# EVALUATION OF COVID-19 PANDEMIC MEASURES FOR MASS TRANSPORTATION IN ANKARA

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HIND FAHAD SAEED SHAHIN

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Submitted by **HIND FAHAD SAEED SHAHIN** in partial fulfillment of the requirements for the degree of **Master of Science in Urban Policy Planning and Local Governments, the Graduate School of Social Sciences of Middle East Technical University** by,

Prof. Dr. Yaşar KONDAKÇI
Dean
Graduate School of Social Sciences ____________________

Prof. Dr. Tarık ŞENGÜL
Head of Department
Department of Urban Policy Planning and Local Governments ____________________

Prof. Dr. Emine Yetişkul ŞENBIL
Supervisor
Department of City and Regional Planning ____________________

**Examining Committee Members:**

Assoc. Prof. Dr. Hediye Tüydeş YAMAN(Head of the Examining Committee)
Middle East Technical University
Department of Civil Engineering ____________________

Prof. Dr. Emine Yetişkul ŞENBIL (Supervisor)
Middle East Technical University
Department of City and Regional Planning ____________________

Prof. Dr. Burcu Çıngı ÖZÜDURU
Gazi University
Department of City and Regional Planning ____________________

**I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.**

**Name, Last name:** Hind Shahin

**Signature:**

**ABSTRACT**

EVALUATION OF COVID-19 PANDEMIC MEASURES
FOR MASS TRANSPORTATION IN ANKARA

Shahin, Hind
M.S., Department of Urban Policy Planning and Local Governments
Supervisor: Prof. Dr. Emine Yetişkul Şenbil

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COVID-19 was labeled a Public Health Emergency of International Concern by WHO on the 30th of January 2020. Countries enacted measures to curb the spread of the virus, many of which resulted in limiting peoples' mobility; mass transportation systems worldwide took the hardest hit. Thus, research emerged on the impact of COVID-19 on mass transit systems worldwide.

This thesis analyzes COVID-19's effect on Ankara's mass transit through detailing the measures taken by the city and the effects those decisions had on its network. Similar to other research, the thesis analyses the objective effects the pandemic had on mass transit. It also focuses on the subjective effects of COVID-19 on the system - an under-researched topic- through investigating residents' risk and efficacy perceptions of mass transit during the pandemic. Applying Protection Motivation Theory, a prominent health-risk behavioral model, literature review and an online survey were conducted to investigate the effects of COVID-19 on perceptions of mass transit in Ankara.

Findings support the hypothesis that COVID-19 had an effect on mass transportation in Ankara in terms of objective metrics such as ridership levels, commute time, commute distance, waiting time, and number of transfers needed; peak hours was the only metric experiencing no change as a result of the pandemic. In terms of the subjective effects of COVID-19 on mass transit in Ankara, participants mostly reported close to neutral efficacy and risk perceptions. Finally, limitations include sample size and time period covered; Findings are true only if corroborated through further research.

**Keywords:** Public Transport Perceptions, Covid-19, Protection Motivation Theory, Public Transport Journeys, Passenger Mobility Behavior.

# ÖZ

COVID-19UN ANKARADA TOPLU TAŞIMAYLA İLGİLİ YOLCU ALGILARINA ETKİSİNİN ARAŞTIRILMASİ

Shahin, Hind
Yüksek Lisans, Kentsel Politika Planlaması ve Yerel Yönetimler
Tez Yöneticisi: Prof. Dr. Emine Yetişkul Şenbil

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Covid-19 (Yeni Koronavirüs Hastalığı) Salgını, DSÖ tarafından 30 Ocak 2020'de 'Uluslararası Önem Arz Eden Halk Sağlığı Acil Durumu' olarak ilan edildi ve ülkeler, virüsün yayılmasını engellemek için çeşitli önlemler almaya başladı. Bu önlemlerin çoğu, insanların hareketliliğini sınırlandırdı ki dünya çapında toplu taşıma sistemleri ağır bir darbe aldı. Bu doğrultuda Covid-19 Pandemisi'nin toplu taşıma sistemlerine etkileri de araştırılmaya başlandı.

