FREE TRADE AND DISEASE: A STUDY OF EXPERTS

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Free Trade and Disease: A Study of Key Experts

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Abstract

Free trade regions and trade routes help to facilitate the spread of disease, which can lead to outbreaks, epidemics, or pandemics. However, shutting down these regions and routes has extreme economic consequences. Inspired by our previous project with the Walvis Bay Corridor Group and the COVID-19 pandemic, our group completed a three round emergent Delphi study of key experts from health care, public health, and the transport field. After surveying our experts, we developed a series of recommendations, including a hierarchy of measures: fundamental, focused, and advanced. We provided an implementation plan for the fundamental measures: personal protective equipment, providing information and disinfection of common workspaces. Finally, four areas were identified for future studies.

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We would also like to show our gratitude to our numerous Delphi study participants. As many of our participants were on the front lines of the COVID-19 pandemic during our study, we greatly appreciate them taking the time to be a part of our surveys.

Finally, we would like to thank the Walvis Bay Corridor Group for all of their help during C-Term. We were disappointed that our group could no longer work with them for our IQP due to the COVID pandemic, but we are still appreciative of their help.

Thank you to all who have helped us along the way.

Executive Summary

Problem:

Trade and disease have been tied together ever since the world became interconnected by the movement of goods and people. The black death is a key example of this, traveling along the silk road until it reached Europe where it killed over one third of the population of Europe (Yue, Lee, & Wu, 2017). The role that trade has in facilitating the spread of disease is increased by the development of free trade regions through free trade agreements (FTAs). The benefits of these FTAs have increased their popularity. These include increased access to goods, generating commerce for a country, and increased movement of people (Blanchet, 1994). With the combination of increased transportation of goods and the increased movement of people throughout free trade regions there is a greater risk for the spread of disease.

Previous examples such as the HIV/AIDs epidemic, Ebolavirus, and influenza or Flu, can provide insight on the impact of trade on the spread of disease. HIV/AIDs currently is disproportionately plaguing Sub-Saharan Africa, where approximately 67% of the global population living with HIV is despite only 15% of the world's population living in the area (The global HIV/AIDS epidemic, 2019) (Sub Saharan Africa Population, 2020). This is often attributed to the link between sex work and the transport industry. The 2014-2016 outbreak of Ebolavirus in Western Africa is another example. One of the main causes of the rapid spread of the virus was the high mobility of people across borders due to the Economic Community of West African States (ECOWAS), a free trade agreement (Wapmuk, Jaji, & Wapmuk, 2015). A virus which is very contagious due to the droplet mode of transmission is the influenza. With its ability to mutate, the risk for outbreak is much greater (CDC, 2020). The spread of these diseases is facilitated by the movement of goods and people, both of which are increased through the

development of free trade regions. While it is important to decrease the spread of disease through free trade regions, it must be done without completely shutting them down, as this can have extreme economic consequences.

Objectives:

In order to address this problem, we have identified three key objectives. The first was to identify major weaknesses in current practices and implementation of prevention initiatives within Free Trade Regions. The second was to design best practices and guidelines for free trade regions during times of epidemic and pandemic. The third was to provide an implementation plan for our best practices.

Our first objective was achieved through research of the policies within two free trade regions, the European Union, and the Southern African Development Community (SADC). Through our research we found that there was a lack of policies with regards to preventative measures within free trade regions. This lack of policy is best demonstrated by the EU. While there is policy regarding the ability of the countries to close their borders, there is no following policy regarding enacting new procedures after the border is closed or procedures for what should happen after the border is closed. The lack of these policies shows a great weakness in current practices and preventative measures.

Our second objective, to design best practices and guidelines for free trade regions during times of epidemic and pandemic, and our third objective, to provide an implementation plan for our best practices, were achieved by completing a study of key experts. We used a Delphi study, which was completed in an emergent fashion through three rounds of surveying. The first round of survey was a brainstorming session where experts were able to propose preventative measures that would be effective in decreasing the spread of disease while also minimizing the economic

impact. From this round we were able to identify common themes between all of the responses as well as the outliers. Based upon round one, we asked our experts to rank the most popular options from round one within the context of three common disease types: bloodborne, respiratory, and vector borne. We then identified common themes and outliers in the round two responses and built a policy framework. We then presented this framework in the third round and asked our experts if they believed that our framework would produce productive policy development. They either agreed or disagreed and then explained their reasoning. During this third round we reached consensus when all of our experts agreed with our policy framework.

Recommendations:

Based on the outcomes of our survey and findings of our analysis, we have developed a series of recommendations for transport companies and private or public health organizations. These recommendations are formatted in a hierarchy, meaning that one level must be implemented before the next. Additionally, we have created an implementation plan for the fundamental measures.

The fundamental measures are personal protective equipment (PPE), providing information for essential employees, and disinfecting common workspaces. Personal protective equipment includes gloves, face masks, face shields, and full body suits. Providing information is based upon developing clear open channels of communication led by trusted employees. Disinfecting common workspaces entails the routine cleaning of areas where there are gatherings of employees.

The focused measures are separated by the common disease types which we have identified. These are contact-based, respiratory, and vector borne. The focused measure for contact-based diseases is education. This entails educating essential employees on high risk

behaviors for contact-based diseases, the preventative options, and the treatment options. For respiratory diseases, limiting human interaction through social distancing is the focused measure. This will decrease the spread of disease by droplet transmission. Vector borne diseases require decontamination zones as the focused measure. Decontamination zones allow for the extermination of various vectors, such as rats, fleas, or mosquitos.

The advanced measures are measures which require a significant level of infrastructure. The first is limiting human interaction through automation. Implementing automation at border crossings and customs will decrease the spread of disease by limiting opportunities for transmission. Treatment and testing is another advanced measure. This entails providing treatment and testing options for essential employees. By doing this an environment is created that helps employees to feel more comfortable self-reporting symptoms. Monitoring and tracing encompass monitoring the health of employees and tracing the spread of disease through human interactions. This implies that essential employees feel safe and are comfortable with their health being monitored. All of these measures are important to implement, but the measures on both the fundamental and the focused level must be implemented first.

The implementation plan for the fundamental measures relies on the usage of these measures on a regular basis. For PPE this means that there must be a supply of gloves, masks, face shields, and bodysuits for all essential employees. Additionally, there must be a reliable supplier which a company can utilize for PPE. These are in place to prevent shortages. Everyday usage, at a basic level, should be the usage of gloves. For information, this means that there must be a weekly meeting with all essential employees to provide information. While this information does not need be related to disease during times of non-epidemic or pandemic, the act of having these routine meetings makes it easier to spread information when it is necessary. Additionally,

there needs to be a defined and organized chain of communication set up. When considering disinfection, all common workspaces must be disinfected at least once a week. Having these measures running at a minimal level during everyday life, builds a structure for these measures to be scaled up during times of outbreak, epidemic, or pandemic.

Future Studies:

Continuing to study this intersection of fields is important. With that in mind we recommend four areas of future studies. These include specialized surveys, alternate supply chains, advanced measures, and the evaluation of our fundamental measures.

In order to delve deeper into the opinions of experts with regards to preventative measures which reduce the spread of disease while minimizing negative economic impact, specialized surveys are necessary. Developing surveys for each field allows for language to be used which does not generalize and simplify the question. Researching alternate supply chains is an important next step. As a result of COVID-19, it has become apparent that there is a great need for these supply chains in order to help prevent shortages. Additionally, it is important to further research our advanced measures. These measures are complex and require infrastructure, therefore requiring further research before implementation plans can be generated. Finally, it is important that our fundamental measures are evaluated in tandem with our implementation plan. This can be completed through further expert studies or a trial of our plan.

Authorship

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

ACRONYM	DEFINITION
AfCFTA	African Continental Free Trade Area
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Treatment
AU	African Union
CDC	Centers for Disease Control and Prevention
COMESA	Common Market for Eastern and Southern Africa
DRC	Democratic Republic of the Congo
EAC	East African Community
ECOWAS	Economic Community of West African States
ECSC	European Coal and Steel Community
EEC	European Economic Community
EFTA	European Free Trade Agreement
ETLS	Economic Community of West African States Trade Liberalization Scheme
EU	European Union
FTA	Free Trade Agreement
GRID	Gay-Related Immune Deficiency
HIV	Human Immunodeficiency Virus
IDUs	Intravenous Drug Users
MPH	Masters of Public Health
MSM	Men who have sex with men
NAFTA	North American Free Trade Agreement
RICAM	International Network of Mesoamerican Highways
SADC	Southern African Development Community

SIV	Simian Immunodeficiency Virus
SW	Sex workers
PCP	Pneumocystis carinii pneumonia
PPE	Personal protective equipment
PrEP	Pre-exposure prophylaxis
WHO	World health Organization

Chapter 1: Introduction

The world is more connected than ever before as countries around the globe conduct trade with each other. The movement of goods was at an all-time high just three months ago, with what seemed to be no ceiling on the global trade market. Goods are manufactured and spread across the globe in a matter of days. This was until the COVID-19 virus engulfed the world in sickness. Trade plays a crucial role to economies everywhere as it allows countries to receive goods and resources not readily available on their own. However, goods and resources are not the only thing to spread through global trade.

During times of outbreak, epidemic, or pandemic, trade can assist in the spreading of diseases across the world. Although trade can be a delivery system for diseases, shutting down trade would have severe consequences that have the potential to cripple economies. Trade must be allowed to continue during outbreaks while still minimizing the risk of transmitting communicable diseases on a global scale.

The problem that our study addresses is that during times of pandemic or epidemic, transport routes and areas of free trade help to facilitate the mass spread of disease. However, completely shutting down these routes has extreme economic repercussions. There are currently no measures in the Schengen code for when pandemics occur. The Schengen code is followed by the European Union and other major trade regions. This means that there are no set measures that would be implemented to reduce the spread of a communicable disease.

The goal of this study is to generate consensus of experts on a policy framework of best practices for limiting spread of disease. To do this, we have identified three main objectives: identify major weaknesses in current practices and implementation of prevention initiatives

within free trade regions, design best practices and guidelines for free trade regions during times of epidemic and pandemic, provide an implementation plan.

Chapter 2: Background

As the world has become more interconnected, there has been a continual push to develop free trade regions and foster free trade agreements. These agreements and regions allow for increased movement of goods and people. With the growth of these free trade regions concerns have been raised over the impact they have on the spread of infectious diseases (Ochieng, 2019). From the history of free trade agreements, to current policies during regular operation and times of outbreak, epidemic, or pandemic, from HIV and Ebola to influenza and Polio, the intersection of free trade and disease is an important overlap to be studied.

2.1 Free Trade Regions and Policy

2.1.1 Definition of Free Trade

Free Trade is the facilitation of trade with no restrictions, meaning no tariffs, taxes or anything that could influence or limit trade. "The merit of free trade was discovered by Adam Smith in his monumental work *The Wealth of Nations*… The rationale for free trade is thus over two centuries old" (Bhagwati, 2003). Therefore, the idea and practice of free trade took over two hundred years to develop and become a major factor in the world's economies. Although free trade was not formally defined until Adam Smith published *The Wealth of Nations*, trade agreements have had their roots in civilizations as far back as Egypt and Roman Empire (Bhagwati, 2003).

As national economies developed and modern theories regarding free trade came to light, it became easier to identify in which situations free trade would be successful. "If market prices reflect 'true' or social costs then clearly… free trade can be shown to be the optimal way to choose trade" (Bhagwati, 2003). This statement suggests that free trade can only flourish if market prices are correct and truly represent a laissez faire economy. However, these developing

theories allowed economists to identify areas where free trade would not flourish. “If markets do not work well, or are absent or incomplete, then… free trade cannot be asserted to be the best policy” (Bhagwati, 2003). This statement asserts that when one nation is much more financially sound than another and these nations develop a free trade agreement (FTA) it can lead to one nation taking advantage of another. There are also different kinds of FTAs: a bi-lateral FTA involves two countries, where a multilateral FTA involves multiple nations (Bhagwati, 2003).

2.1.2 Growth of Free Trade

Free trade regions are regions where multiple nations have developed a Free Trade Agreement (FTA) with one another (Grossman & Helpman, 1993). Free Trade Regions exist on almost every continent, from North American Free Trade Agreement (NAFTA) in North America to European Free Trade Agreement (EFTA) in Europe. Despite free trade existing for hundreds of years, it wasn’t until the 20th century that the scramble to create modern trading blocs emerged. The first wave of these agreements came in the 1950s and 60s in forms of agreements such as the European Economic Community (EEC) and the European Coal and Steel Community (ECSC) (Grossman & Helpman, 1993). These trade unions were created because it was believed that economic unification would bring peace. However, the largest expansion of these FTAs came in the 80s and 90s with agreements such as the European Union (EU) and NAFTA. Although free trade regions generate commerce, there are consequences in letting goods cross borders freely. One of the biggest consequences of a more open border is the spread of disease.

2.1.3 Benefits of Free Trade

In many instances around the world, economies in many nations or states have flourished under free trade agreements. Countries that are part of larger FTAs have the ability to better control international trade. An example of this is how the EEA influenced a large portion of the world's economy when it was formed: "Finally, the EEA, as it will account for 43.2 percent of international trade, may without any doubt be seen as part of the trend in world economy towards the creation of big regional trading blocs" (Blanchet, 1994). By controlling this much of international trade, countries in the EEA are able to influence the world economy.

2.1.4 Free Trade During Epidemics and Pandemics

As FTAs have become more popular, they have created policies that open up borders for people to pass through. This makes the spread of disease across borders much easier as anyone who has contracted the disease will have an easier time getting into another country as there are less restrictions on international travel between countries involved in an FTA. (Kennan, 2013). The explosion of FTAs in the world has left countries to push to create 'trading blocs' so that they are not left out of these agreements. "A turn to increased protectionism against outsiders by groups of countries that have formed free trade regions and as a result start behaving as a bloc toward the outside world" (Krugman, 1991). This causes nations to essentially be forced into FTAs, which in turn creates more open borders that facilitate the spread of disease.

During an outbreak, epidemic, or pandemic, trade slows down. However, nations who have FTAs often have a difficult time closing down their borders. In the United States, policy makers had to move their policy away from free trade and toward domestic production. However, the United States has taken measures to support the import of medical devices which is not recommended by the FTAs they are involved in because it favors one particular industry.

FTAs have been successful economic tools but have far from proven themselves as beneficial in times of outbreak, epidemic, or pandemic (WTO, 2020).

2.1.5 Free Trade in Southern Africa

An example of a developing free trade region is Southern Africa. Various organizations and treaties have been created to achieve similar goals. The goal of the South African Development Community (SADC) is "to achieve economic development, peace and security, and growth, alleviate poverty, enhance the standard and quality of life of the peoples of Southern Africa, and support the socially disadvantaged through Regional Integration." (SADC, 2020).

Groups such as the SADC, the African Union (AU), and the Common Market for Eastern and Southern Africa (COMESA) are working to regulate laws and practices around shipping and border crossing in these countries (SADC, 2020). Some specific goals of these groups are to regulate truck axle loading and maximum dimensioning, enforce the COMESA carrier's license, and regulate transit fees. These regulations would greatly improve the efficiency of inter-country trade. The SADC began a harmonizing effort in 2001 when the group had its members sign a protocol to agree to assist in the development of an adequate road system that would promote socio-economic growth (SADC, 2020). This protocol was designed to have the member states collaboratively create a regional road policy that provides for monitoring the effectiveness of road infrastructure, introduce commercial practices for supporting roads, and develop strategies for reducing operational costs.

There are still borders in Africa, but free trade regions are expanding. In 2008, the East African Community (EAC) along with COMESA and SADC created the African Continental Free Trade Area (AfCFTA). This region encompasses 26 countries across Southern and East

Africa. The free trade region is expanding, but having scattered organizations means there still is a need for unification of regulations in transport law across Africa.

