers with the products they needed in a timely manner. Although supply chains were working to become leaner and more cost efficient in recent years, the pandemic has forced many supply chain managers to rethink how they operate their production facilities and manage their warehouses in order to respond to the pandemic and overflowing demand (Craighead, Ketchen, & Darby 2020).

In order to determine the effects on supply chains most effectively, both historical and current sources must be analyzed, as well as conducting interviews with professors and supply chains professionals to gain personal insight to the direction in which supply chain management is heading. To begin this study, we will describe how a supply chain operates and its purpose related to the business industry, as well as how it touches the daily lives of each person around the world. We will also work to discover how supply chains in the past have adapted to pandemics and other major disruptions, allowing us a look into how the world expects supply chains to function once the pandemic has ended (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007). In addition to this, lockdowns and shortages have affected the way we do global business, such as conducting virtual meetings and decreasing the need for domestic and international travel, so there is also a lot to consider about how the supply chain industry will operate with new techniques and potentially less face-to-face interaction as is occurring in the current time (Allam, 2020). Finally, we will also consider the potential innovation that will come

about at the conclusion of the pandemic and how it can continue to change the efficiency of supply chains.

Literature Review and Background

Within this section, the history of supply chains and their reaction to past pandemics and other major disruptions will be analyzed according to recognized literature and reputable sources. Through this analysis, audiences will be able to determine how the history of supply chains and disruptions continue to affect operations, as well as the effect of COVID-19 on current supply chains.

The Definition and History of Supply Chain

Throughout history, people all over the world have worked to move their products efficiently to different markets to increase their profits and discover new ways of creating value for their customers. In the early years of civilization, humans realized that they did not have enough of the right resources for their needs outside of subsistence farming and crafting, so they turned to trading and exchanging their good and services, which created the early foundations of supply chains (Lillford & Howker, 2000). By definition, a supply chain "comprises the sequence of companies that contribute to the creation and delivery of a good or service to end customers, going from the point of origin of raw materials and subcomponents all the way to the point of consumption" (Prater & Whitehead, 2012: 8). Although this process was much more simplified in the past when businesses and customers were usually local or positioned within the same country, this process of creating and moving products has grown into a global industry that spans an increasing number of markets and consumer bases.

As a result of the need for global supply chains and efficient transportation of goods and resources, the role of supply chain management was created in order to control and oversee each

part of the supply chain itself. This role is well-known in the business environment today, but the term “supply chain” was not created until the 1990s, establishing the increased attention and focus on this flow of information and goods as a strategic operation rather than an unimportant function of a business. (Zuckerman, 2002). Although a supply chain manager is largely involved with the company that employs them, they must also think beyond their company in order to help each function operate seamlessly together and to unite customers, suppliers, and transportation labor forces in the most efficient and cost-effective way possible (Drake, 2011). In addition to these features, the supply chain managers must also think globally and have a significant understanding of the other cultures that they may do business with, so this adds another level of complexity to an already important position in a business.

At its most basic level, there are four types of supply chain management positions or career tracks, and these are procurement, manufacturing, operations/planning, and logistics/warehousing. Through procurement, managers are able to work with other companies to obtain the necessary raw materials and resources needed for production and manufacturing. Not only is this step about gaining these materials, but it is based heavily on negotiation and communication between counterparts (Zuckerman, 2002). For manufacturing, the company is building their products and creating value for their customers through the optimization of their machinery and labor force. For operations and planning, a team of workers often analyzes data collected from the supply chain to create risk mitigation plans to avoid disruptions, and they work to optimize their processes according to the data (Chopra & Sodhi, 2004). Finally, logistics is the process of determining effective ways to organize warehouse operations for their inventory to keep the supply chain working efficiently and moving finished products to their final

destinations through a variety of different modes of transportation, such as planes, trucks, and freight ships.