Bu tez, Covid-19'un Ankara'nın toplu taşıma sistemine etkilerini, alınan önlemler ve bu önlemlerin toplu taşıma kullanımına etkileri ve yolcu algıları üzerinden irdelemektedir. Diğer çalışmalara benzer bir şekilde pandeminin toplu taşıma üzerindeki nesnel etkileri Ankara örneği ile analiz edilmektedir. Buna ek olarak görece daha az incelenmiş bir konu olan Covid-19'un toplu taşıma üzerindeki öznel etkileri de bu tezde yolcuların pandemi döneminde toplu taşımaya yönelik risk ve etkinlik algıları ile araştırılmaktadır. Koruma Motivasyon Teorisi temel alınarak pandemi döneminde yolcu algıları literatür taraması dahil sağlık davranış modeli çerçevesinde çevrimiçi bir anket ile etüt edilmektedir.

Covid-19'un Ankara'nın toplu taşıma sistemine etkisi olduğu hipotezi, araştırmanın yolcu sayıları, işe gelip-gitme süreleri, mesafeleri, bekleme süreleri ve aktarma sayıları gibi nesnel ölçütlere dayanan bulgular ile doğrudan desteklenmektedir. Ancak zirve saatler, pandemi sebebiyle değişmeyen tek ölçüt olarak bulunmuştur. Katılımcıların çoğunlukla risk algılarına rağmen pandemiye karşı nötr tutumları, Covid-19'un toplu taşıma üzerindeki öznel etkilerini ortaya çıkarmaktadır. Son olarak, pandemi döneminde tamamlanan bu araştırmanın zaman-mekan ve örneklem büyüklüğü kısıtları dikkate alınmalıdır. Bu doğrultuda bulgular daha fazla araştırma ile irdelenerek doğrulanabilir.

**Anahtar Kelimeler:** Toplu Taşıma Algıları, Covid-19, Koruma Motivasyon Teorisi, Toplu Taşıma Yolculukları, Yolcu Hareketlilik Davranışı.

*To my mother and her two sisters, Soso & Mimi, the most beautiful women I know.*
*To Falasteen, may we will see your cities free.*

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# CHAPTER 1

# INTRODUCTION

## 1.1 Problem Definition

Strong mass transportation systems with high ridership offer substantial benefits for a society, contributing to the economic, social and environmental domains of sustainable development. Unfortunately, however, the use of mass transport in the majority of industrialized nations has decreased significantly over the past half a century. Instead, there is an increased reliance on private automobiles to provide for mobility needs. This trend has resulted in explosive traffic congestion levels and environmental deterioration. Today, we find ourselves in the middle of a pandemic that threatens to exacerbate this problematic mobility pattern. Ever since the discovery of the first case in Wuhan, COVID-19 resulted in a rapid change of lifestyles including a significant decrease in mobility and an unprecedented increase in teleworking. Those sweeping impacts were the results of governmental measures (e.g. travel restrictions) combined with individual choices to avoid travelling in an attempt to limit exposure to other people and the resulting risk of infection. Although all sectors of travel have declined worldwide, mass transportation has received the hardest blow (Molloy et al., 2020; Astroza et al., 2020). A portion of this reduction, indeed, owes to objective measures such as a reduced service supply, travel restrictions, lockdowns, social distancing and teleworking. On the other hand, however, negative perceptions of mass transportation as a riskier choice than private/personal modes of transport is increasingly recognized as a major determinant of the sector's performance worldwide. Faced with an outbreak of an infectious disease, individuals may take precautionary actions in an attempt to reduce their risk. This includes avoiding situations that are perceived to be risky by the individual, which may or may not accurately reflect the objective threat posed by that situation. In fact, research on the public's reaction to previous outbreaks has demonstrated that persons do engage in misjudged precautionary actions that have adverse effects on post pandemic recovery (e.g. avoiding low risk places or activities) or even on the individual's own health (e.g. avoiding healthcare facilities for fear of infection) (Sadique et al., 2007). The few available research on the effects of infectious disease outbreaks on mass transportation systems indicates the sector's extreme vulnerability to such misjudged precautionary action. The negative economic and social impacts of COVID-19 on mass transportation are not limited to the sector's service performance and financial viability but extend to a wide array of societal and health issues such as social equity and pollutant levels. However, there is a growing fear that the current pandemic will result in a reversal of perceptions where the view of mass transportation as the unhealthy choice will gain ground and shape mobility, and consequently health, patterns long after COVID-19 is gone. In order to avoid the extremely negative societal, environmental, and health impacts of automobile dependent cities, knowledge of how persons respond to the risk of an outbreak is essential to the industry's recovery and growth. Unfortunately, very few studies exist which apply the available health risk behavioral models on the context of mass transit, let alone during a pandemic.