2.1.6 Free Trade in the European Union

The idea for an economic union between countries was new during the inception of the EU. The process of European integration started shortly after the Second World War. After the war, the Treaty of Paris was signed which created the European Coal and Steel Community (ECSC) in 1951. Later, the European Economic Community (EEC) was created in 1957. These were the first in a series of unions and treaties signed to promote peace throughout Europe and create economic stability. Europe did not want a repeat of the World Wars and made strides to prevent another World War from happening by economically binding the countries together (Dedman, 2009).

The EU was established in Maastricht, Netherlands in 1993 to promote peace, inclusion, and stability throughout Europe (Dedman, 2009). The main goals of the EU are to promote peace and develop a balanced, stable, unified, and highly competitive economy. By developing the economy, the EU aims to minimize unemployment. Other goals of the EU include promoting scientific and technological progress, protecting the environment, combatting discrimination, and enhancing cohesion and solidarity among members of the EU and respect the cultural and linguistic diversity present in Europe (The EU in brief, 2016).

A way that the EU achieves its goals is by removing the borders between countries, called internal borders (The EU in brief, 2016). Once a person is inside a country, or member, of the EU, they can travel between other members of the EU without going through a border crossing checkpoint, facilitating travel between these countries as long as you have a European Union passport. This allows anyone, including transporters, to pass from country to country

inside the EU without stopping. As mentioned above, the EU is a free trade region, meaning the transport industry doesn't pay tariffs between these countries either. This allows for cheaper and more rapid transport of goods.

2.1.7 Current Policy in the European Union

The Schengen Borders Code is a document that controls the border process of the EU. This document is comprehensive, defining external and internal border policy as well as detailing processes for border crossing, reintroduction of internal borders, and requirements for entering the EU.

Amid the COVID-19 pandemic, the EU unilaterally reintroduced internal borders effective March 17th, 2020. The French President, Emanuel Macron, called out EU leaders for this decision by saying, "The risk we are facing is the death of Schengen." (Macron to EU Leaders, 2020). Part of his anger stems from countries failing to notify the European Commision about the reintroduction of internal borders which violates Article 28 of the Schengen Code. The lack of protocol dictating what types of safety measures to introduce led to a panic among some EU leaders. This Article 28 of the Schengen Code states:

> Where a Member State reintroduces border control at internal borders, it shall at the same time notify the other Member States and the Commission accordingly, and shall supply the information referred to in Article 27(1), including the reasons that justify the use of the procedure set out in this Article. The Commission may consult the other Member States immediately upon receipt of the notification. (Regulations, 2020).

Members of the EU are allowed to immediately introduce their borders in an emergency for up to ten days and can then renew that period for additional time.

The Schengen Code, although comprehensive in the process to introduce internal borders and external border crossing procedures during times of relative tranquility, lacks any policy or supporting documents for recommendations for enacting efficient and proper plans for border crossings during times of crisis like the COVID-19 pandemic. This lack of preparation leaves a vacuum of what to do in situations like COVID-19.

2.2 Disease and Trade

2.2.1 Introduction to Disease

As the world has grown more interconnected, the spread of this disease can be facilitated through the increased travel of people, the increased transportation of goods, and increased interaction between humans and animals. This can be seen by looking at the role the silk road played on the spread of the black plague or the role of air travel in the spread of HIV/AIDS (Yue, Lee, & Wu, 2017). With factors such as trade routes and air travel there is an increased spread of disease, leading it to jump across continents.

Additionally, as populations have grown, more wildlife has been encroached on, leading to higher levels of interactions with animals. This can increase spillover, when a virus, parasite, or bacteria jumps from an animal to humans, categorizing it as a zoonotic virus parasite, or bacteria. Another method where disease spreads from animal populations to humans is through vectors, such as fleas, ticks or mosquitos (CDC, 2017). Beyond zoonotic and vector borne diseases, there are also food borne diseases, such as a salmonellae infection, or water borne diseases, such as cholera. All of these diseases can arise and become outbreaks, epidemics, or pandemics.

An outbreak is a sudden-rise of the number of cases of a disease, such as the flu every single year. When an infectious disease spreads to multiple people through rapid transmission

then it can be considered to be an epidemic. However, outbreaks are considered to be epidemics and the terms are used fluidly (Caceres, 2015). A pandemic can be defined as a global spread of disease which can affect everyone. Sometimes pandemic and epidemic are used interchangeably, but normally epidemic will be prefaced by global, indicating that it has spread globally. Another important term is endemic, meaning a disease which has constant presence in an area, such as malaria in tropical regions.

An important consideration in the communicability of disease and the mode of transmission of the disease. When considering the mode of transmission this can be defined as how the virus, bacteria, or parasite spreads from either the reservoir, where the virus, bacteria, or parasite originates from, to the infected person, or from infected person to infected person (CDC, 2012). Other important factors and characteristics are the incubation period, the period of communicability, the mortality rate, and the distribution. By understanding the incubation period, the span of time from when someone is infected to when they begin to show symptoms, there is an increased chance that the spread of disease can be tracked (Anderson, Manikkavasagan, & Roberts, 2010). The period of communicability defines how long someone is able to spread the virus after infection. The mortality rate is important to understand the economic burden the disease could have (Anderson, Manikkavasagan, & Roberts, 2010). By understanding the distribution, which demographics a disease is more likely to affect, such as those over 50 or males, targeted preventative methods can be taken. Understanding the spread of disease and its characteristics allows for preventative measures and containment efforts to be taken which will greatly impact the overall spread and potential impact of the disease.

2.2.2 HIV and AIDS

Human immunodeficiency virus (HIV), specifically HIV-1, is the virus which can potentially lead to acquired immune deficiency syndrome (AIDS). AIDS is the most severe and final stage of infection from HIV. HIV is a virus that attacks the immune system, weakening it. As the body is weakened, infections from diseases which the immune system should be able to fight off are now deadly. Co-infections, when a person has two or more infections at the same time, is the leading cause of death of living with people with HIV/AIDS (Chang et al., 2013). Common co-infections leading to death include tuberculosis, hepatitis B, hepatitis C, and malaria (Chang et al., 2013). HIV can be transmitted through semen, vaginal fluids, anal mucus, blood, and breast milk and enter the body through open wounds and mucous membranes (Planned Parenthood). Additionally, HIV can be transmitted through blood transfusions as well as through pregnancy passed from mother to child. HIV tends to have an incubation period of one to four weeks, and it can take up to 10 years without treatment for HIV to reach the final stage of AIDS (Planned Parenthood).

HIV, a zoonotic virus, is believed to have made its jump from chimpanzees in central and western Africa in the early twentieth century (De Cock, Jaffe, & Curran, 2012). Cross-species transmission was believed to have occurred through the hunting and consumption of chimpanzees or “bushmeat”. These chimpanzees can become infected with simian immunodeficiency virus (SIV) (The AIDS institute, 2011). While it is thought that HIV crossed species as early as the 1920s, an outbreak was not seen until the 1980s (History of HIV and AIDS Overview, 2019). The identification of HIV began in the United States when men who have sex with men (MSM) were diagnosed with *pneumocystis carinii* pneumonia (PCP) in Los Angeles (De Cock et al., 2012). PCP was also found in intravenous drug users (IDUs) during the

same year in California (History of HIV and AIDS Overview, 2019). After this small cluster was discovered, another cluster of MSM in New York were diagnosed with the opportunistic cancer, Kaposi Sarcoma (De Cock et al., 2012). These clusters of rare diseases lead to the identification of severe immune deficiency within the infected members. Despite the cluster seen within IDUs, it was initially the sexual connection between the New York cluster and the Los Angeles cluster that indicated that this was a sexually transmitted disease among MSM. The high prevalence rate within this group led medical experts to initially name the disease Gay-Related Immune Deficiency (GRID) (History of HIV and AIDS Overview, 2019) (Timeline of HIV and AIDS, 2016). In 1982 the virus began to spread globally. Cases were being reported in Europe and Africa infecting other populations than MSM, leading to the renaming of GRID to AIDS (History of HIV and AIDS Overview, 2019). Additionally, the first case of infection from a blood transfusion was seen in a cluster of infants. It was not until 1983 that a set of guidelines were disseminated to health care workers (History of HIV and AIDS Overview, 2019). Within the United States in 1983, 2,807 cases had been reported and there were 2,118 AIDS-related deaths (Thirty years of HIV/AIDS: Snapshots of an epidemic).

The slow call to action is often attributed to the lack of relation which the general public felt to those who were infected. The original framing of HIV as a "gay" disease led people to incorrectly believe that it could only be transmitted through anal sex, leading to the high prevalence in MSM. Even though blood was identified as a mode of transmission in 1982, it was not until Ryan White tested positive for HIV in 1985 that HIV became a public problem (Thirty years of HIV/AIDS: Snapshots of an epidemic). Ryan White was a thirteen-year-old with hemophilia who was subsequently banned from school after testing positive (Thirty years of HIV/AIDS: Snapshots of an epidemic). He fought against AIDS discrimination and gained the

attention of the public, stimulating a turning point in the United States where the disease was no longer seen solely as GRID, a "gay related disease". The infection continued an unprecedented spread globally until its believed peak in 1997 when 3.3 million new infections occurred, bringing the total number of people living with HIV/AIDS to an estimated 5.8 million and the number of deaths to 11.7 million (Wang et al., 2016) (Avila et al., 1998). The overall peak of mortalities from AIDS-related deaths was seen in 2005 when 1.8 million people died due to opportunistic diseases (Wang et al., 2016). The impact of HIV was greatly reduced by the development of antiretroviral treatment (ART) in 1996, prevention methods for mother-child transmission, needle exchange programs for IDUs, and pre-exposure prophylaxis (PrEP) which is a preventative medication in HIV-negative males (Timeline of HIV and AIDS, 2016).

Despite the treatment options and prevention methods, the HIV/AIDS epidemic is still prevalent in today's world. While a generalized epidemic never reached the majority of the world, there are areas which have reached this generalized epidemic. Sub-Saharan Africa, which only has approximately 15% of the world's population, has approximately 67% of the global population living with HIV (The global HIV/AIDS epidemic, 2019) (Sub Saharan Africa Population, 2020). Additionally, in other low-income regions and countries, such as Cambodia and Haiti, there has been a higher prevalence than within the rest of the world (Wang et al., 2016). One factor, specifically in sub-Saharan Africa is the high prevalence of HIV in sex workers (SW), leading sex work to be called the driver of the continued transmission of HIV (Kharsany & Karim, 2016).

When considering sex work as the driver of transmission of HIV within sub-Saharan Africa it is nearly impossible to discuss it without discussing the transport industry in tandem. The two industries are interconnected to the point where it has been found that truckers will give

rides to women across borders in-exchange for sexual favors (International Labour Organization, 2005). As various transport corridors have developed, hot spots have grown along theses corridors, becoming areas where sex work is prelevant, fueled by the high-risk sexual behaviors found as a coping mechanism for truckers (Regondi, George, & Pillay, 2013). The first initiatives which were undertaken within Africa at the beginning of the HIV/AIDS epidemic were focused on the ABCs: abstain, be faithful, and use condoms (De Cock et al., 2012). This strategy initially encouraged truckers to adopt “road wives" which were thought of as a “safer” option than simply having multiple sexual partners (International Labour Organization, 2005). However, this feeling of safety led to reduced condom usage, which was ineffective. While various policy initiatives have been undertaken by unions and other organizations representing geographic regions within sub-Saharan Africa, there is a call that they are focusing on only the behavior of the truckers and SW, and not on the vulnerable locations at which these two parties interact (Regondi et al., 2013). Additionally, there have been indications that the policies undertaken by these organizations are not cohesive nor harmonized with each other causing further delays, allowing for truckers to spend more time on the road, leading to “road wives" or other sexual interactions (Regondi et al., 2013).

It is not only in regions with generalized epidemics that have a relationship between areas of free trade and transport and sex work. At the Tijuana and San Diego border crossing there are high levels of prostitution which then results in both tourists and truckers coming to the area continuing the spread of HIV/AIDS across the US-Mexican border (Avila-Ríos & Reyes-Terán, 2014). With regards to the SW specifically, they are often IDUs as well which only increases the chances of potential HIV infection as both SW and IDUs are high-risk populations (Avila-Ríos & Reyes-Terán, 2014). A large difference in the spread across this border versus that in sub-

Saharan Africa relies on the fact that the epidemic in the United States and partially within Mexico is localized, meaning that it impacts more specific high-risk groups versus the general population.

Similar to transport corridors throughout sub-Saharan Africa, there was concern during the development of the International Network of Mesoamerican Highways (RICAM) project about the impact which it would have on the spread of HIV/AIDS (Condon & Sinha, 2010). By focusing on the economic impact that an increased infection of HIV would have on the countries which the proposed corridor was passing through, suggestions regarding prevention measures were delivered. Another similar trend was seen when the connection between commercial sex work and trade routes was noted (Condon & Sinha, 2010). Despite these important considerations, taking the mode of transmission and characteristics of HIV into consideration is the most crucial one. When considering HIV, it is crucial to take note of the slower spread when compared to a disease such as COVID-19.

2.2.3 Ebolavirus

Another virus which is mainly transmitted through bodily fluids, like HIV, but has different characteristics is Ebolavirus. While HIV transmission is limited to semen, vaginal fluids, anal mucus, blood, and breast milk, Ebolavirus can be spread through urine, saliva, sweat, feces, and vomit (CDC, 2019). Ebolavirus can be spread through the semen of someone previously infected and through the dead body of one of its victims. This virus can survive on dry surfaces for an hour or two but can live in bodily fluids for up to several days (CDC, 2019).

Ebolavirus is a zoonotic virus, potentially jumping from nonhuman primates or bats to the human population. This spillover could have potentially occurred due to the consumption of an infected animal or interaction with contagious bodily fluids (CDC, 2019). The first

appearance of the virus seen in the human population was in 1976, when an outbreak occurred in the Democratic Republic of the Congo (DRC). The majority of human to human transmission is attributed to the reuse of needles by nurses treating the infected (Amundsen, 1998). In 1994 an outbreak occurred in Cote d'Ivoire and in 1995 two more outbreaks occurred in the DRC. However, equipped with better knowledge of the virus these outbreaks were limited and more controlled (CDC, 2019). In 2013 an 18-month-old boy contracted Ebolavirus beginning the outbreak in Guinea which would turn into an epidemic (CDC, 2019).

The Ebola outbreak of 2014-2016 infected 28,652 people and killed 11,325 people, resulting in an approximately 40% fatality rate (CDC, 2019). Unlike previous outbreaks, which took place in rural areas, this outbreak took in place in densely populated and mobile regions (Coltart, Lindsey, Ghinai, Johnson, & Heymann, 1979). This outbreak spread silently until March 10, 2014 when the Ministry of Health was alerted to a series of mysterious infections (Coltart et al., 1979). After sending in the experts, this infection was identified as an Ebolavirus and the World Health Organization (WHO) declared an outbreak on March 23. By the end of the month there were 111 suspected cases and 79 deaths in Guinea (Coltart et al., 1979). Then the outbreak spread, roaring into Liberia and Sierra Leone's capitals by July 2014 (CDC, 2019). On August 8th WHO declared that the outbreak was a public health emergency of international concern as Ebola spread into seven more countries: Italy, Mali, Nigeria, Senegal, Spain, the United Kingdom, and the United States. While Liberia, Sierra Leone and Guinea all declared that they were Ebola-free in 2015, there were sporadic reappearances of cases until Liberia finally declared that they were Ebola-free on June 1st, 2016 (CDC, 2019).

