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**Challenges and Recommendations for Disaster Response for
the Medical Supply Chain: A Case Study of Hurricane Laura**

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**An Honors Thesis in partial fulfillment of the requirements for the degree Bachelor of
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I. Introduction

Hurricanes are one of nature's most destructive forces, and, as such, they can have devastating impacts on businesses in affected areas, specifically medical businesses. To effectively prepare for and respond to a hurricane disaster, it is important for businesses involved in the medical supply chain to understand the potential impacts caused by hurricanes, as well as their vulnerability to these disasters. The purpose is to provide an overview of the various factors and challenges in the medical supply chain that must be considered when responding to a hurricane disaster, focusing specifically on Hurricane Laura. This research will explore how companies functioned within the affected region during the hurricane emergency response and include how best to manage resources and risk management strategies. Furthermore, this research will evaluate the impact of public policies related to hurricanes on medical supply chain operations and consider what measures should be taken post-disaster to aid recovery efforts. The findings from this research can then be used by businesses within impacted regions to improve their preparedness and response planning prior to future disasters.

Specifically, I focus on five key issues that I assembled based on the literature that must be taken into account when responding to such a disaster: (1) availability of resources, (2) inventory management control, (3) risk management strategies, (4) coordination among stakeholders, and (5) debris management. This research draws upon qualitative methods including an interview with an industry expert and a literature review to analyze the current landscape of hurricane disaster response in the supply chain. I aim to establish potential solutions for addressing these issues based on previous best practices.

Hurricane Laura

The coronavirus pandemic has had an extreme effect on the global economy. At the same time, 2020 was also a year of natural disasters, with Hurricane Laura being one of the most destructive storms to hit the United States in recent memory (Fernandez & Kessel, 2020). The pooled effects of these two events have been particularly devastating for companies and industries that rely greatly on their supply chains to produce goods and services. Hurricane Laura was a category four hurricane with wind speeds of up to 150 mph, leaving many people without power, homes, and other basic needs (Miroff, 2020). When Hurricane Laura made landfall on August 27th, it caused massive destruction to the Gulf Coast region, specifically the coast of Texas and Louisiana (Fernandez & Kessel, 2020). See Figure 1.1 for Hurricane Laura's landfall locations (The Weather Channel, 2020).

The Weather Channel acknowledges the dangerous winds Laura produced within these two regions:

- Lake Charles, Louisiana: 133 mph
- Calcasieu Pass, Louisiana: 127 mph
- Cameron, Louisiana: 116 mph
- Sabine Pass, Texas: 89 mph
- Alexandria, Louisiana: 86 mph (The Weather Channel, 2020)

The hurricane accounted for 47 direct deaths and \$19 billion in losses, with a storm surge of up to 18 feet above the ground (Pasch et al., 2021). The cost estimate comes from insured losses from the storm as well as the total economic cost of the damages (Isidore, 2020). The National Hurricane Center goes on to say, "Laura also caused 34 indirect deaths in the United States, 26 in Louisiana and 8 in Texas, from carbon monoxide poisoning, storm cleanup-related activities, electrocutions, and heat stress, among other indirect causes" (Pasch et al., 2021). Additionally, the hurricane disrupted transportation networks and halted production at numerous

business sites throughout Louisiana and Texas. This disruption further heightened existing issues associated with the COVID-19 pandemic, as shipping delays meant that businesses could not get materials or completed products to their customers promptly (Durinck, 2020). In turn, production capacity decreased for many businesses, especially those producing medical supplies needed for Hurricane Laura and the pandemic (Sherer, 2022). This leads to increased costs and decreased profits.

Medical Supply Chain

The medical supply chain (MSC) is a vital component in the healthcare industry ensuring that healthcare providers have access to necessary medical products and equipment. The main goals of healthcare supply chain management are to manage supplies, obtain resources, and deliver goods and services to providers and patients (LaPointe, 2022). A significant number of stakeholders are operating in this supply chain process—manufacturers, distributors, providers, patients, healthcare coalitions, and federal programs (TRACIE, 2022). The following explains the roles and importance of each stakeholder in the MSC:

Manufacturers: “Research and develop new products, create and manufacture medical products, monitor and respond to shortages, and produce disposable and durable products, medications, dialysis products, sterilization and medical gases, and IV fluids” (TRACIE, 2022)

Distributors: “Deliver medicines and supplies from manufacturers to providers and healthcare facilities” (TRACIE, 2022)