Supply Chain Disruptions

Speaking on supply chain disruptions, they can be defined more specifically as events that are "unplanned and unanticipated that disrupt the normal flow of goods and materials within a supply chain and expose firms within the supply chain to operational and financial risks" (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007: 132). Over the past few decades, managers and employees have increasingly considered the effects of these disruptions on company operations because supply chain management is labeled more strategic and vital to a company now than ever before (Zuckerman, 2002). For example, supply chain disruptions can be big and obvious, including instances of natural disaster, bankruptcy, war, and terrorism, but they can also be more subtle and harder to detect when operations are underway, such as forecast inaccuracies, capacity issues, and intellectual property breaches (Chopra & Sodhi, 2004). How companies approach these disruptions and identify ways to avoid them has now become a necessary part of any supply chain operation, and it is vital to the success of modern businesses.

With varying levels of severity and increasing effect on supply chain operations, companies must work to identify key points of potential disruption within their value-added activities and to mitigate potential risks. One key reason why a company might feel the effects of a disruption more intensely than a competitor is supply chain complexity, an example of which could be that a company has too many suppliers and production facilities under their control or too much dependence on global operations (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007). Not only would this increase the chance of risk and disruption, but this also decreases supply chain visibility if managers and company leaders do not have the correct tools

or processes to monitor their supply chains. Additionally, if companies work to create risk mitigation plans, but they do not take the time to correctly implement them or uphold them, then the company loses its agility when it comes to future disruption. For example, a company using lean manufacturing techniques may choose to eliminate all inventory to save money and improve processes, but they neglect to identify risks in their supply chain where safety stock and excess inventory might help them to avoid delays (Chopra & Sodhi, 2004). Not only would this help to keep production and sales moving in the face of disruption, but it would give them an edge over competitors who may not have planned for risks as thoroughly.

The History of Pandemics

Over many years of world history, humans have experienced a number of large and devastating epidemics and pandemics that have affected a significant portion of the population. By definition, the word "epidemic" stems from a Greek translation meaning "that which is upon the people", and "pandemic" has been modified from this to provide a narrower sense of the original word, meaning that most often a disease or illness affects a larger group or different regions of the world (Morens, Daszak, Markel, & Taubenberger, 2020). Some specific examples of pandemics occurring throughout history are the bubonic plague in the Middle Ages, smallpox over many centuries, tuberculosis, polio, and Ebola in more recent years (Morens, Daszak, Markel, & Taubenberger, 2020). Although many of these major diseases have since been eradicated due to technological and scientific advances in medicine, pandemics still occur frequently when there is a large exchange of germs between humans and animals.

This past year, COVID-19 was classified as a global pandemic that has reached the far corners of the earth, causing high levels of flu-like symptoms and potential death among those who contract it. Although it has not been moving around the world for a long amount of time, it

presents very similar attributes to the Spanish Flu pandemic of 1918 (Saxena, 2020). Affecting younger portions of the population and spreading through close contact like COVID-19, the Spanish Flu killed a significant number of people in the time that it was most virulent, and there are records of people using face masks and disinfectants to sanitize both their belongings and public spaces to avoid spreading the illness to other people, like many countries are now doing during the COVID-19 pandemic (Efron, & Efron, 2020). Although the Spanish flu has not affected populations since that time, its effect on the economy and social interactions has created a significant amount of information that researchers are now referencing in their reaction to the current pandemic. In addition to this, COVID-19 has also created significant difficulty in working with others because of its high probability to spread between people, so a number of disruptions have resulted from the lockdowns and quarantine periods (Saxena, 2020).

The Effects of COVID-19 on Supply Chains

As COVID-19 continues to limit social interaction and traditional business operations, supply chains have felt the blow of a surplus of demand and a lack of resources to get the necessary supplies to the stores. With the closure of small businesses and a run on supplies such as hand sanitizer, toilet paper, and masks, it has made it more difficult for supply chains to handle the high levels of demand as consumers deplete available stock from store shelves with their amplified buying habits during the pandemic (McKay, 2020). Although supply chains are organized to provide products to consumers when they need them and prepare risk mitigation strategies to avoid stockouts during normal times of the year, there is no possibility that any supply chain manager or company could have predicted the strain on supply chain operations as a result of COVID-19 and the lockdowns (Allam, 2020). Furthermore, the products that are the least available at the current time are commonplace ones that consumers usually only purchase

when they need them rather than when they want them, such as toilet paper and cleaning supplies.