The ability of this virus to spread can be attributed to high population density within the capital cities, conflicts between proper burial methods and cultural and traditional methods, and

higher mobilization across borders (CDC, 2019). Within Western Africa, the Economic Community of West African States (ECOWAS) Trade Liberalization Scheme (ETLS) details the ability of people, goods, and services to move across borders (Wapmuk, Jaji, & Wapmuk, 2015). ETLS was implemented to attempt to reach regional integration within Western Africa and specifically includes protocols related to the development of free trade regions and free trade policies. In the village where the 2014-2016 epidemic began, which is located in the corner of Guinea, Sierra Leone, and Libera, many people are able to cross the borders to find work. Within Mali, a landlocked country, their reliance on imports from other countries forced them to keep their borders open during infection allowing for more cases to enter the country (Wapmuk et al., 2015). This outbreak is not something that can be left in the past.

Currently, there is an outbreak of Ebolavirus in the DRC. This outbreak has been ongoing since August 2018 and is the second largest which has been seen (Ebola Outbreak in the Democratic Republic of the Congo, 2020). While this outbreak is considered to be significantly contained as of now, only appearing in rural communities, there has been a significant amount of concern over the advancement of the AfCFTA as it is being ratified throughout Africa (Ochieng, 2019). Flashbacks to the previous Ebola outbreak in 2014 combined with the current outbreak leads people to have an uptick in concern with regards to what more open borders will mean for the spread of disease within Africa and if it will be harder to contain in the coming future (Ochieng, 2019).

The difference in the epidemics of HIV and Ebola is due to their modes of transmission, their communicability, the incubation period, fatality, and available treatment options. Both of these epidemics were facilitated by the globalization of the world and the development of trade routes and free trade regions. With the continuation of globalization and opening of borders, the

fear which is currently being expressed over AfTFCA is understandable, especially when considering a disease which is easily communicable, and its mode of transmission is airborne.

2.2.4 Influenza

One common illness that has had a history of becoming a global threat is influenza, more commonly known as the flu. Influenza is a viral infection that targets the respiratory system, which are the nose, throat, and lungs of the afflicted persons. There are four different types of influenza viruses: A, B, C, and D. The type C influenza viruses cause mild illness and are not known to develop into epidemics. The type D influenza virus primarily affects cattle and is not known to affect, or even infect humans. The A and B types of the influenza virus are responsible for yearly epidemics (CDC, 2020). Influenza pandemics occur when new strains of type A viruses emerge and are able to spread efficiently between people (CDC, 2020).

Although there are influenza vaccines that are normally recommended every year, they are not a complete defense against influenza. Vaccines are recommended during “Flu Season” which is generally Fall and Winter (CDC, 2020). This is considered the flu season because the influenza virus thrives in the cold (CDC, 2020). Due to this, flu season usually reaches a peak between December and February. Flu shots are not always guaranteed to work because the influenza virus is constantly mutating through antigenic drift, or a slow mutation of the genes of the virus. If the mutation is small enough then the antibodies which were built up from the vaccine will recognize the virus as a threat and protect the body from illness. Antigenic drift is the main reason that people get the influenza virus more than once and is also the reason that different vaccines are created every year (CDC, 2020).

Besides antigenic drift, which is a slow change in genes over time, there is another change that the influenza virus can undergo called antigenic shift (CDC, 2020). Antigenic shift is

an abrupt and major change to type A influenza viruses. These major changes occur in the proteins that make up the virus. Antigenic drift is constantly happening but antigenic shift is less common and can often lead to pandemics. A common antigenic shift is when a type of influenza in animals gains the ability to infect humans due to a shift in its protein build, also known as a zoonotic jump. An example of this is avian flu and swine flu. When shifts occur most people have little to no immunity against the resultant virus (CDC, 2020).

The influenza virus is highly contagious as it moves from person to person. The virus is transferred mainly through droplets created when people cough, sneeze, or talk. When the droplets are inhaled and taken to the lungs the person becomes infected. Although less likely, people can also be infected by touching a surface that has the virus on it then touching their mouth, nose, or eyes. People who get the flu are most contagious in the first three to four days after the illness begins. Infected peoples can begin to be contagious a day before symptoms occur and up to a week after the symptoms leave (CDC, 2020).

In the spring of 2009 a new type A influenza virus emerged due to an antigenic shift. This new virus was called the Swine Flu because a shift occurred allowing pigs to infect people. Although young people had almost no immunity to this new form of the virus, about one third of people over 60 had built up some immunity. This was most likely due to coming in contact with a similar virus in the past (CDC, 2020). Even though the swine flu of 2009 started in the United States it was able to quickly spread around the world, making it a pandemic. By CDC estimates, just in the United States from April 2009 to April 2010, there were 60.8 million cases, 274,304 hospitalizations, and 12,469 deaths. The CDC also estimated that globally between 151,700 and 575,400 died of the swine flu in that same time frame. The 2009 swine flu pandemic was the first

flu pandemic in 40 years showing the infrequency of the antigenic shifts that can cause such major virus changes.

2.2.5 Polio

Another infectious disease that had become a global threat in the past is polio. Polio is a life-threatening disease that is caused by the poliovirus. In modern countries polio has largely been eradicated due to vaccines that are administered to children at a young age. The poliovirus is transmitted person to person and is a paralytic disease. This means that the disease is capable of causing paralysis, and even death, in its worst stages. Only about one out of every four people infected with polio display symptoms. The symptoms are flu-like and usually go away by themself. An even smaller proportion experience advanced symptoms surrounding the brain and spinal cord (CDC, 2020). One of the more advanced symptoms is paresthesia, which is a feeling as if there are pins or needles in your legs. Another advanced symptom is meningitis, which is an infection of the covering of the spinal cord and/or brain. Polio in rare cases can also cause varying degrees of paralysis. Paralysis is the symptom of polio that is able to cause death as it can paralyze the muscles that control breathing which would lead to death.

When infected with polio a person will have the virus living in their throat and intestines. Due to this the poliovirus can be spread by droplets made by coughing, sneezing, and talking. Also, the virus can be transmitted through the feces of an infected person. If the infected droplets or feces come in contact with someone's mouth or eyes then that person will be infected (CDC, 2020). The infected person becomes contagious immediately before symptoms occur and remains contagious for up to two weeks after symptoms go away. In the event that someone is infected and does not display symptoms, they are still able to spread the disease to others that have the possibility of developing symptoms. People that become infected with the virus but do

not show any symptoms are called asymptomatic. Asymptomatic carriers are dangerous as they spread the virus without ever knowing they have it. Polio thrives in unclean areas because the virus can live for up to two weeks in fecal matter. Polio is also able to spread rapidly if the fecal matter is able to infect a water supply, then the virus would be transmittable in the water (CDC, 2020).

Although polio has been recognized through history, major epidemics only began to happen at the very start of the 20th Century. The first large scale epidemic occurred in New York in 1916 with more than 9,000 cases and nearly 2,400 deaths (BBC, 2020). Major outbreaks continued to happen globally and in 1952 the United States hit a record 57,628. The first vaccine was developed in 1952 which saw a large drop in cases in the year following. Then in 1961 a more easily administered oral vaccine was developed and it began to be widely spread to counter the poliovirus. By 1988 polio had disappeared from the United States, Australia, and mostly all of Europe, including the United Kingdom (BBC, 2020). In the same year, 1988, the World Health Assembly resolved to eradicate polio by the year 2000 and these efforts have been largely effective. Only two countries in the world today still experience polio as a threat, being Pakistan and Afghanistan (BBC, 2020).

With highly contagious viruses such as the influenza virus and the poliovirus it is almost guaranteed that modern travel and trade are carriers of disease in times of outbreak. In the 20th century influenza showed itself as the principal infectious disease to be influenced by the growing global transport network. China is an epicenter of trade, so it is no coincidence that the major flu pandemics that started in China in 1957 and 1968 spread to the entire world in under six months (Tatem, 2006). The world is more connected than ever before by trade and travel.

Highly contagious and communicable viruses like the ones mentioned are therefore also able to travel the world with relative ease showing the need for pandemic preparedness.

2.3 Summary

Free trade agreements and free trade regions help facilitate the movement of goods from country to country, but they also help facilitate the spread of disease. Historically, the transport and trade industries have caused epidemics to evolve into pandemics. Without a proper plan in place, when a pandemic strikes, like the current COVID-19 pandemic, the transport industry helps to spread disease while straining the economy as restrictions limit or prevent trade from happening. The intersection of these fields has left a gap in knowledge which calls for experts to come together to discuss the problem. Bringing experts from multiple fields together will begin the development of future preventative measures which can help to stop epidemics evolving into pandemics.

Chapter 3: Methodology

3.1 Introduction

The goal of this project was to generate a consensus from experts on the best practices and measures in free trade regions to prevent the spread of disease while minimizing the impact on trade. These best practices and measures can then be recommended to both trade companies and public health organizations. In order to achieve this goal we have identified three key objectives.

1. Identify major weaknesses in current practices and implementation of prevention initiatives within free trade regions.
2. Design best practices and guidelines for free trade regions during times of outbreak, epidemic, and pandemic.
3. Provide an implementation plan.

To achieve these objectives we have chosen to follow a Delphi Study methodology that allowed us to survey key experts in multiple fields, and generate a final consensus. Below is the timeline which we followed during our Delphi Study (Figure 1).

Figure 1: Survey and Data Analysis Timeline

3.2 Delphi

A Delphi study consists of multiple rounds of surveys in order to create a consensus among a group of experts. Delphi studies usually involve a selected group of experts that will respond to a number of surveys anonymously. These surveys are usually conducted in 'rounds' in which a new survey is sent out each round. Within each survey, the responses from the previous survey are used as feedback for the next survey. This is done in the attempt to create a consensus among the experts in response to the problem at hand. This process is best described by this definition, "The Delphi survey is a group facilitation technique, which is an iterative multistage process, designed to transform opinion into group consensus." (Keeney, 2000). Delphi studies are most commonly used when the following needs to be achieved: "to explore or expose underlying assumptions or information leading to differing judgements; to seek out information which may generate a consensus on the part of the respondent group; to correlate informed judgements on a topic spanning a wide range of disciplines; and to educate the respondent group as to the diverse and interrelated aspects of the topic." (Keeny, 2000). In our case, we are using the iterative process of a Delphi study in order to create a consensus among experts regarding the prevention of spread of disease across free trade regions.

For our Delphi, we chose to design an emergent study; "Emergent design refers to the ability to adapt to new ideas, concepts, or findings that arise while conducting qualitative research" (Pailthorpe, 2017). By creating an emergent Delphi study, we were able to generate new information in the first round to further develop our findings and create the latter rounds of the survey.

To summarize, Delphi studies are an iterative survey process in which experts are given multiple rounds of surveys. This is done in order to create a consensus among this group. We

believe this type of study is suitable in achieving our goal, that being: the consensus of experts regarding how to prevent the spread of disease within free trade regions.

3.3 Preparation

Expert quality and choice are important for the success of a Delphi Study. Our study looks at the intersection of multiple fields. In order to address this, we chose experts from a variety of fields and defined criteria for each field. We chose to include participants with expertise in public health from either academia or think tanks, the transport sector, and healthcare. Our selection criteria are detailed below in Table 1.

Table 1: Criteria of Experts

Expert	Criteria
Public Health	Master of Public Health (MPH) and Ph.D. in a related field
	Or Ph.D.in a related field with demonstrated interest in Public Health
	And published within last 5 years
Health Care Workers	Ten plus years of experience in the healthcare field
	And/or five plus years of experience in government public health organizations
Transport Sector	Ten plus years of experience
	And/or proprietor or owner of a transport company

3.4 Prelaunch

Our first step in this prelaunch process was to begin developing the survey. There were several first features of this survey that were assessed by experts for feedback. We asked them to look at the usability of the survey, the language of the survey, and clarity. Based upon this

feedback we were able to adjust the first round of our survey so that we could facilitate a productive brainstorming session between our experts. After reviewing their feedback and making adjustments to the first round of our survey, we sent our survey to our experts.

3.5 Round One

3.5.1 Goal

The initial goal for the round one survey was to understand the opinions of our experts and generate ideas. By asking an open-ended question we gave the opportunity for the experts to share their thoughts and provide us with a starting point for the following rounds. This round allowed for us to determine a basis of preventative measures from our experts.

3.5.2 Welcome and Informed Consent

In the round one survey we began by enrolling our participants. There was a welcome message with information about our study. This included what the topic of the study was, how many rounds of surveying we expected, and general information about how long the study was. Additionally, below this there was a list, detailing the order of the survey: informed consent, selection of measures, and explanation of thoughts. After the welcome message, we included a section which was equivalent to the informed consent form. They were initially prompted to fill in the blank boxes that ask for their first name, last name, position, employer, and email. The importance in collecting this information was in case the survey was sent to a colleague or someone who we did not initially enroll into our study. By collecting this information, we were able to contact them with the second round. By describing their position, we were able to further assess their position from their perspective. Next they were prompted with a full description of what consenting to the survey entailed. This allowed participants to understand what they were agreeing to before starting the survey. They were then prompted with two options: I accept or I

do not accept and will not participate in this survey. If they chose, I do not accept and will not participate in this survey option then this was the end of the survey for that participant. The next screen they saw was a screen thanking them for their time and that their response was recorded. If they chose the I accept option, they moved onto the main part of the survey.

3.5.3 Question

The main section of the survey was a general question. This question was open-ended as not to limit their answers. However, after the question, there was a parenthesis with a few examples. Below the question there was a text box where they were able to respond. After this question, they moved to a screen thanking them for their participation. All information was stored in Qualtrics, which is a secure database only accessible to the investigators. The first round of this survey can be found in Appendix A.

3.6 Round Two

3.6.1 Goal

After the round one questionnaire closed, and all of the data was collected and data analysis of round one was completed. The goal of this survey was to begin developing either consensus or divergence. This was done by showing our experts the round one data and obtaining their opinions and thoughts on the common threads and outliers.

3.6.2 Data Analysis

The name, employer, and position information were used to validate identity and verify that the given individual who filled out the survey matches our criteria created for the study. Once the expert was verified, the email gave us the ability to send them the next two rounds if a colleague passed on the survey and we did not have their email recorded previously. The common threads from each response were identified and categorized. All outlier responses were

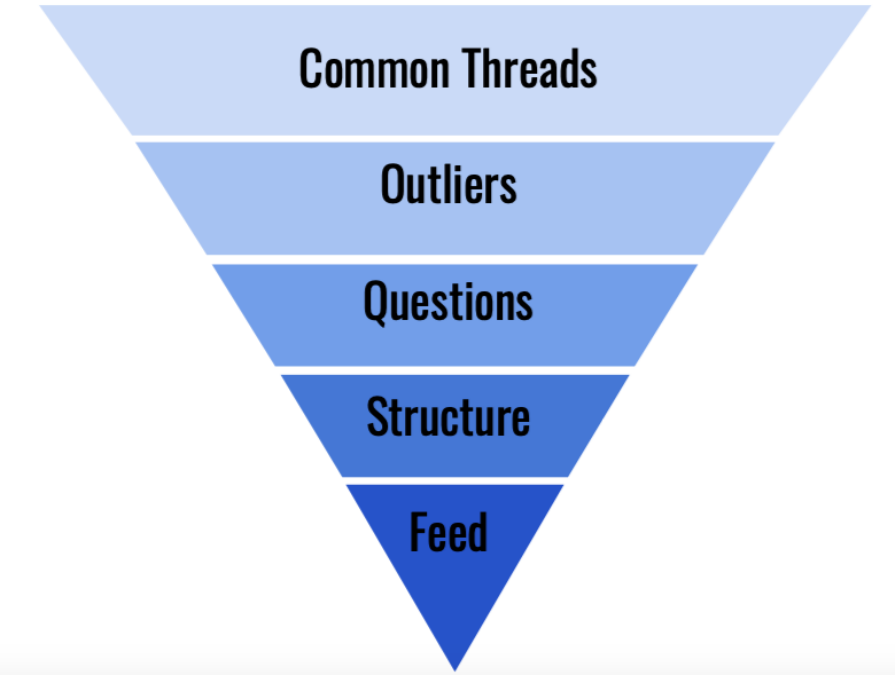
identified. A graphical representation was made of the most popular common threads and was presented to our experts at the beginning of the next round of surveying.