Providers: “Receive medicine and products from distributors, prescribe and dispense medicines and products to patients, and use products in healthcare facilities” (TRACIE, 2022)

Patients: “Manifest unique medical needs that require specific products, influence the demand for medicines and products, and care for and use products” (TRACIE, 2022)

Healthcare coalitions/Federal programs: “Encourage best practices in communicating and engaging with supply chain components, standardize and provide guidance on activities that impact supply chain operations during emergency events, and provide opportunities for supply chain components and coalition members to train and exercise with one another; can also share information and coordinate strategies in their areas to cope with specific supply shortages” (TRACIE, 2022)

It is key to know these stakeholders’ roles in determining the complexities this supply chain faces when a disaster occurs. When a hurricane strikes, the medical supply chain faces significant challenges that can disrupt the delivery of critical medical supplies.

I aim to identify potential solutions for addressing each of these five issues when responding to a disaster based on existing best practices. Ultimately, this thesis will provide an insightful analysis of the complexities associated with responding to hurricanes within the supply chain. It is hoped that the findings of this research will provide both practical and theoretical guidance to supply chain managers in preparing for and responding to hurricane disasters.

The following research leads us to two research questions:

1. *What challenges did the medical supply chain face amid Hurricane Laura?*
2. *How can the medical supply chain improve disaster response in the future?*

The remainder of this paper is organized as follows. Section 2 reviews prior literature on issues within the medical supply chain focusing specifically on Hurricane Laura. Section 3 focuses on my research design on three companies that were impacted by Hurricane Laura and

explains the challenges they encountered through the lens of the issues outlined in the literature review. Section 4 includes my final recommendations and conclusions.

II. Literature Review

Availability of Resources

There have been concerns about the policies and timeliness of FEMA's response to hurricane disasters (Adamski et al., 2006). It is imperative for governments, organizations, and individuals to have proper implementation strategies to respond quickly and efficiently when a hurricane occurs (Dolinskaya, 2018). Many times, there is a lack of rapid response from FEMA in providing proper aid and assistance in affected areas. Previous scholars believe this is due to their absorption into the Department of Homeland Security (DHS) in 2003 impairing their response to disasters (Adamski et al., 2006). The belief was this transition would endanger disaster management through the merging of domestic and national security issues by becoming secondary to decrees made by DHS (Adamski et al., 2006). Amid Hurricane Laura, among other catastrophes, members of Congress showed concern about FEMA's capability to meet the needs of low-income families during multiple disasters (Fox, 2020). Stephen Speight, who lived in a mobile home in DeQuincy, Louisiana, used a nebulizer to help him breathe due to declining health (Hersher et al., 2021). After Laura took Speight's electricity, which was needed to power his nebulizer, he was denied service from FEMA due to his low income (Hersher et al., 2021). Hersher acknowledges that "FEMA was about twice as likely to deny housing assistance to lower-income disaster survivors because the agency judged the damage to their homes to be 'insufficient'" (2021). Once Speight finally received \$1,649 from FEMA 10 months after Hurricane Laura, it was not enough to fix his house, generator, and medical devices. He passed away shortly after (Hersher et al., 2021). FEMA faced challenges dealing with not only wildfires in the west alongside Laura, but the agency was also responding to a worldwide pandemic (Fox, 2020). Furthermore, the U.S. Government Accountability Office (GAO) acknowledges the underlying issues with FEMA to be staffing shortages and workforce qualifications from these multiple disasters and the COVID-19 environment (Currie, 2022).

Inventory Management Control

Supply shortages worsened in recent years due to hurricane disasters and the COVID-19 pandemic, challenging healthcare providers in acquiring necessary items for quality care at affordable rates (Raphelson, 2020). Many attempt to solve how to allocate supplies to the most in need and identify alternate supplies without added expense (Hodgson et al., 2021). A 2020 survey of healthcare providers and suppliers shared that increased emphasis of products made in the United States would ease medical shortages, bidding wars, and other humanitarian-related issues for the future (LaPointe, 2022). The pool of stakeholders believes that the issue to solve should be less reliance on IT and more safety stock (LaPointe, 2022). Some sources disagree. Resilience solutions company Juvare acknowledges the tools needed to respond more effectively to the Hurricane Laura crisis in the middle of a pandemic (Birla, 2020). Juvare deems Geographical Information System (GIS) and situation reporting (SITREPs) vital to clearly see where issues are and provide time-critical data in management control (Birla, 2020). In addition, they believe in centrally coordinated communication such as Built-in Workflows to track multiple cases and provide coordination across teams (Birla, 2020). Most importantly, they consider their emergency engagement platform, WebEOC, necessary for real-time information to effectively plan for a hurricane (Birla, 2020). Technology use is believed to be more important than ever since one must have a balance of emergency response with social distancing protocols

