SUPPLY CHAIN RESILIENCE FOR HEALTHCARE PERSONNEL PROTECTIVE EQUIPMENT(PPE) IN THE FEDERAL GOVERNMENT

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ABSTRACT

This research has aimed to understand supply chain resilience in the federal government, specifically healthcare PPE supply chain resilience. The emergence of the COVID-19 pandemic demonstrated the fragility of global supply chains. Before COVID-19, low-cost medical supplies such as personal protective equipment (PPE), which typically requires less skilled labor, had been produced in China and Malaysia and imported to the United States. However, COVID-19 created an overwhelming shortage in medical supplies globally, forcing the United States to create federal policies that could make their domestic supply chain lines more resilient to external disruptions. This research explored the effects of one such policy intervention, the *"Making PPE in America Act"* of 2021, on maintaining healthcare supply chain resilience of the healthcare supply chains for non-military areas of the U.S. government. Two qualitative studies were conducted to examine the federal government's response to this issue and its impact on the industry. The research provides valuable insights into the resilience of the healthcare supply chains for non-military areas of the U.S. federal government. It enhances limited scholarly literature on healthcare supply chain resilience through the lens of U.S. civilian healthcare federal government organizations. The research highlights the importance of an organizational-level definition of supply chain resilience, which should be articulated throughout the organization to ensure a holistic approach. It also recommends incorporating technologies to facilitate predictive analytics, real-time data, and technology automation. Federal agencies and industry partners can use this research

to develop and implement strategies to improve or, in some cases, create strategies that will positively impact their supply chain resilience posture.

DEDICATION

I am incredibly grateful and overjoyed to share that I have achieved what I consider to be one of the most significant accomplishments of my life. I attribute this success to the grace of God, who has been with me every step of the way. However, I must also acknowledge the unwavering love and support of my husband, Kermit (KC) Jones, without whom I could not have done it. He has been my rock, confidant, and biggest cheerleader throughout this journey. I am also grateful to my children, Marcus (Risa) and Caryll Jones, for their constant encouragement and unwavering support.

As I celebrate this achievement, I cannot help but think of my granddaughters, Mackenzie Sage and Sutton Charlotte Jones. My unwavering commitment and tireless efforts will ignite a spark within them, inspiring them to chase after their aspirations and never give up wholeheartedly.

Lastly, I would like to thank the late Dr. Franklin D. (Sonny) Jones. He was not only my father-in-law but also a father figure to me. Nearly two decades ago, I shared my desire to earn a doctoral degree with him, and he was supportive and encouraging. He never gave up on me; I deeply love and miss him. This manuscript is dedicated to him, and I hope my achievement honors his memory.

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Throughout this program, I am grateful to have received steadfast support from my colleagues, friends, and family. I want to express my deep appreciation for their unwavering encouragement. The relationships I have formed here are significant, and I look forward to nurturing them for many years. I am grateful for the emphasis placed by Dr. Mudambi and our DBA professors on relying on each other to navigate our challenges, and I am thankful for those who have been there for me along the way.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

Figures Page

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The vulnerability of supply chains has been a topic of extensive discourse on account of several occurrences like COVID-19's impact leading to global factory closures (Chen et al., 2020), the 2021 Suez Canal impediment, and the Ukraine conflict (Austin et al., 2021; Cordero, 2020; Gopal et al., 2023; Henrich et al., 2022; Tawani, 2023). Professionals, politicians, managers, and the public now commonly engage in conversations about supply chains (Harding et al., 2023; LePan, 2021; Orr-Ewing, 2021) with frequent discussions on consumer shortages of products like computer chips which are produced mostly from Taiwan (King et al., 2021), healthcare personal protection equipment (PPE), fuel, and baby formula (LePan, 2021). The global vulnerabilities of supply chains have been exposed by the "COVID-19 crisis, post-pandemic economic effects, and the conflict in Ukraine" (Henrich et al., 2022, p. 2), leading business and government leaders to reassess their strategies (Jiang et al., 2021). However, while considering their unique characteristics and requirements, it is crucial to national security to prioritize the resiliency of federal government supply chains.

The effective operation of the federal government relies heavily on contributions from commercial suppliers. Healthcare expenditures in the U.S. rose by 4.1% and reached $4.5 trillion in 2022 (Bailey-Wheaton et al., 2022; Howden, 2023; Sable, 2023). This is a faster increase compared to the 3.2% rise in 2021 but much slower than the 10.6% rate in 2020. The growth in 2022 was mainly due to strong growth in Medicaid and private health insurance spending, although it was somewhat offset by continued declines in supplemental funding by the federal government, which was associated with the COVID-19 pandemic (Bailey-Wheaton et al., 2022; Howden, 2023; Sable, 2023). Dai et al. (2020) states that “in a normal year, the USA spends approximately $5 billion on PPE imports constituting more than 20% of the supply” (p.2748). Prior to the outbreak of the pandemic, the U.S. Department of Veterans Affairs (VA), the largest federal government healthcare network, allocated $10 million per month to procure PPE. During the pandemic’s peak, the VA increased its monthly spending on PPE procurement to $100 million, according to a report by the Senate Veterans Affairs Committee (2020).

Hospitals prefer nitrile gloves due to their chemical-resistant properties and lack of allergens, as reported by Tognini (2021). However, despite a projected national stockpile requirement of 4.5 billion gloves, only 72 million gloves were available in the U.S., leading to a frenzy among states to find gloves. This increase in demand resulted in fraudulent activity, black-market reselling, and unreliable intermediaries, driving prices to over $32 per box from the usual $3 for 100 gloves. Global demand for gloves nearly doubled from 300 billion gloves in 2019 to 585 billion gloves in August 2020, while global manufacturers could produce only 370 billion gloves a year (Tognini, 2021).

Nitrile is made of synthetic rubbers and natural materials primarily sourced from Southeast Asian companies, making it a highly competitive market (Tognini, 2021). Synthetic nitrile rubber (NBR) is made by copolymerizing acrylonitrile and butadiene. This type of rubber is resistant to oils and is commonly used to produce fuel hoses, gaskets, rollers, and other products requiring oil resistance (Britannica, 2023). Skokan's (2021) research shows that the COVID-19 pandemic has significantly increased demand for medical and surgical gloves. This demand has not only come from traditional users but also from the general public's everyday activities. Furthermore, the COVID-19 vaccination drive placed additional pressure on the glove industry. As every COVID-19 vaccine requires a new pair of gloves, the United States alone needed approximately 660 million gloves to vaccinate its entire population.

Skokan (2021) also noted that while three domestic glove producers in the United States produce 6.3 billion nitrile gloves annually, the country imports over 5 billion gloves annually. In response to the COVID-19 crisis, Presidential executive orders were issued to address supply chain resilience, and federal regulations and policies were established to ensure preparedness. Nevertheless, the implementation and execution of supply chain resilience remains a complex task due to the challenges of globalization and various geopolitical situations worldwide (Cohen et al., 2020; Exec. Order 14017, 2021; Sullivan & Deese, 2022). According to Grandview (2024) market insights, the United States medical disposable glove market size was valued at $3.32 billion in 2022.

In March of 2024, SAM.Gov, the federal government's platform for industry communication regarding procurements and products, released a white paper containing specific PPE requirements, specifications, and projected demand for fiscal years 2023 and 2024 (Todd & Ford, 2024). The *2021 Make PPE in America Act* three U.S. federal agencies to buy PPE produced in America. The three agencies covered by the Act are the Department of Health and Human Services, the Department of Homeland Security, and the Department of Veterans Affairs (Todd & Ford, 2024). The Department of Health and Human Services (HHS) oversees and regulates healthcare policies and programs in the United States (HHS.GOV, 2023). The Department of Homeland Security (DHS) ensures the country's and its citizens' safety and security (DHS.GOV, 2023). The VA, or Department of Veterans Affairs, offers a range of benefits and services to qualified veterans and their families. These include healthcare, education, and financial assistance, among others (VA.GOV, 2023). Together, these three agencies had a PPE glove demand of 3.5 billion gloves in the fiscal year 2023 and a projected demand of 3.6 billion gloves for the fiscal year 2024 (Todd & Ford, 2024).

In March 2024, a search on the General Services Agency's (GSA) Advantage supply schedule for powder-free medical nitrile (exam and surgical) gloves displayed a range of prices for a box of 100 gloves from $9.90 to $195.00 per box, with multiple resellers offering the product (GSA Advantage, 2024). In discussion with interview participant S2-P4, the price ranges represented by the GSA Advantage supply schedule make it challenging to accurately compare the medical grade nitrile glove prices pre- and post-COVID-19 pandemic.

Manufacturers of PPE and raw materials were met with an unparalleled demand during the initial stages of the pandemic, which posed a significant challenge to meeting everyone's requirements. The resulting shortages shed light on the United States' reliance on foreign manufacturers, particularly China, as a primary source of PPE. This realization prompted a national conversation on the need for domestic production of critical supplies like PPE, which could better position the country to meet future demand fluctuations (Tagliafierro, 2020). The pandemic caused significant disruption in global supply chains, prompting increased government intervention at the federal, state, and local levels (Exec. Order No. 14017, 2021). In this complex and challenging environment, pressure is growing to simplify and strengthen the federal government's supply chain resilience. Academic research can provide valuable insights in understanding supply chain resilience, especially in operationalizing it within federal government organizations.

The objectives of this research are two-fold. The first study examines the federal government's response to this issue and its impact on the industry. Specifically, the first study explored the supply chain's resilience, focusing on healthcare PPE within the federal government. The objective was to gain insight into how a multifaceted healthcare organization within the federal government defines and identifies the critical factors that impact supply chain resilience. The second study, on the other hand, aims to explore the influence of legislative measures on the domestic production of PPE, considering the role of supply chain resilience. The second study explored the 2021 legislation entitled "*Make PPE in America Act*." Both studies use qualitative research methods with an interpretative research paradigm.

The research performed a comprehensive analysis of the resilience of healthcare PPE supply chains should potential disruptions arise within the federal government. The focus was on pinpointing the key factors that enhance the preparedness of federal government executives in managing supply chain disruptions, specifically those caused by the COVID-19 pandemic. By developing effective strategies to boost the readiness of federal executives, this study hones in on the medical PPE healthcare sector to ensure that federal policymakers are well-versed in how supply chain disruptions can impact national security and supply chain policies. It is widely recognized that supply chain disruptions pose significant hurdles across various industries, including the entire healthcare industrial base. Therefore, it is crucial to equip the U.S. federal government with the necessary tools to tackle these disruptions effectively. Although this study concentrates on healthcare, it recognizes the importance of all industries in maintaining economic stability. A robust healthcare industrial base is critical for safeguarding our nation's security, and all industries must be equipped to manage supply chain disruptions effectively.

Within the literature, a range of definitions exist for critical terms associated with supply chains. Establishing a shared understanding of these terms can promote unity and consistency within an organization. However, due to the varying definitions, these terms often require clarification. This research places great importance on comprehending the meanings of supply chain and global value chains. This is crucial since there are different interpretations of these terms among individuals, scholars, and professionals. For this study, a supply chain is a set of business processes that encompasses a product or service from its inception (design) to disposal (end of life). According to Antràs, (2019) "A global value chain or GVC consists of a series of stages involved in producing a product or service that is sold to consumers, with each stage adding value, and with at least two stages being produced in different countries" (p.553).

This research encompasses two studies that delve into the federal government's approach to supply chain resilience, specifically emphasizing personal protective equipment (PPE) in the healthcare sector. By analyzing the factors contributing to supply chain resilience, Study One investigates the establishment of resilience for critical products and services by the federal government and industry. This study raises two pertinent research questions: How do organizations define supply chain resilience, and how can organizations improve the resilience of the healthcare PPE supply chain?

Study Two builds upon the groundwork laid by Study One by exploring the global value chain research framework in the context of supply chain resilience in the United States federal government, with a particular focus on healthcare PPE, primarily medical-grade nitrile gloves. Study Two aims to clarify the global implications of the "*Make PPE in America Act*" legislation in the United States and its effect on maintaining healthcare supply chain resilience. The second study addresses the following research questions: How does the *Make PPE in America Act* impact the global value chain? What are the significant challenges in meeting the Act's expectations regarding the medical-grade nitrile glove supply chain, and what measures can help the parties in the medical-grade nitrile glove supply chain adapt to meet the requirements of the Act?

This research is divided into four chapters that provide insights into understanding supply chain resilience through the lens of supply chain management. The study's introduction is in Chapter 1, and Chapter 2 delves into the specifics of Study One. The literature review for Study One covers several topics, such as risk management, supply chain resilience, and the federal government's perspective on these matters. The research approach combines academic knowledge with practical expertise, utilizing reflexive thematic analysis.

In Chapter 3, Study Two builds upon the groundwork laid by Study One to investigate global value chains for healthcare PPE, focusing specifically on medical-grade gloves. The literature review delves into the impact of the COVID-19 pandemic on the PPE market, the global value chain framework, offshoring and domestic manufacturing, supply chain resilience, and the federal procurement process. The research framework explored dynamic capabilities and their influence on the global value chain. Study Two also examined the crucial distinctions between "anticipating versus preparing to adapt" and provides insights into the differences between "resilience versus robustness" when managing supply chain disruptions. The study also involved conducting field research on a company that manufactures domestic PPE. Both studies utilize the reflexive thematic analysis method of Braun & Clarke (2022), conducting semi-structured interviews with healthcare supply chain professionals from the government, academia, and industry. Incorporating interviews with government, industry, and academic experts enables the collection of firsthand knowledge and expertise to supplement secondary sources and past research that focus mostly on business-to-business supply chains. Finally, Chapter 4 comprehensively discusses both studies, their limitations, and anticipated results.

The researcher wishes to emphasize that the findings of this study do not necessarily represent the official stance of any participating organization. Additionally, the research was conducted independently and was not officially authorized or endorsed as the official position of any organizations involved.

CHAPTER 2

HEALTHCARE PERSONAL PROTECTIVE EQUIPMENT (PPE) SUPPLY CHAIN RESILIENCE CONSIDERATIONS FOR FEDERAL ORGANIZATIONS

The supply chain is a complex process network connecting governments and businesses worldwide. The supply chain is a critical part of manufacturing and distributing finished goods. It encompasses logistics, transportation management, warehousing, and inventory control. Additionally, it includes the procurement of raw materials necessary for production. Recent events have brought increased attention to the fragility of supply chains and their impact on national security. Studies such as Austin et al. (2021), Gopal et al. (2023), Jiang et al. (2021), and Orr-Ewing (2021) have furthered our understanding of these intricate systems. The COVID-19 pandemic has illuminated the global implications of supply chain disruptions, revealing geopolitical tensions, trade and tariff implications, and our reliance on foreign producers.

The National Strategic Stockpile (SNS) is a collection of commodities the United States government maintains, including medical supplies, petroleum, and other items essential during supply disruptions. The primary aim of the stockpiles is to ensure national security and independence from a foreign policy perspective (Berman & Siripurapu, 2023). Despite its intended purpose, the Strategic National Stockpile program failed to address the severe shortage of medical equipment, such as PPE, during the COVID-19 pandemic. This was particularly shocking for the American public, given that the United States represented “24% of global economic output and spends 17.8% of its GDP on healthcare in 2019” (Sodhi et al., 2021, p. 2,419). Images of healthcare workers resorting to trash bags as a substitute for PPE circulated on social media, highlighting the gravity of the situation. Companies producing these essential goods also faced supply constraints due to the surge in demand (Yu et al., 2020, cited in Sodhi et al., 2021). As a result, federal government supply chain leaders are now choosing between the dominant Just-in-Time (JIT) and Just-in-Case (JIC) inventory management strategies.

The U.S. federal government relies on two common strategies for managing inventory and stockpiles: JIT and JIC. JIT is a lean process because customers order as the need arises. It also reduces waste, "drive efficiency … frees up operational cash flow" (Britt, 2021, para. 2). JIT does not work well without a seamless, undisrupted supply chain. Federal agencies using the JIT strategy depend on contractors for cost reductions and increased efficiencies. However, there is a downside to the JIT strategy, as experienced during the COVID-19 pandemic. Disadvantages to the JIT strategy include delayed delivery when stock levels are depleted. JIT is not always a workable strategy; when severe disruptions occur, such as manufacturing disruptions, when workers are unavailable (Gottron & Herrera, 2020). In contrast, the JIC strategy requires federal departments to purchase and store products on hand to "satisfy demand," its benefits are direct possession and guaranteed delivery of goods. Its stated drawbacks are increased costs and personnel" (Gottron & Herrera, 2020 para. 15). A JIC strategy may not be practical during extensive budget cuts.

JIT and JIC are viable inventories processes that are appropriate under certain conditions. JIT is appropriate when the supply chain is stable with low impact or minimum disruptions. It can also be cost-effective, assuming an agency can predict and forecast the requirements and budget for those requirements. A JIC strategy is appropriate when supply chains are unpredictable; however, there is a financial risk in budgeting for requirements that managers cannot predict or anticipate. A JIC strategy can be beneficial depending on a plan, such as a first-in-first-out scenario. According to a study by Brakman et al. (2020), the Financial Times (2020) has recommended that businesses shift their focus from just-in-time management to a just-in-case strategy to mitigate significant disruptions in their supply chains.

This chapter presents a comprehensive literature review, U.S. federal government supply chain resilience framework, research methodology, data analysis, and conclusion with research contributions. The literature review covers definitions and an overview of supply chain management, risk management, and resilience. Additionally, the literature review provides a federal government perspective on supply chains and supply chain resilience and insights into procurement and supply chain visibility.

Literature Review

A comprehensive understanding of the complexities of supply chain management is paramount to ensure its resilience. The available literature offered invaluable insights and a strong foundation for researchers to identify gaps and areas for improvement. Keeping abreast of the latest advancements is crucial. The study focused on procurement from a governmental perspective of supply chain management. The research methodologies and concepts explored in this study can aid practitioners in identifying gaps and opportunities to enhance government operations.

This literature review aims to review various definitions of supply chain and to highlight critical research on supply chain management, risk management, resilience, procurement, and visibility. The review identified themes and insights from past research to understand better supply chain resilience from the federal government's perspective in product areas designated as critically important. The review concludes by identifying specific gaps in the literature regarding supply chain resilience within the federal government supply chains and supply chain risk management.

Supply Chain Definitions

There is a plethora of definitions of the supply chain. The supply chain in the globalization age has become more complex, with processes interweaving and interconnecting. When discussing the supply chain, it is imperative to think of it either from a holistic perspective or be able to determine the specific portion of the supply chain one is referencing. For this study, supply chain is defined as set of business processes that encompasses the life of a product or service from its inception (design) to disposal (end-of-life). Table 1 depicts supply chain definitions from the research literature. These definitions encompass the business processes needed to flow goods and services from the point of origin or raw material to the end user and disposition. Supply chains encompass several functional areas, such as sourcing/procurement, inventory management, supplier relationships, warehousing, transportation, and other activities that add to the complexity of their connectedness. Therefore, supply chain, supply chain management, and supply chain risk management are essential strategies for understanding and having the ability to operationalize supply chain resilience.

Supply Chain Management

Organizations must understand the significance of supply chain management, which is crucial for efficiently delivering products and services to their end-users (Tawani, 2023). This process helps businesses manage their operations effectively by minimizing production costs, reducing waste, and shortening lead times (Handfield, 2021). Organizations must understand their supplier network by implementing a supply chain management process. The entire product and service lifecycle is included in the supply chain definition, from raw materials to the end customer (Handfield, 2021). This encompasses demand management, planning, sourcing, procurement, inventory, warehousing, logistics, transportation, supply chain security, and product disposal.

Federal organizations must incorporate procedures and processes for managing supply chain risks as they develop and execute their supply chain management strategies. In today’s landscape, supply chain managers must possess the various skill sets needed to grasp the complexities of their field. Managers must also stay informed about rising costs, trade regulations, and sustainability concerns (Tawani, 2023). Additionally, they must identify and mitigate risks while remaining agile in response to market fluctuations. In short, modern supply chain management requires a proactive and multifaceted approach (Tawani, 2023). Table 2 displays various definitions of supply chain management from academic literature.

Supply Chain Risk Management

Supply chain risk management is a business phenomenon that has been most noticeable since the onset of COVID-19. To understand the supply chain risks, organizations must partner proactively with their suppliers to understand all risks in their supply chains to produce maximum business results (Kose & Curtin, 2021). For the first time, supply chain executives finally have a seat in the boardroom, and they now have the attention of top management (Henrich et al., 2022). The federal government has a renewed emphasis on supply chain strategies and the complexity of supply chain processes as various presidential executive orders and senior management emphasis on supply chains have made this topic a top priority (Austin et al., 2021; Exec. Order No. 14017, 2021). The complexity of supply chains requires understanding their various definitions and their relationship to an organization's core functions. Supply chains cannot be examined or discussed without understanding their relationship to supply chain management, risk management, and resilience. The global supply chain and its relationship with supply chain management and risk are necessary because they set the foundation for attaining supply chain resilience. Table 3 provides definitions of supply chain risk management.

Supply Chain Resilience

Supply chain resilience is core to the literature on supply chain risk management, spanning multiple organizational and functional processes, such as manufacturing, sourcing, and procurement, product and project management, logistics, information technology, and more (Demartino & York, 2022; Scala & Lindsay, 2021). The global pandemic highlighted the importance of suppliers and the proximity of their manufacturing bases, particularly in the PPE industry, where little attention has been given to how resilience can mitigate disruptions in healthcare (Scala & Lindsay, 2021). Building resilience means that organizations can manage supply disruptions, but there is limited information on how to adapt routines to foster resilience (Scholten et al., 2019). Aigbedo (2021) states that "resilience within the supply chain context has been defined in various ways in the literature" (p.3). Table 4 offers a range of definitions of supply chain resilience, and this study adopts the definition that highlights an organization's ability to anticipate, plan, respond, react, and recover from disruption at any point in the supply chain. Achieving resilience requires visibility, agility, and collaboration between the organization and its suppliers, working together to restore or reinvent itself better than before the disruption.

The U.S. faced significant challenges with shortages of vital PPE equipment, including ventilators, masks, gloves, and gowns, which hindered the ability to increase domestic production quickly. This increased “disease spread, further illness, and mortality” (Austin et al., 2021, p. 9). The COVID-19 pandemic tested the resilience and robustness of healthcare supply chains. It revealed the vulnerabilities and severity of shortages in critical essential healthcare items like PPE and everyday household goods and services (Sodhi et al., 2021). The pandemic is the “first global-scale outbreak since the 1918 flu pandemic, which infected one-third of the world’s population and caused 50 million deaths worldwide” (Johnson & Mueller, 2002 as cited in Sodhi et al., 2021, p. 2,416).

The COVID-19 pandemic initially started as a public health crisis but has quickly revealed economic and commercial consequences. Some have argued that it has exposed an “unhealthy overdependence on China and that globalization has gone too far” (Evenett, 2020, p. 408). The level of supply chain resilience can differ based on the products or services and the organization affected. However, “resilience in emergency preparedness is the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions” (Austin et al., 2021, p. 19). Responding to future pandemics requires the government to “create a more sustainable and resilient public health supply chain, including drugs, biological products, medical devices, personal protective equipment, and other necessary supplies” (Austin et al., 2021, forward para. 1).

Given the potential for future pandemics, enhancing supply chain responsiveness to accommodate sudden demand surges is imperative (Sodhi et al., 2021). To achieve this, commercial industry and government organizations consistently seek ways to build resilience in supply chains. Rojas et al. (2022) suggest that governments must take three steps to establish critical supply chain resilience: 1) understand suppliers and their suppliers, 2) identify critical suppliers, and 3) create a trusted marketplace. However, the government is a complex organization with numerous regulations and policies, challenging comprehending the intricate processes and practices associated with supply chain risks. Boyens et al. (2012) state that “this lack of understanding, visibility, traceability, and control increases the challenges of managing the risk of exploitation through counterfeit materials, malicious software, or untrustworthy products” (p. 1).

Procurement: A Functional Dimension of Supply Chain Management

It is a common misconception that supply chain and procurement are interchangeable terms. Procurement is just one aspect of the broader supply chain management process. The supply chain includes the entire process of obtaining a particular good or service. According to the Federal Acquisition Regulation (FAR), acquisition procures goods and services for government use (FAR, 2021). Government acquisitions begin with an agency’s need or requirement and involve various stages, including describing the requirements, soliciting, and selecting sources, awarding contracts, contract financing, contract performance, contract administration, and technical and management functions related to fulfilling agency needs through contracts (FAR, 2021).

One effective strategy for procurement/sourcing organizations to enhance their operations is fostering strong supplier relationships and promoting collaboration. With the global supply chain constantly evolving, government procurement professionals must carefully assess any potential impact of these changes on acquiring goods and services. By prioritizing supplier relationships and collaboration, all parties can stay informed about the shifting dynamics of the interconnected and dispersed supply chain. Procurement organizations must focus on enhancing their workforce's soft skills to effectively deal with the evolving supply chain environment, as per Brown (2021).

The distinction between procurement and supply chain lies in their respective functions. Procurement involves acquiring goods and services, whereas the supply chain entails moving and delivering these goods and services to the end user (Sundaram, 2022). Procurement is a means of obtaining products and services. At the same time, the supply chain comprises a range of business processes that span a product or service's entire lifecycle, from design to disposal (Jones, 2022). Procurement refers to the act of acquiring the necessary goods. In contrast, supply chain refers to the supporting infrastructure typically needed to enable their transportation and delivery, as stated by Oakley and Rittel (2022).

Supply Chain Visibility

One of the significant challenges facing the government is the inability to fully comprehend a supplier's "ecosystem beyond tier 1 suppliers" (Rojas, 2020, p.1). During the COVID-19 pandemic, the federal government required market intelligence to locate PPE suppliers without going through the usual bidding process (Finkenstadt & Handfield, 2021). The government knew the companies that could provide the PPE but needed to understand better the supply channels involved. To build resilience, the government must understand and see a supplier's supply chain (Rojas, 2020). According to Xu et al. (2020), "visibility and the ability to effectively respond to disruptions are among the most important metrics for supply chain resilience" (p. 159). Achieving visibility is essential for efficiency and agility during average production and is crucial for understanding resilience in Global Supply Chains (Xu et al., 2020). An organization's ability to identify suppliers susceptible to disruptions is essential to minimize response times and implement remedial measures (Xu et al., 2020). This skill prevents potential supply chain disruptions, ensures business continuity, and maintains customer satisfaction.

To detect potential threats, "including counterfeit parts, financially unstable entities, and hostile foreign direct investments, government organizations must thoroughly understand critical suppliers' supply chains" (Rojas, 2020, p. 3). The issue of supply chain visibility affects all countries, not just the United States, and has resulted in "nationalistic policies that restrict exports when inventory levels are questioned" (Finkenstadt & Handfield, 2021, p. 2). The lack of visibility is compounded by the inability to track supply chain data and manage inventories, particularly for healthcare procurement departments that rely on weekly deliveries using a just-in-time process from third-party distributors selected based on cost (Finkenstadt & Handfield, 2021). Globalization is a significant factor contributing to supply chain vulnerabilities. This is supported by the fact that many surgical masks and respirators bought in the United States come from China and Mexico (Kwon and Kim, 2018, cited by Scala & Lindsay, 2021).

Literature Review Summary

Understanding the global supply chain requires knowledge of various definitions, including supply chain management, risk, visibility, resilience, and their impact on firms. Resilience is crucial in managing supply chain risk and requires a multidisciplinary approach. There is a need for more research on operationalizing supply chain resilience in the public healthcare sector, specifically through federal government intervention. Few studies have explored how the government can mitigate supply chain risk and build resiliency. As Finkenstadt and Handfield (2021) aptly stated, "You cannot manage what you cannot see" (p. 1).

The security of U.S. national health is intrinsically linked to protecting U.S. national interests. While a wealth of research is available on "supply chain performance and resilience," there needs to be more literature that encompasses the complexities of healthcare supply chains and their unique characteristics (Senna et al., 2021, p. 1). Furthermore, federal information on the resiliency of PPE needs to be incorporated into the literature. Limited research exists on the resiliency of healthcare supply chains, and the literature must address the intricate government operations and processes that may contribute to the lack of supply chain resiliency in large, complex organizations.

This review of the literature offers an understanding of the viewpoints of the federal government regarding the resilience of supply chains. It comprehensively analyzes critical aspects of supply chain management, such as risk management, visibility, and procurement. The contributions of esteemed researchers offer valuable insight into the necessary definitions required to establish and strengthen resilient supply chains. These perspectives develop the theoretical framework of the research and provide valuable insights from experts in the field.

Supply Chain Resilience Framework for a U.S. Federal Agency

The literature review on supply chain resilience in the federal government context has revealed limited theoretical development. Given the ongoing risks to the healthcare supply chain, mainly concerning PPE such as facial masks, gloves, and eye protection, it is imperative to establish a solid theoretical foundation that enables a deeper understanding of healthcare supply chain resilience. The shortage of PPE during the COVID-19 pandemic has underscored these concerns, although supply chain challenges in this sector were present even before the pandemic. To strengthen the healthcare PPE supply chain, two important research questions need to be addressed:

1. How do organizations define supply chain resilience?

2. How can organizations improve the resilience of the healthcare PPE supply chain?

Supply chain resilience is an element of risk management (Li & Zobel, 2020). This study builds on existing concepts of supply chain resilience using a qualitative research method with an interpretative research paradigm. As a framework, this study focuses on a supply chain resilience framework specific to the peculiarities of the U.S. federal government. Figure 1 is the supply chain model which this research explores. This research delves into the critical operational processes that are fundamental to the resilience of supply chains. These processes include information technology, procurement and sourcing, organizational structure, and risk management. Furthermore, the study investigates the impact of external factors, such as congressional oversight, regulations and legislation, financial constraints, and source diversification, on the resilience of supply chains within the federal government environment.