3.6.3 Questions

The questions for the round two survey were developed using the following process (Figure 2):

1. Look at common threads of the answers and find what perspective we want to ask the next set of questions from.
2. Identify the answers from the previous survey that stood out and were informative.
3. Develop the key questions to ask.
4. Structure the survey in a way that connects each question together.
5. Be able to feed both the previous common data and outlier data back to drive conversation between experts.

Figure 2: Round Two Questionnaire process



Using this method, we developed the questions for the round two survey found in Appendix B.

3.7 Round Three

3.7.1 Goal

The goal of the third round was to generate either consensus or divergence. The third round survey brought together all the ideas of our experts from the first and second rounds. By the end of the third round survey, our goal was to have created consensus or divergence among our experts on the best practices to minimize risk of spreading disease through trade or transport sectors.

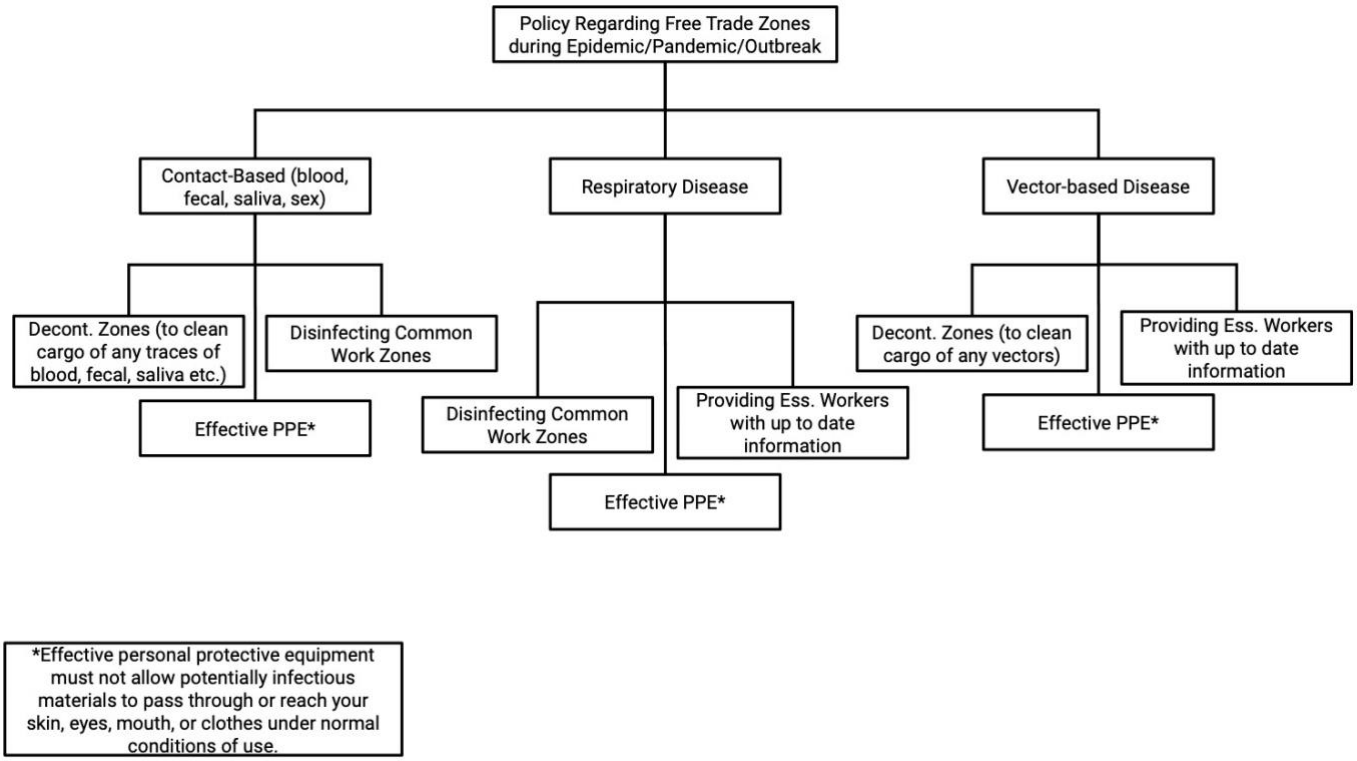
3.7.2 Data Analysis

The round two survey consisted of three main ranking questions based on three common disease types. For each of the disease type, nine measures were presented, and participants were asked to rank these measures from one to nine. One was the most viable, meaning effective while maintaining ease of implementation, and nine was least viable. In each disease type, graphs were made to show how highly, or lowly measures were ranked by the experts. The top three ranked measures for each disease type became our key data as we progressed to the third survey.

3.7.3 Questions

The third round was the final round of surveying in our Delphi study. The third round survey was based on the responses from the second round survey and was the last time data was gathered in the study. Similar to the first and second rounds, the third round survey started with taking the participants' email again. Using the results from round two, we created a policy framework that would be the main focus of the third round.

Figure 3: Policy Framework used for Round Three



Using our framework (Figure 3), we asked the experts if they agreed or disagreed that the framework would lead to productive policy development. The answers from the initial agree or disagree question showed our consensus or divergence. If the expert selected to agree with our policy framework then one more text box appeared, and the expert was allowed to express any additional thoughts or considerations. If the expert selected to disagree then another page was shown after and the expert was able to tell us what piece of the framework they disagreed with. There was also an option to say that they disagreed with the entire framework at the end of the pieces. A copy of the round three survey can be seen in Appendix C.

3.8 Summary

The main goal of this project is to develop a series of best practices and measures to prevent the spread of disease while minimizing the impact on economic trade. The three key objectives which we have identified to help us achieve this goal are to identify major weaknesses in current practices and implementation of prevention initiatives within free trade regions, design best practices and guidelines, and provide an implementation plan. To do this, we completed a Delphi study with experts from the public health, transport, and healthcare fields. This study was completed with three rounds of surveys, each feeding into the next. All of these data were stored securely and analyzed quantitatively and qualitatively. At the end of the study we developed consensus or divergence of opinion from experts, allowing us to develop best practices and measures, therefore achieving our goal.

Chapter 4: Findings

4.1 Introduction

In this section, we analyzed the data acquired through the Delphi study. To find a large pool of participants who are deeply versed in transport law, economics, trade logistics, public health policy, and healthcare would be a next to impossible task. This forced certain limitations in how we asked our questions. Our findings show that there are a series of first measures that can be implemented with ease regardless of mode of transmission. From there more complicated measures can be implemented.

4.1.1 Objectives

The objectives we created and focused on accomplishing are:

1. Identify major weaknesses in current practices and implementation of prevention initiatives within free trade regions.
2. Design best practices and guidelines for free trade regions during times of epidemic and pandemic.
3. Provide an implementation plan.

4.2 Round One Findings

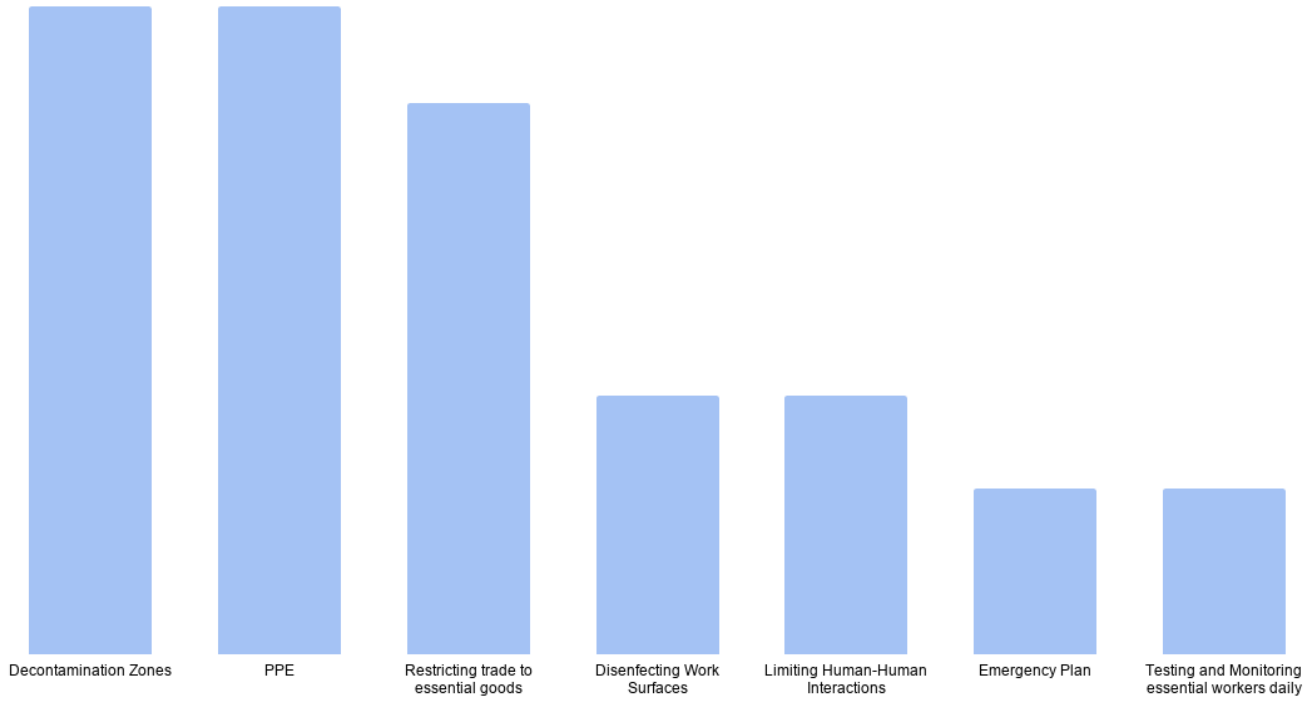
Round one of our study collected data from an open ended question asking our experts about best practices in free trade regions during outbreaks, epidemics, or pandemics. We collected responses from a number of experts in a wide variety of fields including: health care, public health, and transport. Due to the question being open ended, the experts typically included more than one suggestion. Another benefit of creating open ended responses was that it enabled a wide variety of recommendations from our experts, allowing a series of preventative measures to

be suggested. Round one was the initial introduction of our study to the experts and allowed them to begin thinking about the problem.

4.2.1 Common Threads

As a part of our data analysis we determined the common threads present and counted how many experts suggested each of these. The common threads and the magnitude of how many experts mentioned them can be seen in Figure 4, below.

Figure 4: Distribution of Responses Among Common Threads



The ideas that were stated most frequently were the use of decontamination zones and the mandated use of personal protective equipment (PPE). Both of these suggestions were given by 31% of participants. The next most frequent idea presented was to restrict trade to essential goods, which 27% of participants suggested. Following this, the most common response was not a suggestion, it was acknowledgement that diseases have different modes of transmission which need to be considered to accurately provide effective preventative measures. The mentioning of

modes of transmission came up in 22% of submissions. After modes of transmission, there were two measures suggested by 14% of experts. The two measures were disinfecting work surfaces and limiting human-human interaction. Lastly, there were three ideas that were each suggested by 9% of the respondents: develop a regularly tested emergency plan, testing of essential workers, and health monitoring of all essential workers.

4.2.2 Outlier Responses

There were responses that were only suggested by one participant. We qualified these as outliers. One expert responded “Allow public health officials of that jurisdiction to apply general public health rules with ample funding and workforce”. This expert was trying to stress that the people in charge of policy and implementation need to be well educated on the subject matter. It is logical that professionals with the knowledge and experience surrounding infectious disease prevention should be able to have a strong voice on how to proceed and reduce risk. Another expert said “Tracking of persons and equipment involved as supplies move from area to area is encouraged, in particular as the pandemic spreads”. Monitoring the movement of goods and the workers involved with moving them can be compared with the spread of the outbreak to locate correlations between the two. To accomplish this driver manifests or GPS systems can be used to track the movement of trucks and goods. The driver manifest is the company issued document given to its drivers to log where and when shipments are moved. Another example of an outlier response that impacted the development of the round two survey was the following: “You can't treat all diseases the same way. Diseases are passed in different ways and so understanding what you are trying to prevent is an important step”. This was one of many responses that suggested that our group develop the second survey around the fact that there are many different types of

disease. Some respondents even made suggestions as to what kinds of diseases should be included in our second round surveys.

4.2.3 Analysis

The collaboration of the people that we deemed experts in our study was clearly shown in the results from round one. Our study brought together professionals from the public health, transport, and health care fields. Due to the fact that our study was an emergent Delphi study, the experts were able to respond in ways unique to their certain expertise and experiences. There were common themes that spanned the gap between health professionals and transport professionals, but a deeper look into responses yielded comments and suggestions that often showed clearly which side of the gap the professional was on. Responses from transport experts had comments on business as well as inquiries to viability of measures from a transportation company's perspective. The responses from our health experts focused on the viability in terms of public health.

The most common answers of personal protective equipment and decontamination zones were offered by both sides of professionals. There are a number of reasons why this occurred. Firstly, personal protective equipment and decontamination zones were both examples placed in our question as a parenthetical example to spur further thought. With both ideas provided with the question, the experts only had to agree with those certain methods for them to appear in their responses. Besides that reason, both suggestions are broad and able to be applied to multiple cases. This means that personal protective equipment can be different depending on the scenario it is used in. Decontamination zones can also mean different things depending on the situation at hand. Round one being an open question is beneficial, as we used the many varying responses

from different experts to expose all experts within the study to ideas which they had not previously considered in the following rounds.

4.3 Round Two Findings

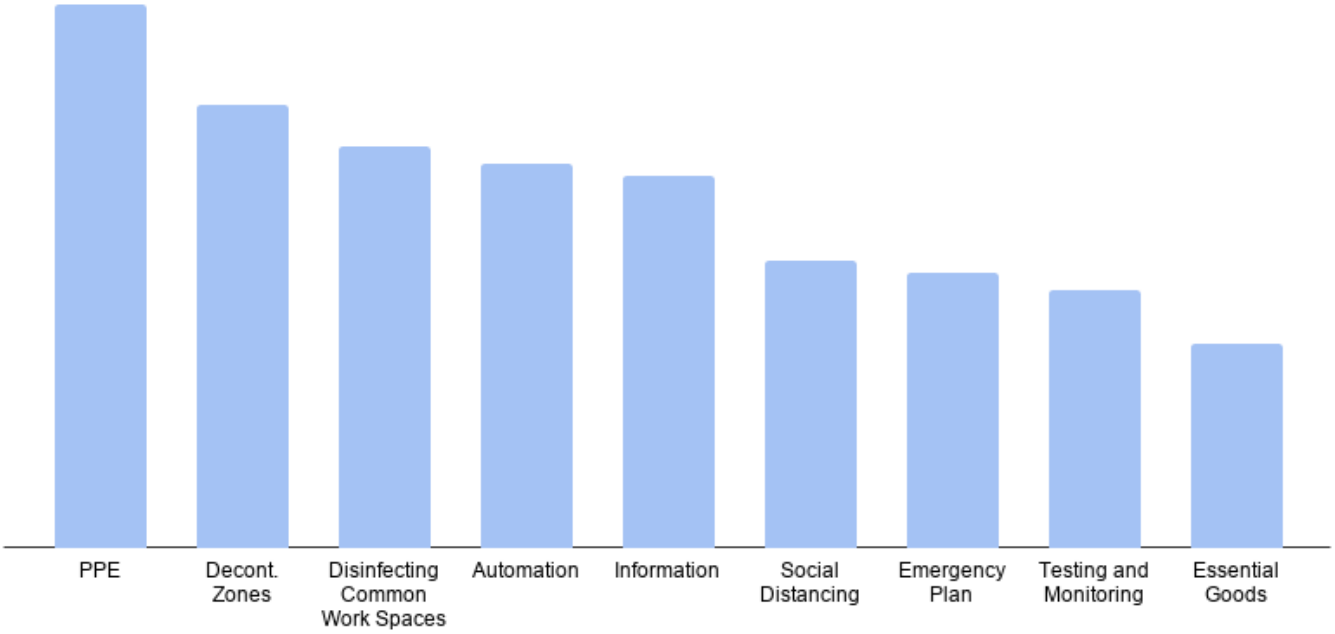
The second round of our survey consisted of a series of questions where our participants were asked to rank the common threads which were identified in round two based upon viability, meaning effectiveness while maintaining ease of implementation. The participants were asked to rank these three separate times based on common disease types: bloodborne, respiratory, and vector borne. After each of the rankings they were asked to fully explain their decisions made throughout the ranking process. At the end of the survey they were asked to provide any additional thoughts which they had.