(Tuttle, 2020). While there is not much supporting research, I believe there are consequences to information technology. There could be a substantial increase in network traffic and loss of access in communication networks due to power outages. Returning to the survey, some sources agree with the healthcare providers though it occurred pre-pandemic. The Department of Industrial and Systems Engineering at the University of Buffalo maintains that the repositioning of items and staffs is key for inventory management, especially during hurricanes (Sabbaghtorkan et al., 2019). Issues are faced here due to most relief supplies being purchased after a disaster because of the high costs of repositioning physical inventory (Hu et al., 2019). There also may be implications with transportation, making it challenging to move people and medical resources from one location to another.

Risk Management Strategies

Evacuation planning and infrastructure damage both face issues that result in afflicted parties failing to receive adequate medical care. These problems desperately need to be addressed.

Evacuation planning remains uncertain to this day, with Hurricane Laura making analysts consider their lack of planning and forecasting. Analysts waited for some time before making their evacuation protocol on Hurricane Laura because of uncertainty on the matter (Morgan, 2020). Windspeeds nearly doubled the day before landfall (Tuttle, 2020). Officials ordered a few hundred-thousand people to evacuate in Texas and Louisiana, but it was too late (Tuttle, 2020). The hurricane developed and intensified too quickly, and many citizens were unable to leave. The lesson learned was to maintain a higher state of alert and present high consideration to all weather forecasts (Morgan, 2020). However, it is forgotten that post-hurricane evacuation leads to issues during a global pandemic. According to NPR, emergency shelters struggled in ensuring the safety of evacuees “without overcrowding and had to direct many to hotels” (Tuttle, 2020). Research conducted by Columbia University and the Union of Concerned Scientists suggested that the quantity of coronavirus cases in the origin and destination counties of evacuees may rise due to the mass evacuations (Hampton, 2020). I interviewed Lane Paton, Account Manager in the Surgical Solution Division at Olympus Corporation of the Americas, and he explained to me the economic issues with evacuations. He stated, “From an economic stance, there comes a lack of supplies, medicine, and gas from COVID-19. When you add a hurricane to it, people with the allotted money and resources buy more than enough, so people that can only afford basic needs do not have anything to buy. It’s the biggest issue facing those of lower socioeconomic status.”

Hurricanes can cause severe damage to roads, buildings, businesses, and other essential structures for daily activity. Relief supplies become unavailable or inaccessible, and some can get trapped far from points of distribution (PODs) (Ma et al., 2022). Once a pandemic is added to this, the environment is extremely unpredictable and results in shifting supply, demand, and communication forms (Ma et al., 2022). Hundreds of thousands lost power during Hurricane Laura, making it difficult for first responders to coordinate rescue and delivery efforts and for residents in Louisiana and Texas to receive critical information (Tuttle, 2020). Lack of information leads to deaths from carbon monoxide poisoning and electrocutions from drowned power lines (Pasch et al., 2021). Why do deaths from carbon monoxide poisoning go up even more so than fires after a hurricane? The reason is wrong positioning and ventilation of generators (Morgan, 2020). Medically, carbon monoxide poisoning is one of the hardest to treat (Morgan, 2020). When conditions are exacerbated by limited access to healthcare facilities and by lack of medical supplies, there is not more action that can be taken. There is a solution that needs to be developed.

Effective risk management can help prevent financial damage, loss of lives, or other negative consequences involved in a hurricane.

Coordination Among Stakeholders

If even one stakeholder is compromised and there is no communication involved in emergency response, delays and inefficiencies in getting proper supplies to people in need will occur. It is important for critical stakeholders to update each other regarding the timing, place, type, and quantity of relief supplies (Ma et al., 2022). However, it is extremely difficult to measure the impact of the hurricane, as information for the demand of resources is limited, inaccurate, and ever-changing (Ma et al., 2022). Many factors can compromise coordination among stakeholders. Figure 1.2 shows a schematic of a disrupted supply chain if stakeholders fail or are unable to fulfill responsibilities (Ma et al., 2022).