Stockouts and increased demand are not the only things affecting supply chains during the COVID-19 pandemic. As states and countries go in and out of lockdowns, the number of workers allowed in warehouses and stores changes frequently, but the overall amount remains lower than the original level before the pandemic due to close contact and the spread of the disease (McKay, 2020). With a lack of workers to move orders and products, the supply chain slows down, causing customers to experience delays in shipping and receiving their items. Although companies are still able to fulfill orders under the restrictions, customers are also discouraged from placing future orders with the company due to the delays, causing a further decrease in profits for the business. The government has also continued to bail out many small businesses that are unable to have the same number of workers in their shops or the same level of interactions with their customers. Similarly, business officials, employees, and managers are unable to interact with each other in person or travel to meet with their counterparts, so they have been forced to utilize virtual meetings to continue to conduct business.

Methods

To determine the current effect of pandemics on supply chains and the innovative outcomes, qualitative data must be collected to further our discussion on this topic. Through the use of interviews and research, we are able to gain a better insight into the experiences of people with direct knowledge of the industry and its innerworkings.

Participants

The participants in this study were professors in the Supply Chain Management department at the University of Tennessee in Knoxville and business managers in the supply

chain career field with at least five years of experience. Although both groups deal with similar topics and issues, insight was needed on the industry from a variety of perspectives to determine whether the future effect of the pandemic on global supply chains is mostly negative, positive or an even mixture of both. In order to document this information, interviews were scheduled over email and then conducted with the participants over the phone or Zoom to get a closer look into the current state of the supply chain industry and document their experiences.

Data Collection Through Interviews

Once participants were selected, they were asked to read over and sign an informed consent document that would allow them to be better informed on their participation in the research project, and they were given the option to withdraw their information and interview data at any time and for any reason. After the interview was set up over a phone call or through Zoom, participants were asked a set of five questions to relay information about their experiences (see Appendix). A total of thirteen business professionals participated representing seven different companies and organizations, and their insight and information is summarized below.

Interviewee Classifications

MANAGER	Performs key supply chain functional responsibilities and manages teams of employees
ADVISOR	Handles consulting services and provides advice to companies on supply chain strategy

Company Descriptions

MANUFACTURER-1	Designs and manufactures products for automobile assembly and maintenance
MANUFACTURER-2	Designs and manufactures innovative automobiles for global markets

MANUFACTURER-3	Manufactures small-scale facilities and lodging for customers
MANUFACTURER-4	Provides convenience and transportation services to customers across the country
SERVPRO	Software-based company providing storage and data analytics services
LOGPRO	Third-party logistics company that handles transportation and movements of goods for large corporations
CONSULTFIRM	Provides consulting services to companies looking to improve or restructure their supply chain strategy

Results

The goal of this research was to determine if the lasting effects of COVID-19 on global supply chains were positive ones, and whether business professionals believe that significant innovation and improvements will be made as a result of the pandemic as a major supply chain disruption. To answer these questions, all participants were asked to describe how their companies responded to COVID-19 and to detail the ways in which they were still working around the effects of the lockdowns. The similarities between responses were immediately apparent. With the increased need for sanitization and social distancing measures, MANAGER from MANUFACTURER-4[1] mentioned the increased use of paperless billing and daily screening of their drivers to ensure safety in and around their warehouses and production facilities. Similarly, MANAGER from MANUFACTURER-2 spoke about the increase in working from home and virtual meetings in order to protect customer and employee safety, but they also mentioned that work-life balance was suffering due to little separation between employees' home lives and virtual work.

[1] Pseudonyms are used to protect confidentially.

