Prospectus

Designing a Wearable Air Filtration System to Block Coronavirus Transmission
(Technical Topic)

Using Actor-Network Theory to Analyze the 2009 H1N1 Pandemic
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

COVID-19 is a contagious and deadly disease that is caused by the virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (*Coronavirus Disease 2019*, 2020). It primarily attacks the lungs and can cause the body to produce an overactive immune response (Sharma, 2020). As the number of COVID-19 cases keep escalating, the impact of this virus continues to cause havoc amongst people worldwide.

In order to limit the spread of the virus and significantly reduce the number of cases, a device that effectively blocks unwanted particles from entering the body is needed. The technical solution we plan on developing to address this issue is to design a novel wearable air filtration system that provides superior filtration and comfortability. This face mask apparatus will not only lower COVID-19 cases, but it will also provide a more comfortable fit that will make people more willing to wear their masks in public. However, a technical solution alone is insufficient to resolve this problem fully because it does not take into account different social factors, like the virus itself, the World Health Organization, and the media, that are consequently playing a role in the COVID-19 pandemic (Anwar et al., 2020).

By only focusing on the technical aspects of the problem and neglecting the social aspects, this inaccurately puts all the blame of the virus to poor technical designs of face masks. However, we know this is not true. There are many other social factors that have played a huge role in the progression of this pandemic. By also considering the social aspects using Actor Network Theory, we can gain a greater understanding of this idea by seeing how different actors, both human and non-human, play a role in the failure of the COVID-19 outbreak.

To effectively reduce the spread of the virus and limit COVID-19 cases, both technological and social factors must be considered. Below, I outline a technical process that

examines the design of a novel wearable air filtration system to limit spread of the virus. I also use the STS framework, Actor Network Theory, to analyze a similar case of the 2009 H1N1 pandemic to show how all the actors, both human and non-human, contributed to the failure and spreading of the H1N1 virus.

Technical

Globally, over 45 million people have been diagnosed with COVID-19 with over 1 million deaths to date, making it a worldwide pandemic (John Hopkins University of Medicine, 2020). COVID-19 got its name because "CO" stands for corona, "VI" stands for virus, "D" stands for disease, and "19" represents the year the disease started (CDC, 2020). It is caused by the coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and it is spread from person to person through respiratory droplets, which can be released from the body by coughing, sneezing, or talking (Ouassou et al., 2020). Because of this, face masks have been widely used to prevent the spread of the virus and to block particles from leaving or entering the body. The current designs of face masks that are used to help reduce the spread of COVID-19 are cloth, surgical, and N95 face masks. Cloth masks are mainly made from cotton and are used to trap droplets that are released when the user coughs, sneezes, or talks (Fox, 2020). Surgical masks are loose-fitting and disposable that protect the users from droplets by filtering out large particles in the air while also reducing exposure to saliva (*Can Face Masks Protect against the Coronavirus?*, 2020). N95 masks are actually a type of respirator that offers the most protection out of these masks. It can filter small and large particles when the user inhales through a one-way valve and is designed for 95% filter efficacy (Qian et al., 1998).

While the current designs of face masks provide some protection from COVID-19, there are still many limitations to these solutions. Both cloth and surgical masks lack a tight seal to the

face, which gives access for small particles to enter the body through the mouth and nose (Fox, 2020). N95 masks contain a one-way valve that releases unfiltered air when the user exhales. This does not prevent the spread of the virus if the user is infected (*Can Face Masks Protect against the Coronavirus?*, 2020). Other than the lack of filtration and spread of the virus, these face masks are also very uncomfortable. All masks during use are constantly covering the mouth and nose which makes it harder to breathe and leads to overheating (Scarano et al., 2020). The build-up of moisture under the mask from breathing also leads to people's glasses fogging up. If the current face mask designs continue to be utilized to prevent the spread of COVID-19, then the transmission of the virus won't slow down significantly. The poor filtration of current designs will allow COVID-19 particles to keep entering into the body, thus infecting more people (Konda et al., 2020). Also, the numerous elements of the current designs provide minimal comfortability. This can lead to people not wearing the masks correctly, like not covering their nose, and even to no use of masks at all.

The goal of this technical project is to design a new and improved wearable air filtration system that will reduce COVID-19 transmission through better filtration and a more comfortable design for users. The system will consist of a HEPA filter that has 99.97% efficacy, a cooling fan, a face shield, and a baseball cap (US EPA, 2019). The incorporation of widely available and inexpensive components into a single apparatus allows for superior filtration and comfortability. In order to develop the design, the thickness of the face shield will be optimized with regards to weight, protection, capability, and optical distortion due to the glare to make sure vision is not affected. The cooling fan will also be optimized with regards to size, static pressure, and weight so that the design pushes sufficient air down for the user to inhale. In order to test the functionality of the system, a filtration test will be designed where critical parameters, such as

the presence of air particles and air flow rate will be tested with different control and experimental groups. To test the comfortability of the design, a study will be conducted that will record categorical measurements of the fit and feel of the device and determine whether the design meets their expectation for comfort. These results will then be analyzed to help determine what design aspects can be modified in order to achieve better filtration and maximum comfortability.