An important term in understanding these issues among stakeholders in disaster response is “bottleneck.” The Committee on Building Adaptable and Resilient Supply Chains After Hurricanes Harvey, Irma, and Maria define bottleneck as “the part of the supply chain most vulnerable to becoming overloaded as the result of a spike in demand or a loss of capacity” (Featherstone et al., 2020). PSEG Long Island’s vice president of Transmission and Distribution Operations sought to settle bottleneck issues during Laura and COVID-19 (O’Connell, 2020). He shared and emphasized the necessity of putting various processes in place to continuously monitor IT systems for capacity and bottleneck issues while providing best practices for safe and reliable service (O’Connell, 2020). Insurance companies are also vital stakeholders in the healthcare industry. Insurers are very cost-conscious and desire minimal delays and waiting periods for patients, inexpensive re-admissions, and quick hospitalization times (Lübbecke, 2019). Their aim is to keep third-party payor expenses to a minimum. Stakeholders must quickly identify potential bottlenecks and take corrective action before shortages occur.

Debris Management

Disaster debris can inhibit responders’ and emergency services’ ability to reach affected parties and can pose significant logistical and financial challenges for both regional and state levels (Brown et al., 2008). According to the designated county reports from United States Army Corps of Engineers (USACE), over \$189 million was given in a public assistance grant for debris removal of 23.8 million cubic yards from Hurricane Laura (*Hurricane Laura Recovery Efforts Through One Year*, 2021). This not only poses financial effects to the agencies involved, but also to the residents whose homes are affected, especially those of a lower income. Georgia, a Lake Charles resident, returned to her home post Laura and found catastrophic damage to her home and massive hurricane debris in her yard (*Disaster Relief for Hurricane Laura Victims*, 2021). She was overwhelmed with the amount of debris that needed to be removed compared with the limited income she had (*Disaster Relief for Hurricane Laura Victims*, 2021). She was aided through Operation Blessing, a nonprofit, but not all residents are so fortunate. Poor management of cleanup can further issues, resulting in slow and costly recovery posing a threat to public and environmental health in the short and long terms (Brown et al., 2008). Strides have been made in this sector from Hurricane Laura. FEMA has developed a HAZUS-MH tool to detect estimates the debris generates (Jalloul et al., 2020). Analysis from Laura resulted in a debris estimate of 1,239,824 tons for brick and wood debris, 64,569 tons for concrete and steel debris, and 10,788,584 tons for vegetative debris (Jalloul et al., 2020). In addition, the Environmental Response Management Application (ERMA) is an online mapping tool created by National Oceanic and Atmospheric Administration (NOAA) to help communities clean up debris post impact (*Map of the Month: Hurricane Laura’s Aftermath*, 2022). In response to Laura, federal

funding was issued for assistance in debris removal at a 75% cost-share, and an amendment was proposed to authorize a 100% federal cost-share for 30 continuous days of debris removal to be determined by state officials (Jalloul et al., 2020). With COVID-19 and three active hurricanes hitting the state of Louisiana, the disaster debris management must have been experiencing large amounts of strain. The social and economic impacts are clear when determining debris management.

III. Research Design

While there is ample research discussing solutions to common issues found in the medical supply chain, there is a lack of application of these ideas in Hurricane Laura. In the following section, I formulate a research design focused on three companies that were impacted by Hurricane Laura and explain the challenges they encountered through the lens of the issues previously outlined in the literature review. I will examine the general solutions of these issues from scholarly sources and determine if the implementation of these solutions during Hurricane Laura could have resulted in improved outcomes. The following companies were chosen because—though the medical supply chain from Hurricane Laura shows improvements to disaster relief response—there still are advances that need to be made addressing these issues discussed in the literature review. It should be acknowledged that each hurricane is complex and creates a diverse set of challenges for disaster relief responders, but it is beneficial to analyze previous events to provide insight for optimal methods in improving the response to hurricane crises in the future. Following my research design, see Table 1.1 summarizing the results.