While increased cleaning measures and remote work were common themes throughout the interviews, there was also variation in the types of responses companies had to this pandemic and what they considered was the best course of action to continue business in a changing environment. For example, MANAGER-1 from MANUFACTURER-3 spoke about the creation of a "COVID-19 task force that was processing and interpreting the changing government orders concerning lockdowns and mask mandates, and that's how we were able to digest this dynamic situation, and provide guidance to our facilities." This task force also worked to keep track of the changing guidelines across state and country borders since they were rarely the same at any given time, where other companies were left "scrambling to make alternative arrangements" as many protocol shifts happened quickly and without much warning (McKay, 2020: 1). MANAGER-2 from MANUFACTURER-3 stated that they increased their supply chain lead times to offset increasing demand as their company was marked as an essential business during the initial lockdowns. Not only did this work to help them reduce demand, but it gave them more flexibility in procuring materials for their products and setting price limits for their customers.

Risk Mitigation and Contingency Plans

In terms of risk mitigation strategies, the business professionals that were interviewed stated that there was no set contingency or risk plan in place to deal with something as large and unique as the COVID-19 pandemic. MANAGER from MANUFACTURER-1 described their company's plan before the start of the pandemic saying, "We had contingency plans for if one of our plants could not produce a certain product or if there was an earthquake and we had to shut down a distribution center for a certain period of time, but we didn't have any plan for something that has lasted as long as the pandemic." Additionally, ADVISOR from CONSULTFIRM stated that only 15-25% of companies actually have set risk mitigation strategies in place to deal with

major disruptions. Only MANAGER-1 from MANUFACTURER-3 described their company's vertical integration as a successful risk mitigation strategy that allowed them to avoid major delays in production throughout the pandemic and continue sourcing while other companies could not receive materials from their suppliers due to lockdowns.

As a result, many business professionals believe that this major disruption to supply chain operations will force companies to create more robust risk mitigation strategies and place higher importance on predictive analytics and visibility (McBeth, 2020; Kee Wee Ng, 2020). MANAGER-1 from SERVPRO stated that "While it [COVID-19] impacted us, it was not a death nell - we had enough contingencies built into our supply chain overall that, while we may have been shut down for certain periods of times, we had additional capacity elsewhere that we could rely on", showing how their company was eventually able to re-route supplies and resources once they got a better handle on the situation. They also described their single dependency management initiative, which allows their company to determine where in their supply chains there might be a dependence on a single supplier or a supplier production capability to avoid similar disruptions in the future. By creating stronger supplier relationships and eliminating points of single-source dependency, these strategies can help companies to balance the risk and avoid future disruptions (Kee Wee Ng, 2020). Additionally, MANAGER-2 from SERVPRO mentioned the increasing focus on supply chain resiliency, such as holding more inventory with less product customization or moving away from lean manufacturing techniques, to ensure that their operations become more agile in the face of disruptions.

After the COVID-19 Pandemic and Supply Chain Innovation

When asked what operations or regulations they believed would remain at the end of the pandemic, all participants agreed that the business world will see less domestic and international

travel for business purposes. Without the need for business travel, it is saving companies considerable amounts of money that would have been originally used to pay for their employee trips, and leisure travel is predicted to return much quicker than business travel for this reason (McKay, 2020). Additionally, MANAGER-2 from MANUFACTURER-2 mentioned that continued virtual interactions will make time-zone differences easier to manage and help business relationships to be more personal as we get more comfortable interacting together online and getting a look into a counterpart's life at home rather than through business dinners and professional exchanges alone. This unique opportunity to build deeper relationships within the supply chain comes at an important time as more businesses were choosing to expand globally before the pandemic.

In relation to less travel for business, interactions between counterparts are expected to continue as a mix of both in-person and virtual communication. MANAGER-1 from LOGPRO claimed that their employees are more productive working from home than they are when required to come into the office every day during traditional work hours, stating that "COVID-19 will and has changed the way that business is done", so they believe that the days of large office buildings and long days on site are coming to an end. In relation to this, MANAGER from MANUFACTURER-1 agreed with this fact, stating that their corporate office is now being transformed into a "collaboration hub" with more common spaces and bigger conference rooms rather than separate personal spaces to be more collaborative after the pandemic and allow employees to reserve which days they would like to physically come into work. This pandemic has also given managers the unique opportunity to realize that innovation is more than just new equipment and software, so the time spent at home and away from the technology has given employees more time to think strategically and problem-solve effectively (McBeth, 2020).