## 1.2 Research Aim, Questions, and Structure

In light of the problem defined above, this thesis aims to contribute to the limited literature on health risk perception and the avoidance of mass transportation usage as a form of precautionary action. To this aim, the thesis attempts to answer the following general question "How has COVID-19 affected Mass Transportation in Ankara?" In the path towards answering this main question, a number of sub-questions warrant investigation. The first sub-question "To what extent are Mass Transportation systems conductive of infectious disease transmission?" attempts to provide an analysis of the actual contribution of mass transportation infrastructure to the spread of an outbreak. In other words, the question provides an objective background against which risk perceptions can be contextualized. The literature review covering this question is detailed in Chapter Two.

Next, the subjective aspect to the threat of infectious diseases in mass transportation is explored. This is done through applying one of the most widely accepted infectious diseases' threat perception models, Protection Motivation Theory, to the context of mass transportation. To this end, Chapter Three deals with the sub-question "What are the determinants influencing individual participation in a health related precautionary action?"

Chapter Four focuses on Ankara, the case study of this research. It includes a background on the status of Ankara's mass transportation system prior to the pandemic, the list of pandemic related measures adopted in the city and their consequent effect on mass transportation ridership, car ownership levels, and other mass transit performance metrics (e.g. average wait time, average commute time and distance etc.) in Ankara.

Chapter Five includes the methodology, analysis and findings of the online survey conducted to investigate the effects of COVID-19 on mass transportation usage and perceptions in Ankara. Finally, the last chapter of the thesis offers a general discussion on the post-COVID-19 future of mass transit.

# CHAPTER 2

# MASS TRANSPORTATION AND INFECTIOUS DISEASE SPREAD

## 2.1 Brief History of Transportation and Infectious Disease Spread

Infectious disease emergence is a very complex process. Often several events and factors must transpire either simultaneously or sequentially for an infectious disease to emerge or reemerge. Factors contributing to emergence of diseases, especially infectious diseases, can be grouped under the two categories of environmental changes and changes in human demographics and behavior. Microbial adaptation and change is one example of environmental changes (Wilson et al., 1994). On the other hand, technologic and economic development, breakdown in public health measures, human travel and commerce can be characterized under changes in human demographics and behavior. Among all factors listed, travel is an especially potent factor given that it contributes to both disease emergence and disease spread.

Throughout recorded history and probably even before that, humans have travelled. Initially, human movement has been driven by necessity in hunter/gatherer societies. As times changed, patterns of travel changed too. Purposes of travel evolved from obtaining food and agriculture to trade and conquest, employment, and finally leisure. Humans, thus, have travelled for different reasons and distances using different modes with varying and accelerating speeds. This idea is nowhere more brilliantly summarized than in the definition of history as the "account of man's travelling exploits and the ensuing consequences" (Cossar, 1994). One such consequence has been the spread of infectious diseases.

In a book titled "Plagues and Peoples", William McNeill details the crucial role of infectious disease in shaping the history of the world such as shaping the nature and location of human societies in addition to shifting power balances in war and peace (McNeill, 1979). In fact, military operations, in addition to trade caravans and religious pilgrimages, have fueled the most violent disease outbreaks in human history. Those include different episodes of the plague and small pox. In his book "Princes and Peasants: Smallpox in History", Donald Hopkins traces the spread of small pox from Egypt to India where it is presumed to first become adaptable to human hosts as early as 1000 B.C. (Hopkins, 1983). Small pox spread through respiratory charges and, albeit less dominantly, through contact with material (e.g. clothing) which was in direct contact with a patient. In the period between 542 and 750 AD, the Justinian plague spread through Mediterranean nations ravaging Persian and Roman populations and armies. Evidence points out that this disease, spreading along trade routes from the Middle East, contributed significantly to the conquest of this area by Muslim armies in the 7$^{th}$ century (Cossar, 1994). One of the most horrific examples of infectious disease epidemics was the Black Death, which began in the year 1320 A.D in Mongolia and its adjacent regions. For 30 years, the disease relentlessly spread along the trading routes of the Mongol Empire affecting China, India, Asia, the Middle East, Northern Africa, Russia and Europe.