4.3.1 Rankings

The measures we asked our experts to rank were personal protective equipment (PPE), decontamination zones (decont. zone), disinfecting common workspaces, reducing human interactions through automation (automation), providing up-to-date information to essential employees (information), reducing human interactions through social distancing (social distancing), having a routinely tested emergency management plan (emergency plan), testing and monitoring essential employees (testing and monitoring), and restricting trade to essential goods (essential goods. Each of these measures were ranked from most viable, meaning effective while maintaining ease of implementation, (1) to least viable (9).

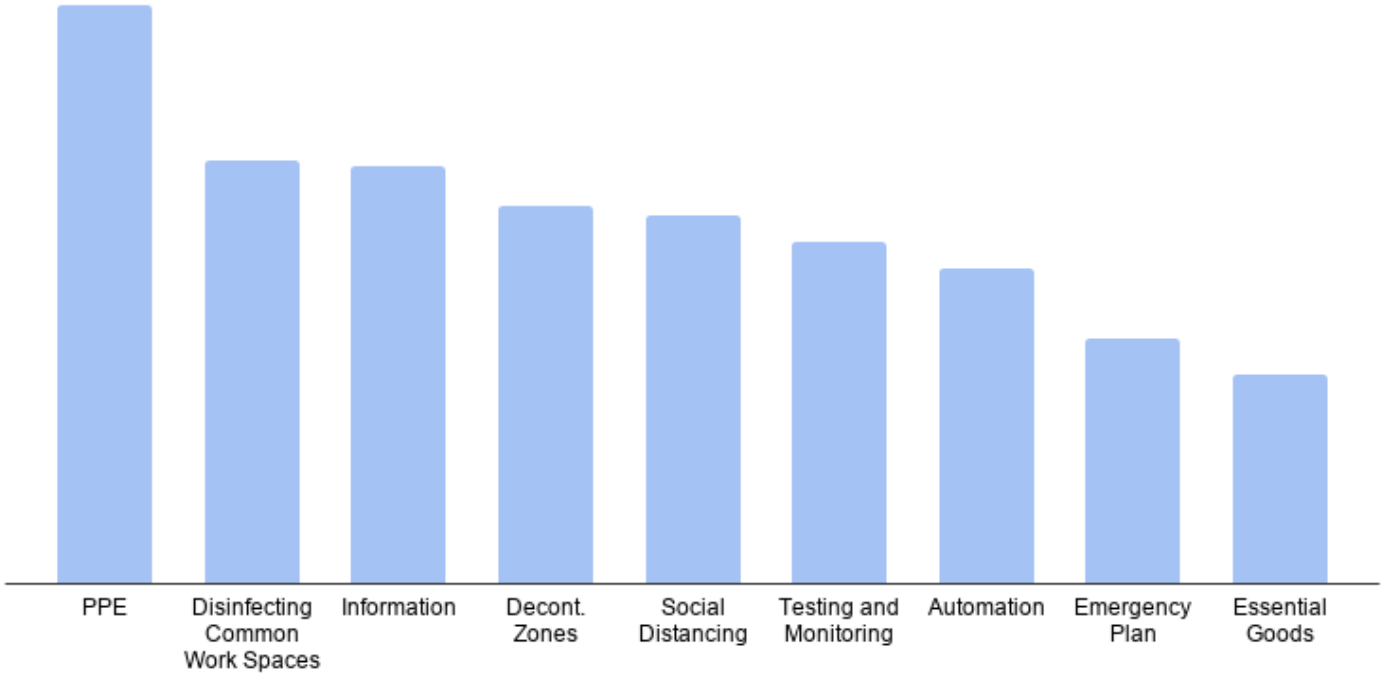
The ranking for bloodborne pathogens can be seen in Figure 5 below. In this figure the category on the left is the highest ranked (most viable) and the category on the right was the lowest ranked (least viable).

Figure 5: Bloodborne Pathogen Rankings



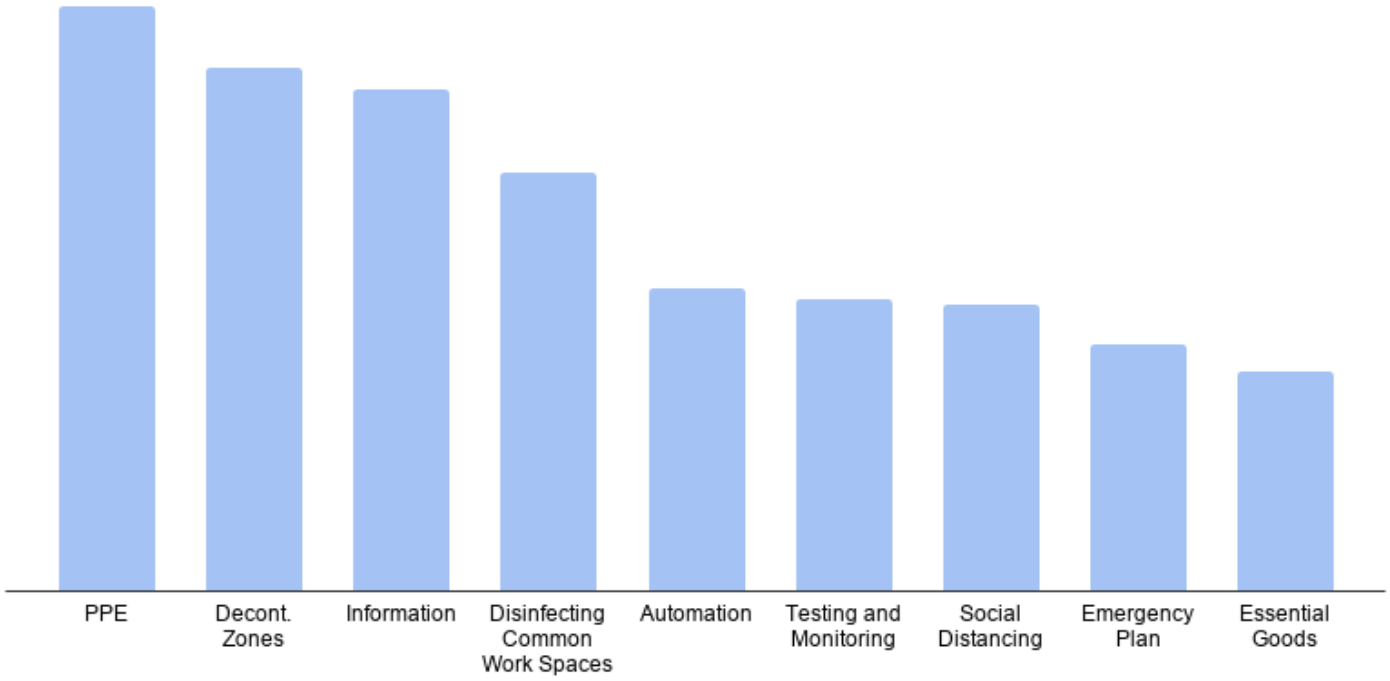
For respiratory diseases can be seen in Figure 6 below. In this figure the category on the left is the highest ranked (most viable) and the category on the right was the lowest ranked (least viable).

Figure 6: Respiratory Rankings



For vector borne disease this can be seen in Figure 7 below. In this figure the category on the left is the highest ranked (most viable) and the category on the right was the lowest ranked (least viable).

Figure 7: Vector Borne Rankings



4.3.2 Ranking Analysis

Some commonalities can be seen between the rankings for each type of disease. Personal protective equipment was the number one choice for each of the types of disease. The top four included personal protective equipment, decontamination zones, and disinfecting common workspaces for each ranking as well. Additionally, providing up-to-date information for essential employees was seen within the top five for all rankings, and was third for both respiratory and vector borne diseases. For the least viable options, having a routinely tested emergency plan and restricting trade to essential goods were in the bottom three for each ranking. Reducing human interactions through automation was above reducing human interaction through social distancing

for all rankings except respiratory. One of the options that varied the most between disease types was testing and monitoring essential employees. While this option never breached the top five, it ranged from sixth to eighth. Similar to testing and monitoring of essential employees, reducing human interaction through social distancing also varied throughout the rankings, ranging from fifth to seventh.

4.3.3 Open Response Analysis

Many different topics were brought to light in the open response section where experts were given a chance to explain their ratings. One common thread among public health experts was concern over the method we used to create our disease types. Some said that our disease types were oversimplifications. However, we often found the need to strike a balance between simplifying the public health terminology so that it could be understood by our experts who are not as familiar with it and still maintaining the integrity of the question. We believe that choosing to represent the more complex idea of modes of transmission through common disease types allowed us to strike a middle ground between these fields. Similar to this, we often heard that some of our preventative measures would not be the most effective when addressing these types of diseases. While they provided methods which would be effective, such as vaccination or treatment for respiratory diseases, they did not suggest these measures within the first round of the survey which is how the measures for ranking were chosen. However, within these suggestions of vaccination and treatment, there was a theme of testing and monitoring. An important point was brought to light that using this preventative measure could create false alarms when considering the widespread monitoring of employees. Instead they suggested that by providing up-to-date information for the employees as well as offering treatment and testing

options to all employees, the fear with regard to self-reporting and monitoring would be decreased. This was also repeated in another response which discussed vaccination.

Beyond the suggestion of items which were not included in the ranking list, there was a significant amount of commentary on both decontamination zones and restricting trade to essential goods. The main commentary on decontamination zones, apart from for vector borne diseases, was that they are time consuming to set up and are costly. This opinion was mainly heard from experts in the transport sector. However, on the public health end, emphasis was placed on the importance of decontamination zones for situations with a highly contagious virus, such as Ebola. Throughout the open response section, decontamination zones and disinfecting common workspaces were routinely used interchangeably. This could be due to the person's interpretation of these measures and whether or not they are differentiating between them. Additionally, when decontamination zones were mentioned without the mention of disinfecting common workspaces, they were usually mentioned in a negative tone. When considering decontamination zones within the context of vector borne diseases, there is a higher number of mentions. It is important to acknowledge that when decontamination zones were mentioned in this open response section, they were mentioned alone and positively. Decontamination zones were indicated as important measures due to the need to provide an appropriate amount of time for the vector to die.

When considering the commentary on the restriction of trade to essential goods there were very few supportive comments. One of the largest issues with restricting trade to only essential goods was how to determine what essential goods were. Additionally, nearly every comment stated that they did not believe restricting trade would be effective, stating that " If contagion if flowing out of the facility this does not stop it from flowing just flows it less. The

other measures are more likely to end the flow.". There was only one positive comment seen with regards to pathogens on the goods and shipping less goods could potentially mean less pathogens. However, others stated that this could be ignored due to other measures which are taken.

One of the most crucial points which was raised in the open response section was the importance of information. Whether it was raised as a part of another point or on its own, it was found as a common thread in the responses. The largest emphasis on information was that in order to implement the other measures there is an underlying need for communication of information. Without this basic level, it was stated that essential employees could be fearful or suspect and therefore less likely to follow preventative measures. Additionally, the thought that more information was always better was expressed, even to the point where it was suggested "Communication is always an issue and this survey reminded me to do that [send information to staff].". Beyond the basic level of communication of information, there was an emphasis on education with regards to bloodborne diseases. This was brought up when experts spoke about the behaviors which place people at risk for bloodborne diseases. It was suggested that by taking communication of key information and adding a level of educational material, that the spread of these diseases can be decreased. In a few responses communication and an emergency plan were suggested hand in hand. One interesting suggestion was that the person who is creating the plan needs to be trusted by the employees in order to secure the success of the plan. Additionally, when suggesting a series of measures, people tended not to mention an emergency plan, but often wrote their responses in the form of a plan.

4.3.4 Key Takeaways

One of the most important takeaways from this round of the study was the relationship between the rankings and the open responses. While the overall rankings were seemingly consistent between the different types of diseases, there were subtle differences when considering those measures below the top four. These differences could be found in more detail in the open response section. The consistency in the top five showed that there were a basic set of measures which should be taken. Additionally, the open responses which had further explanations of their rankings often completed an in depth interpretation of the preventative measures.

The top ranked measures appear to be almost a fundamental standard which is needed for any disease. These create a standard which is necessary before more specified measures can be put into place. These specified measures can be assigned to the common disease types which we have identified. The subtleties arise in fourth to seventh place where there is the most variation from disease type to disease type. It is within these that the focused measures can be taken for disease type beyond the fundamental level. Additionally, it is important to turn to the open response section to see how the respondent interpreted the preventative measures. One of the most important interpretations was that of decontamination zone versus and disinfecting common workspaces. When interpreted as two different measures, decontamination zones were seen as a negative, costly measure, and were not applied to most of the disease types, except vector borne diseases, where decontamination zones were discussed positively. This could be seen across the transport respondents and the public health respondents. The implications of this is that when interpreted separately from disinfecting common workspaces, decontamination zones meant something different and therefore were ranked differently.

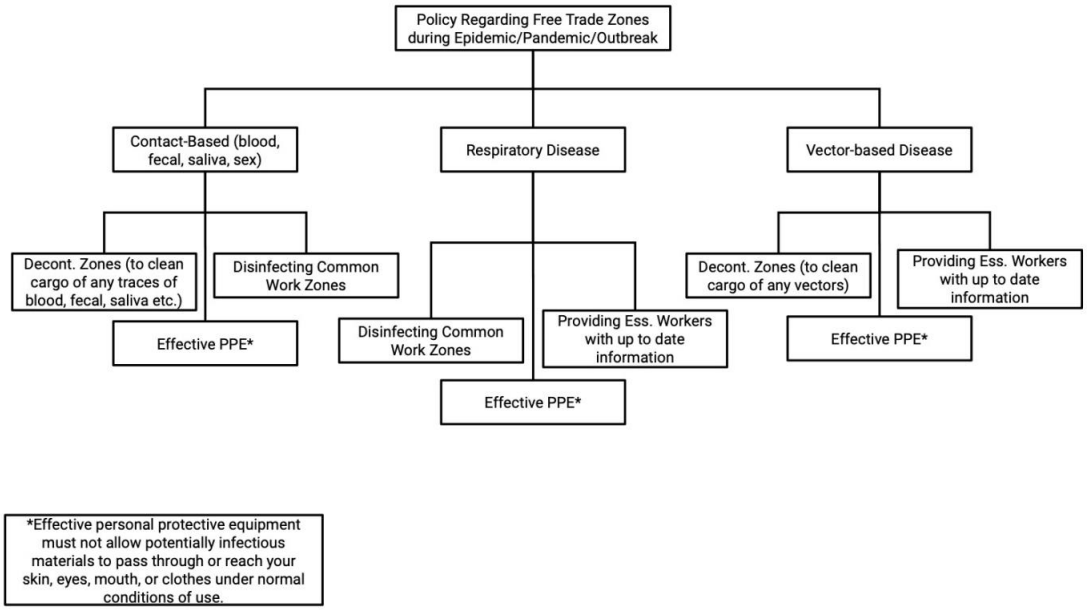
4.3.5 Summary

Based upon the ranking of the preventative measures and the open responses, it is clear that there is a fundamental standard which needs to be in place before more complex measures can be implemented. Additionally, the ranking was greatly dependent on the interpretation of the various measures. Different interpretations were often seen when people spoke about multiple measures together or came from different expert fields. Beyond this, there were different meanings to measures depending on what other measures they were discussed with. It is important to take the rankings hand and hand with the open response in order to best understand how the respondent interpreted the measures and then how and why they ranked them in the order that they did.