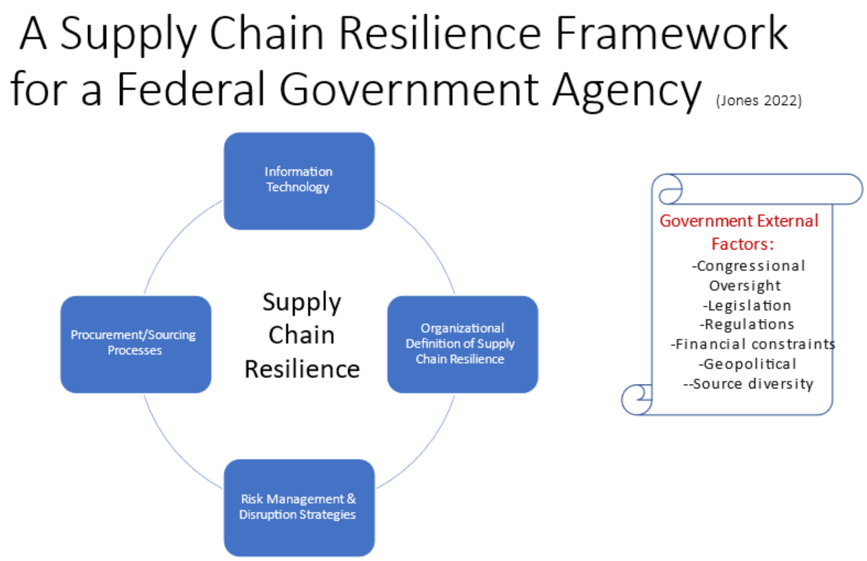


Figure 1. *Supply Chain Resilience Framework for the Federal Government*

Research Method

This research used a qualitative research method with an interpretive research paradigm, employing the Reflexive Thematic Analysis (RTA) process. RTA offers a flexible approach to analyzing qualitative data, wherein themes and patterns in the researcher's data are examined (Byrne, 2021). While various approaches to thematic analysis (TA) exist, this project utilized Braun & Clarke's RTA process. Unlike other thematic analyses, Braun and Clarke differentiate between three principal approaches to TA, including "coding reliability TA, codebook approaches to TA, and the reflexive approach to TA" (Braun et al., 2019, as cited in Byrne, 2021, p.1,392). RTA allows for inductive and deductive reasoning, as "coding and analysis rarely fall cleanly into one of these approaches" (Byrne, 2021, p. 1,397).

An inductive approach was taken to ensure that participants' stories were told in their own words and that preexisting codes from the literature were not used for initial coding (Braun & Clarke, 2022). Table 5 outlines the six phases of Braun & Clarke's process: data familiarization, initial coding, generating themes, reviewing themes, developing themes, and writing the report (Byrne, 2021). A qualitative research methodology was used to gain a better understanding and insights into the federal government's stance on incorporating supply chain resilience. The focus is primarily on the government's efforts to achieve this objective.

Data Collection

According to Temple University's Institutional Review Board (IRB), this study does not fall under human-subject research as it primarily focuses on organizations. The research project utilizes a range of sources, such as multiple documents and semi-structured interviews. The documentary sources consist of scholarly journal articles and websites centered around supply chain resilience, covering procurement, information technology, and other factors relevant to supply chain processes. Moreover, federal government regulations, presidential executive orders, and other public documents about supply chain resilience in the federal healthcare sector were reviewed. These sources provided comparative data on supply chain resilience and its relation to PPE in the healthcare industry. The semi-structured interviews were conducted with senior executives who report to C-suite executives in large government healthcare organizations, including senior and middle managers of a complex federal healthcare organization. One interviewee from a private company conducting business with the federal government was also included.

The interviews comprised 12 semi-structured questions delved deep into the various disciplines influencing supply chain resilience. The participants were experts in medical logistics, enterprise-level supply chains, medical clinicians, information technology, and procurement processes. Table 6 presents the selection criteria used to choose the interviewees. The interviews were conducted in two stages, with 14 participants participating in Study One. Stage one involved six pilot interviews conducted from November 4 to November 8, 2022, while stage two had eight project interviews from January 21 to February 6, 2023. All participants were experts in federal supply chain processes and were recommended or known to the researcher. The pilot interviews were crucial in choosing the most suitable questions for the study and evaluating their effectiveness. After the pilot interviews in November 2022, the researcher established that the questions were appropriate and remained the same for subsequent interviews.

The snowball sampling method was utilized to select interview participants 7-14 (P7-P14) for this study. This method is recognized as a successful technique for identifying participants who may be challenging to reach through other means (Lashley & Pollock, 2020). The participants included a medical center director, two practicing physicians, six supply chain experts, one information technology expert, and three procurement experts. Additionally, one of the participants had extensive experience in the commercial industry, was knowledgeable in conducting business with the Federal government, and had previously served as a senior government official before retirement.

Each participant had in-depth knowledge and experience with federal supply chain processes, but their areas of expertise varied based on their location and role within the organization. Table 7 provides a breakdown of the interview participants’ demographics. The participants had 367 years of experience in federal government supply chain, logistics, procurement, and information technology.

Semi-Structured Interviews

The semi-structured interview questions were carefully crafted by conducting a thorough literature review and strengthened after pilot interviews with federal government practitioners. The researcher followed an interview protocol that allowed for maximum flexibility during the interview, enabling the introduction of new information and modifications to questions when necessary. The interview questions covered several key areas, including defining supply chain resilience, managing risks and disruptions, procurement and sourcing, and information technology capabilities that support supply chain resilience. Before the interviews, all participants were provided with 12 interview questions at least three days in advance of the interview (Appendix A) as part of the interview protocol (Appendix B) to ensure they were aware of the questions, saving time and enabling them to discuss relevant topics. The average duration of interviews was 43 minutes, with each session scheduled for 60 minutes. Participant 8 recommended a question change, which required the researcher to explain the question to each participant before revising it.

Qualitative Data Analysis Approach

All interviews were recorded using Microsoft Teams software and a digital audio recorder as a backup. To secure and control the data, the interview data from the recording was uploaded from the digital recorder to a laptop with authentication capabilities. For the pilot interviews (P1-P6), the digital audio recording was uploaded into Microsoft Word 365 using MS Word transcription features. However, it was found that Microsoft Word's transcription feature was time-consuming and required a lot of data cleansing.

During the transcription process, the data was cleansed by the researcher while listening to the audio files to capture the participants' words. Redundancy was removed, and transcription errors were corrected to keep the data as close to the participant's words as possible. The original thoughts of the interview participant were maintained by keeping as much of the original content expressed by the interview participant as possible. During the interview, notes were taken in a research journal, and salient points were captured for review later using the comment feature in Microsoft Word.

Due to the tediousness of transcribing data using Microsoft Word 365, the researcher purchased Otter.ai, a transcription software application—the recording of interviews involved using Microsoft Teams and a digital recorder. The recorded audio files were later transferred to a laptop and imported into Otter. Ai for transcription. The transcription process included cleaning the files to ensure consistency and preserve the original context of the participants. Demographic information was changed to protect participant confidentiality. The researcher listened to the audio while transcribing the data in Otter Ai, which helped to preserve the participants' thought processes. Once complete, the audio file was exported to an MS Word document. The interview documents were then uploaded to NVivo, a qualitative coding and data analysis software tool. NVivo was used to identify common themes in the data and prevent research bias, resulting in defensible evidence (QSR International, 2022).

Codebook

The reflexive thematic analysis (RTA) process involves immersing oneself in the data by reading and listening to the interview data several times while taking notes to annotate any initial analytical thoughts. Through this process, I familiarized myself with the participants' interview data. I approached the analysis by organizing the data based on the functional areas of the interview questions, such as Organizational Definition of Supply Chain Resilience, Risk Management and Disruption Strategies, Procurement and Sourcing, Information Technology, and National Security Implications of Supply Chain Resilience. The closing question asked participants about the national security implications of supply chain disruptions for PPE.

I began generating initial codes and mapping them to the research question areas using NVivo software. Due to the massive amount of collected data, I reflected to ensure that my data was answering my research questions. I carefully examined my data to focus on the necessary areas. I continually assessed the dataset to create and recreate the codebook in several iterations that resulted in 148 codes (Appendix D). As a result, codes led to themes based on the participant's data, which developed three propositions, and a supply chain mind map emerged with codes, sub-themes, and themes.

Reflexivity

Reflexive Thematic Analysis (RTA) recognizes that knowledge is subjective and depends on circumstances. RTA makes subjectivity an asset rather than a problem in research (Gough & Madill, 2012, cited in Braun & Clarke, 2022). I listened to the interview participants and recorded my thoughts in a journal during semi-structured interviews to better understand the participants' perspectives. Elliott, Fischer, & Rennie, 1999, as cited in Braun & Clarke (2022), state, "Reflexivity is a good quality analysis; researchers must strive to understand and own their perspectives" (p. 8). I learned to be less interruptive and more attentive to their words and expressions. Myers (2020) states, "Notes are in effect another source of data—they are complimentary on what is happening at the time … notes can record what you were thinking and feeling" (p. 177). During transcription, I practiced reflexivity by reading the transcript while listening to the audio. I only included relevant information in the analysis, even if it meant not using some data.

Discussion of Findings

Research Question 1: How do organizations define supply chain resilience? Through the iterative coding process for research question one, three themes emerged where the participants described aspects of supply chain resilience. The three themes are anticipate, respond, and recover. It was found that 28% of the participants, which equals to 4 out of 14 participants, had no knowledge of an organizational definition of supply chain resilience. However, they were able to describe a definition of supply chain resilience based on their team or group. Even though none of the participants confirmed that their organizations had a definition, they described an organizational definition of supply chain resilience. Figure 2 depicts the themes and sub-themes associated with the participants' responses to aspects of supply chain resilience. The participants described aspects of supply chain resilience in response to research question one: How does your organization define supply chain resilience? The following paragraphs outline the themes and include interview participants' quotes and examples relevant to the themes. Table 8 shows participants' responses to research question one.

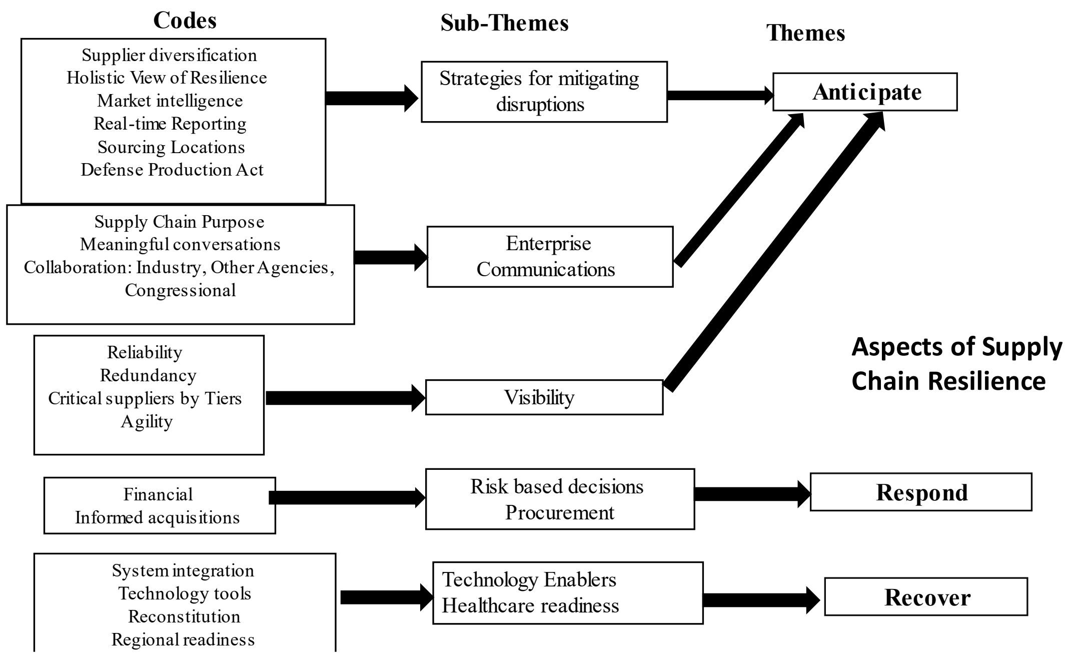


Figure 2. *Codes, Sub-themes, and Themes for Research Question* 1

Anticipate

Participants' responses showed that a key theme is the importance of anticipating supply chain disruptions before they occur. Strategies for mitigating disruptions, Enterprise Communications, and Visibility are sub-themes to anticipating supply chain disruptions. Strategies included supplier diversification, a holistic view of resilience, understanding market intelligence, real-time reporting, and sourcing locations. Enterprise communications are imperative to supply chain resilience because of the internal and external communications necessary for mitigating a supply chain disruption before, during, and after the interruption. Participants felt that visibility into the supply was another critical factor to supply chain resilience. P5 talked intensively about the many supply chain cross points and the number of crossover points in a supply chain, especially the healthcare supply chain.

P5 discussed the analogy of how there are limited suppliers regardless of the product; for example, it does not matter that a manufacturer is in the automobile industry or whether they are making an “MRI machine or PPE, there are only a small group of suppliers with the rare minerals or raw materials for things like resins” (P5). The example discussed relates to the Texas freeze that damaged the facilities that process petroleum refining. “The freeze in Texas created a shortage in resins used in everything from laptop computers to endotracheal tubes” (P5). Participant 2 defined the organizational definition of supply chain resilience as “The ability to anticipate and review redundancies … do I have the ability to see the forecast through analytics and AI?” (P2). Participant 11 stated, “We have been able to build resiliency into the system, by our awareness, our ability to monitor the system more closely. And our ability to identify ways to address any risks with the supply chain” (P11).

Respond

Responding to a supply chain problem emerged as a theme. How government organizations respond is based on a risk-based approach. Respond also has a financial component. An organization needs the ability to know what acquisitions they have in place and to pivot to those acquisitions or quickly implement new ones. A resilient supply chain can anticipate and respond to disruptive events. Christopher and Peck (2004) state, “Supply chains are dynamic networks of interconnected firms and industries …all are dependent on efficient and reliable transportation and communication systems, an obvious point, but one that is often overlooked” (p. 2). The importance of an organization lies in its value because supply chain resilience can add value to its financial standings and customer service, and it can assist an organization in controlling costs (Schuster et al., 2021).

Recover

According to Ponomarvo and Holcomb (2009), organizational resilience includes an organization's ability "to respond and recover at the same or better state" (p.131). A "resilient supply chain includes elements such as a supply base strategy, collaborative planning, visibility, and factoring risk considerations into decisions" (Christopher, 2005, cited in Ponomarvo & Holcomb, 2009, p. 131). Participant 9 referred to the ability to recover during a disruption, specifically regarding government procurements. Participant 9 stated, "I can tell you what we think it is. And that is the ability to react very quickly to meet the supply needs of the organization" (P9).

Research Question 2: How can organizations improve healthcare PPE supply chain resilience?

Through the iterative coding process for research question two, three themes emerged where the participants described ways of improving healthcare PPE supply chain resilience. The three themes are prepared to adapt, information technology, and risk management. Figure 3 depicts the themes and sub-themes associated with the participants' responses to improving healthcare PPE supply chain resilience. Improving healthcare PPE supply chain resilience is a characterization of responding to the research question two: How can an organization improve healthcare PPE supply chain resilience? The following paragraphs outline the themes and include interview participants' quotes and examples relevant to the themes. Table 9 shows participants' responses to research question two.

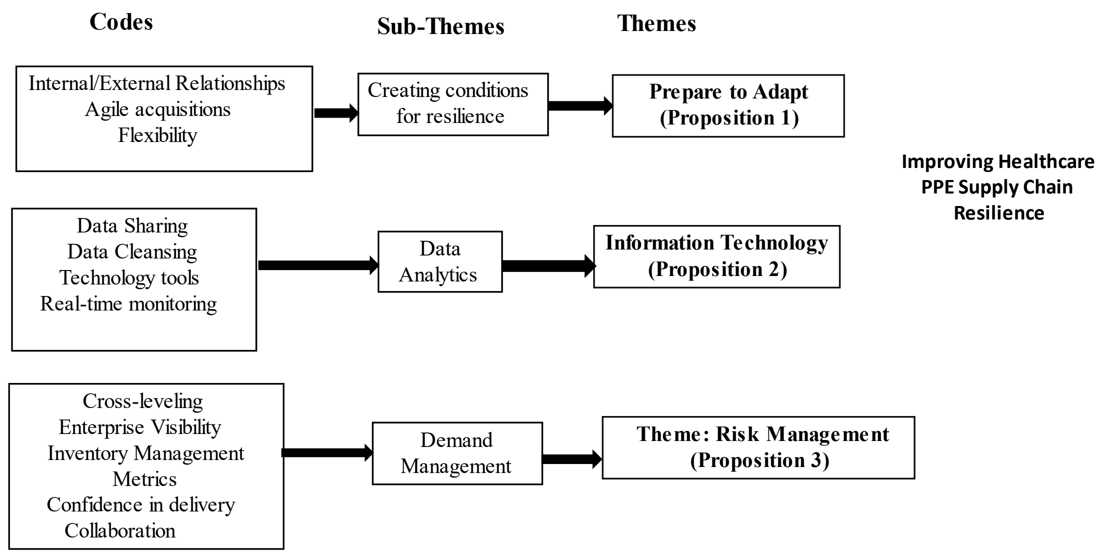


Figure 3. *Codes, Sub-themes, and Themes for Research Question 2*

Prepare to Adapt

The COVID-19 outbreak has significantly impacted the availability and usage of PPE and other essential supplies. Before the pandemic, PPE was easily obtainable, and healthcare professionals did not have to worry about its availability. However, due to the pandemic's global supply chain disruptions, PPE has been scarce, highlighting the necessity for stronger supply chain resilience at a corporate level. The comments from the interview participants provided insight into the development of Proposition 1: Enterprise-level definition of supply chain resilience communicated throughout the organization can help build enterprise-wide resilience, especially during unprecedented disruptions. Participant 1 explained, "There were so many masks around that if you wanted to wear a different mask for every patient, you could. Boxes of masks were routinely placed outside every patient's room, and as we entered a patient's room, we took a mask and put it on"

(P1). Participants highlighted the need for organizations to be flexible and adaptable in their approach to pivoting from one process to another in response to changing conditions. According to Participant 1, “When we talk about supply chain, we completely redefined the supply chain because of the shortage.”

When COVID occurred, healthcare operations handled many change management processes because of global supply chain issues. Participant 5 discussed an analogy between a short-term disruption (hurricane) and a long-term disruption (COVID-19 pandemic)—the critical aspect of improving healthcare PPE centers on hospital preparedness. Organizations will have to be self-sufficient in either a short-term or long-term disruption; they will need to be able to provide critical supplies for themselves, whether local, state, or federal. “Everybody needs to survive on their own” (P5). Although the federal government has the Strategic National Stockpile (SNS), COVID-19 demonstrated that total reliance on the SNS is not a solution for mitigating disruptions.

An audit in 2020 “revealed that the stock of N95 masks, gowns, and gloves had been depleted during the H1N1 pandemic a decade earlier and never replenished. In addition, many of the masks were past their expiration dates” (Handfield et al., 2020, p. 1071). Therefore, given the nation’s SNS capacity, “every hospital in the country needs to be looking at how they make their internal supply chain resilient, and how can they build in some capacity if there is a so-called blackout?” (P5). Hospital preparedness entails asking such questions as “When your normal provider cannot support you, how long could you go? So those are what we need to build in; you have got to be able to maintain for a certain amount of time for yourself” (P5). This example is another example of adapting to disruptive supply chain events.

As stated by Participant 11, “It is important to have enough flexibility in the supply chain to adjust to changes” (P11). An organizational definition of supply resilience allows members of the organization to adapt and recover from disruptive events. Participant 5 discussed that during COVID-19, the organization understood the importance of adapting to changing conditions and recovering from those disruptions. Resilience occurs when organizations build the ability to manage supply disruptions; however, little information exists on how an organization “can adapt their routines to build resilience” (Scholten et al., 2019, p. 430). Participant 6 recognized the importance of supply resilience in accomplishing the mission during COVID-19 to “look at ourselves on a larger scale from the individual facility” (P6).

The participants emphasized the importance of supply chain flexibility and resilience. Organizations must have a clear definition of supply chain resilience and the ability to manage supply disruptions to adapt and recover from disruptive events. However, there needs to be more information available on how organizations can adapt their routines to build resilience.

Information Technology

To establish effective risk-mitigation strategies, organizations can draw on past disruptions to inform their approach (Mandal, 2017). This involves developing a comprehensive understanding of supply chain resilience across the enterprise, a definition that high-level executives should communicate. By doing so, an organization can more effectively adapt, respond, and recover from short-term and long-term supply chain disruptions. In the healthcare industry, information technology capabilities can play a significant role in supporting supply chain resilience. Such capabilities are critical in gaining insights and knowledge of the supply chain from an end-to-end perspective. Innovative technologies, such as additive manufacturing (AM), can also be disruptive but improve supply chain efficiency and resiliency (Belhadi et al., 2022). According to Participant 13 (P13), 3D Printing was utilized during the pandemic to produce large volumes of urgent healthcare products during COVID-19. P13 stated, “Serendipitously, we did a lot with additive manufacturing … we can make masks, tapper hoods, diagnostic swabs in large volumes and distribute them where PPE was needed” (P13). Based on the research literature and participant comments, Proposition 2 emerged: Healthcare supply chains are more resilient when organizations build in technologies that focus on predictive analytics, real-to-near-time data monitoring, and technology automation.

Organizations depend on information technology tools and data analytics to provide information into the supply chain—information technology tools and data analytics facilitate supply chain data across an organization. The capabilities of such tools also allow organizations to monitor the supply chain in real-time. However, the usefulness of information technology and data analytics is only as good as the information put into them. Therefore, data cleansing becomes extremely important, particularly in cases where organizations lack technological capabilities such as artificial intelligence and machine learning.

Government organizations frequently require state-of-the-art systems that can populate information technology tools for real-time automated monitoring, where information is not dependent on humans to input data manually. Many government organizations still need to rely on outdated legacy systems that are as old as 50 to 70 years old. Participants in the research recognize that technology is critical in ensuring supply chain resilience. They also understand the importance of data analytics through dashboards, which provide insights into more information than previously. Participant 14 realized the criticality of data and how data analytics through dashboards gave them insights into more information than they had in the past. P4 stated, “Manually building dashboards for data analytics for inventory reporting. The data tools available to us are better than they have ever been in the past” (P14). In an extensive, dispersed organization, information technology tools become even more critical for data accuracy, real-time information, and decision-making that explore cross-level capabilities and ensure redundancy. Participant 7 commented, “The IT system can give you an additional capability, and it can give you additional insight into what you have going on daily. It gives you a view of everything in your supply chain” (P7). Technology tools are essential as an enabler for mitigating supply chain risk.

Risk Management

Effective supply chain risk management is an essential factor for organizations to consider. Understanding the demand and visibility of the supply chain is crucial to mitigating such risks. Proposition 3, developed based on literature and participant feedback, emphasizes promoting collaboration between internal and external healthcare stakeholders. This collaboration ensures the availability of critical healthcare supplies and builds resilience at the enterprise level. Proposition 3: Enterprise-level supply chain risk management enables collaboration between the internal and external healthcare supply chain stakeholders to build resiliency and ensure critical healthcare supplies are available when needed. Participant 1 highlighted the significance of comprehending the supply chain and ensuring the delivery of quality products by understanding the supplier landscape we are “sourcing from to ensure there is a consistency of supply and variability in supplies” (P1). They also emphasized the importance of providing clinicians with higher-quality PPE. This includes masks that do not fog up for people wearing glasses and various sizes that fit people of all shapes and sizes. Such measures are vital in ensuring the safety and well-being of healthcare professionals.

The COVID-19 pandemic has prompted organizations to reevaluate their inventory management processes. Participant 1 shared their experience of closely examining decision-making processes to reevaluate the staging of supplies. They emphasize the importance of ensuring a sufficient supply of critical products, like PPE, in “high-risk emergency type situations” (P1). The acquisition and inventory processes must be adjusted to maintain the necessary supply and ensure an excellent customer experience. Building trust and improving communication and collaboration are crucial to strengthening supply chain resilience, especially for PPE. Participant 10 emphasizes the importance of rebuilding relationships, focusing on data accuracy, and collaborating with partners. Participant 2 suggests developing legislation “to support onshoring the market space back to the United States” (P2).

Participant 2 recognized the importance of the industry and the federal government collaborating and working together to explore ways to improve supply chain resilience to “make sure that we are prepared in this country as it relates to another viral outbreak” (P2). Communicating and collaborating internally and externally can improve PPE supply chain resilience, especially since “most of the stuff is not manufactured in the United States, it is manufactured in the Pacific Rim nations” (P5). During the interview, participants discussed the criticality of demand management and enterprise visibility into the supply chain to improve PPE resilience. During the interview, Participant 2 stressed the importance of industry and federal government collaboration to improve supply chain resilience. They believe this collaboration is necessary to ensure preparedness for future viral outbreaks. Participant 5 also acknowledged the need for better communication and collaboration, both internally and externally, to improve the resilience of PPE supply chains.

As per Participant 1's insight, "Understanding supply chain demand and supply chain visibility is critical to organizational risk management" (P1). By holistically understanding their strategy for managing supply chain risks, organizations can proactively anticipate and address challenges that may arise due to potential risks. This enables organizations to effectively collaborate with their suppliers and stakeholders to identify and mitigate potential risks in their supply chains, according to Kose and Curtin's research in 2021. Organizations that are aware of their vulnerabilities and understand the source of their supply chain sources will be better equipped to handle or prevent disruptions, as detailed in Gaonkar & Viswanadham, 2004. Organizations must thoroughly comprehend their approach to handling potential risks to optimize supply chain management. This necessitates a comprehensive understanding of the demand and visibility of their supply chain. Organizations can ensure that their supply chain runs smoothly and effectively by identifying and addressing any potential risks ahead of time.

Organizations have several options to strengthen the resilience of the healthcare PPE supply chain. Enterprise Supply Chain Risk Management is vital to help organizations navigate uncertainties and disruptions, particularly during the COVID-19 pandemic. This global crisis has highlighted the fragility and unpredictability of supply chains, underscoring the importance of incorporating risk management principles. To bolster the resilience of the healthcare PPE supply chain, organizations can implement a range of measures, such as adapting to disruptions, harnessing information technology capabilities, and employing risk management principles. Enterprise Supply Chain Risk Management is essential for organizations to manage uncertainties and disruptions, particularly in the aftermath of COVID-19, which has exposed the fragility and unpredictability of supply chains.

Overall Discussion of Findings

This research has aimed to understand supply chain resilience in the federal government, specifically healthcare PPE supply chain resilience. The research focused on critical goods and services for healthcare PPE, such as facial masks, gloves, and eye protection. The following two research questions emerge from the recent crisis involving the PPE shortage during the COVID-19 pandemic, but the supply chain issues in this sector pre-date the pandemic. To improve healthcare PPE supply chain resilience, the study posed two main research questions: Research Question 1: How do organizations define supply chain resilience? Research Question 2: How can organizations improve healthcare PPE supply chain resilience?

For Research Question 1, three themes of supply chain resilience emerged: anticipate, respond, and recover. Figures 4, 5, and 6 show a visualization of the participants' responses to Research Question 1 by themes (Figure 4), sub-themes (Figure 5), and themes by individual participants (Figure 6).

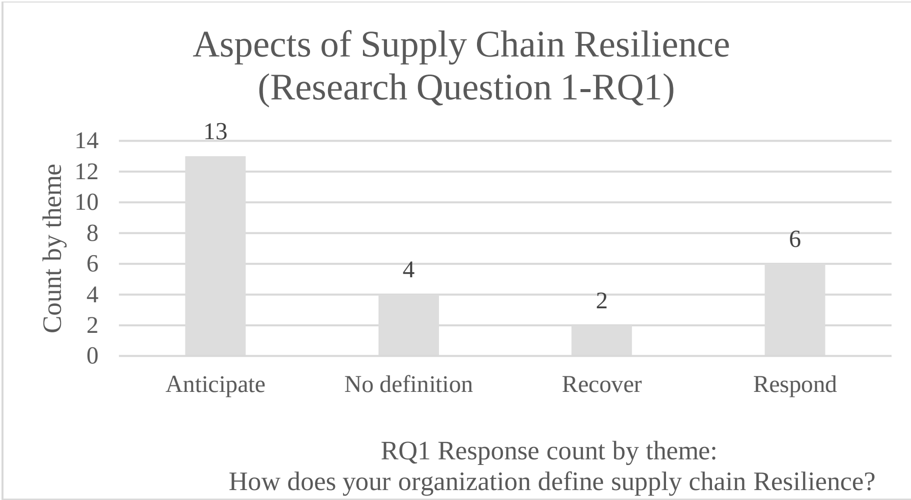


Figure 4. *Study One- Participant's Response Count by Themes (RQ1)*

The data collected from interview participants regarding the definition of supply chain resilience is presented in Figure 4. The chart connects the responses to the three themes of research question one: Anticipate, Respond, and Recover. It also highlights supply chain resilience as an aspect of these themes. If a participant's organization did not have an official definition of supply chain resilience, it was recorded as "No definition." The study's findings indicate that more participants associated supply chain resilience with anticipating and responding to disruptions, while fewer mentioned recovering from disruptions. However, some participants suggested that their organization needed a formal definition of supply chain resilience.

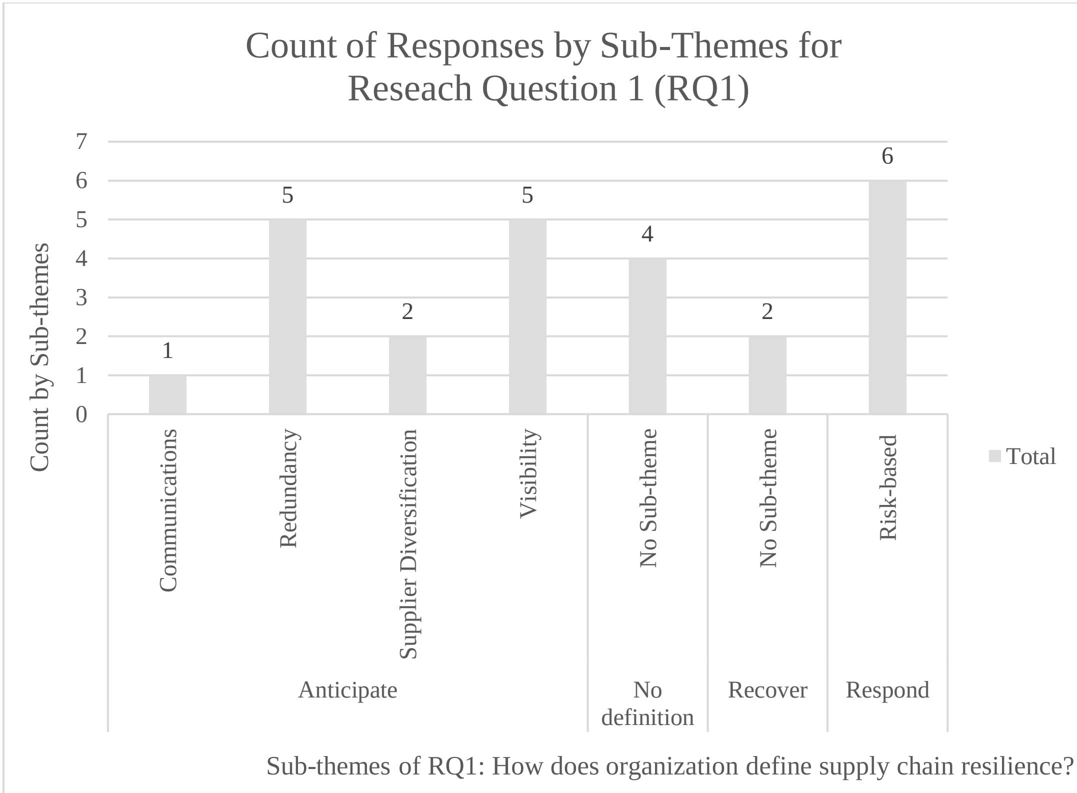


Figure 5. *Study One- Participant's Count by Sub-Themes (RQ1)*

Figure 5 organizes the responses of participants to research question one into sub-themes. The Anticipate theme has four sub-themes: Communications, Redundancy, Supplier Diversity, and Visibility. The Respond theme has a Risk-based sub-theme, while the Recover theme has no sub-theme. The chart shows that the count of participants in the redundancy and visibility sub-themes for the Anticipate theme is higher than that of supplier diversification. Additionally, the Risk-Based sub-theme for Respond has a higher count than all the sub-themes for Anticipate. This indicates that participants associate risk-based approaches with responding to disruptions. It also highlights the importance of redundant capabilities and supply chain visibility in resilience. While communications are crucial, supply diversification is critical when anticipating supply chain resilience.