1. Lake Charles Memorial Hospital

a. General Information

Lake Charles Memorial Hospital, located in Lake Charles, Louisiana, is one of the primary hospitals in the Lake Charles Memorial Health System that has served the community for over 60 years (*Lake Charles Memorial Health System*, n.d.). The not-for-profit hospital prides itself in serving everyone “regardless of age, race, gender, or financial status” (*Lake Charles Memorial Health System*, n.d.). In 2017, to keep up with the growing healthcare needs of the community, the hospital finalized a \$40 million renovation project involving a new emergency department, intensive care unit, and medical office building (*Lake Charles Memorial Health System*, n.d.). Today, the Lake Charles Memorial Health System has become one of the largest healthcare providers in Southwest Louisiana, containing over 300 beds with more than 2,000 employees (*Lake Charles Memorial Health System*, n.d.).

b. Issue

Prompt responses to hurricanes are vital for disaster and evacuation management. Laura developed and intensified too quickly, causing many residents to be unable to evacuate in time, including those at Lake Charles Memorial Hospital. The hospital encountered difficulties in implementing evacuation measures both prior to and following Laura’s arrival. Hospital officials struggled to evacuate 146 patients after the hurricane hit due to lost access to the city’s water (Daigle, 2020). Additionally, a group of nurses and staff members were forced to stay in the ICU to care for 19 babies during Laura as there was insufficient timing to evacuate (*Lake Charles hospital staff stays behind to care for 19 NICU babies during Hurricane Laura*, 2020). The staff had little time to prepare, and the absence of

air conditioning and water posed threats to the children, especially those reliant on respirators and ventilators (Zdanowicz, 2020).

c. *Solution*

Accurate mapping and forecasting tools help identify high-risk zones so that people in these areas can be evacuated early enough before the storm hits. Real-time updates can help officials adjust their plans as needed to ensure maximum safety for those in harm's way. The goal is to shorten the computation time to quicken response through the development of a knowledge database. The utilization of mobile phone location data presents a practical solution to enhancing emergency evacuation planning while not depending heavily on a high-performance computing environment, as evidenced by a study conducted in 2020 (Yin et al.). Figure 1.3 explains the implementation of mobile phone location data (Yin et al., 2020). Their knowledge database model is prepared offline and stores evacuation plans for standard population distributions to quicken the real-time processes for evacuation planning (Yin et al., 2020). The experimental results share that "...the knowledge database can reduce the computation times by an average of 96.76%, with an average fitness value improvement of 21.86%" (Yin et al., 2020). The conclusions of this research indicate that the suggested method has the potential to greatly enhance the efficiency and efficacy of evacuation planning (Yin et al., 2020).

2. Scottsdale Insurance Company

a. *General Information*

A subsidiary of Nationwide Mutual Insurance, Scottsdale Insurance Company is one of the largest excess and surplus (E&S) carriers in the nation (*Scottsdale Insurance Company*, n.d.). The company takes on various types of property and casualty risks, both for commercial and personal property. This includes high-risk properties, environmental liability, and excess casualty coverage (*Scottsdale Insurance Company*, n.d.). E&S companies must always remain alert and maintain a significant degree of adaptability to keep up with the constantly evolving market changes (*Scottsdale Insurance Company*, n.d.). The company uses data analytics to identify potential risks in high-risk areas, allowing them to help prevent losses before they occur (*Scottsdale Insurance Company*, n.d.). Scottsdale Insurance Company faced troubles with clients as a result of Hurricane Laura.

b. *Issue*

Many policyholders in the Louisiana/Texas region filed claims with Scottsdale for damages to their properties following Laura. Scottsdale needed to ensure that policyholders received prompt and fair settlements for their claims because they deserved the full benefit of the premiums they have paid. Unfortunately, this was not the case. The first Hurricane Laura jury trial occurred following price concerns, where Scottsdale Insurance Company was sued by Lake Charles businessman Joey Odom for acting in bad faith (Schmidt, 2022). Odom won a \$1 million verdict in the case because Scottsdale failed to pay him promptly or meet its obligations by paying less than what was owed for his claim (Schmidt, 2022). Attorney Michael Cox who represented Odom had something to say on the matter, sharing, "The insurance companies hold on to their money as long as they

can so they can make money on the investment, and, in doing so, they violate not only the terms of their insurance policy, but they violate Louisiana law, which requires prompt payment of claims” (Lebleu, 2020). This was just one of more than 3,000 claims filed in federal court from Hurricane Laura (Lebleu, 2022).