4.4 Round Three Findings

The framework given to our experts is shown below in Figure 8**.** All of the participants agreed with the proposed policy framework, generating consensus. Based upon that data, the framework we created would lead to productive policy development according to our experts.

Figure 8: Policy Framework Presented to Experts



The experts also had additional comments which clarified their last thoughts. One participant said, “I think this is a start, but these policies and procedures are certainly complicated and dependent upon resources and willingness of people to comply (as we are learning with the current pandemic)”. Throughout the creation of our methodology and the process of collecting all of our data, we learned the depth and complexity of the question we were posing and so did our experts. The findings aimed for in our third round were to create a fundamental set of measures that were either independent or loosely dependent with a disease so they can be implemented before more specific recommendations could be generated by medical professionals researching the outbreak. This was also supported by one of our experts saying:

> As new threats appear it can often take time to root-cause the threat and fully understand whether it is concurrent with other threats [...] I would recommend a policy framework that starts with an initial triage phase that includes the elements of all three that can be quickly implemented before the threat is fully understood. As time progresses, the approach should adjust to the new data. However, erring on the side of strong, decisive action that is semi-agnostic to the nature of the threat may succeed in containment with greater reliability than relying on definitively identifying the threat before acting.

The choice between being broad or more decisive in our recommendations is one that is hard to make. Based on the responses of our experts throughout the study, it is clear that a more general response is favored.

The importance of information was stressed by our experts throughout the study. Two participants stated the importance of proper information channels to be a standard measure for all of them. These inputs were made in previous sections as well.

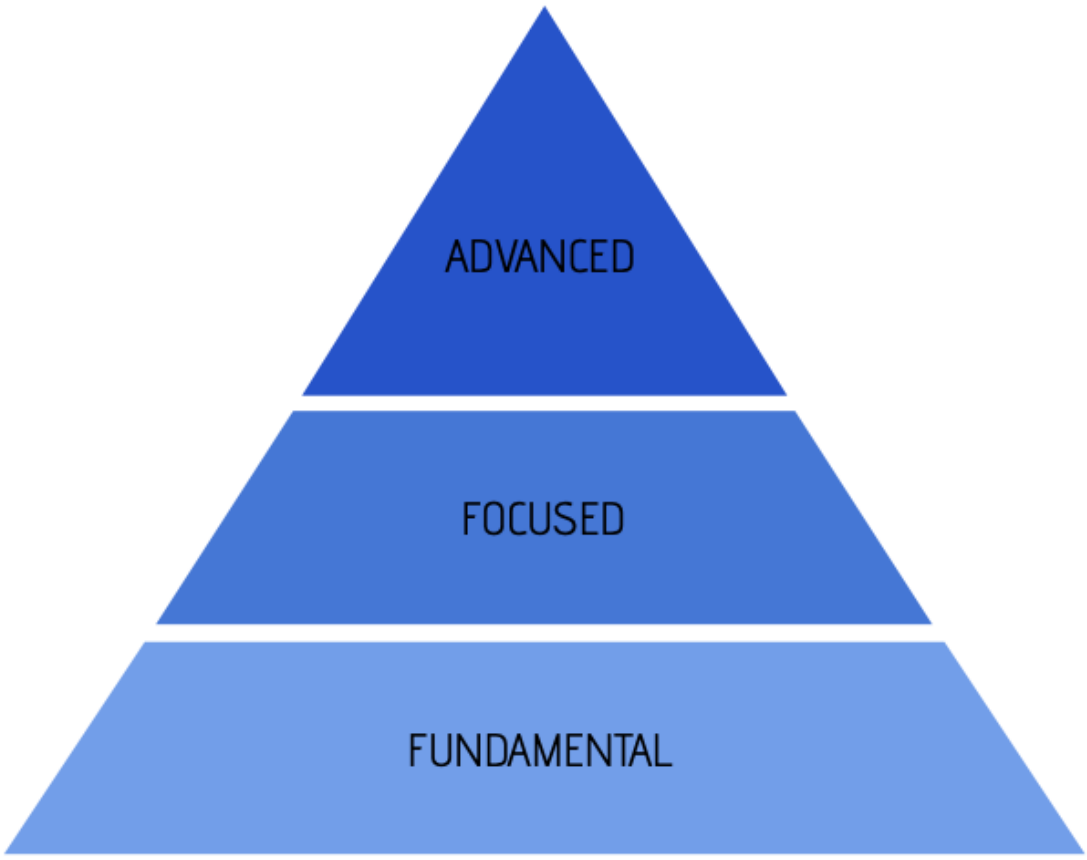
4.5 Summary

The process of this Delphi study can be simplified to creation, comparison and consensus. In the first round, the experts created and formed their thoughts and opinions. In the second round, the experts compared their thoughts to those of the other experts. This allowed the experts to learn what other people were thinking and adjust their thoughts. The final round took everything the experts created and conversed about and fed it back in a succinct manner to gage whether or not we understood what the experts were agreeing upon. Our three round emergent Delphi study produced expert consensus and clear policy recommendations.

Chapter 5: Conclusions and Recommendations

During our Delphi study we were provided with many measures that could be used to reduce the spread of disease during times of outbreak. Our first round introduced our problem to the experts and probed them to initially start thinking about our problem in an open-ended context. After that first survey the next two surveys built off answers provided by the experts to create consensus among them. At the end of the study we created a hierarchy of measures (Figure 9), which dictates the order of implementation.

Figure 9: Hierarchy of Measures



The first level is the fundamental measures. Fundamental measures should be implemented with ease. The main point in developing fundamental measures which are not specific to the mode of transmission is to provide a series of measures which can be used to protect employees until

more specified measures can be put in place. These fundamental measures are personal protective equipment, disinfecting workspaces regularly, and keeping essential workers up-to-date with information. After the fundamental measures are implemented, the focused measures can be implemented. These measures are applied to the three common disease types which we have identified. These are education for contact-based disease, social distancing for respiratory disease, and decontamination zones for vector borne diseases. At the top of the hierarchy are the advanced measures. These measures are complex and require resources and infrastructure to be implemented. They include treatment and testing options for essential employees, automation, and monitoring and tracing of essential employees.

5.1 Fundamental Measures

The fundamental measures are the broad measures which can be applied to any type of disease. The fundamental measures are personal protective equipment, disinfecting workspaces regularly, and keeping essential workers up-to-date with information. These measures create a standard that can be scaled up in times of outbreak, epidemic, or pandemic.

5.1.1 Personal Protective Equipment

Personal Protective equipment is a fundamental measure that is able to be implemented with ease. Personal protective equipment can be many different things such as gloves, masks, face shields, or full body suits. It is critical that transport companies have the necessary personal protective equipment in the case of an outbreak of disease. Personal protective equipment must also be adequate quality to ensure it is offering sufficient protection. Not only does the personal protective equipment need to be readily available but also be adequate in the sense that the equipment works as it should and truly protects against the spread of the disease at hand.

5.1.2 Disinfecting Common Workspaces

Disinfecting workspaces should be something that occurs regularly, but during times of outbreak disinfecting must be done more often and with a higher degree of thoroughness. Frequency of cleaning should be increased proportionally with how widespread and communicable the disease is in the case of an outbreak. Work and common spaces should always be cleaned and disinfected regularly, but in times of outbreak, epidemic, or pandemic a higher attention to detail must be put into the disinfecting of common places, especially within transport companies.

5.1.3 Providing Information to Essential Employees

During events such as outbreaks, epidemics, or pandemics, the information about said diseases must be provided to transport workers quickly and in a way that the workers understand. The information should include how the disease is transmitted, where the disease currently is, whether or not some people are at a higher risk than others, and any other information that would help the workers understand the disease. When all the necessary information is given to essential workers, the risk of contraction of the disease should be lowered due to the workers knowing how the disease spreads. Information that would be a necessity to essential workers would be the mode of transmission of the disease, what types of personal protective gear is effective against the disease at hand, what the symptoms of the disease are, and any other information that would help prevent essential workers from becoming infected.

5.2 Focused Measures

After having the fundamental measures in place, the focused measures can be implemented for common disease types. The common disease types which we have identified are contact-based, respiratory, and vector borne. Contact-based disease is transmitted through bodily

fluid, including feces, semen, vomit, saliva, urine, and vaginal fluids, and blood. Respiratory disease is normally transmitted through airborne particles or droplets. Vector Borne disease is transmitted through animals such as rats and fleas in case of the bubonic plague or mosquitoes in the case of malaria.

5.2.1 Contact-Based Disease

In the case of contact-based disease, there needs to be an increased level of education. This is the responsibility of transport companies and trade organizations due to the link between contact-based diseases, such as HIV/AIDS, and transport. Education is the next step within the concept of providing information to essential employees. It takes information to the next level and therefore belongs in the focused measures. This education ranges from teaching what preventative measures that can be taken, such as engaging in protected sex, using clean needles, to educating people on how to seek treatment for disease and clean bodily fluids safely. By educating the essential employees about proper preventative measures the risk the employees will be at for the disease will be decreased.

For more contagious contact-based diseases, such as Ebola, more strict measures must be taken. These measures focus on limiting human interaction, either through automation or social distancing. Social distancing is recommended over automation due to the expense of automation and feasibility of implementing automation. However, there are situations when social distancing is not feasible, due to lack of space. This is where automation would be a more viable solution as to decrease the need to have human interaction.

5.2.2 Respiratory Disease

Beyond the fundamental measures, the next most important measure to take is reducing human interaction when considering respiratory disease. Decreasing interactions between

humans is important as asymptomatic and symptomatic humans are able to spread disease easily when they are within close proximity of each other. Social distancing is recommended over automation due to the expense and feasibility of implementing automation. In order to effectively use social distancing, it must be followed in all circumstances without any exception. This was the most important measure following the fundamental measures when considering respiratory disease.

5.2.3 Vector Borne Disease

Vector borne diseases present a more unique type of disease. When considering preventative measures beyond the fundamental measures, decontamination zones are recommended. Decontamination zones are the most effective for ridding cargo of a vector and decreasing human interaction with a vector. This could include a holding area where cargo sits for a period of time that is long enough to ensure the death of the vector or could include an area where all vectors are exterminated. The importance in decontamination zones relies on decreasing the contact between humans and the vector. By doing this the likelihood that the disease spreads through the facility and through the cargo when it is further transported is decreased.

5.3 Advanced Measures

Over the course of our study, there were measures which were strongly recommended, but needed greater resources and infrastructure. These are advanced measures as they require both the fundamental and the focused measures to already be implemented. These measures can be thought of as long-term goals which can be met but are not immediately necessary. The advanced measures consist of providing treatment options for essential employees, automating

processes at border crossings and checkpoints, and monitoring and tracking the spread of the disease.

5.3.1 Testing and Treatment Options for Essential Employees

The first of these higher-level solutions is to provide treatment and testing options for essential workers. The benefits of providing treatment options for essential employees are based on the environment which they would create. Without treatment and testing options available, employees will feel uncomfortable self-reporting symptoms. This will partially be fulfilled through the fundamental measure of providing information and the focused measure of education. Additionally, after self-reporting they will be treated, and this will decrease the further spread of disease. Without providing enhanced treatment and testing options, the likelihood that employees will continue to work through symptoms is higher due to fear of repercussions.

Testing and treatment is a broad category which spans over a variety of options. This includes vaccination, preventative medications, and sufficient treatment options. Vaccination is only viable if there is a vaccine available which has been tested and is in sufficient supply. Vaccination is important as it would allow essential employees to gain immunity against the disease and be able to continue to work with a greater sense of safety. Preventative treatment options can be given to employees who are at a greater risk for a disease. This can be discovered through education about disease, one of the focused measures. Sufficient treatment options are necessary when considering testing of employees. Testing is important as it allows for the identification of infection within a facility. However, implementing testing without offering sufficient treatment options leaves employees stranded.

5.3.2 Automation

Limiting human interaction through automation is an effective method when considering decreasing the spread of disease, especially within customs and border crossings. However, this process requires a significant level of infrastructure, such as electricity, advanced operating systems, and technical expertise. Improvements in infrastructure can be made in order to facilitate the proper implementation. Without proper infrastructure, attempting to put in place an automated system would be ineffective and potentially harmful to essential employees.

5.3.3 Monitoring and Tracing

An important advanced measure is the monitoring and tracing of disease. This includes monitoring essential employees and then tracing the spread of disease through those who have become infected. This measure must be supported by treatment and testing. If employees are monitored and their interactions are traced without having a safety net in place, it is likely that they will be fearful and uncooperative. Additionally, if they are identified as possibly infected through monitoring and tracing, testing and treatment are the next steps. In order to successfully monitor essential employees, key symptoms must be identified, such as temperature. Monitoring must be completed consistently and routinely to achieve effectiveness. Tracing is beneficial throughout a community allowing for people who are potentially infected to be identified based upon their interactions. In order for tracing to be successful, the fundamental measure of providing information must be implemented. Beyond this, tracing involves a significant amount of resources and funding. Without these resources and infrastructure, these measures would not be successful.

5.4 Implementation Plan

An objective of this study was to provide an implementation plan for transport companies and public health organizations in times of outbreak, epidemic, or pandemic. The easiest way to accomplish this is to have a standard plan that is followed at all times that can then be scaled up in the event of an outbreak, epidemic, or pandemic. By creating fundamental measures that are in place at all times, companies will be able to react more quickly to the sudden emergence of a disease. Personal protective equipment should be an everyday part of transport companies, with ample inventory available. Companies should have regular routines of cleaning, including disinfection of spaces frequented by employees. Even without the occurrence of a pandemic, companies should have direct and available lines of communication to provide information to all employees from people in charge.

5.4.1 Personal Protective Equipment

Personal Protective Equipment (PPE) must be implemented in everyday use in order to facilitate the scaling of PPE during times of outbreak, epidemic, or pandemic. By implementing daily usage, there will be a routine set in place with regards to PPE, which then decreases the resistance to scaling. Everyday PPE usage is, at a minimum, gloves. When scaling, face masks, face shields, and full body suits should be considered.

In order to implement this a strong and reliable supply of PPE is also needed. As can be seen during the COVID pandemic, reliable sources of PPE were difficult to find. To do this, all essential employees in free trade regions need to have access to a one-month supply of disposable PPE in the event of an outbreak. Many countries around the world stated that they faced a one-month shortage of PPE during the COVID-19 pandemic (Kaplan, 2020). Disposable PPE refers to gloves and masks. There also must be reusable PPE such as face shields and

bodysuits. There should be a minimum of one bodysuit and one face shield for every employee that is on a specific shift. The source of the PPE must be reliable, meaning the supply chain cannot be disrupted during an outbreak, epidemic, or pandemic. This can include having alternate supply chains in place that ensure the continued supply of this crucial equipment.

5.4.2 Providing Information to Essential Employees

Providing up-to-date and clear information to essential workers is a crucial fundamental measure. Essential employees must be given access to reliable information quickly. These employees must be given current information that is relevant and meaningful to the problems at hand. This is achieved through developed and open channels of communication. The channels of communication need to have defined positions from the highest level of a company or organization to the lowest. Additionally, these channels must be monitored in order to ensure that they are being utilized effectively and efficiently. Every person who is a part of a communication chain needs to know what their position entails and who the people in the chain around them are.