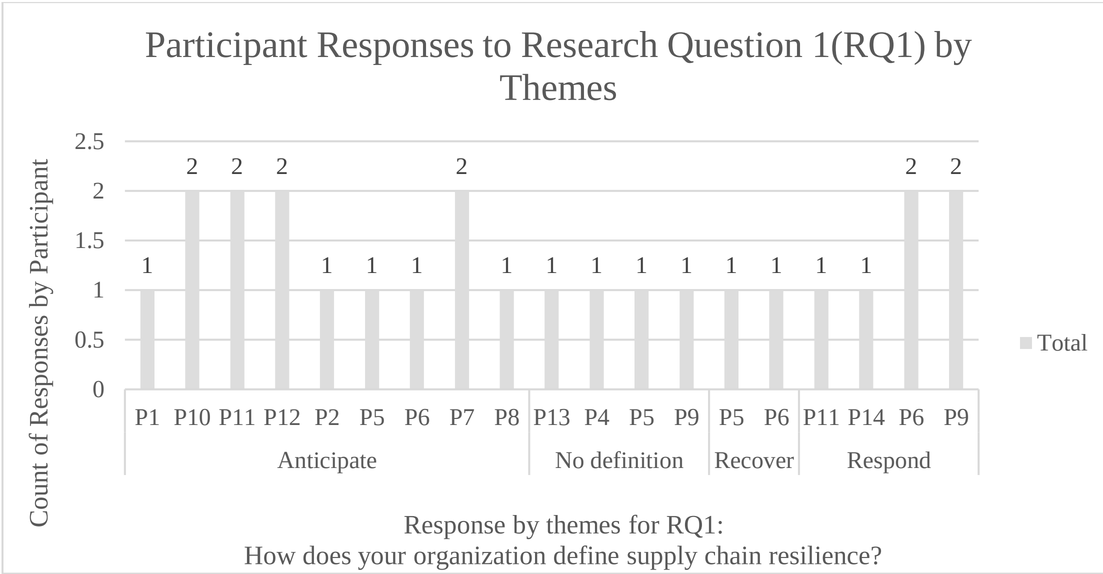


Figure 6. *Study One- Count of Responses by Participants (RQ1)*

In Figure 6, it is evident that participants showed greater emphasis on anticipation than on responding or recovering. Responding was still more prevalent than on recovering. It is essential to note that while "No Definition" was not a theme, the number of responses from participants who selected it was higher than those who chose the "Recover" theme. Enterprise resilience exists throughout the culture of an organization, and an organization's culture facilitates its ability to accept and respond to disruptive environmental changes. Responding to changes in the environment allows managers and staff to "have a complete understanding of the environment and its patterns of change … in the face of unexpected changes in the environment, the firm should have the ability to survive, adapt, and respond to changes" (Kamalahmadi & Parast, 2016, p. 120). This research provides valuable insights into the sub-themes and themes contributing to supply chain resilience. Organizations and practitioners may face significant challenges because supply chain disruptions can impact their ability to maintain operations and meet customer demands. Developing effective strategies for enhancing supply chain resilience is essential to address this issue. These insights provide valuable guidance on anticipating, responding to, and recovering from supply chain disruptions, ensuring businesses can continue operating effectively during challenging times. By using these strategies and approaches, organizations can minimize the impact of disruptions, mitigate risks, and maintain their competitiveness in the market.

The second research question pertains to enhancing resiliency in the healthcare PPE supply chain. Through a process of iterative coding, three main themes emerged from interviews with participants: “Prepare to adapt,” “Information technology,” and “Risk management.” These themes are aligned with the three propositions. Valuable insights were obtained from the feedback provided by the interviewees and their connection to the themes mentioned above, which led to the formulation of the three propositions. Proposition 1 posits that an enterprise-level definition of supply chain resilience communicated throughout the organization can help build enterprise-wide resilience, especially during unprecedented disruptions. Proposition 2 states that healthcare supply chains are more resilient when organizations build in technologies that focus on predictive analytics, real-to-near-time data monitoring, and technology automation. Finally, Proposition 3 suggests that enterprise-level supply chain risk management enables collaboration between the internal and external healthcare supply chain stakeholders to build resiliency and ensure critical healthcare supplies are available when needed.

Figures 7, 8, and 9 show a visualization of the participants' responses to Research Question 2 by themes associated with propositions (Figure 7), sub-themes (Figure 8), and themes by individual participants' responses (Figure 9). The findings of research question 2, which aimed to enhance healthcare PPE, are illustrated in Figure 7. The chart depicts the correlations between the responses of interviewees and the three themes of the research question: Adapt, Information Technology, and Risk Management. The data reveals that Risk Management is the most critical factor for improving healthcare PPE resilience, followed by Adapt and Information Technology. Furthermore, the results indicate that enterprise-level supply chain risk management can foster Collaboration among healthcare stakeholders and ensure the availability of essential healthcare supplies. This is consistent with Proposition 3. Proposition 1 underscores the importance of defining supply chain resilience at the enterprise level, which aligns with the Adapt theme. Proposition 2 emphasizes the need for advanced technologies, including predictive analytics, real-time or near-time data monitoring, and technology automation, to enhance the resilience of healthcare supply chains, which relates to the Information Technology theme.

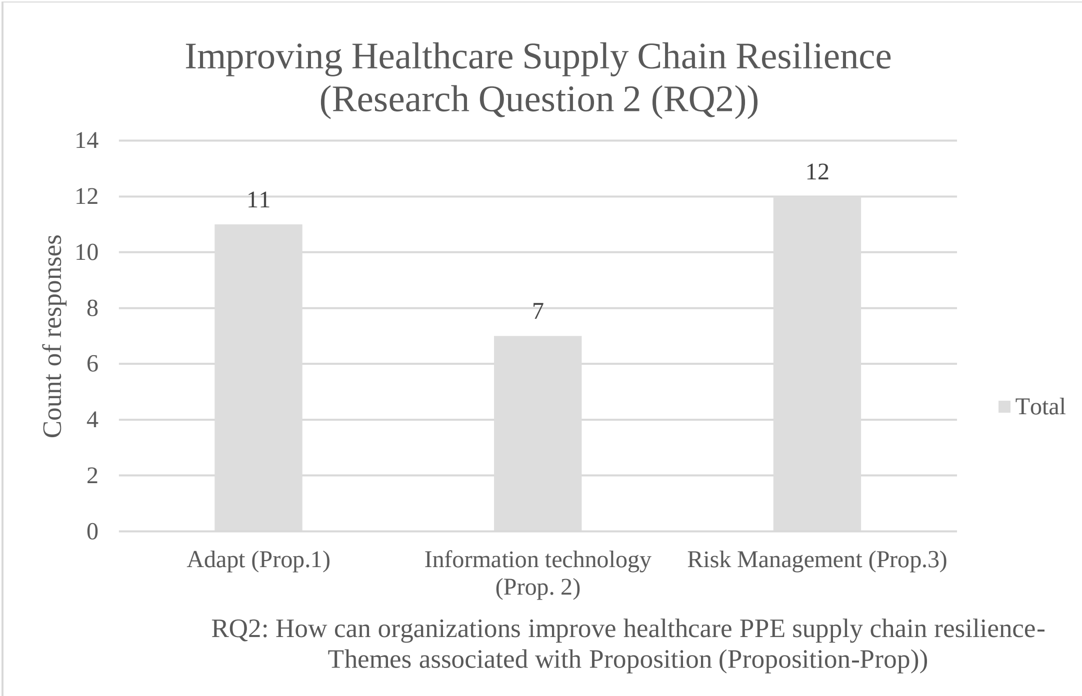


Figure 7. *Study One: Participant's Response Count by Themes (RQ2)*

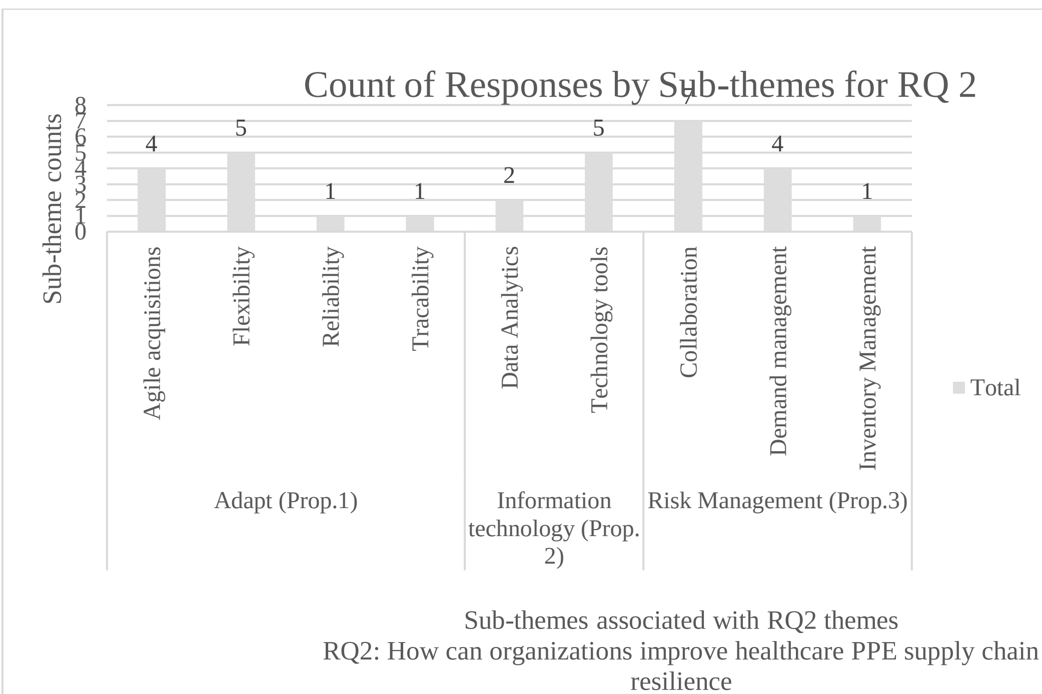


Figure 8. *Study One: Count by Responses by Sub-themes (RQ2)*

Figure 8 presents the sub-themes of each theme according to participant responses. The Adapt theme has four sub-themes: Agile acquisitions, Flexibility, Reliability, and Traceability. The Information Technology theme includes two sub-themes: Data analytics and Technology tools. The Risk Management theme encompasses the sub-themes of Collaboration, Demand, and Inventory management. The chart shows that Flexibility received more responses than Agile acquisitions, while Technology tools received more responses than Data analytics. Moreover, participants considered collaboration the most critical sub-theme among the sub-themes of risk management.

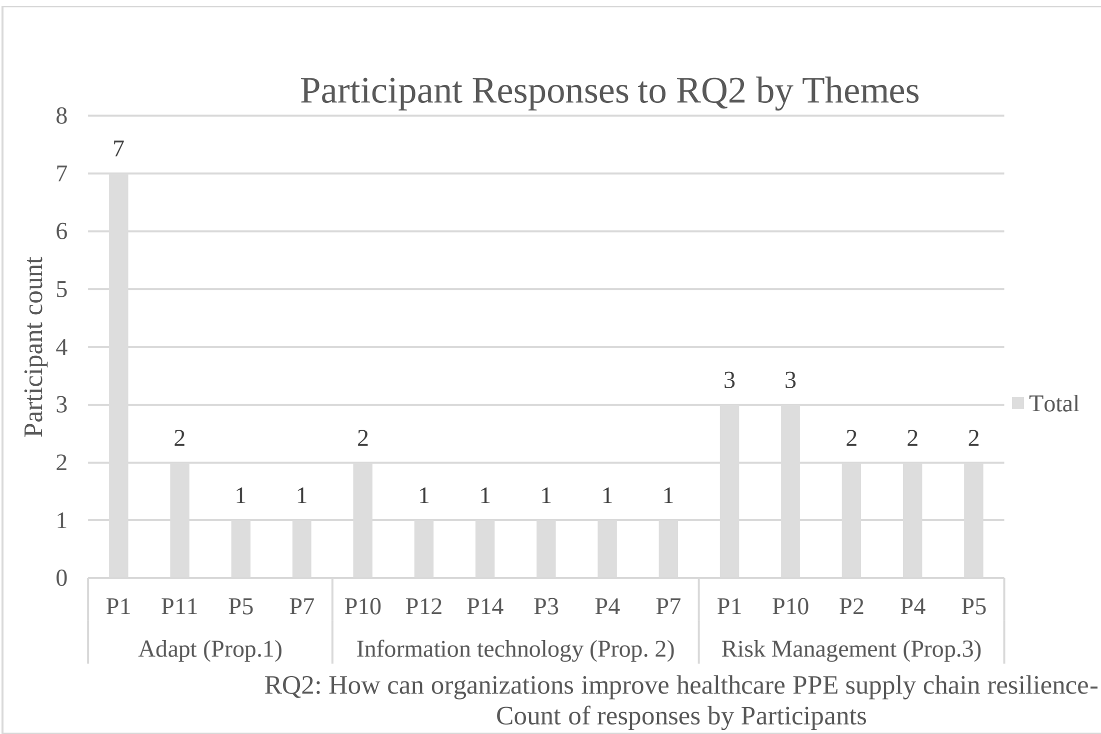


Figure 9. *Study One: Count of Responses by Participants (RQ2)*

Figure 9 displays the count of responses by participants. The data indicate that Risk Management garnered more responses than Demand management. Additionally, Demand management responses were more critical than Inventory management. This underscores the significance of risk management in improving healthcare PPE resilience. In summary, this study provides valuable insights into the various sub-themes and themes that enhance the resilience of healthcare PPE supply chains. These findings can serve as a critical resource for organizations and professionals seeking to develop effective strategies and approach to bolster supply chain resilience and sustain operations in the face of disruptions. Proposition 1 proposes that a clear and shared understanding of supply chain resilience at the enterprise level can significantly improve overall resilience, particularly in times of unexpected disruption. Each organization member must contribute to this understanding and work towards achieving it to ensure the company's longevity. In today's constantly changing business environment, companies face countless challenges, and it is essential to develop a robust risk management plan that allows for a swift recovery from setbacks. This requires building strong internal and external relationships and remaining adaptable to unforeseen circumstances. Despite the difficulty, companies can overcome any obstacle with the right strategies (Mansouri et al., 2010). By communicating the definition of supply chain resilience throughout the organization, everyone can work towards the same goals and ensure that resources are used effectively. Resilience occurs when organizations build the ability to adapt and manage supply chain disruptions (Scholten et al., 2019). This shared understanding of resilience allows adaptability and flexibility to be implemented, leading to quicker response and recovery from disruptions and opportunities to learn and improve (Christopher & Peck, 2004; Kamalahmadi & Parast, 2016; Ponomarvo & Holcomb, 2009; Schuster et al., 2021).

Adopting technology focusing on predictive analytics, real-time data monitoring, and automation is the premise behind Proposition 2, which proposes to improve the resilience of healthcare supply chains. Information technology capabilities are crucial for healthcare organizations to obtain comprehensive knowledge and insights into their supply chains. Additive technologies like 3D Printing can also enhance the efficiency and resiliency of supply chains (Belhadi, 2022). Predictive analytics and extensive data capabilities can identify potential risks and disruptions beforehand. Industry 4.0 can assist organizations using technology to analyze historical data; patterns that indicate future disruptions can be revealed, allowing organizations to develop contingency plans and minimize risk (Ralston & Blackhurst, 2020; Tjahjono et al., 2017). Real-time data monitoring can help organizations track the status of their supply chains and identify potential problems in advance, enabling corrective action to be taken before disruptions occur. Technology automation can streamline manual processes in the supply chain, improving efficiency and freeing up resources, allowing organizations to better respond to disruptions (Ralston & Blackhurst, 2020; Tjahjono et al., 2017).

As proposed in Proposition 3, enterprise-level supply chain risk management promotes collaboration among internal and external healthcare stakeholders to establish resiliency and ensure the availability of essential healthcare supplies. According to Kose and Curtin, in 2021, holistic management of supply chain risks enables organizations to anticipate and handle potential challenges proactively. This approach helps organizations realize if they have adequate supplier diversity or visibility in their supply chains. By being aware of their vulnerabilities and comprehending their supply chain sources, organizations can better handle and prevent disruptions, as mentioned by Gaonkar &

Viswanadham in 2004. In today's complex and interconnected healthcare supply chain, enterprise supply chain risk management is crucial to guarantee the availability of critical healthcare supplies. Through collaboration with all stakeholders, organizations can establish resilience, ensuring that patients continue to receive the care they need. This increased visibility and collaboration ultimately improves supply chain resilience (Finkenstadt & Handfield 2021; Rojas, 2020; Xu et al., 2020). The federal government can leverage the findings of this research to strengthen the resilience of the healthcare PPE supply chain. The insights gained from this data can inform the development of policies and procedures that will effectively address supply chain disruptions and minimize vulnerabilities.

Research Contributions and Conclusions

This research holds both practical and theoretical significance, with a particular focus on firms rather than the unique characteristics of the federal government. The theoretical aspect of the study delves into the intricacies of supply chain resilience to translate academic information into terms that practitioners within the federal government can utilize. By understanding the underlying theory, the researcher has shared valuable academic knowledge with those in the field. Although there has been limited research in the healthcare industry, the ongoing supply chain challenges caused by the COVID-19 pandemic have highlighted the importance of healthcare as a critical national security concern.

Contribution to Theory

This research from Study One combines academic literature and real-world experience in the federal government environment to contribute to supply chain risk management and resilience theory. It aims to increase the understanding of new supply chain practices in the changing world. It highlights the need for visible and secure capabilities from an end-to-end perspective to achieve more resilient distributions. Scholten et al. (2014) noted that academic supply chain management literature needs to provide “management guidance on implementing and operationalizing the concept of supply chain resilience” (p. 211). Therefore, the study proposes three distinct recommendations to enhance the resilience of healthcare supply chains.

The first recommendation is to establish a shared comprehension of resilience by fostering robust relationships, adaptability, and communication. Organizations can improve their resilience by creating the capacity to adapt and manage supply chain disruptions, enabling adaptability and flexibility to be implemented, resulting in quicker response and recovery from disruptions (Scholten et al., 2019). This shared comprehension allows all stakeholders to work towards the same objectives to ensure that resources are utilized efficiently and effectively (Christopher & Peck, 2004; Kamalahmadi & Parast, 2015; Ponomarvo & Holcomb, 2009; Schuster et al., 2021).

The second proposition suggests using advanced tools such as predictive analytics and automation to enhance the efficiency and resiliency of supply chains (Belhadi, 2022). Predictive analytics and extensive data capabilities can identify potential risks and disruptions beforehand. In contrast, real-time data monitoring can assist organizations in tracking the status of their supply chains and identifying potential problems in advance. Technology automation can streamline manual processes in the supply chain, improving efficiency and freeing up resources, allowing organizations to better respond to disruptions (Ralston & Blackhurst, 2020; Tjahjono et al., 2017).

The third proposition emphasizes the significance of efficient risk management through collaboration and supply chain visibility. Organizations can better handle and prevent disruptions by knowing their vulnerabilities and comprehending their supply chain sources (Ralston & Blackhurst, 2020; Tjahjono et al., 2017). Collaboration with all stakeholders can establish resilience, ensuring clinicians can provide patient care when needed despite a supply chain disruption. This increased visibility and collaboration ultimately improve supply chain resilience (Finkenstadt & Handfield, 2021; Rojas, 2020; Xu et al., 2020).

Contribution to Practice

Academic research conducted by Study One has provided clarity on the necessary actions to support healthcare organizations and federal government agencies. This research can help federal agencies develop strategies and policies to improve their supply chain resilience posture, benefiting the government's commercial partners. The study provides valuable insights into the federal government's unique situation and enhances limited scholarly literature on supply chain resilience from a federal government perspective. Its findings can assist the federal government in implementing supply chain management policies and taking necessary actions.

The study highlights the importance of an enterprise-level definition of supply chain resilience, which should be articulated throughout the organization to ensure a holistic approach. This approach can help build enterprise-wide resilience during unprecedented disruptions, enabling the organization to adapt, respond, and recover from disruptive events. The study recommends incorporating technologies to facilitate predictive analytics, real-time data, and technology automation. These technologies can make organizations more resilient and eliminate manual processes used during the COVID-19 pandemic. Automation, such as data analytics, can assist government leaders in understanding their demand and inventory capacities, enhancing visibility and transparency in their supply chains. Supply chain resilience definitions within organizations facilitate a unified approach, ensuring all members are aligned and working towards the same goals. By using this strategy, companies can anticipate potential hazards and weaknesses in advance, which results in proactive risk management, collective recovery efforts, and streamlined resource allocation. This shared understanding fosters greater adaptability and flexibility, enabling quick response and recovery and opportunities for growth and development.

The study highlights that managing supply chain risks will remain crucial for government officials. They must foster and improve stakeholder relationships, collaborate with internal and external healthcare supply chain stakeholders, and build resiliency to ensure critical healthcare supplies are available when needed. Collaborative relationships can assist government leaders in understanding and assessing risks, enhancing their ability to develop and implement risk mitigation strategies.

Limitations and Future Research

The research offers a comprehensive understanding of the post-COVID period of a federal healthcare organization. It is important to remember that the study concentrated on a major US healthcare organization under the federal government and yielded valuable observations. However, it is worth noting that the data collection and results are confined to individuals who participated were from one federal and one commercial organization. Therefore, it may not fully apply to all federal government organizations or commercial industries. This research provides a basis for forthcoming investigations on how government agencies and private companies collaborating with the federal government can enhance supply chain resilience.

Further studies can examine the best practices utilized by other government agencies and commercial industries to enhance their supply chain resilience posture. Additionally, further research could examine the impact of supply chain resilience on our nation's national security posture, particularly in the healthcare sector. Another area of interest is identifying best practices to mitigate cybersecurity risks in healthcare medical devices with embedded information technology capabilities.

In summary, this research delves into supply chain resilience in federal government organizations. It provides valuable information that can positively impact the federal government's supply chain resilience posture by blending academic literature and practitioners' insights. This research has the potential to significantly improve the resilience of our nation's supply chain, with far-reaching implications for our national security. Healthcare is a critical aspect of public health, safety, and security, and this study underscores the importance of continued investigation in this area. Moving forward to Chapter 3, the focus turned to a detailed analysis of healthcare's complex global value chains. Specifically, the research highlighted the pivotal role that medical-grade gloves play in maintaining the robustness and effectiveness of the U.S. federal healthcare supply chains.

CHAPTER 3

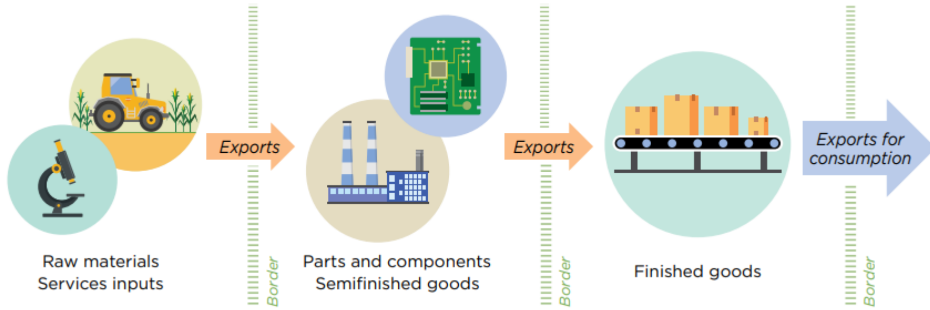
EXPLORING GLOBAL VALUE CHAINS FOR HEALTHCARE PERSONAL PROTECTIVE EQUIPMENT

Introduction

The COVID-19 pandemic showed the dangers of relying too much on the interconnected global value chain. As a result, managers in the federal government and commercial industry are rethinking their production strategies and their place in the global value chain (Becerra, 2022; DeCarlo & David, 2020; Executive Order 14017, 2021; Ngo & Dang, 2022; Ryan et al., 2022). The process of the worldwide value chain involves the fragmentation of production activities and their allocation across different countries (Antràs, 2019; Pananond et al., 2020; Gereffi et al., 2022). Antràs, 2019 stated that "global value chain or GVC consists of a series of stages involved in producing a product or service that is sold to consumers, with each stage adding value, and with at least two stages being produced in different countries" (p.553). According to the World Bank (2020), this strategy enables companies to "concentrate on their core competencies" and provide specialized goods and services (p. ix).

The global value chains (GVCs) have changed how products are made and who does the work, with production networks now spanning across the globe. In 2005, Gereffi et al. proposed a global value chain framework emphasizing the importance of "inter-firm linkages and power dynamics that regulate value chain coordination (p.97)." They focused on the relationship between a small group of suppliers in the first tier and their buyers (Gereffi et al., 2005). However, it is crucial to consider the impact of all actors, regardless of their position in the value chain. Suppliers of components and equipment hold significant leverage on the upstream end. For instance, Intel and Microsoft have established guidelines that other value chain participants must follow in the personal computer industry. These parameters are in place to regulate the behavior of most other members (Gereffi et al, 2005). The GVC approach has helped companies compete, create jobs, and advance technology by using different manufacturing stages in different countries (Ngo & Dang, 2022; Ryan et al., 2022).

As a result, businesses prioritize their strengths in domestic markets and entrust other responsibilities to reliable partners. Building lasting relationships between enterprises is a common practice, and economic factors and policies influence a country's participation in Global Value Chains (GVCs) to promote engagement and optimize benefits (Gopal et al., 2023; World Bank, 2020). Figure 10 visually represents the global value chain and its fragmentation from raw materials to finished products. This depiction of the global value chain is crucial in understanding how products and commodities move from raw materials to the end customer. It is equally vital that government leaders have a clear understanding of supply chain processes, particularly for critical products, systems, and services, in the event of a supply chain disruption occurrence. With this knowledge, government organizations can plan and implement resilient strategies. Typically, government agencies collaborate with value-added resellers (VARs) since original equipment manufacturers (OEMs) do not sell directly to them. For instance, government healthcare agencies obtain PPE from distributors or VARs. Before the COVID-19 outbreak, government agencies relied on their VARs and distributors to handle supply issues and ensure contract compliance. However, the pandemic has prompted a change in approach. Austin et al., 2021, identified the vulnerability of "the U.S.'s reliance on foreign manufacturing and lack of domestic manufacturing capabilities" (p.9).



Source: The World Bank copyright 2020. The International Bank for Reconstruction and Development/The World Bank; Washington, DC 20433.

Figure 10. *The Global Value Chain*

GVCs have revolutionized the industry, enabling poorer countries to participate and develop their economies without constructing entire industries from the ground up. Specialization has proven a lucrative strategy, but GVCs are now at a critical juncture. Growth has dwindled since reaching its peak at 52% of global trade in 2008 due to complex factors such as a decline in worldwide development and investment and the maturation of value chains (Iakovou & White, 2020; World Bank, 2020). Additionally, the need for more advancement in international trade liberalization and the emergence of labor-saving technologies like automation and 3D printing could further discourage production overseas. Unless trade liberalization is reinforced, it is unlikely that value chains will expand in the future (World Bank, 2020).

GVCs have been a governance tool for multinational enterprises (MNEs) for many years, helping firms efficiently organize their international business activities with other companies. However, some experts believe the pandemic has significantly changed

GVC design, resulting in a new normal. The new normal refers to a “situation of radical change” (Verbeke, 2020, p. 444) because of external shock experienced by firms and society, such as an environment-related shock like climate change. Given globalization and cost reduction strategies, numerous manufacturing organizations have opted to offshore or backshore their production.

The pandemic significantly impacted firms with international commercial connections, “including multinational enterprises (MNE), small and medium-sized businesses, new ventures, and their supply chain partners” (Verbeke, 2020, p. 444). The pandemic resulted in significant issues for the global economy, especially regarding the supply chains for essential medical equipment. Many large multinational companies have struggled with their global value chains, which have revealed areas for improvement in their supply lines. To address this, some people have called for manufacturing operations to be returned to their home countries to improve supply chain resilience and national security (Ryan et al., 2022). The COVID-19 pandemic has clarified that economic resilience is crucial in GVCs. Disruptions within any part of the system can trigger a severe global economic downturn. Previous historical events, such as the global financial crisis and the 2011 Tohoku earthquake, exemplify the significant impact on GVCs. Due to factory closures in China in the early months of the pandemic, critical parts were unavailable (Pietrobelli et al., 2021).

Extensive studies have been conducted in supply chain management and international business to explore how collaborative efforts affect a company’s performance. Nevertheless, additional research is necessary to comprehensively grasp the consequences of unpredictable market conditions and the influence of global value chains. (Arora et al., 2021). Aggarwal's analysis suggests that, in 2023, the concept of governance within a value chain refers to how one entity controls other players and allocates value. Aggarwal (2023) identifies five categories of power - hierarchy, market, and hybrid - which include modular, relational, and captive forms. Hierarchy and market structures are the most common, with hierarchy favoring internalizing activities within the orchestrating firm for complex transactions. In contrast, market structures coordinate activities through market prices for less complicated transactions. Hybrid forms lie between these two and involve cooperation and control mechanisms. Modular chains are formed through simple transactions; relational chains involve complex interactions, and captive chains arise when a dominant company holds power over smaller suppliers. GVCs have been used as a governance mechanism for multinational corporations to manage their international business activities, with effective governance forms proving more successful than less effective ones.

Building upon the findings of Study One, Study Two examines the global value chain research framework about supply chain resilience within the United States federal government. Specifically, the study focuses on healthcare PPE, particularly the supply chain of medical-grade nitrile gloves. Through an exploration of the *Make PPE in America Act* and its impact on healthcare supply chain resilience, Study Two sheds light on the global implications of this legislation. Furthermore, the study aims to uncover critical distinctions between "anticipating versus preparing to adapt" and provide insights into the differences between "resilience versus robustness" when managing supply chain disruptions.