By the end of the fifteenth century, measles, influenza, mumps, smallpox, tuberculosis, and other infections were already prevalent in Europe. Starting from 1517, smallpox and measles brought by European colonizers ensured the extermination of around two million Native Americans by 1530 (Cossar, 1994). In fact, small pox wiped one third to half of Santo Domingo's population as early as in 1518 and spread to other areas of the Caribbean and the Americas (Crosby, 1972). Another pandemic of small pox took place in Yugoslavia in the year 1970. The source of the outbreak was a pilgrim returning from Mecca who contracted the disease visiting a religious cite in Iraq. However, given the fact that he showed no symptoms, he was never isolated and managed to continue travelling all the way back home. There, in Yugoslavia, the pandemic resulted in 35 deaths (WHO, 1972).

The effect of human movement on the spread of disease is further illustrated in the pandemics of cholera. While cholera has been endemic in India for around two millennia, it only spread to the rest of the world in the 19$^{th}$ century. The first cholera pandemic of 1817 to 1822 was carried to Asia, Africa, Europe, and America on the backs of travelling British soldiers. A second outbreak of cholera crossed to South America on boats loaded with Irish immigrants (Cossar, 1994).

The influenza virus is the pathogen believed most likely to cause pandemics; causing three outbreaks in the 20th century alone. The wake of the 20th century saw the emergence of one of the deadliest influenza pandemics, that of the Spanish Flu. The pandemic raged from the beginning of 1918 until mid-1920, killing 21 million people, more than those killed by the First World War (Cossar, 1994). Others estimate the death toll caused by this strain of the influenza virus to be 25 to 50 million people (Taubenberger et al., 2019). Many attribute the widespread nature of the infection to technological advancement which allowed faster movement for an increased number of people. Two other 20th century pandemics caused by influenza viruses were the Asian influenza and the Hong Kong influenza in 1957 and 1968, respectively.

It is easy to regard those diseases as phenomena of the past, compared to the ongoing COVID-19 pandemic. However, apart from the current pandemic, coronaviruses have led to two serious human infectious diseases in the last 20 years. The first of these, Severe Acute Respiratory Syndrome (SARS), was first detected in November 2002 in the Guangdong Province of China (Ahmad et al., 2009). The disease spread quickly among the province's medical staff. On February of the following year, one of Guangdong's infected doctors travelled to Hong Kong, leading to the global spread of the disease (Tsang et al., 2003). Before dying of the disease several days later, the 64 year old nephrologist spent one night in a hotel in Hong Kong. There, he managed to infect 17 other hotel guests and visitors who, in turn, carried the virus with them to various destinations including Toronto and Singapore (Wang, 2014). The first recognized SARS case in Taiwan, one of the pandemics hardest hit regions, was of a 54-year-old businessman who traveled to Guangdong, China, on 5 February 2003, and returned to Taiwan via Hong Kong on 21 February but was not hospitalized until 8 March 2003 (Twu et al., 2003). Although this businessman and the Guangzhou doctor arrived to Hong Kong on the same day, 21 February 2003, it is not known if they flew using the same airlines. Although interpersonal transmission of the first SARS outbreak (November 2002 to July 2003) was successfully stopped, the global spread of this bat originating virus (SARS-CoV) still caused 8,447 cases and 774 deaths in 32 countries (WHO, 2003).

The second outbreak of an infectious disease caused by a member of the coronaviruses family was the Middle East Respiratory Syndrome caused by MERS-CoV in 2012. The outbreak started in The Kingdom of Saudi Arabia and spread to other countries including the United States, England, France, and South Korea. At the end of November 2019, a sum of 2,468 people had been infected across the globe (WHO, 2019). According to research, this Coronavirus, like its predecessor, originated from bats. However, it was only transmitted to humans after passing through camels as intermediate hosts (Omrani et al., 2015). Today, the world finds itself living in fear of yet another coronavirus, that of COVID-19. The first reported case was in China in 2019, hence the name of the disease. On January, 2020 the official number of reported cases in China alone exceeded the number of previous SARS cases in the entire world combined (X. Pan et al., 2020). On the same day the World Health Organization labeled the disease as more dangerous than its 2003 predecessor and announced a Public Health Emergency of International Concern.