STS Problem

In April of 2009, the Centers for Disease Control and Prevention (CDC) confirmed the first two cases of the novel influenza A (H1N1) virus in the United States (*What Is the Pandemic (H1N1) 2009 Virus?*, 2010). This virus lead to a worldwide pandemic that lasted about 17 months total (*2009 H1N1 Flu Pandemic Timeline*, 2019). The CDC estimated that from April 2009 to April 2010, there were roughly 60.8 million cases of H1N1 with over 12,000 deaths just in the United States (*2009 H1N1 Pandemic*, 2019). It is commonly referred to as the "swine flu" since the current strain was originated in pigs. It is spread from person to person through infected respiratory droplets and is transmitted as easily as the normal seasonal flu (Jilani et al., 2020). Many people believe the sole reason for the H1N1 outbreak was due to poor agricultural surveillance of pigs (Zarembo & Kaplan, 2009). They believe that if farmers were more aware of the health of their pigs, then there would not be a global pandemic of the H1N1 virus. The U.S. Agriculture Department even decided to launch a pilot surveillance project to look for new strains of the virus in pigs (*Influenza A Virus in Swine Surveillance Information*, 2020).

Even though this explanation of the pandemic's failure is somewhat true, this view overlooks many other factors and actors that also led to the H1N1 outbreak and contributed to the rapid spread of the virus. Not only were there technical factors that contributed to this failure,

but there were also many different social factors. For example, the World Health Organization (WHO) was a critical actor that played a role in the spread of the H1N1 virus. Their poor control of the virus through miscommunication and removal of pandemic guidelines received much criticism and contributed to the progression of the H1N1 disease (Kamradt-Scott, 2017). If we continue to only blame the farmers and agricultural committees, we will not understand the roles the other actors played in the pandemic's failure. By recognizing this, we can make sure to look at all the potential actors that contributed to the failure of a global pandemic in order to prevent it from happening in the future.

To analyze this idea, I will use the Actor Network Theory to argue that not only are the pig farmers to blame for the spread of the virus, but there are also other actors to blame including the H1N1 virus itself, the World Health Organization, and the media. The vaccine can also be seen as an actor, but it actual helps to stabilize the network. Using Actor Network Theory, it will allow me to analyze the interconnections between heterogenous actors, both human and non-human, associated in a single network. The idea of a network builder will be introduced to recruit these heterogenous actors to accomplish a common goal (Cressman, 2009). More specifically, I will use Michel Callon's concept of translation which examines the process of forming and maintaining an actor network. Translation revolves around assigning actors roles and translating their interests to serve those of the network (Callon, 1986). Using this concept, I will analyze the roles that both human and non-human actors played in the failure of the H1N1 pandemic and how these actors can cause the network to become vulnerable and unstable. The CDC will be used as the network builder that recruits these actors to accomplish a common goal. To support my argument, I will analyze evidence from Cressman and Callon articles, which provide further clarification regarding Actor Network Theory and translation. Also, I will use articles from

PubMed Central and the CDC website to further analyze the H1N1 virus and its effects. Lastly, I will use journal articles from the National Center for Biotechnology Information and newspaper articles to closely look at the different social factors that played a role in the spread of the virus.

Conclusion

In this paper, the technical and social factors together address the failure and continuous spreading of the COVID-19 virus. The technical report will deliver a new design of an improved wearable air filtration system that will provide better filtration of COVID-19 particles and more comfort to the users. This novel device will significantly lower COVID-19 cases and greatly reduce the spread of virus from person to person. In addition, the STS research paper will seek to provide further insight into Actor Network Theory by analyzing the case of the 2009 H1N1 pandemic. In this, we analyzed the different human and non-human actors that contributed to the failure of the H1N1 pandemic by using Actor Network Theory. This analysis will help broaden our understanding of how different actors can play such important roles in a network for a common purpose.

The results of the technical report will help resolve the broad socio-technical issue of preventing the spread of the COVID-19 virus by utilizing a system with better filtration of infected particles and comfortability. The findings from the STS paper will also help resolve the socio-technical issue by clearly showing and explaining how social factors play a huge role in contributing to the spread of the COVID-19 virus all over the world. Without this insight, people will not understand and look in to other possible actors that contributed to this outbreak. This analysis can be used for future outbreaks, so people can further understand how many different factors can contribute to its failure.

Word Count: 1987

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