The *Make PPE in America Act* requires three U.S. federal agencies (DHS, HHS, and VA) to issue long-term contracts for American-made PPE and ensure that American workers and healthcare professionals have the necessary PPE. The legislation defines PPE as gear or clothing protecting individuals from disease transmission, which includes "surgical masks, respirator masks, face shields, protective eyewear, gloves, disposable and reusable surgical and isolation gowns, and head and foot coverings" (*Make PPE in America Act*, 2021, p. SEC. 70952). Studies One and Two expanded upon concepts of supply chain resilience through qualitative research methods within an interpretive research paradigm. Study Two aimed to address three critical research questions related to the *Make PPE in America Act*:

1. How does the *Make PPE in America Act* impact the PPE global value chain?

2. What are the significant supply chain challenges in meeting the Act's expectations?

3. What measures can help the medical nitrile glove supply chain parties adapt to meet the Act's requirements?

The study employed a meticulous and comprehensive approach to answer these research questions. This involved conducting a thorough literature review, adopting a sound theoretical perspective, utilizing a robust research method, performing data analysis, and drawing well-founded conclusions. The literature review examined the implications of the COVID-19 pandemic on the market for PPE, the practice of domestic manufacturing versus offshoring, the resilience of supply chains and the global value chain, and the procurement process at the federal level regarding domestic production. The research findings and contributions are presented in the conclusion, along with an acknowledgment of potential study limitations. The study aimed to provide valuable insights to stakeholders and decision-makers in the PPE industry, and its rigorous methodology and analysis ensure the validity of its conclusions.

Literature Review

Impact of COVID-19 on the PPE Market Supply Chain

The COVID-19 pandemic sparked a massive demand for medical PPE that far exceeded the available supply (Dallas et al., 2020). This demand was compounded by the global supply chain, prompting many firms and governments to rethink their strategies and focus on domestic production (Morales-Contreras et al., 2021; Ngo & Dang, 2022; Shih, 2021). Before the outbreak of the pandemic, many nations placed considerable emphasis on international trade and the production of medical supplies. The United States and Germany were recognized for their proficiency in manufacturing advanced medical technology (Gereffi, 2020). At the same time, China and Malaysia were leaders in low-tech, low-cost production that required less skilled labor for items like gloves, face masks, and gowns. The resulting low cost and labor made such medical supplies widely accessible. However, the pandemic created an overwhelming shortage of these supplies worldwide, leading to more controls on exports and initiatives to increase domestic output (Gereffi, 2020; Morales-Contreras et al., 2021).

The pandemic highlighted the lack of transparency in the PPE global supply chain. The international world depends on medical PPE markets in Asia, which has led to PPE market fluctuations, exorbitant prices, and a need for more transparency about PPE, highlighting a lack of healthcare resilience. China was and remains the largest producer of PPE. When China experienced disruptions in the early parts of the COVID-19 pandemic, the world suffered a global shortage of PPE (Ngo & Dang, 2022). Global demand for PPE shortages at the beginning of the pandemic and China's panic resulted in "hoarding, bidding wars, and export bans" (Garcia-Santaolalla & de Klerk, 2022, p. 401). As highlighted by Garcia-Santaolalla and de Klerk (2022), this event emphasized the critical role of trade in effectively managing global crises. As such, it is imperative for efforts to address recovery measures and future preparedness to prioritize strengthening the resilience of the supply chains for PPE.

Offshoring and Domestic Manufacturing

Globalization entails the seamless movement of products, services, and capital across international and regional borders. It is widely recognized as a crucial component for corporations, stakeholders, and governments, as it is expected to operate reliably and efficiently (Gopal et al., 2023). The global value chain, encompassing various supply chain stages, commencing from raw materials and culminating in finished products for end consumers, is an intricate part of offshoring, a phenomenon catalyzed by globalization. The worldwide outbreak of COVID-19 and other events like the Russia/Ukraine conflict, political tensions, and climate change have brought to light the long-standing problems in global supply chains. These occurrences have caused people to realize that supply chains are imperfect (Gopal et al., 2023; Ngo & Dang, 2022; Schwarzenberg et al., 2020). According to Schwarzenberg et al. (2020), the manufacturing industry has become a cause for concern, particularly after the COVID-19 pandemic uncovered its weaknesses.

These weaknesses underscore the vulnerability of offshoring and the impact of geographical distance on an organization's operations when supply chain disruptions occur. Research by Tate et al. (2014) has identified several critical factors, “including customer location, natural disasters, currency valuation, labor and transportation costs, and availability, that play significant roles in U.S. companies’ decision-making process” when choosing their preferred manufacturing locations (p. 381). Other weaknesses include delays in working capital due to shipping container transit, ocean liner transportation, and safety stock in distribution centers (Schwarzenberg et al., 2020; Tate et al., 2014). “The physical and sometimes cultural distances between manufacturing and design operations” (Tate et al., 2014, pp. 382-383) can hinder innovation. Consequently, many companies are reevaluating their manufacturing locations.

While offshoring, which involves relocating manufacturing operations to countries with lower labor costs, can bring cost savings, it also “carries significant risks such as supply chain disruptions, geopolitical situations, competencies and knowledge loss, brand damage, or deficient intellectual protection policies of manufacturing recipient countries” (Sanchez & Muzzio, 2021, p. 28). Although some companies relocated their operations to East and South Asia in the early 2000s to take advantage of lower costs, such a move requires significant adjustments, including establishing foreign business units or joint ventures and managing communication, among others (Mugurusi & de Boer, 2019; Sanchez & Muzzio, 2021).

Governments and citizens have duly acknowledged the significance of supply chains for critical products and materials as a vital component of national defense and security strategy (Iakovou & White, 2020). Manufacturing is fundamental to the US economy, employment, and defense (Sergent, 2014). In 2014, Sergent reported that the manufacturing sector saw increased productivity and output. However, concerns were raised from 2001 to 2010 about the decline in manufacturing jobs due to outsourcing. According to Shih (2020), manufacturers must improve their production capabilities by upskilling their workers, possessing procurement skills, and sourcing the necessary raw materials for their products. It is also crucial to incorporate quality management processes, logistics, and security measures. Despite manufacturing companies in the US, many have outsourced production to foreign producers, decreasing domestic manufacturing capabilities (Shih, 2020).

From Bown (2022), an implication is that the United States should maintain detailed data on the production and capacity of PPE to prepare for potential disruptions. Medical industries should undergo stress tests and scenario-planning war games to achieve maximum preparedness while regulators monitor them. Healthcare organizations should know their demand projections and quickly understand domestic manufacturers' capacity and response rates to scale production under different disruption scenarios. Relying solely on domestic production or imports from one source poses risks (Bown, 2022).

Supply Chain Resilience and the Global Value Chain

The worldwide outbreak of COVID-19 has had a substantial effect on the global economy, highlighting the difficulties in managing global value chains (GVCs) across various sectors. There is a growing demand for greater resilience in GVCs to ensure that essential products are delivered promptly and in good condition. However, the pandemic has highlighted that GVCs are not resilient enough to handle the increased risk and urgency. (Phillips et al., 2022, p. 73). To mitigate risks and vulnerabilities and identify opportunities to reconfigure GVCs, companies must scrutinize their GVCs, as examining beyond their tier 1 suppliers is the only way to stress-test them (Phillips et al., 2022). According to Phillips et al. (2022), "The GVC concept explains how value is created, distributed, and captured as organizations around the world collaborate to bring products to market and ensure sustainability for local communities" (p.73). Understanding how suppliers can cope with the impact of global incidents, such as disruptions in supply and demand, is a topic of interest for researchers and practitioners (Choksy et al., 2022). Resilience means returning to normal operations, while robustness means functioning during a disruption. It is critical to protect national security interests, and reshoring and regionalization are necessary for maintaining it. Building supply chain resilience is now a fundamental strategic goal for governments worldwide (Gereffi et al., 2022). Resilience is characterized as the capability to adjust and react to disturbances and guarantee the continuation of operations within global value chains (Ryan et al., 2022).

Federal government entities and their business partners must prioritize the creation of a robust and flexible supply chain capable of withstanding any potential disruptions. This effort entails recognizing and prioritizing the supply chain’s most critical and strategic components before any issues arise. By developing contingency plans, organizations can respond promptly and effectively to mitigate the impact of any potential disruptions. Moreover, it is essential for industry partners supporting the government to collaborate to establish alternative solutions enabling swift recovery from potential disruptions, further supporting the government and its critical operations.

A comprehensive study by Harding et al. in 2023 thoroughly outlined the benefits of having a resilient supply chain. Resilient systems and organizations can adapt to disruptive events by planning, sustaining, and absorbing shocks. The concept of resilience has multiple dimensions and can mean different things depending on whether it pertains to operational efficiency, global value chain governance, national security, or the state level (Choksy et al., 2022; Gereffi et al., 2022). While efficiency in manufacturing has led to China and other Southeast Asian countries becoming primary locations for production, the recent focus on GVC resilience has raised questions about the relationship between efficiency and resilience. Although short-term efficiency and resilience may conflict, they are not mutually exclusive in the long term (Gereffi et al., 2022). According to Wei & Li (2022), "the Biden Administration has used political power to reconstruct the global supply chain, and the supply chain is regarded as the key approach to uniting its allies and partners" (p. 78). Additionally, Wei and Li (2022) acknowledged that the Biden administration has associated supply chain resilience with the nation's national security, a shift from its previous focus on economic efficiency.

The Federal Procurement Process Concerning Domestic Production Post-COVID-19

The federal procurement process and domestic production have been highlighted in several Presidential Executive Orders and federal guidelines since the onset of COVID-19 (Austin et al., 2021, Exec. Order No.14001, 2021; Exec. Order No.14005, 2021). The COVID-19 pandemic has emphasized how crucial supply chains are for the country’s public health and economic stability. Public health supply chains face several challenges, such as relying on components from foreign sources, prioritizing cost reduction over diversity, facing workforce shortages, encountering financial barriers, and needing help with coordination issues. These issues were present before the pandemic but became more apparent when the United States struggled to obtain enough PPE at the outbreak's start. However, the U.S. Government's investment in domestic manufacturing capabilities has significantly improved the situation (Sullivan & Deese, 2022).

Under President Biden and Vice President Harris, the administration established a policy emphasizing the use of goods, products, materials, and services manufactured in the United States, with federal financial assistance awards for procurements. This policy aims to stimulate American businesses and industries and support American workers (Exec. Order No.14005, 2021). The federal acquisition system enables agencies to procure the goods and services necessary to achieve their objectives. The system operates with a focus on delivering products that are affordable, timely, and of high quality to ensure customer satisfaction. This is achieved through the promotion of healthy competition, the utilization of successful contractors, and the maximization of commercial products. As a result, the system seeks to minimize administrative costs while maintaining a fair and transparent approach to fulfilling public policy objectives (Cecire et al., 2020). Following FAR Subpart 6.3, agencies can utilize noncompetitive procedures in specific circumstances. This approach can prove beneficial in addressing emergencies or facilitating supplier initiatives. However, the impact of federal contracts on companies over the long term remains uncertain (Cecire et al., 2020). Given the lack of domestic producers for many products and the "specific circumstances" clause, the federal government's path to source healthcare PPE in the US remains unclear.

Literature Review Summary

The PPE industry has faced multiple difficulties due to the COVID-19 pandemic. These challenges range from increased demand to shortages in materials and labor, as well as port delays and manufacturing shutdowns. Such challenges have significantly impacted the United States, making it increasingly difficult to obtain essential products. The scarcity of critical medical PPE has caused global panic, disrupting global value chains. In an article titled “PPE, top to bottom,” Pasternack (2021) underlines the importance of manufacturing diversity, visibility, and transparency in the PPE industry to tackle these issues. Companies must show adaptability and flexibility to succeed in future supply chains. Additionally, there is a growing interest in local PPE production, with consumers seeking information on product sourcing.

This research has identified several gaps related to PPE, including assessing the effectiveness of PPE manufacturing implementation and examining the potential impact of government policies. Furthermore, exploring ways to increase domestic manufacturing of affordable PPE through reshoring and new domestic producers is crucial. Investigating the relationship between national security implications and supply chain resilience for healthcare PPE is another vital area for research. Lastly, examining the role of technology in enhancing the visibility and transparency of supply chains for federal procurement is essential.

U.S. Domestic Nitrile Glove Value Chain

This study expands upon the findings of Study One by delving deeper into the global value chain research framework for healthcare PPE in the United States federal government’s nitrile glove industry. The primary focus is how the *Make PPE in America Act* impacts the supply chain resilience for medical-grade nitrile gloves. Domestic conditions and challenges regarding increasing PPE production in America and supply chain knowledge, transparency, and procurement strategies are examined. The challenges associated with domestic manufacturing are also explored. Figure 11 provides an overview of the domestic nitrile glove value chain, illustrating the process from raw materials to glove manufacturing, packaging, and distribution.

The research examines the raw materials required for medical-grade nitrile gloves, their sourcing, manufacturing process, and quality assurance standards. The domestic value chain is viewed from the domestic manufacturer, the distributor, and the end-user/customer perspectives. At the same time, external factors such as market demands, environmental factors, and congressional and regulatory oversight are also considered. The domestic value chain was further explored during a visit to a domestic PPE medical-grade nitrile glove factory, providing valuable insights into the PPE manufacturing process and information gathered from interview participants. The global value chain research is analyzed comprehensively to gain valuable insights into its impact on the supply chain's resilience in the United States federal government's healthcare PPE industry.

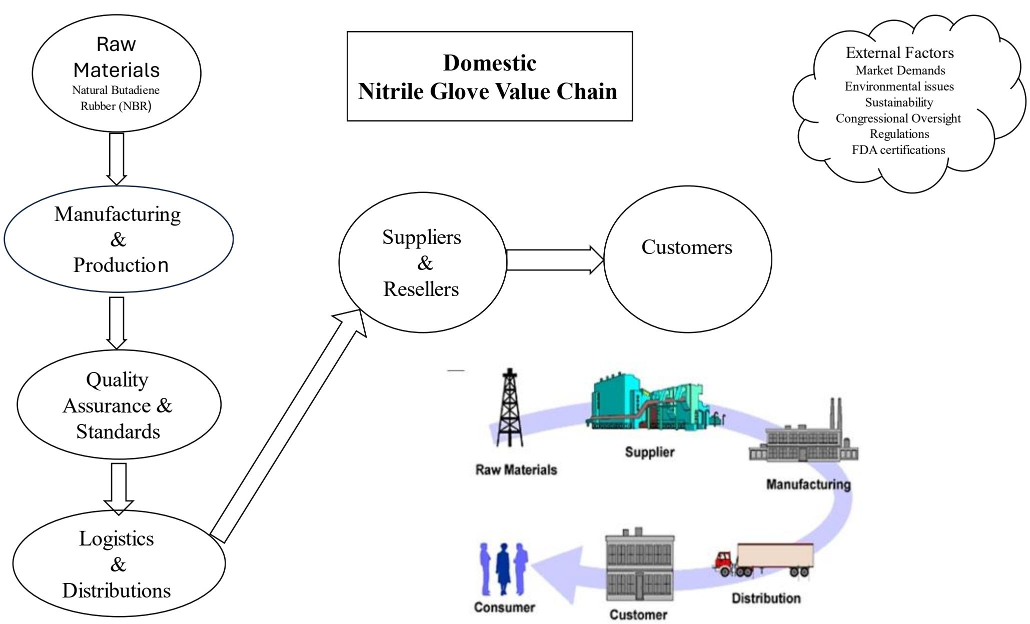


Figure 11. *Domestic Medical Glove Global Value Chain*

The Medical Gloves

The healthcare product supply chains are intricate and diverse. It is essential to note that medical supply manufacturers primarily generate their business volume from the commercial market, which makes up around 97-98% of their sales, according to the Coalition for Government Procurement (2023). A specific research context is helpful to focus on both theory and practice. The supply of medical-grade nitrile gloves is vital to the federal government, the patients it serves, and the entire nation. In the United States, various products are available that are marketed as gowns, apparel, and gloves that protect from potential health hazards (Center for Devices and Radiological Health, 2020). Gloves are worn on the hand or fingers to prevent the transfer of materials from the environment to the wearer. They are designed for medical purposes, particularly in preventing the transmission of infectious diseases, including those related to COVID-19 (Center for Devices and Radiological Health, 2020).

Obtaining gloves became the second most significant challenge in caring for COVID-19 patients after staffing (Barlow, 2022). Supply and pricing levels were affected by shipping delays and raw material shortages, allowing counterfeit products to enter the market. At the beginning of the pandemic, the medical glove demand exceeded production by 40% (Barlow, 2022; DeCarlo & David, 2020). Inventory planning models are crucial for stable supply chains during disruptions. Tronex Healthcare used this model to maintain glove allocation during the COVID-19 pandemic. However, the pandemic caused a surge in demand for raw materials, resulting in price hikes and supply constraints (Barlow, 2022).

A decentralized approach to ordering gloves resulted in higher costs and variability in care delivery. The lack of supply chain visibility created challenges in distributing healthcare supplies, particularly for facilities needing gloves and PPE during the COVID era. This vulnerability is mainly due to suppliers and vendors. Consumption patterns were the primary issue affecting glove supply, which needs to be understood (Barlow, 2022). For example, instead of consolidating glove purchases for maximum economy of scale, many facilities ordered multiple brands and sizes; however, usage levels needed to be considered, which created value leakage or underused brands could save costs and create more space for critical supplies.

Efficient supply chain management is critical in balancing demand and supply to prevent losses in sales or inventory shortages. Inefficient supply chain processes can result in up to 25% of operating costs being wasted, making it crucial to ensure accurate demand and supply matching (Gereffi et al., 2022). The upstream supply chain deals with sourcing raw materials, while the downstream supply chain involves the customer receiving the finished products. Developed economies like the U.S. and Europe are the biggest consumers of rubber gloves (Gereffi et al., 2022). Rubber glove production involves smallholders providing raw materials to manufacturers. Thailand and Malaysia dominate rubber cultivation and downstream activities. Malaysia’s Big Four glove makers account for two-thirds of global medical glove supply, while distributors like Cardinal Health handle distribution.

Although gloves may seem straightforward, their supply chain is quite complex. For a federal government agency to consider sourcing products made in the U.S., understanding the global value chain of the product is a crucial first step. To achieve this, I created a visual representation (Figure 12) of the global value chain of PPE medical gloves, from the raw materials to the end-user product. This snapshot displays the raw materials used for each type of glove, allowing researchers to understand the manufacturing and production processes and the usage and disposal processes. This visualization served as a reference source for the process before touring the domestic manufacturer and receiving a briefing on the production process.

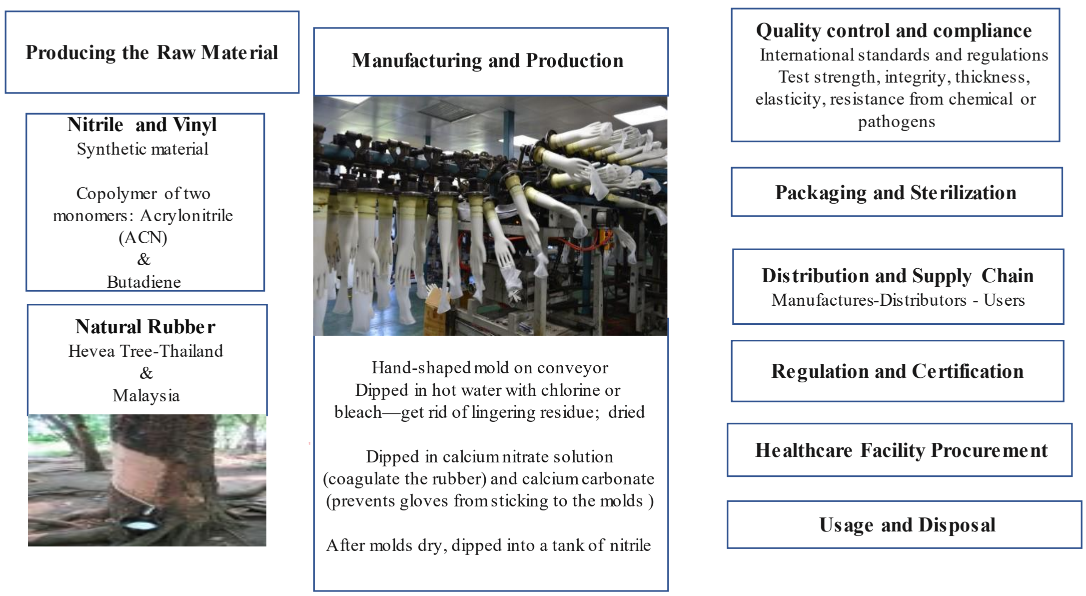


Figure 12. *Medical Gloves: From Raw Materials to Disposal*

Healthcare PPE gloves are made from three primary raw materials: latex, nitrile, and vinyl. Latex gloves are produced by collecting liquid latex from rubber trees and combining it with chemicals to create a flexible and pliable compound. They are environmentally friendly, as rubber trees can live for up to 100 years and can be tapped every two days without being cut down. However, their use is limited due to the risk of developing an allergy. Exposure to latex can cause symptoms such as itchy skin, difficulty breathing, and even skin discoloration (Bitsch, 2023; James, 2023; Refersion, 2021).

Nitrile gloves comprise synthetic rubber, precisely a combination of acrylonitrile and butadiene. These chemicals are derived from crude oil and undergo a process known as polymerization to produce liquid nitrile. The liquid is mixed with other substances to create a consistent dry rubber material (James, 2023). One notable characteristic of nitrile gloves is their high acrylonitrile (Acrylo) content, which renders them resistant to hydrocarbon fuels and petroleum-based oils. However, nitrile gloves are less flexible than their latex counterparts and may tear if stretched excessively. Additionally, nitrile is one of the purest forms of rubber, devoid of natural proteins or additives. As such, nitrile gloves are a popular choice for sterilized procedures in laboratory and hospital settings (James, 2023). Nitrile gloves are available in various thicknesses, lengths, and applications. However, they are the most expensive option among the three types (James, 2023).

Vinyl gloves are synthetic rubber gloves made from polyvinyl chloride (PVC) and plasticizers. These gloves are like nitrile gloves and have a longer shelf life than latex gloves. Additionally, they are more cost-effective to produce. However, vinyl gloves have some limitations. They are more relaxed and form-fitting than other gloves, making finger movements difficult and causing them to tear easily. Vinyl gloves are most appropriate for situations involving no potential dangers, such as food handling, cleaning, and manufacturing (James, 2023).

Additionally, vinyl gloves' production, usage, and disposal can release chlorine-based chemicals, harming the environment. Frequent use of vinyl gloves can elevate the amount of chlorine in a person's system and may result in severe health issues such as cancer. Therefore, vinyl gloves are now limited to minimizing their impact on human health and the environment (James, 2023). Nitrile and synthetic materials are chemically synthesized through copolymerization. This involves bonding butadiene and acrylonitrile monomers together. Once nitrile is synthesized, it is sent to a factory for production into gloves, which follows a similar process as that of latex and vinyl gloves. However, there are a few critical differences in the manufacturing process of latex gloves (Refersion, 2021).

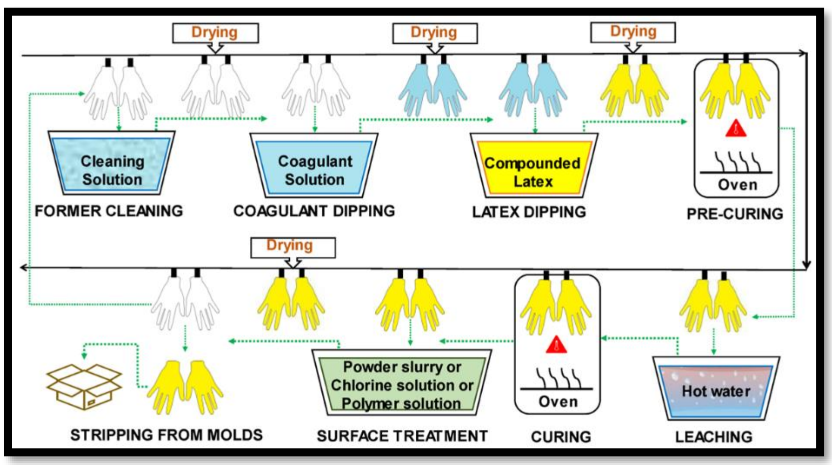


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Figure 13. *Medical Glove Production Process*

The production process (Figure 13) starts with a hand-shaped mold made of ceramic or aluminum on a conveyor. To eliminate any residue from previous batches, the molds are immersed in hot water with chlorine or bleach and then dried (Refersion, 2021; Travin, 2021). They are then coated in a rubber stick and dipped into a calcium nitrate solution to coagulate the rubber and calcium carbonate to prevent the gloves from sticking to the molds. After the molds dry, they are dipped into a tank of nitrile. Before gloves are sent to shelves, they undergo quality control and compliance testing. Every batch is tested twice to ensure regulatory requirements and quality. To determine whether a glove is safe for medical use, regulatory tests are conducted to assign the highest safety rating. On the other hand, batch tests are carried out to ensure that the glove's quality meets the American Society for Testing Materials (ASTM) standards. The batch is rated based on the number of gloves that do not pass the test, with a pass rating granted if only a tiny percentage of gloves fail. For instance, if only 1.5 out of 100 gloves fail, the batch can be deemed acceptable for medical purposes. Industrial-grade glove batches can have up to 2.5 gloves per 100 fails. Tests include:

- Sterility tests for sterilization.
- Pinhole tests for leakage.
- Dimension tests for thickness.
- Aging tests to check for tensile and elongation performance over several hours.

All gloves are manufactured and tested with a protective rating before being sent to shelves (James, 2023; Refersion, 2021; Travin, 2021).

Research Method

The research utilized secondary and qualitative data from in-depth interviews to fill the gap in academic literature and address research questions. The researcher employed an inductive reasoning approach to collect and analyze the data. Additionally, the researcher conducted hands-on, field research by touring a medical grade nitrile glove manufacturing facility. During this field trip, the researcher gained an immersive understanding of the intricate processing of the gloves, as depicted in Figure 12, and the manufacturing and production process, showcased in Figure 13. This comprehensive experience enabled the researcher to fully comprehend the complexities of producing nitrile gloves in America.

Throughout the journey, it became evident that government managers must comprehensively understand manufacturing processes across all levels, including senior executives to middle managers. As the manufacturing industry has become more complex and constantly evolving, with the emergence of new technologies and processes at an unprecedented rate, understanding this knowledge has become essential. Government managers who are accountable for regulatory compliance, policy development, and funding decisions must possess a comprehensive understanding of manufacturing processes. This understanding will allow them to make informed decisions that benefit customers, constituents, and the American taxpayer.

Data Collection

According to Temple University's Institutional Review Board (IRB), this study does not fall under human-subject research as it primarily focuses on organizations. The research utilizes a range of sources, such as multiple documents and semi-structured interviews. The data collection involved gathering comprehensive insights on the subject matter using various sources, including data from Study One, source documents, a domestic PPE manufacturing factory tour, and semi-structured interviews. The document sources included academic articles and relevant websites about the resilience of supply chains and global value chains. The researcher examined public documents such as federal government regulations, government audit reports, and presidential executive orders to understand supply chain resilience in the healthcare industry, focusing on the federal government. These sources provided valuable insights and an opportunity to compare the global value chain and resilience, especially in healthcare PPE, specifically medical-grade nitrile gloves.

To ensure the accuracy and consistency of the research findings, the researcher developed a set of semi-structured interview questions by carefully crafting them based on a comprehensive literature review. The semi-structured interviews comprised eight questions, including seven open-ended questions and one closing question. The interview participants deeply understood the impact and requirements of the *Make PPE in America Act* and the concept of supply chain resilience in the U.S. federal government. They also understood how the *Make PPE in America Act* would affect the Global Value Chain of healthcare PPE, particularly medical-grade nitrile gloves. The participants had expertise in the domestic manufacturing of PPE, specifically nitrile gloves, government procurement, medical logistics, enterprise-level medical supply chain expertise, and logistics. Table 10 shows the selection criteria for Study Two participants.

Seventeen individuals from various organizations were interviewed in this research, including two federal government agencies, two domestic nitrile glove manufacturing companies, one industry distributor, one from academia, and one non-profit organization. Table 11 provides a detailed breakdown of the different types of organizations participating in the interviews. It is important to note that the content of this research does not represent the official stance of any participating organizations. Two government organizations participated from the healthcare sector. Government 1 operates within healthcare, while Government 2 focuses on setting healthcare policies for both public and private sectors. Domestic manufacturers of medical gloves made of nitrile from Industry 1 and Industry 3 were represented, with production sites located across the

United States. A PPE distributor represented Industry 2, while the academic participant offered a comprehensive understanding of supply chain operations and logistics from academic, government, and industry perspectives. The non-profit organization present was federally mandated to provide specific PPE products to the government but did not manufacture them. Instead, they sourced them from PPE manufacturers or resellers and contracted with the government to ensure their purchase of the PPE products.

During Study Two, 17 participants were interviewed in 14 separate sessions across two stages. The naming convention S2-P# was used to differentiate participants, with S2 representing Study Two and P# representing the participant number. The first stage occurred between July 28 and August 31, 2023, with three participants participating in pilot interviews. Convenience sampling was used to select participants who were easily accessible and recommended. All participants were knowledgeable about federal supply chain processes. The pilot interviews were crucial for selecting appropriate questions and evaluating their effectiveness in answering the research questions for Study Two. The questions were slightly modified after the pilot interviews to align with the research questions.

Additionally, as the foundation of Study Two, two of the interview questions explored the differences between anticipating and preparing to adapt and insights into the differences between resilience and robustness about supply chain disruptions. The second stage involved 14 interview participants *(*S2-P4 -S2-P14) from November 2 to December 14, 2023. In some interviews, there were multiple participants. In those cases, the participants are represented by S2-P7-1 and S2-P7-2, indicating that two participants were in that interview. In the case of S2-11, S2-P11-1, and S2-P11-2, three participants participated in that interview. Table 12 provides the demographics of all 17 participants.

While touring a domestic manufacturing facility, the researcher, their doctoral advisor, and a fellow doctoral student were privileged to observe the latest dipping technology in modern glove manufacturing. The factory's machines were 800ft long, 30ft tall, and had 32,000 formers. These 6th-generation machines can produce 38,000 gloves per hour; resulting in a manufacturing potential of producing up to 80 million gloves per month. It can take up to four months to address the issue of prolonged supply chain disruptions, resulting in subpar products. However, Industry 3 has prioritized agility and flexibility in its manufacturing process, allowing logistics to be resolved within weeks, resulting in quicker solutions to any problems that may arise. Industry 3 has also expressed its dedication to meeting the needs of its customers. They can deliver specific glove sizes within a week, avoiding potential shortages, which is a significant advantage.

Industry 3 can maintain a steady and efficient production process thanks to its reliable raw material supplier. With a strategic stockpile of four to six months' worth of materials in the U.S., they are always prepared with the necessary resources, no matter where they are located. While their nitrile is produced in Italy, the other chemicals used in their gloves are manufactured domestically in the U.S., allowing for a seamless production process free of delays. Industry 3 regards its supply chain as entirely domestic, as its material supplier in the U.S. manages the materials sourced from Italy.