c. Solution

Governor of New Orleans John Bel Edwards acknowledges that ““It is confusing in the statutes of Louisiana today exactly what the bad faith penalties are on insurance companies, how much they are, and when they’re triggered. We need to simplify that”” (Wilson, 2022). Insurance companies frequently succeed in underpaying insurance claims because insurers are unaware of their legal entitlements (*Understanding Natural Disaster Litigation Against Insurance Firms*, n.d.). Moreover, policyholders of insurance policies lack the skill or capability to handle a plaintiff’s case (*Understanding Natural Disaster Litigation Against Insurance Firms*, n.d.). The key to addressing this issue is to build resilience and provide education to victims about risk mitigation and insurance to create proper coordination among stakeholders (Snape, 2023). Insureds need to have a clear understanding from their insurers on coverage limits, policies, and exclusions, whether it be commercial or personal property. This will help prevent misunderstandings and disputes to avoid making the disaster even worse. Efforts must be made towards enhancing coordination among stakeholders in the future, whether this be through educational campaigns or insurance companies being fully transparent with their policyholders.

3. Olympus Corporation of the Americas

a. General Information

Olympus Corporation of the Americas (referred to as Olympus) manufactures optical and digital precision technology and is a leading supplier in its field (*Olympus Americas*, n.d.). The primary focus of Olympus is on medical equipment and imaging solutions for healthcare professionals. They are committed to developing technologies that improve patient care and increase efficiency for healthcare providers (*Olympus Global*, n.d.). The corporation produces medical, surgical, and imaging systems (*Olympus Global*, n.d.). Their mission statement is “... help enhance lives by delivering healthcare providers with quality technologies that exceed their expectations and allow them to advance their clinical delivery” (*Olympus Americas*, n.d.). I conducted an informal conversation with company representative Lane Paton, Account Manager in the Surgical Solution Division in the Louisiana region at Olympus, to gain insight on the challenges the company and its stakeholders encountered during Hurricane Laura. He has given full consent for using the following quotations.

b. Issue

Olympus has a supply distribution center in Memphis, TN, working as a hub for medical supplies such as disposables, capital, and ventilators. When Hurricane Laura occurred, Olympus’s equipment would be transported from the Memphis warehouse to Louisiana by FedEx or UPS. “The warehouse is full of our equipment but, since Olympus relies on third-party companies to deliver needed supplies from distribution centers, damage to critical infrastructure in Louisiana

from Laura impeded the transport of goods from these drivers. After a hurricane, it becomes a regional issue because Louisiana does not have the resources or the buying power, and delays and bottlenecks in the supply chain are more frequently observed at the stage of distributing goods rather than the production phase.” Distribution is often executed by businesses with less preparedness capacity. “The hospital had gotten power from our generator, but, if you don’t have the supplies, you cannot provide the care to your patients. FEMA’s job is food, water, and shelter; healthcare supplies are abandoned, but they are just as important as food. You need your normal supplies and medical supplies. It affected me and hospitals in my territory.” Lane went on to share a tragic story of a woman in need of surgery, saying, “Because we couldn’t get the needed supplies in a timely fashion, the hospital canceled the surgery, and we failed to get her the help she needed. Following the cancelation, she lost her job and her insurance. From the beginning manufacture to the patient, to the people in charge of the product, everyone is affected.”

c. Solution

Demand by FEMA can “outstrip local markets for resources such as fuel, trucks, drivers, and warehouse space in the affected area” (National Academies of Sciences, Engineering, and Medicine, 2020). To address this issue, there needs to be a shift towards “identifying bottlenecks and broken links in local supply chains and pursuing strategic interventions to assist stakeholders in returning regular supply chains to normal operation as rapidly as possible” (National Academies of Sciences, Engineering, and Medicine, 2020). This requires better planning and communication between FEMA and stakeholders, including prioritizing assistance for key facilities and workers to enable rapid restoration of local supply chains (National Academies of Sciences, Engineering, and Medicine, 2020). Additionally, systems are needed to “gather real-time information about unfolding impacts like revealing what roads are blocked” to allow local stakeholders to respond to the impact and give response to third-party companies (National Academies of Sciences, Engineering, and Medicine, 2020). This would enable companies to “more effectively prioritize the distributions of critical relief supplies and anticipate possible cascading effects of those decisions” (National Academies of Sciences, Engineering, and Medicine, 2020).