As illustrated in the examples above, the relationship between travel and the emergence and spread of diseases is quite an established one. The movement of humans and materials has been the pathway for the circulation of infectious diseases since time immemorial and will continue to influence the emergence, frequency, and spread of infections. When humans travel, microbes, animals and a myriad of biologic life also travels with them. This allows different genetic pools to mix in unprecedented rates and combinations.

While travel may involve short distances or the crossing of international borders, most of literature has focused primarily on the latter’s role in infection spread. Consequently, air travel’s role in airborne and droplet transmitted disease transmission (TB, SARS, influenza, measles) has been the subject of considerable research (Abubakar, 2010; Hoad et al., 2013; Mangili & Gendreau, 2005; Moser et al., 1979; Young et al., 2014). In addition, a number of studies focus on respiratory infections (influenza, TB, Legionella) in all forms of ship travel: passenger, cargo, or naval (CDC, 2010; Houk, 1980; Tarabbo et al., 2011; Vera et al. 2014; Ward et al., 2010).

In contrast and until recently, the interactions between urban transportation and disease spread and emergence has been largely overlooked. This disparity in research is counterintuitive for various reasons. One of the most striking of which is the fact that mass transit built environments share important characteristics with other transport built environments including those of sea and air mentioned above. It is true that certain aspects of different transport built environments might differ based on what they transport (e.g. passengers vs. freight), the medium they travel through (i.e. air, land, water) and the vehicles used. However, they are all subject to an assemblage of indoor pollutants derived from outdoor sources, building materials, and occupant activities. Of these contaminants, biological agents pose the greatest threat given their allergenic, toxic, and infectious potential. Biohazards can infiltrate transport built environments using different pathways such as doors and windows, heating ventilation and air condition (HVAC) systems, and attachment to objects or infected people and animals (Nasir et al., 2016). In general, this applies to mass transit infrastructure as it does to that of aviation or shipping. Indeed, research has already demonstrated that enclosed environments, including different transport environments, are complex ecosystems where complicated interactions occur between humans, microorganisms and the physical environment (Kelley & Gilbert, 2013; Kembel et al., 2012; Nazaroff, 2016).

Consequently, anyone with an experience in using mass transportation can attest to the fact that such an environment is rife with opportunities for disease spread. In fact, one study found that public buses ranked third (following day care facilities and playgrounds) in the presence of bodily fluids (Gerba, 2005). Another study from Nottingham, UK, found that use of public buses and trams constitutes a significant risk for contracting acute respiratory infection in winter (Troko et al., 2011). Indeed, various studies have confirmed the presence of a risk factor linking the use of buses and the transmission of various airborne diseases such as influenza, measles and tuberculosis (Browne et al., 2016; Feske et al., 2011). Numerical modelling studies have also been conducted to measure the risk of airborne infection spread via mass transportation (Furuya, 2007; Zhang et al., 2016). For example, Zhao et al. (2015) have capitalized on Beijing's urban subway mobility data in order to plot the risk of an epidemic propagation via the city's subway system. When it comes to ground transport, a review by Mohr et al. (2012) has reported 14 events of airborne infection transmission in mass transportation (commuter buses, school buses, train). A study on London's underground and airborne disease transmission concluded that there was, indeed, a correlation between the use of the underground system and cases of influenza like illness (ILI) in London. More precisely, the research concluded that a higher number of ILI cases emerge in areas where the population spends more time in the underground or have a higher number of contacts when travelling. At the same time, the authors found that the number of ILI cases decreases in areas where inhabitants' use of the underground is limited or where such use incurs fewer contacts (Goscé & Johansson, 2018).

This is not to say that disease transmission is an inevitable fate of mass transportation. After all, the contamination and transmission of pathogens is the end result of a series of successive interactions between infectious agents (reservoir), hosts and transmission pathways (environment).

### 2.2 Factors Affecting Disease Transmission in Mass Transit Systems

Available literature on airborne infectious disease transmission in transport built environments, though relatively scarce, provides useful information on factors influencing the risk of exposure to biological hazards. Those factors, in turn, can be influenced, to varying degrees, by the design, construction, operation, management of, and behavior in different transport environments. The following section explores some of these factors in detail, specifically those pertaining to pathogen characteristics, nature and design of mass transportation and passenger behavior. An important note to make here is that the distinctions made below are not clear cut. For example, distance travelled is classified both as an element of transportation design and passenger behavior. This is only natural given that it is, indeed, a product of both. Duration of a trip might increase as a result of a poorly designed and/or integrated transportation system. It might, however, also be the result of personal choices and circumstances (e.g. long distance between work and home or a family member who lives far away).