In order to implement the provision of essential employees with information, communication chains need to be well established not just during an outbreak, epidemic, or pandemic. This would entail weekly meetings. Within these meetings, disease does not need to be the topic of discussion, unless during an outbreak, epidemic, or pandemic. Holding weekly meetings creates a structured system and sets a routine. This facilitates the increase in meetings with essential employees during times of outbreak, epidemic, or pandemic. Additionally, by holding weekly meetings with the same person running them, a relationship is formed. By building this relationship, there is a level of trust between employees, increasing the level of compliance.

5.4.3 Disinfecting Common Workspaces

Disinfection of common workspaces is an effective measure which is relatively easy to implement into everyday life. We defined common workspaces as any surface or item that is touched almost daily, which includes desks, keyboards, countertops etc. Additionally, common workspaces include areas within the facility where multiple employees gather or visit, such as breakrooms, waiting rooms, or bathrooms. In order to implement this, essential employees will need reliable access to disinfecting supplies and will need to consistently disinfect their work areas. This would involve cleaning sprays, wipes, and other products that are meant to disinfect high volume areas. There must be approximately a month's supply of these disinfectants for everyday disinfection. This is extremely important when considering shortages seen during COVID-19. Beyond having a supply, there must be a reliable supply chain established where these disinfectants can be purchased. The disinfecting of these workspaces will be done at least once a week as a preventive measure. Having this routine in place during 'normal' times will make the scale up process much easier.

5.5 Future Research

The decision to pose our research problem at the intersection of multiple fields limits the ability to discuss specific topics related to each field in greater depth. This is due to a lack of knowledge base of certain participants to others. This initial design choice allowed us to look at a much bigger picture, but hampered our ability to focus on certain elements. We would recommend that there is further research done on this problem.

Our recommendation would be to research this problem more in depth in each field and then explore the intersection of the fields again. Through our background research, we found little discussion about this topic and little evidence of implementation of these types of measures.

To be able to have conversation and research on a set of measures that could be done on all of the modes of transmission without the need for simplification would be valuable.

Along a similar route, analyzing alternate supply chains and assessing the current viability or effectiveness and the robustness of supply chains across the world would prove fruitful. The ability to prevent the shortage of resources due to suppliers of goods and trade routes being compromised is invaluable. In the current COVID-19 pandemic, the world is experiencing shortages of medical supplies and food with little that can be done about it. If an alternate supply chain plan was in place, this shortage of supplies could be prevented.

Researching the advanced measures mentioned by our experts is another way to continue this conversation. Some of these concepts brought up through our data were not talked about in great detail due to a lack of higher-level knowledge in these topics being shared among all participants of our study. These topics include automation, treatment and testing, and monitoring and tracing disease spread. Any of these topics could produce an interesting research opportunity when presented and pitched to the correct group of experts with a good knowledge base shared among them.

We hoped to have started a conversation that can continue and be expanded upon by others. Beyond our advanced measures, we hope that future studies would include the evaluation of our current measures. Whether this is completed through another series of surveys of experts or through the implementation of our measures and evaluation through feasibility and success, we believe that the continuation of this study is extremely important.

5.6 Summary

The development of our hierarchy of measures was based upon the results of surveys and the expert opinions. Within this hierarchy each level of measures must be implemented before the next can be. These levels are fundamental measures, focused measures, and advanced measures. Fundamental measures include personal protective equipment (PPE), providing information to essential workers, and disinfecting common workspaces. The focused level is separated by three common disease types. For contact-based diseases, education is an important measure. For respiratory disease, social distancing is the next measure to be implemented. In the case of vector borne diseases, decontamination zones are necessary. On the most advanced level are measures which require resources and developed infrastructure. These include treatment and testing measures, limiting human interaction through automation, and monitoring and tracing disease. Implementation of our fundamental levels was based upon the need that all of these measures are implemented on an everyday level. Importantly for the implementation of these measures having a supply of both PPE and disinfectants is crucial for disease prevention. Finally, we identified four key areas for future studies. These are specialized surveys, alternate supply chains, the advanced measures, and the evaluation of our fundamental measures.

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Appendix A: Round One Survey

Block 1

Welcome

Welcome to our survey. We would like to thank you for taking the time to participate in our series of surveys. We are a group of student investigators exploring the gap in knowledge of public health and transport policy. We would like to use your expertise to bridge this gap and try and create a series of prepared measures that could be used in free trade regions in the future when a disease strikes.

The study will take place over 3 weeks. We anticipate that each round should take you no more than 15 minutes each. The round one survey asks you to brainstorm different measures you would foresee being helpful to the continual operation of a free trade regions. In round two and three, we will be releasing our a report of our findings and select anonymous responses from the previous survey. We will again ask your opinions on the data and if there are any further suggestions. The round two survey will use data from round one and the round three survey will use data solely from round two.

Principal Investigator: Joseph Doiron

Investigators: Colby Gilbert, Kiernan Joyce, Julia Noel, Jim Zickl

Contact Information:
jdoiron@wpi.edu; gr-fts-pandemic@wpi.edu

Round 1:

1. Informed Consent Form: Please review the document and accept
2. Selection of Measurements
3. Explanations on thoughts

Click the arrow below to continue.

Informed Consent

First Name

Last Name

Employer

Position

Email
*Only used to continue sending you the survey

Informed Consent Agreement for Participation in a Research Study

Title of Research Study: Free Trade: Pandemic Delphi Study

Introduction:
You are being asked to participate in a research study. This study will take about fifteen minutes to complete, spread over the span of 3 weeks. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may fully informed decisions regarding your position.

Purpose of the Study: The purpose of this study is to investigate preventive measures that can minimize the spread of disease without substantially impacting economic trade and prepare a series of recommendations to send to governmental health and transportation organizations.

Procedures to be followed: You will be asked to fill out a few surveys. You can choose to skip any question you do not wish to answer and can discontinue your participation in the study at any time. In order to skip a question, simply write N/A. The first survey will ask for your participation and also has the first round of technical surveys at the end. We will ask the participant to list preferred measures to take during a disease outbreak in a free trade zone. One week later, we will send out another survey based on the results of the first survey requesting participants to give their thoughts on what other experts chose and the reasoning behind these choices. Then, we will send out a final survey a week later that asks for the participants thoughts on the data from the round two survey.

Your answers may be shared anonymously as part of a report sent to survey participants. This potentially includes the entirety of your response being shared. Additionally, the responses from this first survey will be used to develop the secondary survey and so on. Finally, it is important to understand that the "sharing" of these responses is simply to reach either a convergence or divergence

of opinion by the end of the study. This convergence or divergence will then be discussed in our final report.

Risks to study participants: This is a minimal risk survey. There is also a very small chance that others will find out how you have answered, which may impact your personal or professional life.

Benefits to research participants and others: Participants may benefit from this study by being given the opportunity to learn from their peers. Findings from this study will potentially benefit governments pursuing transport health policy.

Record keeping and confidentiality: Responses will be stored in the Qualtrics survey system. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators and under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Cost/Payment: There is no direct cost or payment for participation.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

Investigator Contact Information:
jdoiron@wpi.edu; gr-fts-pandemic@wpi.edu

Professor Kent Rissmiller:
WPI IRB Chair
508-831-5019
kjr@wpi.edu

Gabriel Johnson
Human Subjects Administrator
508-831-4989
gjohnson@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may be otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit. All personal information gathered in this survey will be solely for administrative purposes.

By accepting below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

- ○ I accept
- ○ I do not accept and will not participate in this survey

Block 1

What measures does a free-trade region need to include in their free-trade agreement to minimize the spread of disease without substantially impacting economic trade during an outbreak/epidemic/pandemic of a communicable disease? *i.e. decontamination zones, restricting trade to essentials, etc.*

Appendix B: Round Two Survey

Block 2

Welcome

Welcome to our second survey. We would like to thank you again for taking the time to participate in our series of surveys. We are a group of student investigators exploring the gap in knowledge of public health and transport policy. We would like to use your expertise to bridge this gap and try and create a series of prepared measures that could be used in free trade regions in the future when a disease strikes.

The study will take place over 3 weeks. We anticipate that each round should take you no more than 15 minutes each. The round two survey asks you to rank each of the most popular measures from round one within the context of specific disease types. We will again ask your opinions on the data and if there are any further suggestions. The round two survey will use data from round one and the round three survey will use data solely from round two.

Principal Investigator: Joseph Doiron

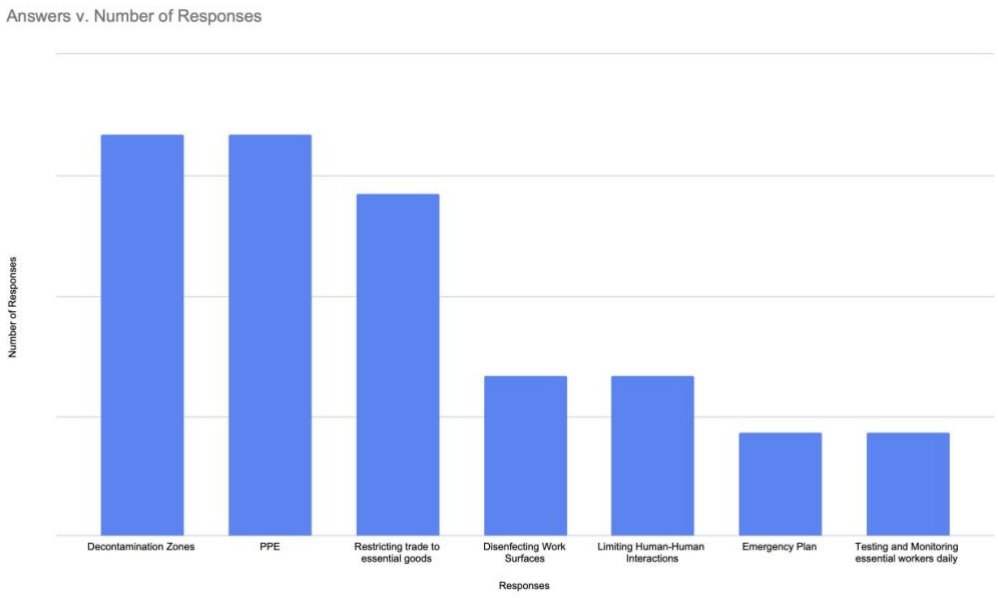
Investigators: Colby Gilbert, Kiernan Joyce, Julia Noel, Jim Zickl

Contact Information:
jdoiron@wpi.edu; gr-fts-pandemic@wpi.edu

Round One Summary:

The ideas that were stated most frequently were the use of decontamination zones and the mandated use of personal protective equipment, or PPE. Both of these suggestions were

given by 19% of participants. The next most frequent idea presented was implementing limitations on what are acceptable/essential goods, which 16% of participants suggested. The graphic below shows the most common responses shown by your peers in relation to each other.



Email

*Only used to continue sending you the survey

Please rank the following preventative measures from most effective (1) to least

For each of the following common ways a disease spreads, please rank the

following preventative measures from most viable (1) to least viable (9) by dragging the options

In our context, viable means effective while maintaining ease of implementation.

Bloodborne pathogen (i.e. HIV/AIDS, Hepatitis C, or Ebola)

Decontamination Zones

Personal Protective Equipment

Disinfecting Common Work Spaces

Restricting Trade to Essential Goods

Limiting Human-Human Interactions through Automation

Limiting Human-Human Interactions through Social Distancing

Testing and Monitoring Key Health Indicators of Essential Workers Daily (i.e. taking temperatures)

Regularly Tested Emergency Management Plan

Providing Essential Employees with up to date Information

Please describe the rationale for your decisions

Block 4

For each of the following common ways a disease spreads, please rank the

following preventative measures from most viable (1) to least viable (9) by dragging the options

In our context, viable means effective while maintaining ease of implementation.

Respiratory Disease (i.e. Influenza, Tuberculosis, or Measles)

Decontamination Zones

Personal Protective Equipment

Disinfecting Common Work Spaces

Restricting Trade to Essential Goods

Limiting Human-Human Interactions through Automation

Limiting Human-Human Interactions through Social Distancing

Testing and Monitoring Key Health Indicators of Essential Workers Daily (i.e. taking temperatures)

Regularly Tested Emergency Management Plan

Providing Essential Employees with up to date Information

Please describe the rationale for your decisions

Block 3

For each of the following common ways a disease spreads, please rank the

following preventative measures from most viable (1) to least viable (9) by dragging the options

In our context, viable means effective while maintaining ease of implementation.

Vector Borne Disease (i.e. Bubonic Plague, Zika Virus, or Malaria)

Decontamination Zones

Personal Protective Equipment

Disinfecting Common Work Spaces

Restricting Trade to Essential Goods

Limiting Human-Human Interactions thr ough Automation

Limiting Human-Human Interactions thr ough Social Distancing

Testing and Monitoring Key Health Indicators of Essential W orkers Daily (i.e. taking temperatures)

Regularly Tested Emergency Management Plan

Providing Essential Employees with up to date Information

Please describe the rationale for your decisions

Block 2

Based upon the given information, are there additional thoughts which had occurred to you while taking this survey?

Appendix C: Round Three Survey

Block 2

Welcome

Welcome to our third and final survey. We would like to thank you again for taking the time to participate in our series of surveys. We are a group of student investigators exploring the gap in knowledge of public health and transport policy. We would like to use your expertise to bridge this gap and try and create a series of prepared measures that could be used in free trade regions in the future when a disease strikes.

The study will take place over 3 weeks. We anticipate that each round should take you no more than 15 minutes each. The round three survey asks you to evaluate our policy framework which we developed from the round one and round two data. We will again ask your opinions on the data and if there are any further suggestions. The round three survey will use data from round one and round two.