IV. Conclusions/Recommendations

In conclusion, there are many areas that need improvement in the medical supply chain when it comes to humanitarian disaster responses specifically related to hurricanes. By increasing collaboration among multiple stakeholders across different sectors, implementing capacity building initiatives within local communities, improving delivery services’ speed, and establishing better communication systems in evacuation planning strategies, there is opportunity for an efficient system that is more resilient towards hurricane disaster. While there is ample research discussing solutions to common issues found in the medical supply chain, there is a lack of application of these ideas in Hurricane Laura. My research design suggests that the implementation of these strategies could have improved outcomes for these three companies along with many others in the medical supply chain. Exciting opportunities for further research

exist, but hopefully, in the meantime, this thesis has informed the reader on guiding best practices for the future of humanitarian disaster response.



Figure 1.1 Hurricane Laura landfall location

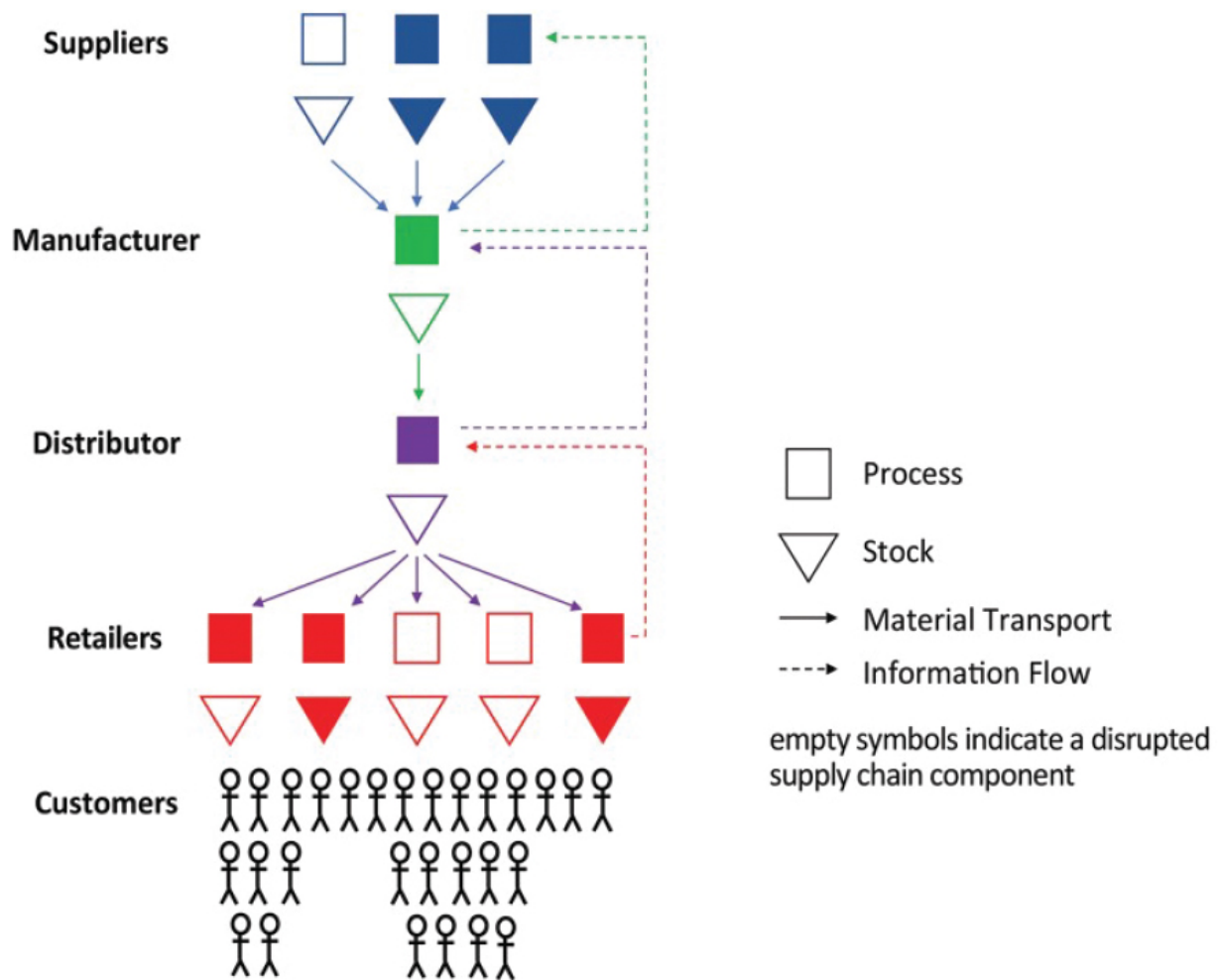


Figure 1.2 Schematic of a disrupted medical supply chain

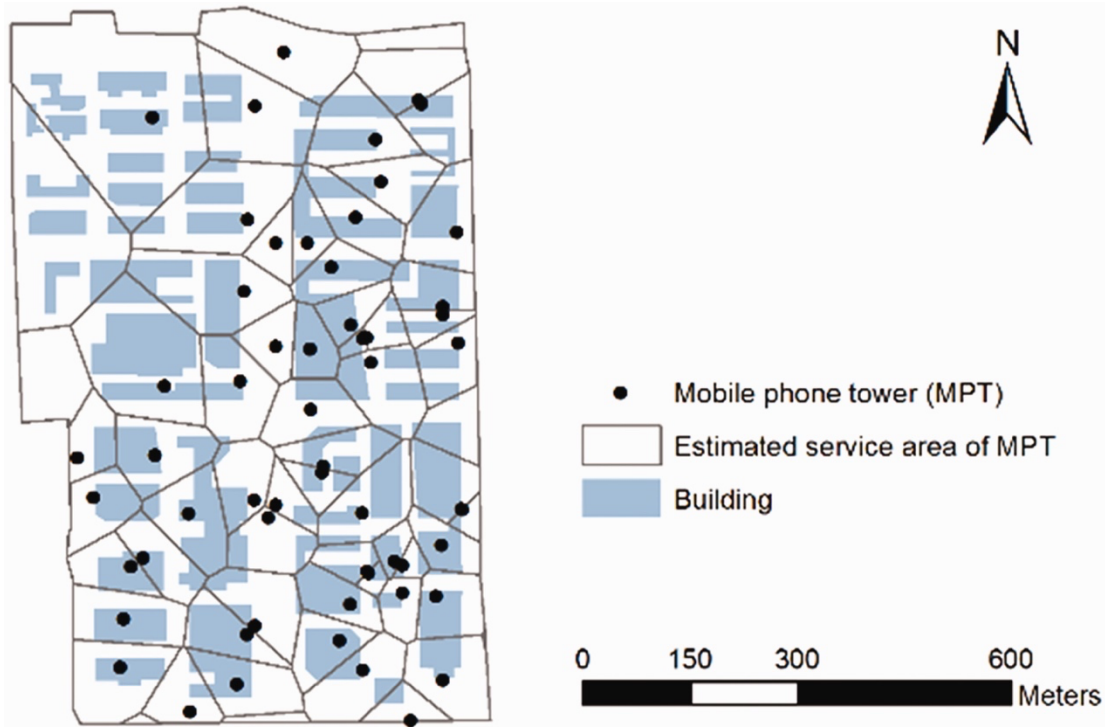


Figure 1.3 Implementation of mobile phone location data

Research Design Summary Table

Issue	Company and Challenges	Solution