Industry 3 has partnered with a second raw material supplier in South Korea, ensuring a full year's supply of onshore raw materials. Natural butadiene rubber (NBR), the raw material for medical-grade nitrile gloves, boasts an impressive shelf life and can be revitalized with additives, guaranteeing freshness and purity. In addition, their raw material supply chain partner stores materials at their U.S. factory for up to 30 days, providing Industry 3 with a generous four to six-month supply of materials to operate at maximum capacity. The U.S.-based supplier delivers raw materials within one day. In contrast, raw materials from Italy arrive within two weeks - a significantly shorter timeline than the four to six weeks required for delivery across the Pacific Ocean.

Semi-Structured Interviews

The researcher utilized pilot interviews with experts in supply chain operations, specifically those with experience in the federal government healthcare sector and academia participants with extensive experience in government logistics, to determine the most appropriate inquiries for research. During the pilot, convenient sampling (S2-P1-S2-P3) was used to select readily available research participants (Myers, 2020). In stage 2, snowball sampling was used for the remaining 14 interview participants (S2-P4-S2-P14) to identify additional participants beyond the convenience sample, as Lashley and Pollock (2020) suggested. This strategy has been shown to provide access to more vulnerable and difficult-to-reach social groups. The pilot interview data and the remaining project interviews were analyzed using NVivo for Study Two.

The participants were given the interview protocol (Appendix B) and eight interview questions (Appendix C) at least three days before the interviews. This allowed them to familiarize themselves with the topics and save time during the interviews. The interviews were scheduled for 60 minutes, but on average, they only lasted 38 minutes. To facilitate innovative ideas and adaptability, the researcher employed an interview protocol that could be adjusted during the interview.

Qualitative Data Analysis Approach

The researcher employed digital collaboration tools such as Otter.AI, Microsoft TEAMS, and Zoom to analyze qualitative data. To ensure data privacy and security, the researcher used facial recognition software and researcher-only passcodes to verify access and store data on a secure computer. During interviews, notes were taken, and essential points were highlighted with Microsoft Word's comment feature and in the researcher's journal. Participants' demographics were modified during transcription using Otter.AI to guarantee confidentiality. The audio files were reviewed to ensure accuracy and minimize redundancies and transcription errors while maintaining the original content's integrity. The researcher used NVivo, a qualitative and data analysis software, to identify common themes, minimize research bias, and gain a deeper understanding of the data through rigorous coding (QSR International, 2022). Finally, the researcher created the final codebook using Microsoft Excel, including codes, subthemes, and themes.

The research followed the Reflexive Thematic Analysis (RTA) process for inductive and deductive reasoning outlined by Byrne (2021). This approach provided a flexible framework for analyzing the data's themes, adhering to the guidelines established in Braun & Clarke's RTA process (Byrne, 2021). This strategy ensures that participants' narratives are conveyed clearly and concisely, following Braun and Clarke's methodology (2022).

Reflexivity

The researcher utilized RTA to gain insights by analyzing data from the practitioner's point of view and reviewing academic literature. According to Gough and

Madill (2012) as cited in Braun and Clarke (2022), RTA acknowledges that subjectivity is inherently subjective and context dependent Braun & Clarke (2022) suggest that the concept of researcher bias, which assumes the existence of unbiased or objective knowledge creation and the ability to regulate bias, is not applicable in reflexive TA. Gough and Madill (2012) add that subjectivity should not be viewed as a hindrance to eradication but rather as a tool for conducting analysis (as cited in Braun and Clarke, 2022, p. 8). To understand the participant's perspectives and intentions comprehensively, the researcher engaged in reflexivity and documented observations in a journal. This process involved reflecting on biases, assumptions, and experiences that may affect the interpretation of the data collected. The researcher recorded their reactions, thoughts, and challenges during the study. By doing so, the researcher ensured that their understanding of the participant's views was accurate and unbiased, resulting in more meaningful and insightful data analysis. The researcher remained reflexive, as Elliott et al. (1999) and Braun and Clarke (2022) recommended. They suggest that "researchers should attempt to understand and take responsibility for their perspectives" (Elliott et al., 1999 as cited in Braun & Clarke, 2022, p. 8).

Discussion of Findings

Study Two takes a closer look at the global value chain research with a focus on supply chain resilience in the US federal government, with a particular emphasis on healthcare PPE. Specifically, the impact of the *Make PPE in America Act* on global supply chains and its contribution to maintaining healthcare supply chain resilience for medical-grade gloves was explored. The study also delved deeper into the previous findings to identify key differences between "anticipating versus preparing to adapt" and provide insights into the nuances of "resilience versus robustness" in the face of supply chain disruptions.

Meaningful Differences Between Adapting and Anticipating Supply Chain Disruptions

Adapting and anticipating supply chain disruptions are crucial to effective supply chain management. Key differences between these approaches include adaptation being reactive and anticipating being proactive. Adapting to a supply chain disruption requires collaboration, making and implementing decisions in real-time, speed, and flexibility. Amico et al. (2024) state that systems have adaptive abilities when they have backup suppliers, and to be adaptive means having flexibility. According to Amico et al. (2024), a system can be adaptable if it has backup suppliers. Being adaptable is synonymous with having flexibility. The authors explain that "natural disasters, geopolitical tensions, and public health crises" can cause significant disruptions to supply chains, resulting in shortages. Therefore, flexibility is proposed as essential to supply chains' ability to adapt to such obstacles (Amico et al., 2024, p.4).

Adapting to a supply chain disruption also requires making quick decisions and implementing changes fast. Adapting to unexpected events relies on the ability of an organization to gather accurate information, which requires reliable business partners capable of providing relevant information to aid in decision-making. Without these partnerships, an organization may be constantly reactive instead of proactive due to the need for more data. According to S2-P4, adapting to an organization's ability to gather accurate information is crucial. For an organization to gather or access reliable information, it is essential to have reliable business partners who can provide them with relevant information to aid in their decision-making process. Participants in Study Two highlight that effective decision-making relies on business partners conducting research and providing relevant information. S2-P5 provides an example of adapting during COVID-19 when there was a shortage of medical-grade nitrile gloves. They had to ration gloves for critical medical care and used nitrile and latex gloves unless there were allergies or other circumstances. This extended the life of their PPE products, and the FDA's shelf-life extension program was beneficial. However, adaptability can also come with bureaucracy.

COVID-19 caused S2-P5's organization to realize that adaptability is critical to surviving and thriving in a constantly changing environment. Participant S2-P6 emphasized that adapting to market changes requires anticipating potential challenges and understanding the market well. It is crucial to comprehend the sources of products and how they are transported from one place to another. It is also essential to know about the companies that manufacture these products and the potential challenges they may face, such as workforce strikes.

To be able to adapt effectively, access to this information is necessary. Participants S2-P6 shared an account of adapting to a situation without warning of an impending disruption. The incident involved a strike by UPS workers, mostly union workers. The strike caught them off-guard and forced them to react instantly. Participants S2-P6 explained that they immediately contacted the top leadership at UPS to inquire about the situation since their organization relied heavily on UPS's services. Meanwhile, another organization member decided to refrain from taking risks and arranged for the items to be shipped by another carrier. However, other carriers needed to become more familiar with specific UPS tasks, making this solution less than ideal. Consequently, even after learning about the disruption, they had to put in additional effort to adjust and learn new processes to cope with the situation.

During the interviews, the participants explored various traits related to adapting to supply chain disruptions. These conversations yielded several recurring themes visually represented in Figure 14. One emerging theme was the need to make unplanned cost trade-offs to maintain an adequate supply chain. Another important theme was the value of flexibility and adaptability when faced with unforeseen disruptions. Lastly, the participants emphasized the importance of a reactive approach to address and resolve any issues that may arise quickly.

Codes & Themes of Adapting to Supply Chain Disruptions

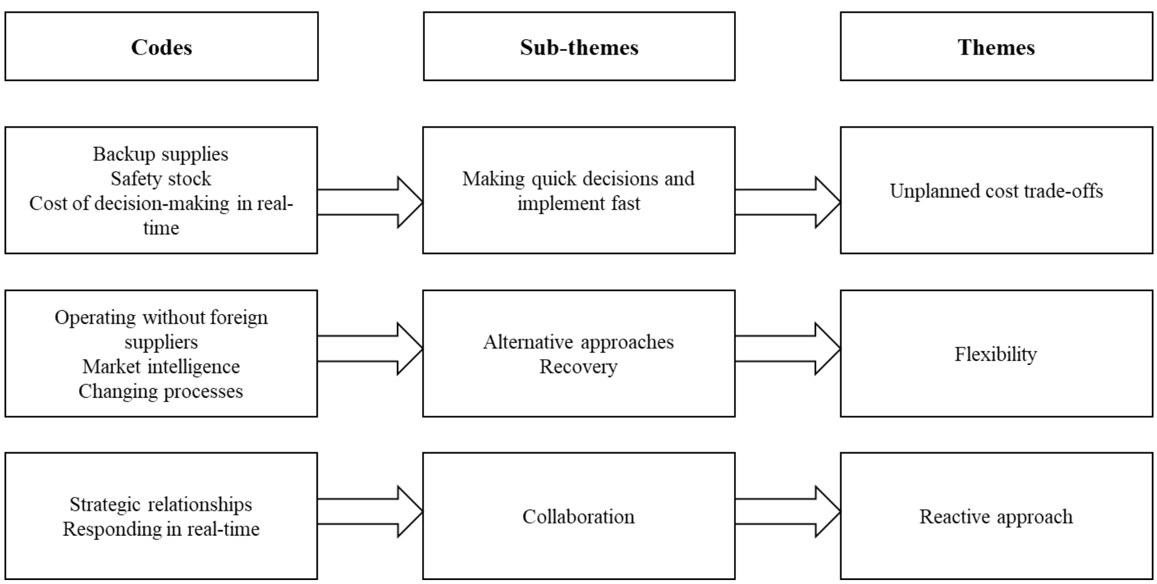

Figure 14. *Codes & Themes of Adapting to Supply Chain Disruptions*

Organizations must promptly adapt to a supply chain disruption by identifying cost trade-offs and flexibility in changing processes to react swiftly when the disruption occurs. However, anticipating a supply chain disruption can enable organizations to proactively plan to prevent or mitigate the disruption when it occurs, thereby minimizing its impact. Participants in the interview, S2-P4 and S2-P5, emphasized the importance of understanding supplier relationships and diversity. They also stressed the need to be prepared for crises, which requires a proactive approach. However, it can take time to invest the necessary funds in preparedness. Hospitals, for instance, operate with a profit margin and are unlikely to stockpile ample supplies such as nitrile gloves. In crises, they may need to ask the federal government for help. Another participant, S2-P11, discussed the importance of anticipating and adapting to potential risks in a supply chain. According to them, anticipation and adaptation are interrelated, and possessing one trait makes it easier to have the other. However, S2-P10 noted a meaningful difference between the two concepts. Adapting is a reactive response to a supply chain disruption, while anticipating is a proactive approach that involves advanced planning. According to Yang et al. (2021), successful adaptation to changes in the supply chain necessitates effective collaboration with partners. Adaptability requires integration and reconfiguration of internal and external organizational resources and processes, which calls for collaboration across internal functions and with significant suppliers and customers.

S2-P10 also discussed the Continuity of Operation Plan (COOP) as an example of anticipating a supply chain disruption. The COOP plan involves mitigating risks in advance, such as server failure, to avoid potential disruptions. In contrast, adapting is a response to a disruption without prior preparation. S2-P6 suggested that continuous market research is essential to understand supply chain disruptions. Understanding how things move from one point to another and monitoring manufacturing companies, workforce, and strikes are crucial to anticipating and adapting to potential challenges. Access to information is vital in this regard.

Out of the 14 interview participants, four individuals, comprising 28% of the group, shared their perspective that adapting and anticipating supply chain disruptions are interconnected and interdependent rather than separate entities. In other words, they viewed these two aspects as intertwined components of a more extensive system, where the ability to anticipate disruptions is crucial for adapting to them effectively and vice versa. Figure 15 presents the interview participants' codes and themes regarding anticipating supply chain disruptions. During the interviews, the participants highlighted the importance of anticipating supply chain disruptions through market intelligence. Anticipating supply chain disruptions involves comprehensively understanding an organization's strategic partners and market intelligence to approach potential disruptions proactively. Additionally, participants emphasized the need to project and plan for preventive measures to prepare for potential supply chain disruptions.

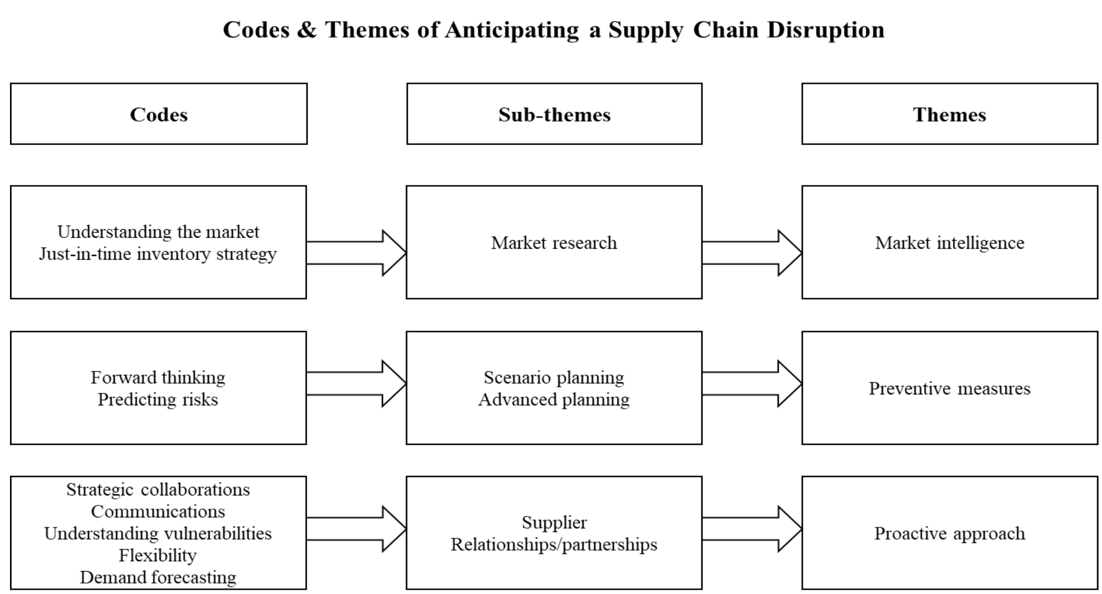

Figure 15. *Codes & Themes of Anticipating a Supply Chain Disruption*

Effectively managing supply chain risks requires both adaptation and anticipation of potential disruptions. Adapting involves reacting quickly to unexpected disruptions, while anticipation involves proactive planning and scenario assessments to prepare for potential disruptions. By anticipating potential disruptions, preventive measures can be developed and executed before a disruption occurs. Table 13 visually compares the differences between adapting and anticipating supply chain disruptions. While both approaches are crucial for managing supply chain operations, they involve different strategies and methodologies tailored to specific situations.

Meaningful Differences Between Supply Chain Resilience and Robustness

An organization's ability to bounce back from a disruptive event requires a resilient supply chain. The supply chain must adapt and recover quickly from unexpected, disrupted events like natural disasters, transportation challenges, snowstorms, hurricanes, or shortages in supply. Supply chain resilience requires visibility, flexibility, agility, and supplier diversification (Christopher & Peck, 2004; Todo et al., 2022; Tukamuhabwa et al., 2015). On the other hand, a robust supply chain must withstand and minimize the adverse impacts while the event is ongoing. Organizations with robust supply chains focus on preventing disruptive events from occurring in the first place to reduce the impact on their operations (Christopher & Peck, 2004; Todo et al., 2022).

During the second study, participants discussed the distinctions between supply resilience and supply chain robustness. Participant S2-P11 noted that while the two concepts are different, it can be challenging to differentiate between them. S2-P11 explained that a robust supply chain is like redundancy and is crucial to creating a resilient supply chain. Redundancy involves having options and secondary sources and adapting to disruptions. Other participants also shared their insights, such as S2-P14, who suggested sourcing from multiple U.S. manufacturers to ensure supply chain resilience. S2-P6 emphasized the importance of having long-term solutions that can be relied upon when needed. S2-P10 distinguished between supply chain resilience and robustness, highlighting that resilience involves the ability to withstand or recover quickly from difficulties, while robustness involves resisting or adapting to change. S2-P10 emphasized that both concepts are crucial, with resilience essential to avoid supply chain disruptions and robustness necessary for maintaining supply chain strength and stability.

S2-P7 added that resilience means being flexible and not dependent on one source or factory. In the context of PPE manufacturing, S2-P6 compared resilience and robustness, stating that resilience refers to the availability of a specific item. In contrast, robustness concerns the item's ability to meet specific criteria or standards. For instance, S2-P6 explained that *Make PPE in America Act* requires that PPE comprise 100% of the components produced in the United States. While medical-grade nitrile gloves are available, they do not meet the *Make PPE in America Act* criterion, making robustness an essential factor in PPE manufacturing. S2-P13 explained that a robust supply chain differs from a resilient one, as robustness is more about how much depth it has, while resilience is more about how quickly it can recover. However, S2-P7 reiterated that robustness and resilience are necessary for a flexible and non-dependent supply chain.

Supply chain resilience refers to having what is needed to handle an initial contingency response, such as having communication networks and contingency response plans (S2-P10). On the other hand, supply chain robustness refers to having a partner network that can be relied upon in case the resilience plan no longer works (S2-P4). Participant S2-P5 highlighted the challenges in product distribution and emphasized the need for an efficient supply chain to distribute products to individuals effectively. They discussed the distinction between supply chain resilience and robustness as the ability to recover from a failure, which is what resilience means, whereas being prepared to deal with potential failures is what robustness entails (S2-P5). According to S2-P9, it is crucial to avoid relying on a single vendor to minimize the overall risk in the supply chain. They stated that robustness includes redundancy and the ability to withstand an attack, loss, or failure. It is about being prepared for unexpected events.

In contrast, resilience involves recovering quickly after an attack or failure. It is a reactive process that requires immediate action. Ensuring the continuity of operations in supply chain management requires equal attention to robustness and resilience (S2-P8). Both factors are equally important. For instance, when there was a shortage of hand sanitizers across 450 airports in the U.S., the government switched to other manufacturers with isopropyl alcohol on their pallets and could supply it. Therefore, resilience is a broad category that includes multiple factors, and robustness is just one (S2-P8).

Figure 16 was created with the invaluable insights gathered from participant interviews on supply chain resilience. Through thorough discussions, numerous codes were analyzed, identifying three main themes: forward-thinking, market intelligence, adaptability and responsiveness. Participants strongly emphasized the need for forward-thinking, stressing the importance of quickly sourcing from alternative suppliers and returning to normal operations in the face of disruptions. Market intelligence was chosen as a theme due to organizations' need to diversify their suppliers and implement strategic measures. Lastly, adaptability and responsiveness were highlighted as crucial traits of resilience, with some participants even viewing resilience as a reactive process.

Codes & Themes of Supply Chain Resilience

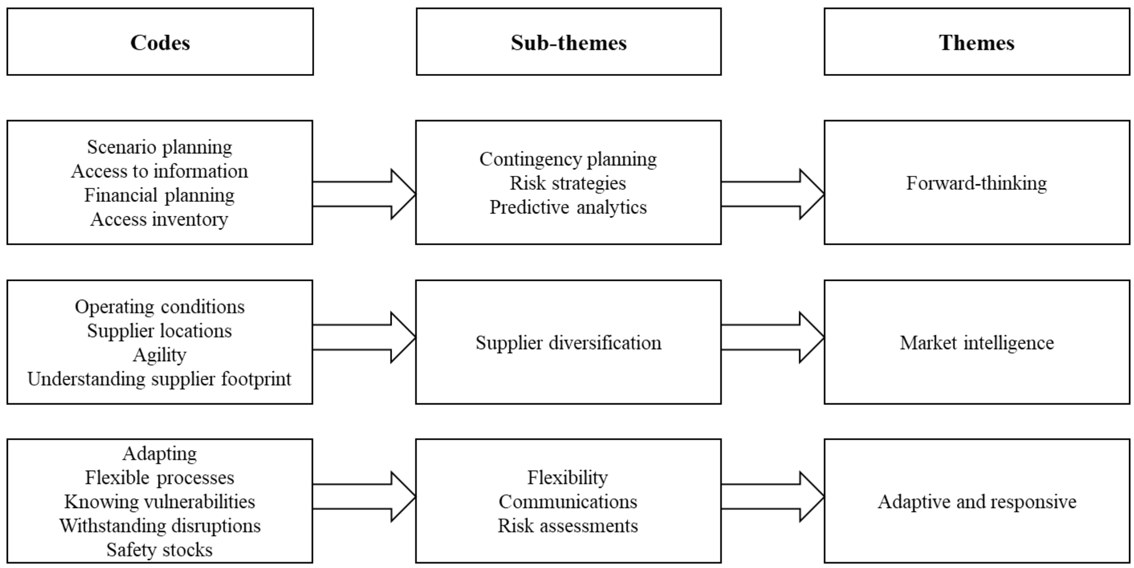

Figure 16. *Codes & Themes of Supply Chain Resilience*

The insights shared by interview participants were crucial in shaping the themes related to supply chain robustness. Figure 17 depicts the three themes that emerged from the discussions: preventive, redundancy, and proactive measures. To avoid or lessen the effects of supply chain disruptions, companies put in place preventive measures such as maintaining larger quantities of inventory, keeping buffer stocks, and working with multiple suppliers. The participants emphasized the importance of a resilient supply chain that includes alternative and redundant suppliers and systems. Building a robust supply chain requires proactive measures, such as careful planning and preparation. However, as the interviewees noted, these proactive measures can be expensive, as they necessitate financial resources to establish the necessary redundancies for a secure and dependable supply chain.

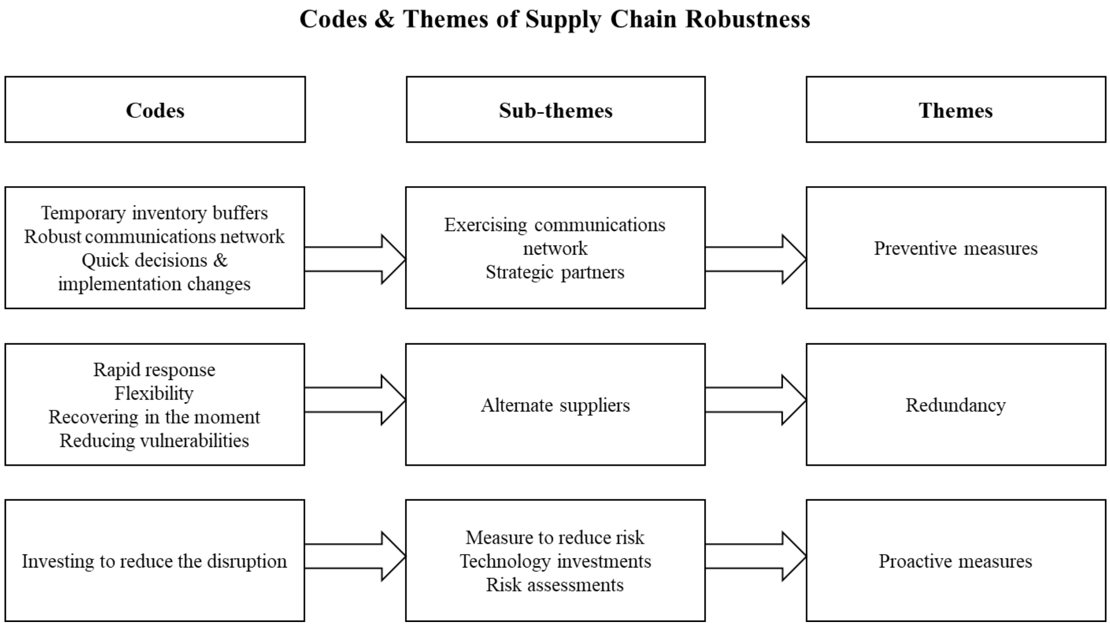

Figure 17. *Codes & Themes of Supply Chain Robustness*

In summary, the discussion centered on the critical nature of robust and adaptable supply chain management. The participants underscored the importance of cultivating trustworthy partner networks if the resilience plan falls short. Additionally, they emphasized the necessity of an effective supply chain to distribute products to individuals efficiently. Finally, they delved into the distinction between supply chain robustness and resilience and how both are integral to supply chain management to ensure uninterrupted operations. Table 14 outlines the differences between supply chain resilience and robustness. Resilience pertains to the supply chain's ability to recover and restore after experiencing disruptions. In contrast, robustness refers to its capacity to endure and withstand such disruptions. Both approaches entail unique strategies, challenges, and benefits.

Research Question One: How Does the Make PPE in America Act Impact the Medical (Nitrile) Glove Value Chain?

Throughout the interview, the participants shared their diverse viewpoints on the potential impact of the *Make PPE in America Act* on the value chain of medical-grade nitrile gloves. While a few participants believed the Act would not create any impact, others opined it might have a negligible effect. Nonetheless, most participants agreed that the Act's influence on the value chain of medical gloves should be assessed at the national level rather than solely relying on the federal government's investment. In other words, the Act's impact should be viewed holistically to understand how it would affect the entire medical glove market in the country.

As per the insights shared by S2P-P1, the *Make PPE in America Act* poses a significant challenge to the global value chain. To guarantee the accessibility of basic materials and decrease labor expenses, obtaining nitrile gloves from the Far East is presently the most viable approach. According to S2-P1, glove production in the United States is impractical because of environmental constraints. They also noted that the industry's reliance on overseas operations to minimize expenses results in heightened supply chain dependencies and a greater risk of substantial supply constraints.

Participant S2-P4 suggests that the domestic supply of raw materials needs improvement, which requires partnering with external sources to acquire them. From a value chain perspective, this incurs significant expenses. To address this issue, S2-P4 proposed the *Make PPE in America Act*, which aims to manufacture medical-grade gloves within the United States. This would reduce the need to import raw materials and promote the domestic circulation of funds. However, the increased cost of production in the U.S. due to higher wages and transportation expenditures poses a challenge. This, in turn, affects third-party insurance reimbursements, ultimately leading to higher healthcare coverage costs for customers. Even though the Act could generate more domestic revenue, it may hurt the value chain, as noted by S2-P4.

S2-P2 argued that the *Make PPE in America Act* could potentially revolutionize supply chains and the industrial base in the United States. Their main point emphasized investing in domestic supply chains to ensure self-sufficiency. To drive their point home, S2-P2 used oxygen concentrators as an example, pointing out that over 90% of these life-saving devices were manufactured overseas during the COVID-19 pandemic. This example effectively highlights the urgent need for investment in the domestic industrial base to secure critical supplies during times of crisis.

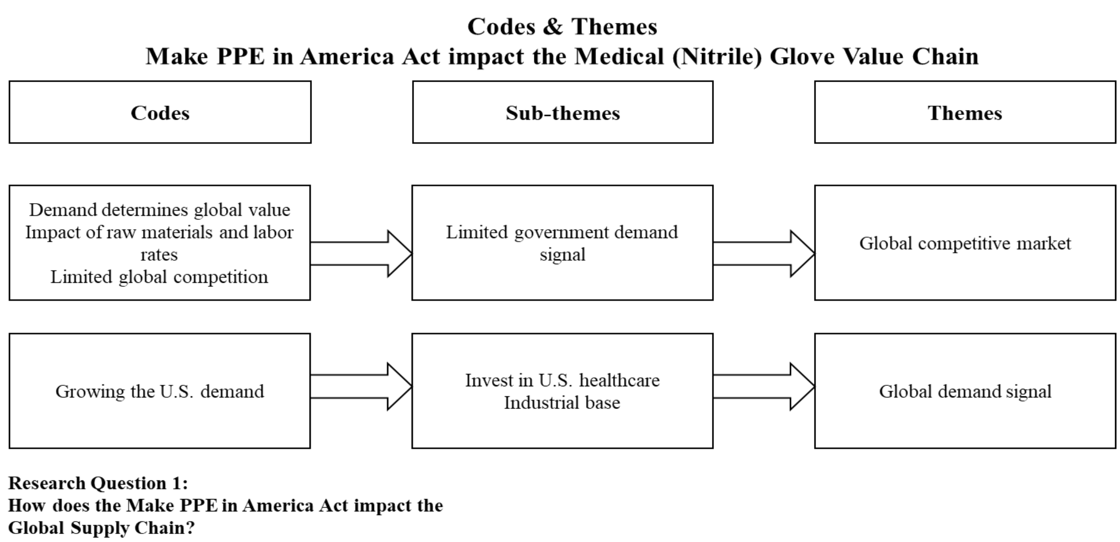

Figure 18. *Codes & Themes - Make PPE in America Impact the Medical (Nitrile) Glove Value Chain*

The findings presented in Figure 18 reflect the results of interviews conducted with participants regarding the impact of the Make PPE in America Act on the global value chain. The study discovered that the PPE market is highly competitive and has a significant global size. However, the limited market size of federal healthcare systems, which accounts for less than 2-3% of PPE in the United States, may have little impact on the global value chain. Although participants acknowledged that the Make PPE in America Act could affect medical-grade nitrile glove demand for relevant organizations, they did not believe it would significantly impact global demand from a value perspective. Participants referred to the just-in-time inventory implementation, which restricts significant stockpiling and influences global demand. Furthermore, the participants believed that national industrial efforts in PPE healthcare would be necessary for the legislation to impact the global market or demand.

According to the reports from Grandview Research (2023) and the Coalition for Government Procurement (2023), the global market size for PPE and federal healthcare systems, including the Department of Veterans Affairs and the Department of Defense, accounted for $2.3 billion out of $79.3 billion (3% of the global market size). Another report from VynZ Research (2023) estimated the global disposable glove market size to be $7.9 billion. According to the PPE spending data for Fiscal Year 2023 (S2-P4), Government 1 spent $2 billion on PPE. The actual spending data for 2023 healthcare exam gloves was $74.9 million, and healthcare surgical gloves were $13.4 million, with a total healthcare glove expenditure of $88.3 million. Therefore, it is estimated that Government 1 spent $88.3 million on healthcare gloves, representing 1.18% of the global disposable glove market size. Government1's actual expenditure of $2 billion annually in

2023 on PPE represents 2.51% of the global PPE market size. Figure 19 shows the global PPE market size versus the federal healthcare systems and the actual PPE spending in fiscal year 2023 for Government 1. It also depicts the global PPE market size for disposable gloves against the spending that Government 1 expended on medical nitrile gloves (exam and surgical gloves). Figure 19 leads to the assumption that such a small percentage of federal healthcare demand is unlikely to impact the PPE global value chain.