### 2.2.1 Pathogen Transmission Method

Transportation planning can significantly limit passengers' risk of exposure to biological hazards by understanding the critical factors that affect the probability of infection transmission. In fact, one of the most important prerequisites to creating a bio resilient transport environment is developing a basic understanding of the different ways in which infectious disease can spread. Without such knowledge, the transportation sector will be unable to implement proper infection control measures and effective prevention campaigns. Based on the nature of the microorganism causing a given disease, various transmission methods can be identified. Relevant to this research are four transmission methods, namely transmission by direct contact, indirect contact, droplet contact, and airborne transmission.

Direct contact transmission requires physical contact between an infected person and a susceptible person, physically transferring the microorganism responsible for the disease. Direct contact includes kissing, sexual contact, contact with bodily secretions, body lesions, or merely touching an infected individual. Transmission through direct contact can easily occur on increasingly crowded mass transportation vehicles as increased crowdedness contributes to increased physical contact between passengers. Crowdedness also increases the probability of coming into contact with an infected person's lesions and bodily fluids through exposed breaks in their skin.

Indirect contact transmission, on the other hand, refers to infection transmission through contact with a contaminated surface. Some microorganisms are capable of surviving on surfaces for prolonged periods of time. This depends on the type of microorganism, the material(s) from which the surface is made, and the frequency of surface cleaning and disinfection. Thus, direct contact transmission occurs when microorganisms are transferred from one infected person to another without an intermediate object, while indirect contact transmission requires the presence of a contaminated intermediate object (Siegel et al., 2007).

Apart from direct and indirect contact, some diseases can be transferred when droplets containing microorganism come into contact with a susceptible person's eyes, nose, or mouth. Those pathogen-laden droplets are generated when an infected person coughs, sneezes, talks or sings. This process is referred to as droplet contact transmission. Droplets are usually too large to remain in the air for long periods of time and eventually fall off or settle out of air. This leads us to the final method of infection spread, that of airborne transmission.

Airborne transmission occurs when residue from evaporated droplets or microorganism laden dust particles have the ability to remain suspended in air for prolonged periods of time. Organisms transmissible through this method must have the ability to survive outside the body for extended periods of time and be resistant to drying. To simplify, droplets discharged by an infected individual can either settle or remain suspended in air depending on droplet composition and size at the time of release. Small size droplet nuclei can remain in the air for longer durations allowing it to be transported away from its initial source by air currents or recirculation ventilation. On the other hand, larger droplets settle out of air contaminating surfaces. Thus pathogens that spread through droplet contamination start a new cycle where they also spread using the indirect contact method through deposition on different surfaces such as ticket and cash machines, seats, doorknobs, staircase and escalator railings, and grab rails. If anything, this highlights an important point: the types of transmissions described above are not mutually exclusive. In fact, successful infection transmission from source to host is a multifaceted process which may include varying combinations of the four pathways listed above, making it difficult to pin point a single pathway and exclude another.

### 2.2.2 Characteristics of the Transportation System

Apart from characteristics pertaining to the pathogen itself, major risk variables pertain from the very nature of mass transportation and its environment. The advantages of an integrated transit system with extensive area coverage are many. Those include low per rider environmental footprint and higher energy savings compared to car based transportation (Shapiro et al., 2002). In addition, higher transit ridership results in reduced congestion on roadways thus reducing travel time for both transit and non-transit passengers. These advantages are the results of the defining characteristics of mass transit, namely the transportation of large numbers of people, in close proximity to one another, relying on the minimum amount of labor possible. However, those very same advantages turn into issues of concern when it comes to the emergence and spread of infectious diseases.

For example, research has already demonstrated that overcrowding in small enclosed spaces, poor ventilation, recirculation of contaminated air, and increased time of exposure will, in turn, increase a person's likelihood of contracting an airborne disease (Nardell, 2016; Wanyeki et al., 2006). In addition, those defining features of mass transit contribute to the industry's struggle in enacting traditional public health protections to help stem the spread of disease. Mass transportation users and personnel face various hurdles when it comes to applying the most basic public health precautions. Given the limited number of employees on board and their few scheduled breaks, opportunities to disinfect and even to simply clean vehicles are few and far between. In addition, mass transit lacks running water or the chance to practice social distancing measures. Thus and regardless of transmission mechanism (droplet contact, airborne transmission etc.), disease transmission occurs regularly on mass transportation vehicles (buses, trains, etc.).