Principal Investigator: Joseph Doiron

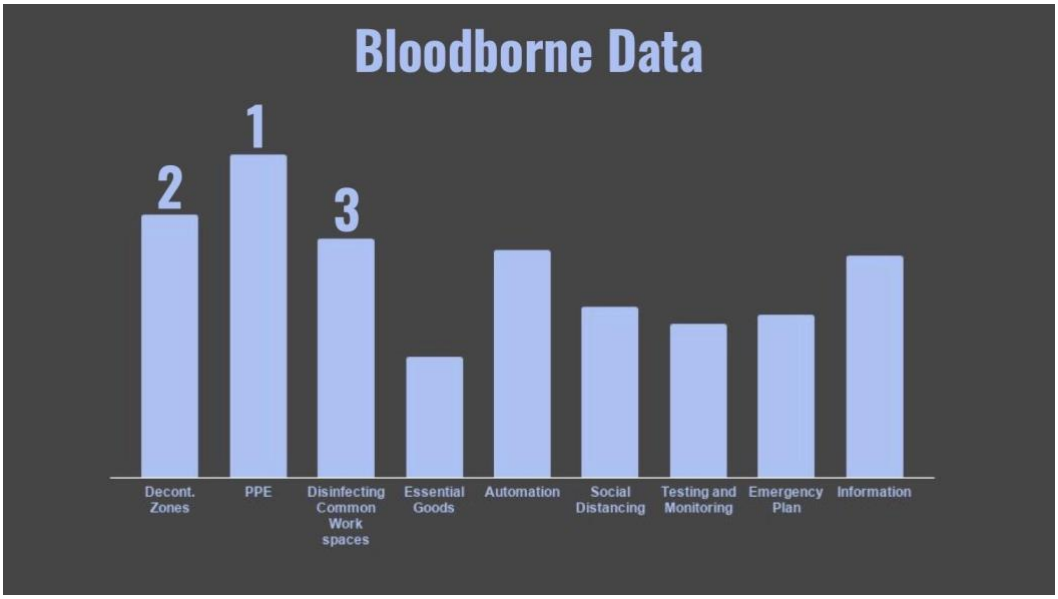
Investigators: Colby Gilbert, Kiernan Joyce, Julia Noel, Jim Zickl

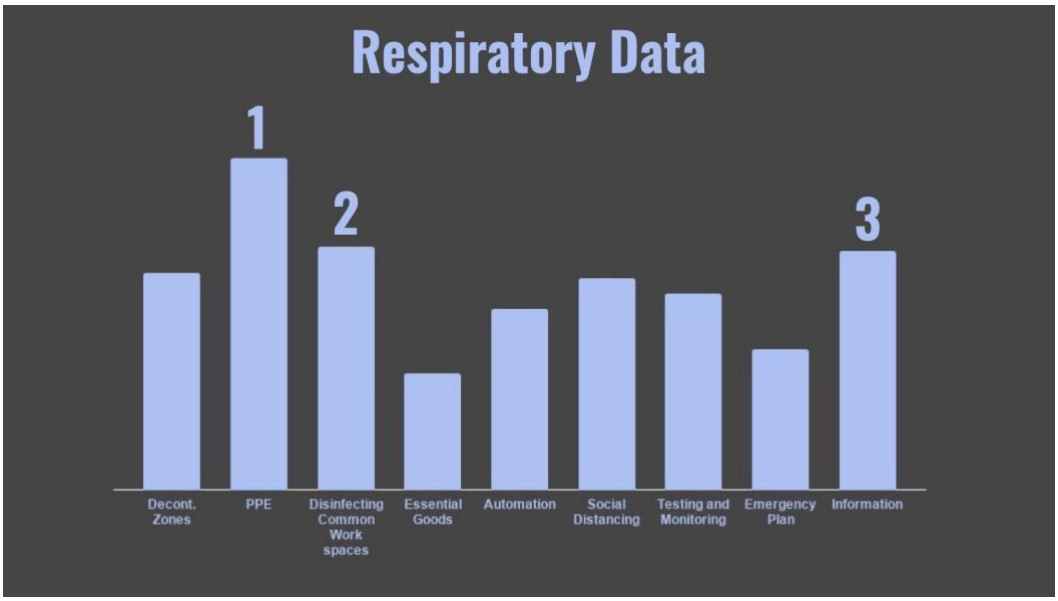
Contact Information:
jdoiron@wpi.edu; gr-fts-pandemic@wpi.edu

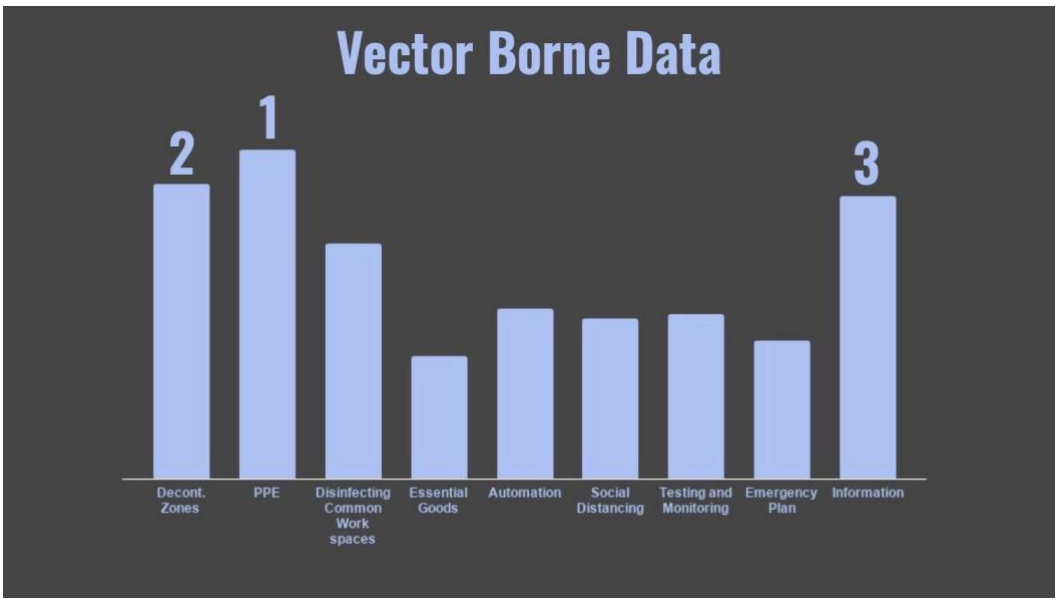
Round Two Summary:

During the second round of our study we asked you rank the most popular results within the context of the way disease spreads. For bloodborne diseases, the most popular options were personal protective equipment, decontamination zones, and

disinfecting common workspaces. For respiratory diseases, the most popular options were personal protective equipment, disinfecting common workspaces, and providing essential employees with up to date information. For vector borne diseases, the most popular options were personal protective equipment, decontamination zones, and providing essential employees with up to date information. Using this information and your comments we were able to build a policy framework. A policy framework is one of the first steps in building policy that outlines the foundation. You will be asked whether or not you agree with this framework on the following page. Below are graphs of the data from round two.



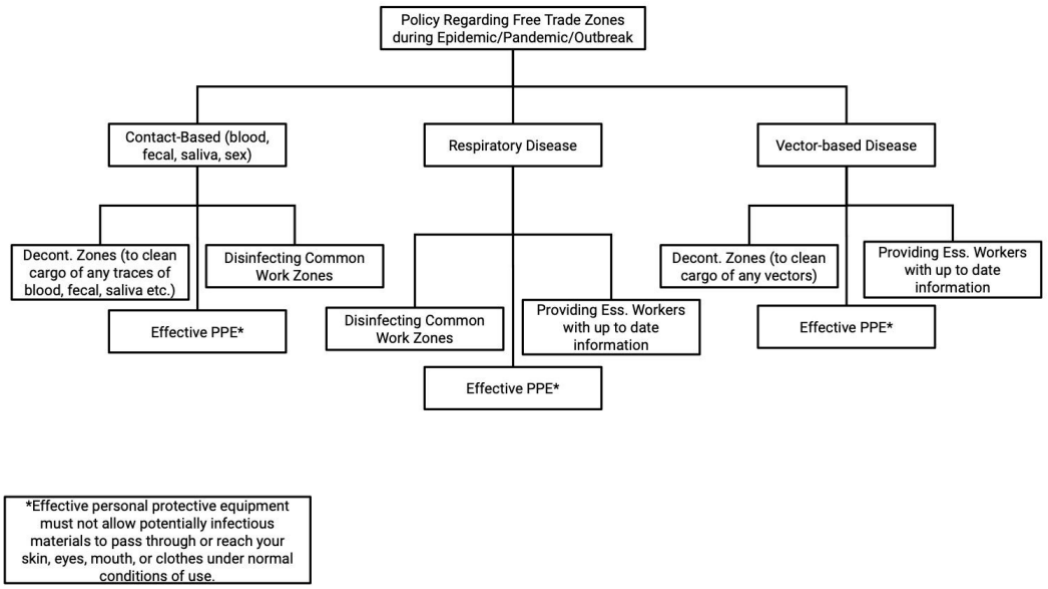

Respiratory Data
1
2
3
Decont. Zones
PPE
Disinfecting Common Work spaces
Essential Goods
Automation
Social Distancing
Testing and Monitoring
Emergency Plan
Information


Vector Borne Data
2
1
3
Decont. Zones
PPE
Disinfecting Common Work spaces
Essential Goods
Automation
Social Distancing
Testing and Monitoring
Emergency Plan
Information

Email

*Only used to continue sending you the survey

Default Question Block

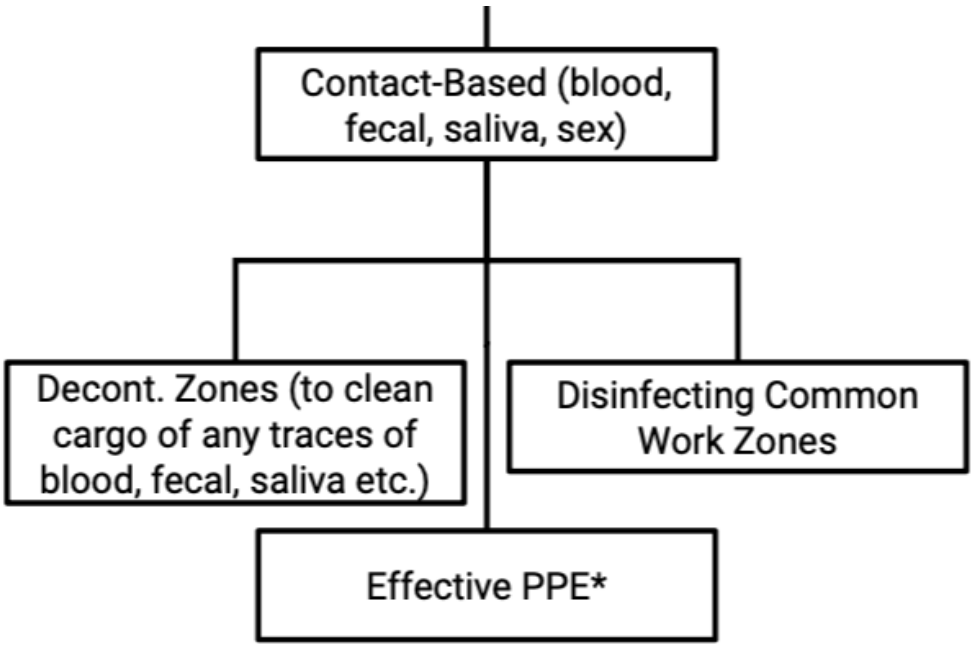


Do you believe that this policy framework would lead to productive policy development?

- ○ Agree
- ○ Disagree

Are there any recommendations you have?

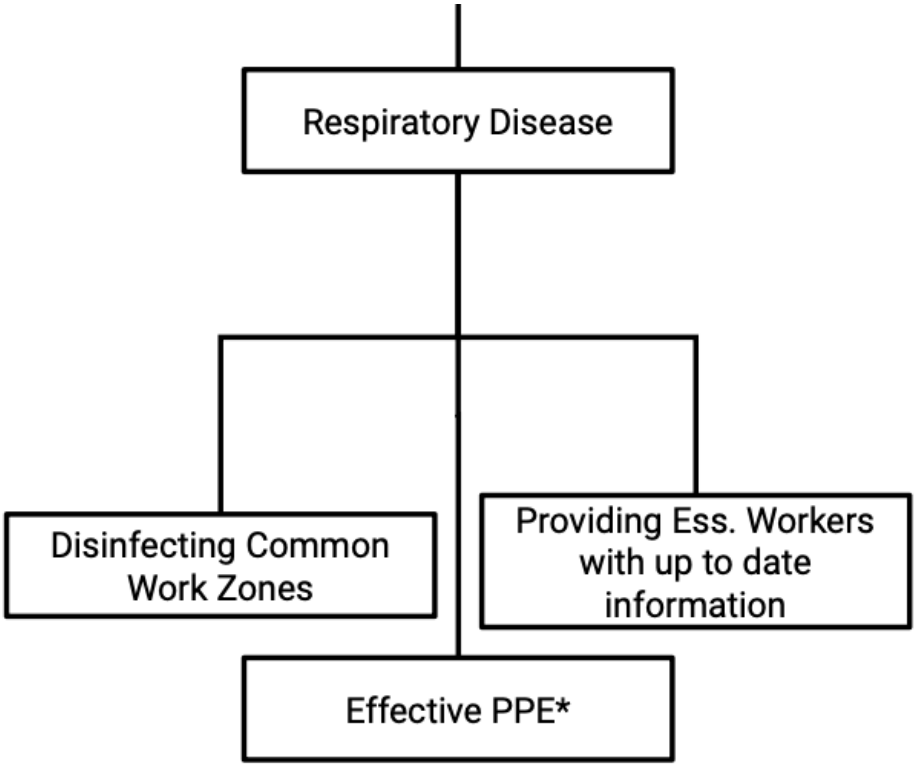
Block 2



Do you have issues with the Contact-Based Branch?

- ○ Yes
- ○ No

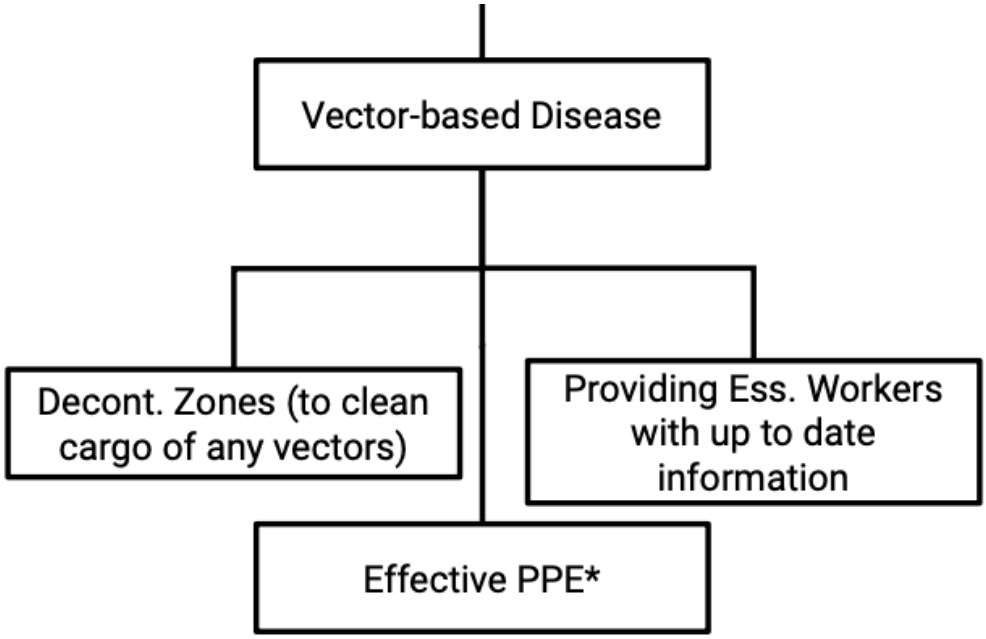
If so, what are they?



Do you have issues with the Respiratory Branch?

- Yes
- No

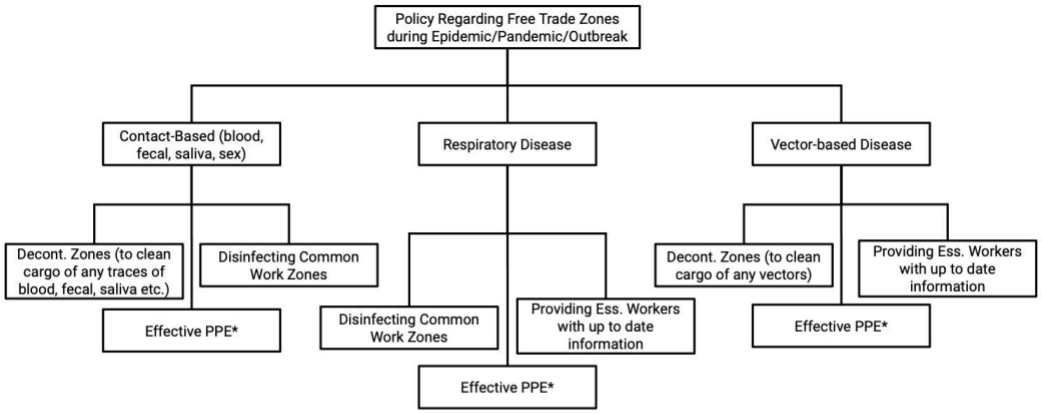
If so, what are they?



Do you have issues with the Vector Branch?

- ○ Yes
- ○ No

If so, what are they?



*Effective personal protective equipment must not allow potentially infectious materials to pass through or reach your skin, eyes, mouth, or clothes under normal conditions of use.

If you disagree with the framework as a whole, why?

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