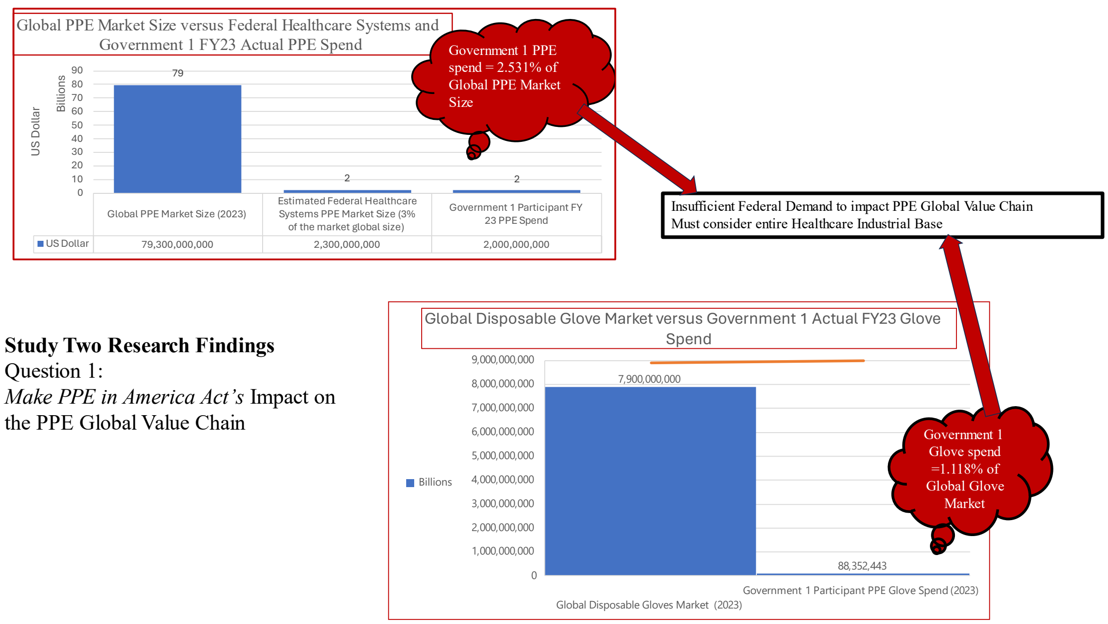

Figure 19: *Global PPE Market Size versus Federal Systems Market Size*

Research Question Two: What are the Most Significant Supply Chain Challenges of Meeting the Expectations of the Act?

During the interview, the participants discussed a multitude of challenges associated with meeting the expectations of the *Make PPE in America Act*. These challenges ranged from the availability of raw materials to conflicting government regulations and the impact on small businesses. Interviewee S2-P1 specifically highlighted the challenge of producing medical-grade nitrile gloves using raw materials not manufactured in the United States, while S2-P2 emphasized the pressing need for domestic manufacturers. Meanwhile, S2-P3 brought up the difficulties organizations face when procuring gloves in large quantities, mainly if they are domestically produced in the U.S. due to their higher cost. Despite these obstacles, the participants stressed the importance of finding American manufacturers to provide gloves to support the *Make PPE in America Act's* mission goals during the COVID-19 pandemic. However, S2-P13 expressed concerns about the government relying on the private sector to adapt to market conditions and emphasized the need to follow existing laws and regulations for long-term success. Additionally, S2-P2 discussed the challenges of investing in innovative glove products while considering the difficulties of sourcing raw materials.

The United States' heavy reliance on foreign markets for PPE, particularly gloves, presents a significant hurdle for the *Make PPE in America Act*. The country's dependence on overseas suppliers leaves it vulnerable during national security crises, pandemics, and other emergencies (S2-P1). The Act aims to address this issue by promoting self-sufficiency and reducing foreign reliance through producing PPE from raw materials to finished products within the United States. However, the economic benefits of producing PPE overseas limit the country's ability to achieve this goal, exacerbating the dependency issue. Despite efforts to encourage domestic manufacturing, the current demand signal remains low, with only 1 to 2% of PPE being produced domestically, which cannot significantly impact the industry (S2-P1, S2-P4). A more robust demand signal is necessary to influence the industry rather than solely relying on the federal government's intention to produce PPE in America (S2-P1).

One participant (S2-P2) discussed the challenge of investing in innovative glove products, citing difficulties in sourcing the necessary raw materials. Another participant (S2-P11) discussed the challenge of adequately training lawmakers on the meaning and impact of legislation. To fully understand the effects of a bill, lawmakers must research its details. For instance, they must be aware that raw materials for nitrile gloves are not produced in the United States, making it impossible to produce gloves that are 100% American-made.

However, another participant (S2-P14) talked about the difficulty of incentivizing domestic manufacturers without proper decision-making leadership. Offering a premium to small businesses without considering the actual cost of doing business and the model's sustainability could increase prices and ultimately hurt the product's commercial viability. It is essential to consider the model's sustainability beyond the initial inception.

Participant S2-P7 expressed interest in the federal government purchasing gloves from domestic manufacturers while establishing their raw material facility for NBR, the raw material for producing nitrile gloves. The participant recommended modifying the legislation for nitrile gloves to include 60% US and 40% non-US content, given the significant investment domestic manufacturers require to reintroduce nitrile gloves production in the US. They also suggested that the government should avoid buying gloves made in Malaysia or China and instead consider purchasing from them until their raw material plant is operational. The participant raised concerns about the government's waiver process and recommended explicitly changing the legislation for nitrile gloves since the raw materials are not manufactured in the United States.

S2-P9 believes that manufacturing companies can produce goods, but the primary concern is the demand for those goods, mainly in the initial stages. Smaller businesses must ensure sufficient demand before investing capital to expand their production capacity. The main risk here is the gap between the production and purchase phases, which cannot be guaranteed as there are no assurances, especially with federal procurement and short-term purchases. This risk makes it challenging to guarantee production several years ahead.

During an interview, several participants expressed their opinions on various issues related to legislation, raw materials, and trade agreements. Participant S2-P11 stated that lobbyists significantly influence legislation, and large manufacturers and the most prominent lobbyists have the most influence. The participant believes companies should be allowed to source raw materials from Trade Agreements Act (TAA) compliant countries since nitrile raw materials are not manufactured in the United States. S2-P11 thinks their company should not be penalized for not abiding by regulations, as they have invested $180 million in domestically manufacturing nitrile gloves. The participant emphasized the need to protect Small Businesses, Small Disabled Veteran-Owned Small Businesses (SDVOSBs), from any adverse impact from government dealings with manufacturers. Participant S2-P14 highlighted the challenges of imposing import tariffs and their potential impact on trade agreements. The participant expressed concern that such tariffs could violate treaties, further complicating matters at a macro level.

S2-P13 mentioned that raw materials are not an issue due to the Federal Acquisition Regulation, Part 25. The regulation provides deviations for relief from certain things not made in the US, but there needed to be a connection in thinking that it would give relief for rubber and latex products. The participant believes that the Act impacts understanding how various legislations work together. During the discussion, S2-P14 raised a complex scenario that involved conflicting legislation. The agency highlighted the significance of receiving a clear directive from Congress on which law to follow, as agencies can only comply with practical and reasonable legislation. Congress expressed a willingness to address the issue and make any essential adjustments. In a separate point, S2-P8 raised a question about the need for multiple specifications for medical-grade gloves and suggested consolidating them for simplicity.

During the interview, participants discussed the challenges that hinder fulfilling the *Make PPE in America Act's* rules. Their decision points on the challenges associated with the Act, particularly the medical-grade nitrile gloves, resulted in five identified themes in Table 20: capacity and scalability, global trade dynamics, procurement strategies, regulation and compliance, and workforce and labor concerns. The theme of capacity and scalability emerged due to the limited demand that the federal government requires compared to the market from the national healthcare industry. Participants' comments identified capacity and scalability as themes because the federal government's ability to surge could result in a higher demand for domestic manufacturers. Another challenge supporting this theme is the impact on small and medium-sized businesses. Also, insufficient product demand is attributed to the decrease in COVID-19 cases and the shift in consumer behavior.

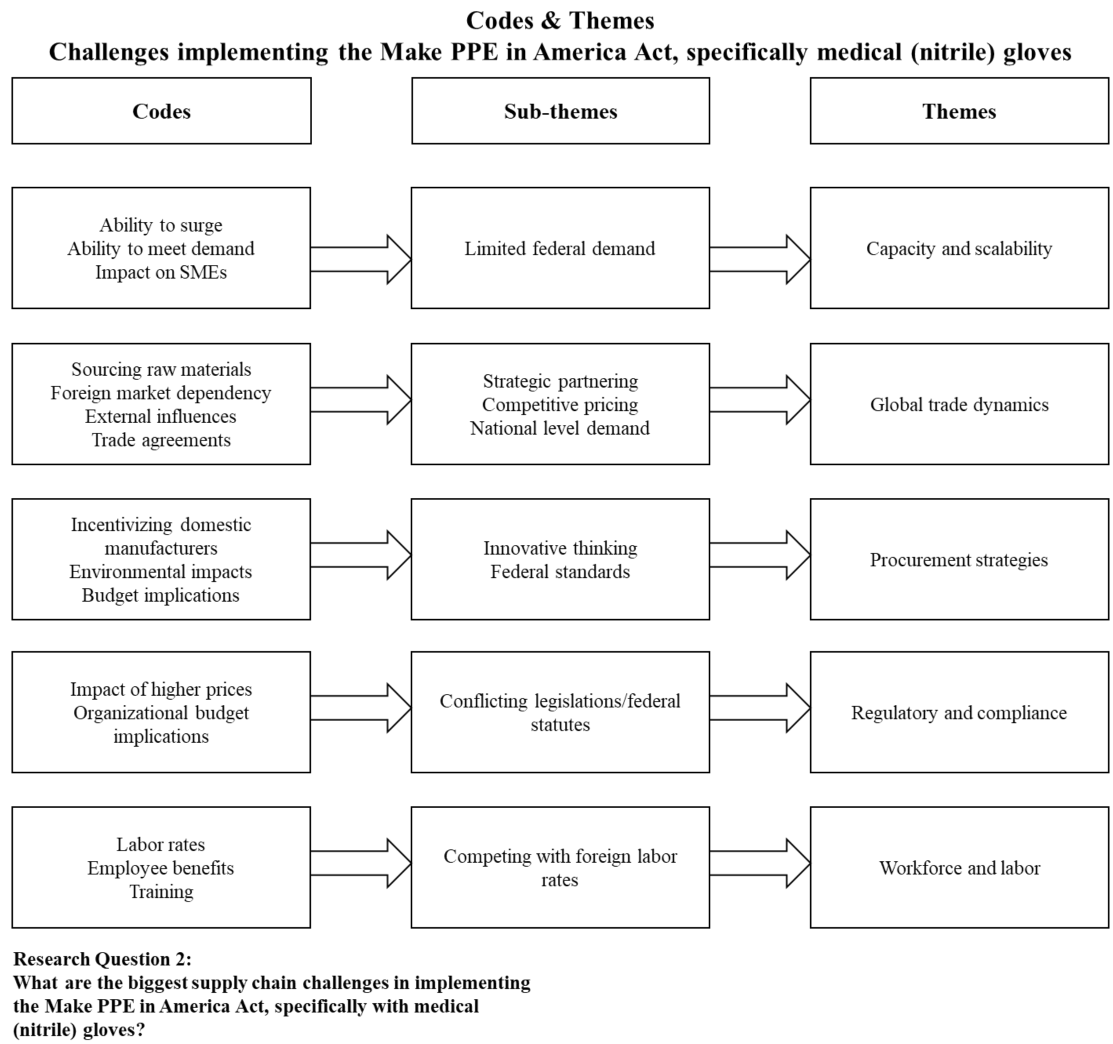

Figure 20. *Codes & Themes- Challenges Implementing the Make PPE Act in America, Specifically Medical (nitrile) Gloves*

Global Trade Dynamics emerged as a theme due to the raw materials needing to be available in the United States. Because of the unavailability of raw materials, domestic manufacturers must continue to depend on the foreign market. This is critical because the *Make PPE in America Act* requires everything, including raw materials, labor, and every aspect of the manufacturing process, to be made in America. Procurement strategies emerged as a theme of participants' comments regarding incentivizing domestic manufacturers who have invested a lot of public and private funding to build the infrastructure and everything else required to support these capabilities. The challenge for the federal government revolves around the need to receive the necessary funding to incentivize the manufacturers from the budget provided to them by Congress. In today's challenging times, many organizations struggle to make critical funding decisions that can impact their operations and overall mission. Organizations are frequently confronted with tough decisions, such as investing their finite financial resources in acquiring Personal Protective Equipment (PPE) from American manufacturers at premium prices or focusing on equally crucial aspects of their operations, such as nurse call centers. This is undoubtedly a challenging and intricate choice, as both alternatives are necessary but carry significant expenses. Therefore, organizations must prioritize and assess their options carefully, ensuring that their strategic decisions align with their goals.

Regulatory and Compliance was another theme that emerged. The impact of external influences and trade and tariff agreements impacted this theme. Relying on regulations and compliance resulted as a theme because participants commented on the environmental and sustainability concerns of manufacturing medical (nitrile) gloves. Additionally, the tariffs, international trade accords, and the diverse criteria stipulated by the Food & Drug Administration (FDA) add to the complexity of the Act’s implementation. The Act’s impact on smaller enterprises is a concern, as the compliance costs and rigorous standards may be too much for them to handle. Finally, making PPE in America requires a paid workforce based on American salary and benefits parameters. Finding, training, and retaining American workers with the knowledge, skills, and abilities to do the technical and engineering tasks could be challenging.

Research Question Three: What can be Done to Help the Medical Glove Supply Chain Adapt to Meet the Requirements of the Act?

During the discussion, the participants highlighted various vital strategies that would be necessary to ensure the supply chain of medical gloves, specifically nitrile gloves, could adapt and fulfill the requirements of the *Make PPE in America Act*. Some of the solutions discussed included the need for better collaboration with industry and Congress and innovative approaches, such as Congress allocating funding that the government could use to incentivize domestic manufacturing and support small businesses. The participants suggested that effective communication between the government and industry is crucial to addressing challenges and concerns. Participant S2-P4 highlighted the need for their agency to join supplier-provider consortiums to stay competitive in the changing healthcare industry landscape. They emphasized that their agency only holds a small 2% market share, so they must adjust their perspective on their place in the industry. By collaborating with other organizations through consortiums like the Strategic Marketplace Initiative, they can collectively create plans to maintain their profit margins and increase their resilience in contingencies. S2-P4 stressed the importance of participating in these conversations early on and being flexible in adapting to industry changes to remain competitive.

Participant S2-P10 highlighted the significance of incentivizing businesses to build domestically and provide them with contracts. The participant suggested that the government provide clear and concise instructions on the required items to assist companies in meeting demands. They also suggested the challenges of manufacturing PPE in the U.S. The cost of production is a significant factor, and manufacturing locally means higher prices due to minimum wage and the need for fringe benefits. The government's role in incentivizing manufacturers and suppliers is crucial, and a strategic reserve for PPE would be helpful. Although the government's goal is still being determined, small businesses' survival is a concern, and sole-source contracts might cut out suppliers. Participant S2-P9 discussed procurement strategy as the Federal Acquisition Regulation's allowance for small business set-aside contracts. S2-P9 stated, "One of the ways we could solve … is to have some additional set aside or preferences which we do a bit. But again, we cannot guarantee anything multi-years out, because these are short-term buys" (S2-P9). They also commented that the manufacturing industry is competent and willing to produce goods. However, due to the current low demand, small businesses are at risk of investing their capital to expand their production capacity. This is because there is no guarantee that customers will buy their products after they have invested in the expansion. The timing between production and purchase is a significant risk for the industry. The good news is that federal procurement can help resolve this issue through better processes.

Participant S2-P14 shared their thoughts on the potential impact of Congress's desire to revive American manufacturing. They suggested that small businesses, especially Small Disadvantaged Veteran Owned Small Businesses (SDVOSB) and distributors, start considering U.S. sourcing and collectively discuss the matter. Additionally, Participant S2-P14 pointed out that such legislation might have unintended consequences for industries like Industries for the Blind. "Everyone is looking at the legislation from their perspective and not from the whole government" (S2-14). Some participants proposed a risk-based strategy for forming partnerships to better comply with the *Make PPE in America Act*. This strategy would involve evaluating the risks associated with different potential partners and prioritizing those who can offer the most value while reducing potential risks. By adopting such an approach, manufacturers can more effectively fulfill the requirements of the Act while also ensuring the safety and quality of the PPE produced. During the interview, Participant S2-P4 proposed a risk-based approach to forming partnerships that prioritize commitment from the federal government towards Service-Disabled Veteran-Owned Small Businesses (SDVOSB). This approach emphasizes vendor and government collaboration rather than a one-sided buyer-supplier relationship. The risk management plan is a shared responsibility between the vendor and the government. The government's annual commitment to a certain amount of demand is vital for supporting the vendor's operations. This type of partnership is considered essential by S2-P4 for building domestic capacity.

Participant S2-P11 discussed the need for long-term commitment to domestic manufacturers or suppliers for a specific, meaningful volume. Participant S2-P11 shared insights on assisting medical glove supply chain parties to comply with the *Make PPE in America Act*. According to S2-P11, the solution is complex and more than just about securing a contract or supplier for a two-year supply agreement for a meaningful volume. There are many nuances and competing interests within the federal government's agencies. S2-P11 acknowledged that being a domestic manufacturer of nitrile gloves benefits the country, but what works for a small startup might not work for larger suppliers with bigger budgets. The more prominent vendors employ many Americans but also prefer sourcing overseas products due to cheaper costs, enabling them to sell at a competitive price. However, only some people on U.S. soil have the market share that the large glove manufacturers do.

S2-P9 recommended working very closely with industry as partners, not just as another entity, giving speeches, having publications, and having Congressional Hearings. The participant also recommended that the federal government release draft requests for proposals (RFPs) to enable industry to collaborate on the government's requirements. Participant S2-P9 stated that the "biggest piece is that there is a continuous communication with industry for awareness as well as understanding of both: what our demand and what our requirements are, as opposed to what their capacity and availability is" (S2-P9). Participant S2-P6 recommended "collaboration with that industry … where we would have a communication with them as far as what we are looking for how to reverse Industry Days where they tell us what they can do" (S2-P6). S2-P2 stated, "We need to focus on the healthcare industrial base … be aligned with the nation's needs from a security point of view, public, public health, economic and military security" (S2-P2). S2-P2 emphasized the importance of Washington legislation expanding its focus beyond the healthcare supply chains in the government sector. The aim is to consider the national healthcare industrial base and align it with the nation's security needs, such as public health, economic, and military security. This alignment should also consider the private sector's objectives, which are centered on profit and risk to the firm. One way to achieve this is by investing in the industrial base to reconfigure supply chains.

Participant S2-P3 proposed that more than traditional tradeshows may be needed to attract businesses for domestic manufacturing. The government should establish an environment that encourages investment in industry, such as providing tax incentives or subsidies. These initiatives aim to incentivize individuals to enter the industry, as it can be gratifying. According to participant S2-P1, Congress should explore funding opportunities for innovation to expand our resource options for producing gloves, whether from corn-based, vegetable-based, or other materials, as latex is not a viable option. Nitrile is ruled out due to raw material constraints, the lengthy growing period in the U.S., and its negative environmental impact on production. Therefore, what alternative approaches can we take to achieve a similar result with a different type of glove that can be manufactured on a large scale within the country and establish a sustainable foundation? Participant S2-P6 believes that Congress could have conducted more comprehensive research on the market before introducing the legislation. It would have benefited Congress to collaborate with the FDA to establish a solid foundation for the U.S. industrial base related to the subject matter that needed approval. According to S2-P6, the legislation was drafted without fully comprehending all the challenges, resulting in small businesses requiring assistance to produce enough of the product to be profitable. They also mention that only 1% of the product meets the federal government's needs, posing a significant challenge.

S2-P8 questioned the necessity for multiple specifications for medical-grade gloves and proposed consolidating them. The responsible agencies must identify their critical requirements and explore ways to simplify the specifications. Meanwhile, S2-P11 has suggested that removing the raw material component from the legislation would help build the industrial base in the United States. According to S2-P11, the current confusion and hangups are due to the unavailability of raw materials in the country. Therefore, it is crucial to have a customer base in the country to invest in production capacity rather than penalizing the manufacturers who have already built it. S2-P11 emphasizes the need to approach the problem reasonably and with education. “Just removing the raw material component, if it is not readily available, would go a long way in building the industrial base here …Nobody wants to buy it from overseas” S2-P11. S2-P3 stated that the Buy American issue cannot be resolved with just a procurement strategy. They suggest that the government and industry must encourage people to start manufacturing plants by creating creative and attractive approaches. This will make it profitable for the industry to invest in PPE manufacturing. The government should create an environment that rewards people who invest in the business by offering tax breaks or subsidies.

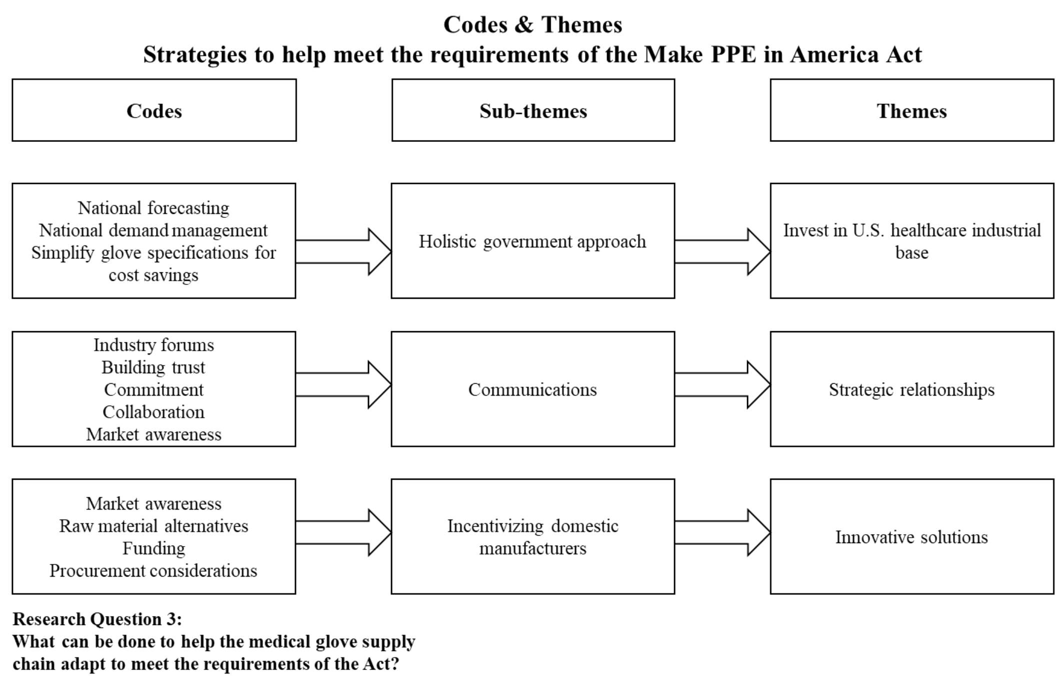

Figure 21. *Strategies to Help Meet the Requirements of the Make PPE in America Act*

In Figure 21, three themes highlight various strategies identified by interview participants to aid stakeholders in implementing the *Make PPE in America Act*. The first theme concerns investing in the U.S. healthcare industrial base, which emerged due to limited demand at the federal healthcare level. Participants noted the necessity for improved communication with private and public healthcare industries to forecast demand on a national level. Additionally, they emphasized the importance of simplifying medical glove specifications, such as color variations. The theme of strategic relationships also emerged, with participants underscoring the significance of market awareness for organizations and legislators requiring American-made products. For instance, the raw materials for nitrile gloves are not produced in America. Finally, participants discussed the potential of innovative solutions, including exploring alternative raw materials like corn. They viewed these questions as collaborative discussions that require further attention.

Study Two Overall Discussion and Findings

This study addressed three important research questions regarding the *Make PPE in America Act*. The questions were:

1. How does the Act affect the global value chain for PPE?

2. What are the significant supply chain challenges in meeting the Act's demands?

3. What measures can help the medical glove supply chain parties adapt to meet the *Make PPE in America Act's* requirements?

The research analyzed the impact of the *Make PPE in America Act* on healthcare supply chain resilience and its global implications. The study highlighted the critical distinction between "anticipating" and "preparing to adapt" and provided valuable insights into managing supply chain disruptions with "resilience" versus "robustness." The study found that the *Make PPE in America Act* has limited impact the global value chain despite the highly competitive market and significant global demand. However, participants acknowledged that the Act could affect medical-grade nitrile glove demand for relevant organizations. However, they did not believe it would significantly impact the global market from a value perspective.

Participants identified several challenges associated with the *Make PPE in America Act*, such as capacity and scalability, global trade dynamics, procurement strategies, regulatory and compliance issues, and workforce and labor concerns. The federal government needs to incentivize domestic manufacturers, which requires funding from Congress, resulting in mission trade-offs. Compliance with regulations and environmental sustainability concerns in manufacturing medical gloves are also challenges. Lastly, finding, training, and retaining the American workforce with the necessary skills and knowledge to do the technical and engineering tasks could be challenging.

Participants discussed various strategies to support stakeholders in implementing the *Make PPE in America Act*. These included investing in the U.S. healthcare industrial base, improving communication with both private and public healthcare industries to forecast demand on a national level, and simplifying medical glove specifications. Additionally, the importance of market awareness for organizations and legislators requiring American-made products was emphasized, and participants explored innovative solutions such as alternative raw materials like corn. In summary, the study provided valuable insights into managing supply chain disruptions with “resilience” versus “robustness” and identified primary supply chain challenges that arise from meeting the Act’s expectations. The study emphasized the need for a resilient supply chain and suggested measures such as maintaining more extensive inventories, working with multiple suppliers, and creating redundancies.

Study Two Research Contributions and Conclusions

The research contributed to both practical and theoretical significance by thoroughly comprehending the supply chain practices that have emerged in recent years. The study specifically focused on three main areas: the impact of supply chain resilience on the global value chain, the importance of supplier visibility and demand management, and how legislation affects federal procurement processes. The research offers valuable insights into the global value chain for medical-grade gloves and domestic PPE manufacturing capabilities. Moreover, this study adds scholarly literature on the unique relationship between the federal government and its commercial partners. From a business standpoint, suppliers with robust and resilient supply chains could hold a competitive edge. This research will expand the current limited scholarly research on supply chain resilience from a federal government viewpoint.

Contribution to Theory

This research combines academic literature and real-world experience in the federal government environment to contribute to supply chain risk management and resilience practices. It aims to increase the understanding of new supply chain practices in the changing world. It highlights the need for visible and secure capabilities from an end-to-end perspective to achieve more resilient distributions. Scholten et al. (2014) noted that academic supply chain management literature needs to provide "management guidance on implementing and operationalizing the concept of supply chain resilience" (p.211). This research adds to the existing body of literature, which requires a more comprehensive understanding of the federal government's healthcare PPE approach and domestic manufacturing. The research aligns with supply chain and risk management by presenting strategies and highlighting areas where resilient supply chains are essential for organizations.

The research defined essential supply chain terminologies, such as resilience, adaptation, and anticipation of disruptions. It emphasized the significant differences between supply chain resilience and robustness. The research also offers valuable insights from a federal government perspective on anticipating and adapting to supply chain disruptions and shedding light on the distinctions between supply chain resilience and robustness. Additionally, it provides helpful information on the challenges associated with implementing the *Make PPE in America Act* and offers recommendations for organizations to ensure its successful execution.

Contribution to Practice

Ensuring the resilience of our supply chain has become crucial due to the COVID-19 pandemic and other natural disasters such as wildfires, floods, hurricanes, and tornadoes, as well as the influence of climate change. This study analyzed the *Make PPE in America Act*, which focuses on the global value chain for medical-grade nitrile gloves. The study examined the challenges and strategies to enhance the Act's effectiveness. It also explored the understanding of supply disruptions by the federal government and industry and outlined necessary steps to improve organizations' resilience. The findings of this study can help managers improve supply chain resilience, enable risk assessment managers to develop effective risk mitigation strategies and assist government officials in effectively collaborating with industry stakeholders.

The study highlights the significance of collaboration, governance, contingency planning, and adaptability in establishing resilience. Supply chain managers must align their operations with organizational priorities, goals, and strategies to achieve this. Government personnel can engage with local PPE glove manufacturers and visit their facilities to gain insight into their manufacturing and production processes, sustainability practices, cutting-edge equipment, and automation capabilities. It is also essential to comprehensively understand the sources of raw materials suppliers use. Ultimately, managers can leverage these insights to cultivate stronger relationships with key stakeholders and suppliers, enhance supplier relationship management, and gain visibility into critical suppliers within the organization.

Limitations and Future Research

The amount of data available for the study was limited by gathering information from just two federal government organizations and three industry firms. However, the study's scope of information gathering was also affected by some limitations. For instance, one organization provided only a single participant, restricting the amount and diversity of data collected. To conduct more comprehensive research, additional federal organizational participation, congressional staffers, or individuals in legislation construction could have been involved. Additionally, the study focused on a limited selection of industry organizations, resulting in fewer participants. More comprehensive research is needed to collect sufficient data on supply resilience and the impact of the *Make PPE in America Act* on domestic manufacturers, distributors, and resellers across the industry, especially on medical-grade nitrile gloves.

It would be advantageous to employ a quantitative and qualitative research strategy to conduct a more exhaustive and all-encompassing study on the *Make PPE in America Act*. Enabling a more comprehensive range of participants, such as those from industry, federal agencies, and congressional lawmakers, to participate in the study would result in more generalizable findings. This approach would ensure that the study's results apply to a larger group. Additionally, future research must consider the impact of cybersecurity on government supply chains and evaluate how federal agencies in the healthcare sector have implemented supply chain resilience in their organizations, comparing their practices before and after COVID-19. Lastly, future studies must focus on the United States healthcare PPE industrial base to ensure supply chain resilience.

The PPE space has many players, and an additional challenge is that the government typically contracts with distributors and resellers, not manufacturers. To navigate this successfully, government executives and supply chain officers must thoroughly understand supply chains, including sourcing strategies and production processes. It is crucial to consider factors such as limited data availability, regulatory alignment, geopolitical influences, and cost constraints. Federal legislation must ensure that executive orders and other legislative measures do not conflict. It is essential to remember that medical nitrile glove production does not occur domestically, and raw materials must be obtained from elsewhere. The federal government must remain mindful of geopolitical concerns such as trade, tariffs, labor issues, abuse, and international relations.

Hands-on research without sponsorship can be relatively expensive and require extensive data collection, analysis, and information dissemination. As a federal employee, this research is not sponsored by the government, making it difficult to share within the organization. However, the insights from this research will be valuable to the government as additional congressional mandates will be forthcoming on domestic manufacturing sectors, such as semiconductors in the information technology sector.