<p>Risk Management Strategies</p>	<p>Lake Charles Memorial Hospital: Due to how quickly and intensely Hurricane Laura developed, the hospital encountered difficulties in implementing evacuation measures.</p>	<p>Mobile phone location data: The knowledge database model is prepared offline and stores evacuation plans for standard population distributions to quicken the real-time processes for evacuation planning.</p>
<p>Coordination among stakeholders</p>	<p>Scottsdale Insurance Company: The company failed to pay policyholders promptly or meet their obligations by paying less than what was owed for their claims.</p>	<p>Educational campaigns: Insureds need to have a clear understanding from their insurers on coverage limits, policies, and exclusions. Insurance companies must be fully transparent with their policyholders.</p>
<p>Inventory Management Control</p>	<p>Olympus Corporation of the Americas: Olympus relied on third-party companies to deliver needed supplies from distribution centers, and damage to infrastructure in Louisiana from Laura impeded the transport of goods from drivers.</p>	<p>Real-time information systems: Revealing what roads are blocked would allow local stakeholders to respond to the impact and give proper response to third-party companies.</p>
<p>Coordination among stakeholders</p>	<p>Olympus Corporation of the Americas: FEMA lacks in providing healthcare supplies, affecting Olympus and hospitals in the territory.</p>	<p>Planning and communication: FEMA and stakeholders must prioritize assistance for key facilities and workers to enable rapid restoration of local supply chains.</p>

Table 1.1 Research Design Summary Table

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