In terms of innovations and improvements specific to supply chains, one of the most common responses from participants was the acceleration of the near-shoring and re-shoring trend that was occurring just before the start of the pandemic. MANAGER-2 from LOGPRO stated that dependency on China for sourcing and manufacturing hindered a lot of supply chain companies during the pandemic, so many will look to near-shore or re-shore a portion of their operations to decrease lead times and increase control in the face of disruption. Additionally, companies will now be encouraged to look into regions of the world they had not previously considered for supply chain operations, such as Malaysia and Vietnam, so this will allow them to reduce their dependence on single countries and take advantage of increasing technology in emerging ones (Anderson, 2020). Similarly, ADVISOR from CONSULTFIRM mentioned that more companies will focus on last-mile delivery, as well as "next level parcel delivery", and work to be more comfortable with online purchasing as a result of the lockdowns affecting in-store operations. With portions of company supply chains relocated to be closer to their corporate headquarters and greater focus on online operations, businesses will also have increased supply chain visibility as information is shared more efficiently (Kee Wee Ng, 2020).

In addition to shifts in globalization, the majority of the interview participants also agreed that increased automation in factories and transportation, such as driverless trucks and robots in production plants/distribution centers, will increase significantly as a result of the COVID-19 pandemic. MANAGER-2 from MANUFACTURER-3 stated that "there already has been a lot of focus on automation, but this virus would be yet another reason to drive that forward even more". Automation continues to function, even when people cannot due to things like COVID-19, so an increase in spending around this new technology can be expected in the next few years after the end of the pandemic (McBeth, 2020).

Conclusion

Even though the COVID-19 pandemic has had considerable negative effect on supply chain operations and agility, it is clear from the available sources and research that positive innovation and improvement are already occurring within the supply chain in the form of risk planning and new technology. With an increase in automation in production and warehouses, greater virtual interaction between global counterparts, and new risk mitigation planning techniques, the pandemic has uncovered flaws within the supply chain that must be rectified if companies hope to remain competitive in the future. Additionally, improvements that were being made to supply chains before the pandemic have also been accelerated as companies see a greater need for agility and visibility within their business. Therefore, the effects of this COVID-19 pandemic on supply chains are becoming more positive than negative with each passing day.

It is important to note that this research study was conducted only from a small portion of businesses and scholarly sources, so there are limitations to the applications of these conclusions on a larger scale. However, it can be determined that COVID-19 has had both a negative and positive effect on supply chain operations, with improvement and innovation significantly increasing as the pandemic is residing. If the results of this study remain true, more consistent improvement to supply chain operations is likely to occur on a larger scale because the steps that only a few companies are already taking to respond more fully to disruption represent a greater overall trend.

In the future, it is important that companies remember the negative effects of the pandemic and continue to take advantage of new information and studies on how to avoid major disruption to their supply chains again in the future. With increased risk mitigation strategies and more interest in predictive analytics, companies can better prepare for a large-scale situation like

COVID-19, as an event like this is likely to occur again in the future. By studying history and looking into future innovation, companies can be better off than they were before the pandemic and take advantage of the positive effects of the virus for years to come.

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Appendix

Interview Information

Interview Questions for Business Professionals

1. How long have you worked with the company, and what is your experience of working in supply chain management in general?
2. What risk mitigation plans does your company currently have in place to avoid national disasters, pandemics or other major disruptions?
3. How has your company responded to COVID-19, and how are they still working around the effects of the lockdowns?
4. Do you see any of the current operations staying after the conclusion of the pandemic, such as virtual meetings and less travel for business?
5. What innovation or improvements to the supply chain do you see as likely to occur?