CHAPTER 4

CONCLUSION AND POTENTIAL CONTRUBUTIONS

The COVID-19 pandemic brought to the forefront supply chain weaknesses of the healthcare industry (Hossain et al., 2022; Jiang et al., 2021; Ngo & Dang, 2022). The disruption caused by the pandemic has caused the federal government to look closely at supply chain operations (Exec. Order No. 14017, 2021; Cohen et al., 2020; Henrich et al., 2022). The pandemic has caused a significant increase in the demand for medical PPE, resulting in a global shortage of supplies (Austin et al., 2021; Dallas et al., 2020). To augment domestic manufacturing capacity, the U.S. government must prioritize addressing the unique challenges faced by American small and medium-sized manufacturers confronting production constraints (Verbeke, 2020). Collaboration and partnerships among government, academia, and companies will help mitigate skill gaps, initiate job training opportunities, and support small businesses (Ngo & Dang, 2022).

The research consists of two studies that investigated the resilience of the healthcare PPE supply chain. The first study explored how organizations define supply chain resilience and how they can enhance it. It concluded that federal agencies must define supply chain resilience at the enterprise level to ensure that organizational priorities are aligned and that organizations communicate and identify risk strategies during supply chain disruptions.

The research suggests three main themes for improving resiliency in the healthcare PPE supply chain: "Prepare to Adapt," "Information Technology," and "Risk Management." In contrast, Study Two examined the impact of the *Make PPE in America Act* on healthcare supply chain resilience and its global implications. It analyzed the Act's influence on the value chain for PPE globally and explored strategies to assist medical nitrile glove supply chain parties in meeting its requirements. The research identified several challenges facing the Act, including capacity and scalability, global trade dynamics, procurement strategies, regulatory and compliance issues, and workforce and labor concerns. The research concluded that the *Make PPE in Ac*t has an insufficient impact on the PPE global value chain.

The research recommends that the United States take a holistic approach to the Healthcare Industrial Base as it may warrant an impact on the global value chain. Incentivizing domestic manufacturers who have invested in public and private funding is critical to the viability of domestic manufacturing in the United States. The federal government must collaborate with the industry to identify alternative sources of raw materials required for medical-grade gloves. This research can help government managers gain a better understanding of supply chain resilience and can assist them in developing supply risk strategies and supply chain risk assessments.

Contribution to Theory and Practice

This research provides valuable insights for organizations seeking to update and strengthen their supply chain resilience strategies and risk assessments. By leveraging this research, federal managers can foster stronger relationships with key stakeholders across government, industry, and academia. This research can help federal managers update and develop supply chain resilience strategies and risk assessments. Federal managers can leverage research to build stronger relationships with key stakeholders both on the government side and in industry and academia. The research offers invaluable information on the *Make PPE in America Act* and its impact on the global PPE value chain. The research offers insights for the federal government and stakeholders to understand the impact of the *Make PPE in America Act* on the global PPE market size. It can also motivate governments and encourage leaders to consider looking at the entire healthcare national industrial base. A holistic federal policy can have a more significant impact on the PPE value chain. The research provides the necessary information for federal leaders to better understand supply chain end-to-end visibility.

Government leaders must understand the various manufacturing processes, not just depend on the paper acquisition processes. Understanding the differences is the only way for the government to know and include salient characteristics in our solicitations. We need to amend the Federal Acquisition Regulation so that the government can ask for details on supply chain processes, such as the source of raw materials. Additionally, it offers insights on domestic PPE glove manufacturing for federal managers to consider. These insights can contribute to federal procurement strategies and strategies for managers to consider when building supply chain strategies and supply chain risk assessments from a holistic approach to healthcare supply chain resilience from a national industrial base perspective. Adopting a holistic policy at the national industrial base can significantly increase the impact on the global PPE value chain and provide greater leverage for the United States PPE domestic manufacturers. This research will provide federal leaders with the necessary information to better understand the supply chain's end-to-end visibility. This understanding will enable us to position ourselves for future pandemics and learn from past experiences.

To achieve this, it is crucial that government leaders understand the intricacies of various manufacturing processes and do not solely rely on paper acquisition processes. By understanding these nuances, the government can only include salient characteristics in their solicitations. For instance, amending the Federal Acquisition Regulation to include supply chain process details like the source of raw materials can provide crucial insights for federal managers to consider. Ultimately, these insights can contribute significantly to federal procurement strategies and inform managers when building supply chain strategies and risk assessments.

Managerial Take-aways

After conducting this research, I found several significant takeaways managers should consider. Specifically, they should assess the vulnerabilities and weaknesses caused by COVID-19 and determine if they are better equipped to handle disruptions than initially. The following points can act as indicators to develop strategies for supply chain resilience or risk management.

-Define supply chain resilience from an organizational or enterprise level. Consider the following example: Supply chain resilience refers to the capacity to rebound quickly from a disruptive incident and rejuvenate.

-Ensure a resilient supply chain; organizations should focus on visibility into their supply chain and have the necessary information technology tools for predictive data analytics and system and data monitoring. They should also prioritize flexibility and agility, including having alternative sources and being nimble enough to pivot during disruptions.

-Organizations need to diversify their sources and not assume that having multiple suppliers means they have diversified their sources. To achieve this, businesses need to have a clear understanding of their suppliers' supply chains. This means knowing where their suppliers are getting their supplies, including the raw materials used in their products.

-Organizations should also identify their critical suppliers and understand their supplier's supply chains, vulnerabilities, and challenges. This includes identifying critical systems and suppliers supporting those systems down to manufacturing. It is important to note that organizations should identify suppliers beyond Value-Added Resellers.

-Foster solid relationships and promote collaboration with suppliers

-Organizations must ensure their distributors/resellers understand where the product components are manufactured.

-Government executives should visit domestic Personal Protective Equipment (PPE) manufacturing factories to gain firsthand knowledge and acquire necessary skills and abilities. This knowledge could lead to discrimination factors for future solicitations. It is essential to specifically inquire about raw material sources to understand which manufacturers are receiving raw materials from China and which ones are receiving them from countries that are allies of the United States.

Potential questions that managers could ask:

-Acquiring knowledge and insights into my supply chain is vital, and information technology capabilities are crucial. Are my forecasting opportunities being viewed from an organizational standpoint? Does my organization possess tools such as predictive analytics, artificial intelligence, or machine learning to bolster the resilience of its supply chain?

-Furthermore, is our supply chain flexible enough to adapt quickly to unforeseen disruptions? Do we have alternative suppliers to turn to if a critical supplier is affected? Have we formed strategic alliances with indispensable suppliers? How robust and resilient are our supply chains? What provisions are in place to tackle disruptions, and how is our organization preparing for them?

Limitations and Future Research

While both studies yielded valuable results, it should be noted that the scope of this research was limited to just two Government organizations and four industry companies. Future studies must expand their focus by exploring best practices in federal agencies and commercial industries to enhance supply chain resilience. Given the importance of healthcare to public health, safety, and security and supply chain resilience's impact on national security, continued exploration in this area is crucial. Although supply chain management and international business have been extensively studied to understand how collaborative efforts impact a company's performance, further research is needed to understand the consequences of unpredictable market conditions and the influence of global value chains (Arora et al., 2021). Incorporating a quantitative research methodology and capturing a broad range of participants from federal and commercial organizations would bolster the validity of future studies.

To ensure the success of future studies, researchers should examine successful practices used by other government agencies and commercial entities to improve supply chain resilience and develop innovative strategies. Future research could also explore how supply chain resilience affects national security, particularly in the healthcare industry. Another area of interest could be identifying the most effective approaches to managing cybersecurity risks in the supply chain, especially for healthcare devices that integrate information technology.

Future research should focus on the sustainability of Personal Protective Equipment (PPE) to ensure that healthcare workers and the public are protected without compromising the environment. One way to achieve this is by exploring ways to recycle medical-grade gloves and other medical PPE, which can significantly reduce the amount of waste produced in the healthcare sector. Developing innovative and practical solutions for recycling and reusing PPE is a way to protect the environment.

Conclusion

This research delves into the concept of supply chain resilience and its practical and theoretical implications. It provides invaluable insights for managers in the federal government and the businesses working with them. The information presented can aid organizations in establishing and implementing effective supply chain strategies. Incorporating interviews with government, industry, and academic experts proved valuable to the research process. This allowed for gathering firsthand knowledge and expertise that would have been difficult to acquire through secondary sources alone. Despite my limited experience researching PPE, the participants generously shared meaningful insights into the medical supply chain sector based on their experiences and organizational culture. Furthermore, they shared their experiences and perspectives on federal policies, regulations, and market trends. This personal aspect of the information was unavailable through secondary sources or may have needed to be updated. Qu &

Dumay (2011) noted that the research interview is distinct in its capacity to reveal the interviewee's personal and occasionally unexpressed social sphere, which can provide new insights into "alternative assumptions and perspectives" (p. 255).

A key takeaway is understanding the supply chains of an agency's most critical suppliers, including upstream and downstream components, raw materials, and other essential elements. It is crucial to take geopolitical factors into account to create robust supply chains. Executive and senior managers must work alongside policymakers to ensure well-informed legislation. The federal government should prioritize the procurement of PPE made in America, necessitating domestic manufacturing in the United States. This strategy is feasible but is likely dependent on the availability of domestic raw materials or a change in federal regulations that require government agencies to purchase PPE from manufacturers who produce at least 75% of their products domestically using US labor when raw materials are not domestically sourced. To ensure success, Congress must allocate additional funds to federal agencies to offset the increased cost of procuring these products in America. This is especially important since the legislation explicitly targets federal agencies in the congressional mandate. As the cost disparity between American and foreign sources is due to higher American wages, this approach would require Congress to allocate additional funds to these agencies. It would also encourage more prominent distributors, manufacturers, and resellers to source their PPE from domestic manufacturers instead of continuing to obtain them from foreign suppliers.

Moreover, this approach will ensure domestic manufacturers' investment in bringing American manufacturing back to this country is sustainable. To establish a dependable supply chain for producing domestic goods, government organizations must conduct a comprehensive analysis and remain diligent in identifying the origin of their raw materials. Considering products that heavily rely on raw materials sourced from foreign nations but involve significant domestic production is critical. Federal procurement standards can prevent manufacturers from constantly sourcing from nations with geopolitical issues due to low costs by enabling domestic manufacturers to contribute a portion of their materials. However, the *Make PPE in America Act* must be implemented nationwide, not just for three federal organizations, to achieve this objective or come close to impacting the global value chain of PPE, specifically medical-grade nitrile gloves.

To transform how we acquire healthcare PPE and its associated raw materials, private and public healthcare organizations should prioritize sourcing materials domestically to impact the global value chain. Additionally, supplier diversification emerged as a critical solution based on the research. Although redundancy can provide some level of protection, diversification is a more practical approach to handle disruptions in the supply chain. Organizations can build resilient supply chains by enabling access to alternate sources with different upstream and downstream supply chains that can withstand disruption and manage risks while maintaining operations. It is essential to have a comprehensive understanding of the supply chain to achieve that goal.

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APPENDIX A

TABLES

Table 1

Definitions of Supply Chain

Term	Author & Year	Definition
Supply Chain	Alagarsamy et al. (2021)	Several organizational activities exist: “Procurement, production scheduling, order processing, inventory management, transportation, warehousing, and customer service” (p.1).
Supply Chain	Boyens et al. (2021)	“Resources and processes linked between and among multiple levels of an enterprise” (p.1). The links include the entire lifecycle from sourcing to disposal.
Supply Chain	Vilko et al. (2014)	“A series of activities and organizations through which material and information move on their way to the final customer” (p.5).
Supply Chain	Jones (2022)	“A supply chain is a set of business processes that encompasses the life of a product or service from its inception (design) to disposal (end of life).”

Table 2

Definitions of Supply Chain Management

Term	Author & Year	Definition
Supply Chain Management	Handfield, 2021	“Supply chain management is the handling of the entire production flow of a good or service — starting from the raw components to delivering the final product to the consumer” (para. 1).
Supply Chain Management	Mathew et al., 2019	“Supply Chain Management in healthcare should ensure complete end-to-end visibility of information among suppliers, manufacturers, distributors, and customers” (p.2).
Supply Chain Management	Lambert & Cooper (2000)	Business processes that integrate starting with the end-user through the original suppliers to add value for customers

Table 3

Definitions of Supply Chain Risk Management

Term	Author & Year	Definitions
Supply Chain Risk Management	Dubey et al. (2018)	Strategically coordinating and collaborating with buyers and suppliers “to ensure the continued economic viability of business entities” (p.245).
Supply Chain Risk Management	Ferry & Poindexter (2016)	Risk to sabotage or intentionally introduce any supply chain disruption in any part of the supply chain
Supply Chain Risk Management	Kamalahmadi & Parast (2016)	“SCRM is concerned with assessing sources of risk across the supply chain and developing strategies to deal with them” (p.116).
Supply Chain Risk Management	Vilko et al. (2014)	“Supply chain risk management concerns risk as a situation entailing exposure to two essential components: an event and the uncertainty concerning the possible outcomes” (p.4)

Table 4

Definitions of Supply Chain Resilience

Term	Author & Year	Definition
Supply Chain Resilience	Scholten et al. (2019)	"The adaptive capability of an organization to prepare for, respond to, and recover from any type of supply chain disruption" (p.431).
Supply Chain Resilience	Hohenstein et al. (2015)	"The supply chain's ability to be prepared for unexpected risk events, responding and recovering quickly to potential disruptions to return to its original situation or grow by moving to a new, more desirable state" (p.90).
Supply Chain Resilience	Brusset & Teller (2017)	"An operational capability that enables a disrupted or broken supply chain to reconstruct itself and be stronger than before" (p. 59).
Supply Chain Resilience	Kose & Curtin (2021)	"The ability of an organization to avoid, absorb, and recover from the business impact of major disruptions through a risk-balanced approach to product, supply chain strategy, and network design" (p.4)
Supply Chain Resilience	Healy (2015)	Supply chains that recover or prevent disruptions by balancing risks and costs that avoid disruptions
Supply Chain Resilience	Mork et al. (2021)	Timely response based on time information with agility to change direction
Supply Chain Resilience	Jones (2022)	Anticipate, plan, respond, react, and recover from disruption. Requires visibility, agility, and collaboration, working together to restore or reinvent itself better than before

Table 5

Reflexive Thematic Analysis Process

Reflexive Thematic Analysis Process (Byrne, 2021)	**Descriptions**
Phase 1: Data Familiarization	Reading the data to become familiar with it. Identifying tying the information to research questions
Phase 2: Initial Code generation	Breaking the data into manageable parts/labels: Codes should stand independently to identify everyday data items.
Phase 3: Generating Themes	Searching for themes. A shift from individual data items to "interpreting the data into meaningfulness across the dataset" (p.1403)
Phase 4: Reviewing Potential Themes	Developing and reviewing themes. Looking for shared ideas, conceptual coherence, and "if the items/codes form a coherent pattern" (p.1403). Repeatedly reviewing the potential themes against the "coded data and the entire dataset" (p.1404)
Phase 5: Defining and naming Themes	"Deep analysis of the underlying data items" (p. 1407)
Phase 6: Producing the Report	Ensure completion and accuracy of the report. Iterative approach as information changes throughout the process, specifically codes, themes, notes, memos

Note: A worked example by Braun and Clarke's approach to reflexive thematic analysis (pp. 1398-1410), by D. Byrne, 2021. Copyright 2022 by David Byrne, 2021.

Table 6

Study One-Interview Selection Criteria

Competences/skills	Experience level	Organizational dimension
Supply Chain knowledge	Supply chain professionals at various levels (Mid-level to Executive Management)	The federal government and private sector
Supply chain knowledge in the healthcare sector may include other industry sectors.	Mid-executive leadership	Federal government agencies and the Private sector in the healthcare sector and other industry sectors
Procurement/Sourcing	Experience in the federal government and businesses supporting the federal government	Leading consortium groups advising the federal government on supply chain capabilities in the healthcare sector
Knowledgeable of federal government supply chain and procurement processes and commercial industry supply chain practices	Experience in the federal government and businesses supporting the federal government	Federal government agencies and the Private sector in the healthcare sector and other industry sectors

Table 7

Interview Participant's Demographics for Study One

Participants	Experience Level	Competency/skills	# Years of experience
P1	Senior Executive	Medical Physician	21+
P2	Senior Executive	Medical Supply Chain	20+
P3	Senior manager	Procurement/Acquisition	16
P4	Senior Executive	Procurement/Acquisition	25
P5	Senior Executive	Medical Supply Chain	30
P6	Senior Executive	Medical Supply Chain and Acquisition	20
P7	Senior manager	Acquisition and Supply Chain	25
P8	Senior Executive	Information Technology	30+
P9	Senior manager	Procurement/Acquisition	20+
P10	Senior manager	Medical Supply Chain and Logistics	14
P11	Senior Executive	Medical Center Director	30
P12	Senior VP Consultant,	Supply Chain	30+
P13	Senior Executive	Medical Physician	20+
P14	Senior manager	Medical Supply Chain	21

Table 8

Study One: Participant's Response to Research Question 1

Participant (P)	Research Question 1: How does your organization define Supply Chain Resilience
P2	"The ability to anticipate and review redundancies … do I have the ability to see the forecast through analytics and AI?"
P4	"I am not sure we have defined supply chain resilience."
P8	"The visibility of the supply chain that we need to ensure visibility of and make sure it is resilient."
P9	"I do not know if my organization has a definition of supply chain resilience."
P9	"I can tell you what we think it is. And that is the ability to react very quickly to meet the supply needs of the organization."
P10	"For resilience, we now have our dashboard in better visibility of what we have in the enterprise and what we have inbound into the enterprise."
P11	"We have been able to build resiliency into the system by our awareness, our ability to monitor the system more closely. And our ability to identify ways to address any risks with the supply chain."

Table 9

Study One: Participant's Response to Research Question 2

Participant (P)	Participants' responses to Research Question 2: How can organizations improve healthcare PPE supply chain resilience?
P1	"How do we sustain a sufficient supply to allow us to deliver that great experience at the end of the line? And how does that change how we procure?" "Understanding supply chain demand and supply chain visibility is critical to organizational risk management."
P2	"We need to create legislation to support onshoring of that market space back to the United States."
P3	"Data is power; knowledge is power… Information technology tools are needed for data accuracy."
P5	"Prepare to adapt to changing conditions and then be able to withstand and recover from those disruptions."
P7	"The IT system can give you an additional capability, and it can give you additional insight into what you have going on daily, and it gives you a view of everything you have in your supply chain."
P10	"First, build trust … rebuilding relationships and mending those bridges, focusing on data integrity, data, data accuracy, collaboration, and communication.
P11	"It is important to have enough flexibility in the supply chain to adjust to changes."

Table 10

Study Two- Interview Selection Criteria

Competences/Skills	Experience Level	Organizational Dimension
Healthcare Supply Chain Knowledge	Various levels (mid-managers to senior executives as well as non-managers).	Government, academia, and industry
Procurement and Sourcing	Experience in the federal government procurement process, specifically healthcare PPE	Government, academia, and industry
Policy, Regulations, Oversight	Knowledge of federal government legislations and impacts both internally and externally.	Government, academia, and industry

Table 11

Study Two: Types of Organizations

Types of Organizations	Number of Organizations per Type	Number of Participants
Government	2	8
Non-Profit	1	1
Industry-Domestic PPE Manufacturer	2	6
Industry- US Distributor (Reseller)	1	1
Academic	1	1
Total	7	17

Table 12

Study Two: Participant's Demographics

Participants *=Pilot participants	**Experience Level**	**Competency/Skills**	**Industry/Government**
*S2-P1	Senior Executive	Medical Supply Chain/Procurement	Government-1
*S2-P2	Professor, Ph.D.	IT Engineer/Logistics	Academia
*S2-P3	Senior Executive	Procurement	Government-1
S2-P4	Senior Manager	Medical Supply Chain/Logistics/Procurement	Government-1
S2-P5	Senior Executive	Medical Logistics	Government-1
S2-P6	Senior Executive	Procurement	Government-1
S2-P7-1	VP Sales	PPE Manufacturer	Industry-1
S2-P7-2	Technical Director	PPE Manufacturer	Industry-1
S2-P8	Senior Executive	Procurement	Government-2
S2-P9	Senior Executive-Political Appointee	Procurement	Government-1
S2-P10	CEO	PPE Reseller	Industry-2
S2-P11	CEO	PPE Manufacturer	Industry-3
S2-P11-1	Director of Sales	PPE Manufacturer	Industry-3
S2-P11-2	Director of Sales	PPE Manufacturer	Industry-3
S2-P12	Manufacturing Engineer	PPE Manufacturer	Industry-3
S2-P13	Supply Chain	Supply Chain/Logistics/Procurement	Non-profit
S2-P14	Senior Executive	Procurement	Government -1

Table 13

Study Two- Aspects of Adapting and Anticipating Supply Chain Disruptions

Aspect	**Adapting to Supply Chain Disruptions**	**Anticipating Supply Disruptions**	**Participant's comments**
Definition	Change strategies and the way you operate during a disruption	Forward-thinking; preparing for disruptions	S2-P6: "Adapting to a situation without warning of an impending disruption" S2-P4: "Anticipating a supply chain disruption will be predicated on your supplier relationships."
Focus	Reactive responses after the disruption begins	Proactive response to prepare for a disruption	S2-P9: "Adapting is Reactive" S2-P9: "Anticipating is having a proactive approach."
Approach	Real-time changes during and after the disruption	Preventive actions necessary to prepare for disruptions	S2-P5: "Adapting requires changing a lot of processes." S2-P10: Anticipating ..where you plan and are prepared in case something goes wrong."
Key Characteristics	Agility, flexibility, and Adaptability when disruptions occur	Forecasting, strategic planning	S2-P2: "Adapting to market changes requires anticipating potential challenges and understanding the market well." S2-P4: "Anticipating is understanding who your suppliers are."

Strategies	Alternative suppliers, changes are quick and fast	Prevention or reducing the impact of a disruption	S2-P5: “Adaptability is critical to surviving and thriving in a constantly changing environment.” S2-P9: “Proactive plan to be able to adapt in advance.”
Challenges	Operations must be agile and flexible, increasing costs that may not have been planned.	Accurate forecasting and risk assessments, which may change or may not be correct specifically in uncertain circumstances	-P8: “Adapting is what you do once you know something is happening”? S2-P10: “One must possess some anticipation to adapt effectively.”
Examples	Changing suppliers or rerouting transportation routes	Stockpiling inventory and diversifying suppliers in anticipation of a disruption	S2-P4: Adapting: “When situations shift, we can respond with industry, and that, not against industry.” S2-P6: “To anticipate disruptions, knowing the market.”

Table 14

Aspects of Supply Chain Resilience and Robustness

Aspect	Supply Chain Resilience	Supply Chain Robustness	Participants' Comments
Definition	"An organization's capacity to rebound from a disruptive incident and rejuvenate itself quickly" (Jones, 2024).	"A robust supply chain can resist disruption and minimize operational impact" (Jones, 2024).	S2-P1: A resilient supply chain is defined explicitly as one that can quickly recover from disruptions S2-P10: "Robustness refers to the ability to resist or adapt to change."
Focus	Recovery and responding to the disruption	Preventive measures to reduce or minimize the impact of the disruption	S2-P13: "Resilience is how quickly it can recover from something like the pandemic."
Approach	Reactive, adapting in real-time	Proactive actions put in place to mitigate or avoid disruptions	S2-P9: "Resilience is a reactive process that requires immediate action."
Key Characteristics	Flexibility, adaptability, and agility	Stability, strength, and redundancy	S2-P10: "It is your resilience that you can withstand or have some flexibility or elasticity there." S2-P10: "Robustness is vital for maintaining supply chain strength and stability."
Strategies	Supplier diversification, Logistics strategies that allow organizations to respond – rerouting transportation plans	Redundant suppliers/systems Buffer stocks	S2-P11: "A resilient supply chain has optionality and secondary sources, which allows it to avoid relying solely on one country, company, or region." S2-P9: "Robustness includes redundancy and the ability to withstand an attack, loss, or failure."
Challenges	Higher costs for rapid response capabilities. Requires an inventory strategy that balances Just-in-Time and Just-in-Case approaches (Jones, 2024).	Increase costs because of redundancy; Buffer stocks could lead to excess capacity (Just-in-Case inventory strategy)	S2-P14: "Resiliency takes investment to create." S2-P5: "Robustness is getting ready for the hurricane and having everything in place."
Examples	On-the-spot sourcing from alternative suppliers	Multiple suppliers, higher inventory levels	S2-P4: "Supply chain resilience refers to having what is needed to handle an initial contingency response, such as having communication networks and contingency response plans." S2-P4: "Robustness is getting ready for the hurricane and having everything in place."

APPENDIX B

INTERVIEW QUESTIONS FOR STUDY ONE

Interview questions focus on the following areas: Organizational definition of supply chain resilience, risk management and supply chain disruption, procurement/sourcing, and information technology capabilities. There are 12 primary interview questions with several probing questions, which allow the researcher to follow up on a question about the primary question.

Interview setting: MS TEAMS and ZOOM and face-to-face.

1. How does your organization define supply chain resilience?
2. How does your organization measure supply chain resilience?
3. How and to what extent was the COVID-19 pandemic different from other disruptions?
4. What changes is your organization implementing to facilitate supply chain risk management and resilience?
5. Discuss your take on inventory for emergency stock/inventory levels, specifically for PPE.
6. Explain your organization's procurement process and ability to respond during a supply chain disruption.
7. Explain how geopolitical activities affected your supply chain resilience and sourcing strategies.
8. How does supply chain resilience affect acquisition strategies?

9. How did your organization use information technology to support supply chain processes during the COVID-19 crisis?
10. What are the national security implications of supply chain disruptions for PPE?
11. What should organizations do to mitigate these implications?
12. Are there any additional comments, lessons learned, or best practices gained for supply chain resilience, specifically for PPE?

APPENDIX C

PARTICIPANT INTERVIEW PROTOCOL

Research Study: Exploring Global Value Chains for Healthcare Personal Protective Equipment

Investigator: Dr. Susan Mudambi, Professor, Department of Marketing, Temple University

Interviewer: Luwanda Jones, doctoral student at Temple University

Overview: This study involves research on the global value chain framework and its impact on supply chain resilience in the United States federal government, specifically focusing on healthcare Personal Protective Equipment (PPE). The study aims to explore the global implications of the United States legislation called the *Make PPE in America Act* and its effects on the supply chain of medical-grade gloves.

What participants should know:

Your contribution to the research study will help us understand this topic better.

Participation is entirely up to you. You can choose to opt out of the study anytime. If you decide not to participate, there are no adverse consequences.

Participation involves answering interview questions through verbal communication, writing, or typing. The duration of the interview is a maximum of 60 minutes.

Interviews conducted through MS TEAMS or ZOOM will use the automatic transcription feature. A digital recorder will be used for face-to-face interviews, and the recording will be transcribed.

There are no expected risks or discomforts beyond what you may experience in your day-to-day activities.

Your personal information and research study records will be kept confidential.

If you have any questions, concerns, or complaints regarding the research study, please get in touch with Dr. Susan Mudambi at (215) 204-3561 or email susan.mudambi@temple.edu

APPENDIX D

INTERVIEW QUESTIONS FOR STUDY TWO

The title of this study is "Exploring Global Value Chains for Healthcare Personal Protective Equipment." This study explores the global value chain research framework through the lens of supply chain resilience in the United States federal government, specifically focusing on healthcare Personal Protective Equipment (PPE). The study proposes to explore the global implications of the United States legislation entitled *Make PPE in America Act* and its effects on maintaining healthcare supply chain resilience, explicitly highlighting the supply chain of medical grade gloves. The research is based on an organizational perspective and not an individual perspective. The interview questions will cover several areas, including healthcare supply chain, procurement/sourcing, information technology tools, and federal policies and legislation. Study Two consists of seven semi-structured interview questions.

Study Two Interview Questions: In the first study, researchers found that preparing to adapt and anticipating supply chain disruptions are critical aspects of supply chain resilience. They also identified a difference between supply chain resilience and supply chain robustness. Questions one and two aim to validate and confirm the study's findings.

1. Explain meaningful differences between the preparation to adapt and the ability to anticipate supply chain disruptions.
2. Explain meaningful differences between supply chain resilience and supply chain robustness.

3. How does your organization view the legislation's impact on the global PPE value chain, specifically medical-grade gloves?

4. What are your organization's most significant challenges in meeting the expectations of the *Make PPE in America Act*?

5. How does your organization monitor and assess the capacity and capabilities of domestic manufacturers to meet the increasing demand for PPE in the United States?

6. What procurement strategies will your organization propose to implement the Make in America Act?

7. How does your organization collaborate with industry associations and trade organizations to promote the domestic manufacturing of PPE and address any challenges or barriers that may arise?

Closing question: Are there any additional comments, lessons learned, or best practices for implementing the *Make PPE in America Act*, specifically for medical-grade gloves?

Thank you for taking time out of your busy schedule to participate in this research.

End of Interview Questions

APPENDIX E

STUDY ONE CODEBOOKS

Study One: Initial Codebook Based on Interview Questions coded in NVivo and exported in an Excel spreadsheet.

Table 15

Study One: Initial Codebook Based on Interview Questions from NVivo

Improving PPE SCORES: 23 primary codes/27 sub-codes= 50 codes
Alternative products
Building Trust
Centers
Medical centers
Regional readiness centers
Strategic acquisition center
Changing federal legislation to support PPE resilience.
Collaboration
Collaborating at the Federal level
External Collaboration
Building Trust
Internal Collaboration
Relationship building
Conditions for Critical Healthcare Operations
Holistic view at the national level
Know the purpose of the supply chain.
Congressional involvement
Consistency equals product quality.
Creating inventory buffers for resilience
Data accuracy requires data cleansing.
Demand management
Confidence in supply delivery
Cross-leveling supplies for resilience

From manual to near real-time reporting
Inventory management
Relooking inventory management
Diversity of suppliers at the manufacturer's level is needed.
Emergency
Emergency caches
Emergency clause
Emergency use authorizations
National emergency
Order issue services emergency performance.
Flexibility
Governance
inventory
Automated inventory management system
Inventory management
Inventory side
Market Intelligence
Planning for disruptions
PPE as a regular commodity
Building in self-sustainment
Reinventing emergency management for critical supplies
Real-time reporting
Risk-based management approach.
Regional readiness centers
Variation in manufacturers
Visibility to the raw material
White House working group.

Codes\\Information Technology: 5 primary codes/4 sub-codes = 9 codes

Participant discussions on information technology capabilities
Information technology capabilities during the COVID-19 pandemic
Information Technology tools
Reporting tools for visibility
Manual processes

Human intervention augmented by dashboard development.
Outdated IT capabilities
Outdated technology
System integration and Data standardization

Codes\\Measuring supply chain resilience: 11 primary codes
Confidence
Daily reports
Data management tools
Data Sharing
Measurement varies per organization.
Measuring with stock out
Not aware of measurements
Pre and post covid
Procurement measurements
Robust measurements
Tracking critical supplies

Codes\\National Security implications: 6 primary codes and 8 sub-codes = 14 codes
Federal market share for healthcare is not robust.
Geopolitical impacts
Market Intelligence
Trade impacts
Healthcare readiness
Readiness cost money
Implementation Metrics and Outcome Metrics
Defense Production Act changes
Outcome metrics tied to National Stockpiles
Strategy for metrics at the Federal level
Federal-level metrics dependent on funding
The national scope includes vendor-managed inventory.
Vendor-managed inventory as an insurance policy.
A national view of SCRES is critical.

Codes\\Procurement and Sourcing: 14 primary codes and 1 sub-codes = 15 codes
Agile
Buy American Act
Onshoring challenges
Clarity
Contract Language with Supply Chain Resilience
External influences
Legislation Impact
Market Intelligence
More informed acquisition processes
Negative and positive aspects of government purchase cards
Planning
Sourcing locations
Supplier diversification
Supply chain disruptions associated with Prime vendors.
Supply chain resilience and government procurement

Codes\\Supply Chain Management: 3 primary codes
Planning for disruptions
Pre COVID and Post Covid
The process from Just in Time

Codes\\Supply chain resilience definition: 12 primary codes/12 sub-codes = 24 codes
Adaptability RQ2)
Building in self-sufficiency
Considerations for the next disruption
Alternative sources
Collaborating with the private sector
Flexibility
Anticipate
Understanding the various tiers in the supply chain
A holistic view of resilience from an enterprise view

Know the purpose of the supply chain.

Meaningful conversations affect supply chain resilience.

Conversations with managers and customers

Real-time reporting

No organizational definition is known.

Redundancy

Reliability

Confidence in delivery

Reliability

Robust

Supply Chain Purpose

Traceability for gaps

Visibility

Visibility and Agility

Vulnerability

Codes\\Supply chain risk management: 15 primary codes/ 7 sub-codes = 22 codes

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Addressing risk

Data management

The difference in the COVID pandemic versus other supply chain disruptions

Efficiency

Medical PPE

Advanced actions are required for PPE demand.

PPE Demand management

Just in time, the model did not work.

No resiliency in Just-in-time

Unprecedented

Digital stockpiling

Enterprise SC risks

Federal legislation

Internal and external collaboration

Inventory management

Just-in-time practices

Medical Industrial Base
Mitigate risk
Supplier Diversification
Supplier Management
Untracked products lead to SC risks and decrease readiness
Visibility and Agility

Total: 148 codes

Study One: Codebook for Research Question 1

They were completed in Excel using codes created in NVIVO.

NOTE: Supplier Diversification and redundancy are listed below as sub-themes to the theme of Anticipate; however, in the final mapping of the codes depicted in Figure 2, supplier diversification and redundancy are captured as codes for the sub-theme Strategies for mitigating disruptions to the theme Anticipate.

Table 16

Study One: Codebook for Research Question 1

Participant (P)	Responses to RQ1: How do organizations define supply chain resilience?	Theme	Sub-theme
P1	"If we're talking about supply chain resilience, it's not good enough to just define that, and we have to say, what is the purpose of the supply chain, that is, a supply chain is providing supplies, equipment, and stuff, things that are necessary for a purpose."	Anticipate	Communications
P11	"We defined it by being able to have alternate sources should the primary source fail. Understanding cost issues, protecting the supply chain from fraud and waste -- Folks who tried to abuse a vulnerability or lack of supplies, things of that nature."	Anticipate	Supplier Diversification
P2	"The ability to anticipate and review redundancies … do I have the ability to see the forecast through analytics and AI?"	Anticipate	Redundancy
P10	"My organization defined supply chain resilience by having redundant measures set to be a backstop to provide supplies and items in health care delivery."	Anticipate	Redundancy
P11	"My organization defined supply chain resilience by having redundant measures set to be a backstop to provide supplies and items in health care delivery."	Anticipate	Redundancy
P6	"It's building in the redundancies to ensure any supply chain disruption."	Anticipate	Redundancy
P7	So let's figure out what you know: where is the material coming from	Anticipate	Redundancy
P10	For resilience, we now have our own dashboard for better visibility of what we have in the enterprise and what we have inbound into the enterprise	Anticipate	Visibility

P12	"Takeaways on resiliency-- visibility on the supply chain. A key piece of supply chain risk management and resiliency. I need to see the supply chain; the only people with that information are the commercial distributors. Visibility down through the supply chain allowed me to manage and mitigate issues. In the commercial world, for supply chain risk management, I find that clients are doing two things: Resiliency equals visibility and agility."	Anticipate	Visibility
P5	"We do not have visibility to that level."	Anticipate	Visibility
P7	We learned that we need to know where the products come from	Anticipate	Visibility
P8	"The visibility of the supply chain that we need to make sure visibility of and make sure it is resilient."	Anticipate	Visibility
P13	"I do not know that there is an agreed-upon definition because the pandemic exposed what I would call the lack thereof."	No definition	No Sub-theme
P4	"I am not sure that we have actually defined supply chain resilience ... we're still working on the supply chain management assessment."	No definition	No Sub-theme
P5	"National Strategy for Resilient Public Health Chain defines it because that's the executive branch definition coming out of COVID."	No definition	No Sub-theme
P9	"I do not know if my organization has a definition of supply chain resilience."	No definition	No Sub-theme
P5	Referencing recovery: "Using innovative ideas to recover from disruptions."	Recover	No Sub-theme
P6	"We have the ability to overcome that and rebound from it even if it means reaching back to another level."	Recover	No Sub-theme
P11	"We have been able to build resiliency into the system by our awareness, our ability to monitor the system more closely. And our ability to identify ways to address any risks with the supply chain."	Respond	Risk-based
P14	"The ability to have enough of the products on hand to be able to operate."	Respond	Risk-based
P6	"Resilience is having a tactical, operational, and strategic depth of our supply chain enablers."	Respond	Risk-based

P6	"And once we see those, and ideally, it's early enough, we will take the proactive action to step in and provide either oversight or direction or action if we have to at the national level to provide materials to the local level."	Respond	Risk-based
P9	Referencing the ability to respond during a disruption--contract action: "The very first thing is communication, open communication."	Respond	Risk-based
P9	"I can tell you what we think it is. And that is the ability to react very quickly to meet the supply needs of the organization."	Respond	Risk-based
P12	Alternate sources of supply, their spending dollars: companies are spending dollars to stand up new suppliers, diversify their suppliers, and diversify where their suppliers are.	Anticipate	Supplier Diversification

Study One: Codebook for Research Question 2

They were completed in Excel using codes created in NVIVO.

NOTE: Agile acquisitions and flexibility are listed below as sub-themes to the theme of Adapt; however, in the final mapping of the codes depicted in Figure 3, agile acquisition and flexibility are captured as codes for the sub-theme Creating conditions for resilience. Technology tools are captured in Figure 3 as codes for the sub-theme Data Analytics to the theme of Information Technology; Collaboration and Inventory Management are captured in Figure 3 as codes for the sub-theme Demand Management to the theme of Risk Management.

Table 17

Study One: Codebook for Research Question 2

Participant (P)	Responses associated with RQ2: How can organizations improve healthcare PPE SCRE	Theme	Sub-theme
P1	"Level of reliability that is with the delivery the of the supply to the endpoint and where it will be used."	Adapt (Prop.1)	Reliability
P1	"When we talk about supply chain, we completely redefined the supply chain because of the shortage."	Adapt (Prop.1)	Flexibility
P1	"When you think about resilient supply chains, it is partly how you develop and design the supply chain to deliver on time, quality, and consistency."	Adapt (Prop.1)	Agile acquisitions
P1	Implications from just-in-time supply chain process.	Adapt (Prop.1)	Agile acquisitions
P1	"How do we sustain a sufficient supply to allow us to deliver that great experience at the end of the line? And how does that change how we procure?"	Adapt (Prop.1)	Agile acquisitions
P1	Traceability with critical players in the supply chain to understand gaps in the supply chain	Adapt (Prop.1)	Traceability
P1	"Measuring supply chain resilience depends on how the organization organizes their supply chain."	Adapt (Prop.1)	Flexibility
P11	"It's important to have enough flexibility in the supply chain to adjust to changes."	Adapt (Prop.1)	Flexibility
P11	We defined (resilience) as being able to have alternate sources should the primary source fail.	Adapt (Prop.1)	Agile acquisitions
P5	"Prepare to adapt to changing situations."	Adapt (Prop.1)	Flexibility
P7	"Creating those conditions to have the products they need when needed. Three Parameters: 1) physically capable-- physical infrastructure in place to move goods, house goods to maintain goods, and inspect the; 2) Are we financially capable? Are we fiscally capable so that we have the assets that we can leverage? Do we have the assets that we can move? Can we competitively exercise acquisitions in a compressed timeframe because we have the financial resources	Adapt (Prop.1)	Flexibility

	needed to respond? 3) Are we ready from a contingency perspective? Do we have the relationships in place that will allow us maximum flexibility? Do we have an infrastructure in place that allows us to create strategic business relationships so that in the event of a contingency environment, or an event where we need to exercise a resilient supply chain, we have those relationships that we can leverage?"		
P10	"Having redundant measures set."	Information technology (Prop. 2)	Technology tools
P10	Making it easier to leverage technology as an enabler	Information technology (Prop. 2)	Technology tools
P12	"Resiliency equals visibility and agility."	Information technology (Prop. 2)	Technology tools
P7	"The IT system can give you an additional capability and insight into what you have going on daily, and it gives you a view of everything you have in your supply chain."	Information technology (Prop. 2)	Technology tools
P4	Technology tools to monitor the market	Information technology (Prop. 2)	Technology tools
P14	They were manually building dashboards for data analytics for inventory reporting. The data tools that are available to us are better than they've ever been in the past.	Information technology (Prop. 2)	Data Analytics
P3	"Data is power; knowledge is power." Information technology tools are needed for data accuracy	Information technology (Prop. 2)	Data Analytics
P1	"Understanding supply chain demand and supply chain visibility is critical to organizational risk management	Risk Management (Prop.3)	Demand management
P1	"Resilience is that the supply chain is sufficiently robust with a confidence level of the delivery of the equipment."	Risk Management (Prop.3)	Demand management
P2	And so that has been an exciting conversation that makes it possible for the industry and government to consider the proverbial standard for a supply chain	Risk Management (Prop.3)	Collaboration

	regarding pandemic response and resiliency.		
P10	"More communications across"	Risk Management (Prop.3)	Collaboration
P10	"First, build trust … rebuilding relationships and mending those bridges, focusing on data integrity, data, data accuracy, collaboration, and communication."	Risk Management (Prop.3)	Collaboration
P2	"We need to create legislation to support onshoring of that market space back to the US."	Risk Management (Prop.3)	Collaboration
P4	Looking at market research and market conditions continuously.	Risk Management (Prop.3)	Collaboration
P4	"Industry and the federal government are looking at supply chain resiliency together to ensure that we are prepared in this country as it relates to another viral outbreak."	Risk Management (Prop.3)	Collaboration
P5	"Most of the stuff is not manufactured in the United States but in the Pacific Rim nations. How do we manage that risk by bringing manufacturers onshore?"	Risk Management (Prop.3)	Collaboration
P1	Resilience, in part, does not mean you need to source from a single vendor that would be a high-risk endeavor regarding PPE	Risk Management (Prop.3)	Demand management
P10	Using enterprise tools, albeit in a legacy environment, to access, display, and verify the accuracy of the data. Facilitates cross-leveling efforts across the enterprise.	Risk Management (Prop.3)	Demand management
P5	COVID caused an "unprecedented level of demand that had been unpredicted. No one knew how much PPE we would need, and the just-in-time supply chain could not take the demand for more PPE because of the simultaneous global demand for PPE."	Risk Management (Prop.3)	Inventory Management

APPENDIX F

STUDY TWO CODEBOOKS

Study Two: Initial Codebook Based on Interview Questions coded in NVIVO and exported in an Excel spreadsheet.

Table 18

Study Two: Initial Codebook Based on NVivo Data

Total Number of Codes from NVIVO data: 147
Meaningful differences between Adapting and Anticipating Supply Chain Disruptions= 19 codes
Adapting to a supply chain disruption= 12 codes
Ability to change processes
Access to information
Adaptation requires future planning.
Collaboration
Examples of adaptability
Having a supply chain strategy is essential to adapting.
No meaningful difference
Reactive
Supplier relationships
Understanding suppliers of the suppliers
Adaptation is reacting to information once you know a disruption is or will occur.
Access to information is crucial in adapting to a supply chain disruption.
Anticipate a supply chain disruption.
Adapting is a component of anticipate
Mitigate Risk
Proactive

Understanding the market
Continuous market research
Proactive in knowing what could occur
To anticipate means understanding the market before a disruption occurs.
Meaningful differences between resilience and robustness= 29 total codes
Supply chain resilience= 14 codes
Resilience requires a long-term strategy.
Having access
Nitrile Gloves
Different use cases for Nitrile Gloves per agency
DOD uses small quantities for hospitals
Stockpile because of the Berry Act
HHS stockpiles for emergency purposes
I do not see much impact. I say that because, in the marketplace, the organization probably represents less than 1% of 1% of total purchase of gloves.
Flexible, not dependent on one source
Having a long-term strategy
Having access
Lack of knowing the definition
Reactive
Recover from a disruption.
Supply Chain Robustness= 14 codes
Different from resilience
Having contingency plans
Mitigating risk
On a global scale, the supply chain is not robust.
Partnerships
Redundancy
Robust in depth
A robust supply chain can be resilient; a resilient supply chain may not be robust.
Robustness comes from a position of understanding how to maintain

Robustness does not necessarily mean resilience.
Robustness is a part of resilience.
Robustness is just market forces.
Supply chains function well regardless of the circumstances.
Understanding the ebbs and flows of the supply base
Withstanding a disruption without system failure
Research Question One: How the Make PPE in America Act impact the global value chain =24 codes
Competition limited
Demand determines impact
Depending on Congress for exceptions to the legislation
Labor rates
Location of raw materials
Percentage of the Market
Comparative advantage
Jump starter for Industrial Base
Demand signal uncertainty
Desire to impact robustness
Difficult to determine the impact
Federal government demand does not impact the industrial base of the country at large.
The federal government is not the most robust need.
Impact of Tariffs
Industrial Base
Insignificant but a step in the right direction
Just in time inventory
Limited impact on the global supply chain
Nitrile gloves are complex to manufacture
Not globally sustainable
Raw materials not in the US
Significant impact
Understanding the Foreign Side of Commerce
Value of the legislation but not the global value chain
Research Question Two: Challenges associated with the Make PPE in America Act = 55 codes
Availability and quantity

Considering market conditions
Dependency on foreign markets for raw materials
EPA and environmental issues
Federal government limited percentage of the market
The federal government must understand the market.
Financial risk to small businesses
Finding sources and balancing costs.
Fringe benefits
Funding
Impact of Lobbyist
Impact of TAA
Impact of the government budget
Impact small businesses
Incentive the manufacturer
Lack of collaboration
Limited Demand
National security implications
No office that looks specifically at Buy America in details
Planning
Quality
The risk industry will build up the industry without guarantees that customers will buy.
Statutory variations
Things outside of our control, sourcing of raw materials
The time it takes to build capacity.
Too many variations
Understanding the raw materials that make up the product
Cost increases due to doing business in the US
Dependency on Foreign markets
The Federal Government cannot do this alone.
History of Nitrile glove
Cost parity
Finding a way to make Nitrile in the US
Greater output
Logistics versatility
No shelf life for Nitrile
Raw materials are stored for one to two years.
Time to get the raw materials

The government is not the industry's focus.
Legislation was put together too fast.
Self-dependency
Availability of raw materials
Communicating challenges to Congress
Conflicting legislation
Costs
EPA policy impact
Environmental considerations
Finding domestic companies that are producing in America
Impact of costs
Impact on small businesses
It takes time to build a domestic infrastructure.
The country affects domestic manufacture; the federal government cannot do it alone.
People, Process, and Technology
Trust
Understanding the market
What can be done to help the parties in the medical glove supply chain meet the requirements of the Act ?=20 codes.
Commitment
Communicating with Industry
Comprehensive exception to policy for nitrile gloves
Engagement with Industry
Focusing on the industrial base
Industry engagement
Innovation
Alternatives to NBR
Innovations
Learn about the impact of the legislation prior to putting it into law.
Collaborate with the FDA and affected agencies before issuing the legislation.
Distributors own customer and end-user relationships.
Research for understanding the impact of legislation
An industrial base is a solution that is required.

Partnership
Procurement will not fix Buy America.
Removing the sourcing of the raw materials for nitrile gloves would increase the national industrial base.
Standard specifications
New government processes are needed.
Slightly modifying the legislation for success.

Table 19

Study Two Codes and Themes- Adapting to Supply Chain Disruptions

Participant	Prepare to Adapt to a supply chain disruption	Sub-theme	Theme
S2-P4	Effective decisions, rely on business partners	Collaboration	Reactive
S2-P8	"You first have to have access to the information."	Collaboration	Reactive
S2-P8	"What do you do once you know something is happening"?	Collaboration	Reactive
S2-P8	" You may very well have other things that you need to learn for you to properly adapt."	Collaboration	Reactive
S2-P10	It is Reactive	Adaptability	Reactive
S2-P7	Not relying on foreign sources	Alternative approaches	Flexibility
S2-P8	Requires thinking about the future regularly	Alternative approaches	Flexibility
S2-P7	**"**We are not dependent upon foreign sources of supply."	Alternative approaches	Flexibility
S2-P4	Make our business more akin to what is going on across the industry	Collaboration	Reactive
S2-P5	Adaptability is critical to surviving and thriving in a constantly changing environment	Making quick decisions and implementing fast	Flexibility
S2-P5	Requires changing a lot of processes	Making quick decisions and implementing fast	Flexibility
S2-P4	Understanding the problem	Making quick decisions and implementing	Unplanned Cost trade-offs

S2-P5	It costs billions of dollars to be fully prepared	Making quick decisions and implementing	Unplanned Cost trade-offs
S2-P6	Adapting to a situation without warning of an impending disruption	Collaboration	Reactive
S2-P9	Adapting is Reactive	Collaboration	Reactive
S2-P2	Adapting to market changes requires anticipating potential challenges	Making quick decisions and implementing fast	Unplanned Cost trade-offs

Table 20

Study Two: Codes & Themes for Anticipating Supply Chain Disruptions

Participant	**Ability to Anticipate a disruption** **Understanding the Market**	**Sub-theme**	**Theme**
S2-P8	We should find out what's happening as it relates to a disruption in the supply chain by doing what I call continuous market research.	Market Research	Market Intelligence
S2-P6	Market research is not just about buying a product	Market Research	Market Intelligence
S2-P4	Understanding who your suppliers are	Supplier Relationships	Proactive approach
S2-P10	Reactive and proactive.	Scenario Planning	Preventive Measures
S2-P11	One must possess some anticipation to adapt effectively.	Scenario Planning	Preventive Measures
S2-P9	Adapting is a component of anticipating, but adapting alone is not sufficient.	Scenario Planning	Preventive Measures
S2-10	Anticipating is a more proactive approach	Scenario Planning	Preventive Measures
S2-P9	"Anticipating is having a proactive approach to a proactive plan to adapt in advance."	Scenario Planning	Proactive approach
S2-P6	Continuous market research is essential	Supplier Relationships	Proactive approach

Table 21

Study Two: Supply Chain Resilience Codes & Themes

Participant	Resilience	Sub-theme	Theme
S2-P11	Quickly recover from disruptions. A resilient supply chain has optionality and secondary sources, which allows it to avoid relying solely on one country, company, or region.	Supplier Diversification	Adaptive and responsive
S2-P14	"Multiple sources and spread it out slightly."	Supplier Diversification	Market Intelligence
S2-P6	"Long-term is what you need to be there when you need it."	Contingency Planning	Forward-thinking
S2-P6	"Resilience is just having access."	Contingency Planning	Market Intelligence
S2-P10	"Flexibility or elasticity there."	Flexibility	Adaptive and responsive
S2-P10	"Withstand or recover…Becomes reactive."	Recover	Adaptive and responsive
S2-P7	"Resilience means you are flexible and not dependent upon one source or factory."	Supplier Diversity	Market Intelligence
S2-P4	"Resilience is my plan, my response action."	Contingency Planning	Forward-thinking
S2-P4	Having what is needed to handle an initial contingency response	Contingency Planning	Forward-thinking
S2-P9	"Resilience is the ability to recover. "	Recover	Adaptive and responsive
S2-P9	"Resilience is how you pick up the pieces after the hurricane hits."	Recover	Adaptive and responsive
S2-P10	It's your resilience that you can withstand or have some flexibility or elasticity there.	Recover	Adaptive and responsive
S2-P13	"Resilience is how quickly it can recover from something like, say, the pandemic."	Recover	Adaptive and responsive

S2-P9	Recovering quickly after an attack or failure. It is a reactive process	Recover	Adaptive and responsive
S2-P14	Resiliency takes investment to create	Contingency Planning	Forward-thinking

Table 22

Study Two: Supply Chain Robustness Codes & Themes

Participant	Robustness	Sub-theme	Theme
S2-P11	A robust supply chain may involve redundancy	Alternate capabilities, Communications network	Redundancy
S2-P10	Ability to resist or adapt to change; Vital for maintaining supply chain strength and stability.	Strength and Stability	Redundancy
S2-P6	Ability to meet specific criteria or standards.	Supplier Diversity	Preventive actions
S2-P5	Essential as the supply chain can function well no matter what.	Forecasting	Proactive measures
S2-P9	Robustness is getting ready for the hurricane and having everything in place.	Forecasting	Proactive measures
S2-P10	Quality of being strong and healthy is not likely to break at all.	Strength and Stability	Redundancy
S2-P13	Robustness can be resilient, but resilience does not have to be robust.	Strength and Stability	Redundancy
S2-P4	Supply chain robustness is your partner network.	Diversifying Suppliers	Redundancy
S2-P9	You have actions or processes and plans to anticipate the potential outage.	Risk Strategies	Preventive actions
S2-P9	Robustness includes redundancy and the ability to withstand an attack, loss, or failure.	Risk management	Redundancy
S2-P9	Robustness is about being prepared	Anticipate	Proactive measures
S2-P4	Requires partnerships	Strategic Relationships	Preventive actions
S2-P11	“Robustness would have more to do with redundancy.”	Strategic Relationships	Preventive actions

Table 23

Study Two- Research Question One-Codes and Themes

Participant	Study Two: Research Question One: How does the Make PPE in America Act impact on Global Medical (Nitrile) Glove Value Chain	Sub-Theme	Theme
S2-P1	It is extraordinarily challenging because the medical supply chain has been a just-in-time inventory, and JIT has very little overhead; it is usually made to use without a whole lot of stockpiles.	Limited government demand signal	Global Competitive Market
S2-P1	So, you had a demand signal that was generally routinely met and kept up with. That was okay until the demand signal was not just you; everyone else simultaneously had significantly increased demand for the same items. Thus, everyone in the supply chain could not handle it.	Limited government demand signal	Global Competitive Market
S2-P1	Why would industry invest in something that gives them a blip today?	Limited government demand signal	Global Demand signal
S2-P5	Minimal impact. VA is less than 1% of the global procurement piece for nitrile gloves. For lack of a better term, we’re a blip on the radar, if that.	Limited government demand signal	Global Competitive Market
S2-P1	The raw materials and their meager labor rates make it a tough competitive market.	Limited government demand signal	Global Competitive Market
S2-P2	It will change supply chains. It also changes the industrial base and how it needs to grow.	Investing in the US healthcare industrial base	Global Demand signal

Table 24

Study Two: Research Question Two- Codes & Themes

Participants	**Study Two: Research Question Two- Challenges implementing the Make PPE in America Act, specifically medical (nitrile) gloves**	**Sub-Theme**	**Theme**
S2-P1	If made here in America, the EPA would not allow it because of the secondary and tertiary gases and outputs it puts into the environment.	Environmental Impact	Regulatory and Compliance
S2-P3	They have passed their FDA and other stringent requirements that they happen at the manufacturing	Environmental regulations	Regulatory and Compliance
S2-P4	" We have to partner with someone to obtain the raw materials. From a value chain perspective, that gets costly".	Raw material availability	Global Trade Dynamics
S2-P3	I can't get on the phone and find American manufacturers that have the gloves that we need in the quantities.	Raw material availability	Global Trade Dynamics
S2-P2	Investing in innovative glove products while considering the challenges of sourcing raw materials takes time and effort.	Raw material availability	Global Trade Dynamics
S2-P1	Our dependency is 95 to 98% or greater on the foreign markets for our PPE.	Decreased US Competitive Landscape	Global Trade Dynamics
S2-P11	Lobbyists influence legislation	Trade Agreements	Global Trade Dynamics

S2-P11	Companies should be allowed to source raw materials from TAA-compliant countries	Trade Agreements	Global Trade Dynamics
S2-P14	“There’s no attestation required from those TAA countries as to where their components came from.”	Trade Agreements	Global Trade Dynamics
S2-P14	Imposing import tariffs and their impact on trade agreements.	Trade Agreements	Global Trade Dynamics
S2-P11	Proper training	Training	Workforce and Labor
S2-P1	Labor rates make it a tough competitive market.	Competing with foreign labor rates	Workforce and Labor
S2-P3	Speaking from other American-made product lines, we pay a much higher price for that product.	Budget implications	Procurement Strategies
S2-P14:	Finding compliant sources and balancing that against the additional cost.	Budget implications	Procurement Strategies
S2-P10	America has a minimum wage; you got to have fringe benefits you got to have, etc., which adds to the cost.	Budget implications	Procurement Strategies
S2-P2	Somehow incentivize small and medium-sized manufacturers	Innovation thinking	Procurement Strategies
S2-P14	“Recognize the impact on everyone’s budget.”	Budget implications	Procurement Strategies
S2-P4	We are 2% of the market share.	Limited Federal Demand	Capacity and scalability

S2-P1	How do we have self-dependence, so we do not have that overseas reliance where we put ourselves at risk, where you have a national security issue	Limited Federal Demand	Capacity and scalability
S2-P1	High dependency of the United States on foreign markets for Personal Protective Equipment (PPE)	Limited Federal Demand	Capacity and scalability
S2-P1	"From the ability to influence industry, we need something larger than just saying the federal government will make PPE in America."	Limited Federal Demand	Capacity and scalability
S2-P4	We only spend about 2 to 3% of healthcare supply chain products	Limited Federal Demand	Capacity and scalability
S2-P9	The primary concern is the demand for those goods, primarily in the initial stages (raw materials).	Limited Federal Demand	Capacity and scalability
S2-P9	Smaller businesses must ensure sufficient demand before investing capital to expand their production capacity.	Ability to meet demand	Capacity and scalability
S2-P10	"The issue is whether this put small businesses out of business."	Ability to meet demand	Capacity and scalability
S2-P13	But if they don't follow through with what's already gone into law … It will be detrimental in the long term for the government to get the private sector to answer their call to action.	Conflicting legislation/statutes	Regulatory and Compliance
S2-P13	" Act's conflict with the rules currently in place"	Conflicting legislation/statutes	Regulatory and Compliance

S2-P13	The regulation provides deviations for relief from certain things not made in the US.	Conflicting legislation/statutes	Regulatory and Compliance
S2-P14	You can't give us legislation that requires something that we're not allowed to follow.	Conflicting legislation/statutes	Regulatory and Compliance
S2-P7	"We want the federal government to buy gloves … that are maybe 60% US content and 40% content coming from outside of the US."	Conflicting legislation/statutes	Regulatory and Compliance
S2-P8	"Biggest challenges for stakeholders because there can be so many variations."	Conflicting legislation/statutes	Regulatory and Compliance
S2-p11	"Removing the raw material component, if it's not readily available, would go a long way in building the industrial base here.	Conflicting legislation/statutes	Regulatory and Compliance
S2-P6	With various executive orders, legislation, and guidance coming out of OMB, someone probably needs to step back and look at all that to do what I call a sanity check.	Conflicting legislation/statutes	Regulatory and Compliance
S2-P11	Because they don't understand the market?	Market Intelligence	Procurement Strategies
S2-P14:	Incentivizing domestic manufacturers	Innovative thinking	Procurement Strategies
S2-P3	The government should create an environment that rewards people who invest in the business by offering tax breaks or subsidies.	Innovative thinking	Procurement Strategies

Table 25

Study Two: Research Question Three- Codes & Themes

Participant	Study Two: Research Question Three- Helping stakeholders implement the Make PPE in America Act	Sub-Theme	Theme
S2-P4	Joining consortiums…collaborate and adjust our strategies early on.	Communications	Strategic Relationships
S2-P6	“We have to start talking about how to work from a whole government perspective”	Holistic Government approach	Invest in National Healthcare Industrial Base
S2-P7	Referencing collaborating with another manufacturer: “ We need each other to do this to make this thing work.”	Communications	Strategic Relationships
S2-P10	“A major factor is to incentivize them to build and then provide them contracts”	Incentive domestic manufacturers	Innovative solutions
S2-P5	“If there had been a concerted effort of the legislators … to bring in all parties to discuss it before putting it on the street, the legislation would have been a lot better”	Communications	Strategic Relationships
S2-P9	Have some additional set aside or preferences which we do a bit. But again, we can’t guarantee anything multi years out, because these are short term buys.	Incentive domestic manufacturers	Innovative solutions
S2-P14	Finding suitable sources	Communications	Strategic Relationships
S2-P7	We would like the federal government to buy gloves … that are maybe 60% US content and 40% content coming from outside of the US.”	Incentive domestic manufacturers	Innovative solutions

S2-P4	"Make a commitment. This is not a buyer supplier relationship. Now this is a partnership."	Communications	Strategic Relationships
S2-P11	"And it would work cleanly, but that's obviously not how that works".	Incentive domestic manufacturers	Innovative solutions
S2-P9	"Continuous communication with industry for awareness	Communications	Strategic Relationships
S2-P5	From a nitrile glove prospective, the partners need to work to get an exception from that component of legislation, and then just move on.	Communications	Strategic Relationships
S2-P6	"Monthly industry forums"	Communications	Strategic Relationships
S2-P6	You must partner with different councils and have meetings with them periodically.	Communications	Strategic Relationships
S2-P9	Working very closely with industry as partners	Communications	Strategic Relationships
S2-P2	"We need to focus on the healthcare industrial base"	Holistic Government approach	Invest in National Healthcare Industrial Base
S2-P8	Industry Days	Holistic Government approach	Invest in National Healthcare Industrial Base
S2-P3	The government must think of ways to attract industry to domestic manufacturing.	Communications	Strategic Relationships
S2-P9	Continuous communication with industry	Holistic Government approach	Invest in National Healthcare Industrial Base
S2-P1	Look at ways that they can fund innovation	Incentive domestic manufacturers	Innovative solutions
S2-P6	Need to know if they are creating another chemical like nitrile	Incentive domestic manufacturers	Innovative solutions

S2-P6	“Learn about the market before introducing this legislation	Incentive domestic manufacturers	Innovative solutions
S2-P8	Identify their critical requirements and explore ways to simplify the specifications.	Holistic Government approach	Invest in National Healthcare Industrial Base