More importantly, crowding is common place in both transportation vehicles and transportation hubs, particularly during rush hours. For example, results of a survey conducted by UK's Department for Transport demonstrated that the top ten overcrowded services were over their capacity by a range of 47 to 66 percent (DfT, 2011). During peak hours, passengers are stuck in close proximity to each other in poorly ventilated areas. In the presence of a symptomatic individual, such conditions create ripe environments for disease spread via direct or/and indirect means.

In this aspect, a research on influenza transmission in aircrafts highlighted the significance of ventilation. The study cited an incident where an airplane was delayed for 3 hours in an airport, remaining on the ground with the ventilation system turned off. Seventy two percent of the fifty four passengers on board were infected due to the presence of one patient on board (Moser et al., 1979). Another research, studying disease spread on naval ships, found that tuberculosis transmission was the result of the dispersion of infectious droplet nuclei in a closed environment via recirculation ventilation system (Houk, 1980). When it comes to the effect of proximity on disease spread, the WHO recommends performing contact tracing of all individuals who were in close proximity (defined as within two rows) of an infectious TB person for a duration of more than 8 hours during air travel (WHO, 2008).

Despite the differences between the three modes of travel (air, water, and land), the same environmental factors (proximity to infectious source, duration of exposure, and ventilation conditions) have been found to be true on land based mass transportation. Research concluded that closed windows and doors (poor ventilation), recirculation (ventilation systems) and crowding (proximity to infection source) increase risk of airborne infection transmission on mass transportation (Mohr et al., 2012). Similarly, Edelson and Phypers (2011) found that poor and/or closed ventilation in addition to proximity to index case increased the risk of exposure to Tuberculosis on mass transportation (Edelson & Phypers, 2011). In fact, various studies from countries with high TB rates demonstrated that the often-crowded and poorly ventilated conditions on mass transportation may significantly contribute to the spread of TB infections (Andrews et al., 2013; Horna-Campos et al., 2010).

Exposure duration, another important risk factor, varies significantly in different transportation vehicles and their hubs. Exposure might occur over a single trip (long or short) or during multiple or repeated trips. A link has been established between transmission and short but repetitive exposure, also referred to as cumulative exposure (Golub et al., 2001; Horna-Campos et al., 2007; Mohr et al., 2012). This indicates that the effect of exposure duration on successful airborne infection transmission may vary according to attributes of the infectious source, host, and environment (e.g. pathogen concentration, proximity etc.) (Nasir et al., 2016). It should be noted that exposure duration is influenced, among other things, by the degree of transportation system integration.

Finally, the hygrothermal condition of the built environment may affect the process of disease transmission. The term 'hygrothermal' is a combined expression referring to the movement of heat and moisture through buildings. Repeated wetting, drying, freezing and thawing of the fabric of a building can cause problems such as mold growth among many others. Unfortunately, the relationship between the aforementioned variables remain poorly understood and under-researched.

### 2.2.3 Passenger Mobility Behavior

Finally, designing effective intervention strategies would be incomplete if it accounts for factors relating to pathogen characteristics and environmental determinants alone. A third set of factors has an extremely influential role in the process of disease spread in transportation systems. Understanding passenger mobility behavior plays an important role in identifying groups of passengers that possess a higher potential of spreading disease. In fact, detailed mobility profiles including health related datasets provide crucial data that may contribute to a better understanding of a disease status and its progression (Nie et al., 2015; Wesolowski et al., 2016). For example, Pappalardo et al. (2015) found that explorers have more influence on disease spread than returners do. Returners are a group of passengers whose movement behavior is dominated by a pattern of few most frequented locations. Explorers, on the other hand, are individuals whose movement is defined by the tendency to wander between a larger number of different and new locations. Explorers, thus, cannot be characterized by their most frequently visited location as recurrent mobility has almost no contribution to their overall movement patterns.

In an incredibly informative and detailed paper titled “Identifying highly influential travelers for spreading disease on a public transport system”, Shoghri et al. (2020) study the effect of three mobility behavior aspects (degree of exploration, distance travelled and number of encounters of passengers) on infectious disease spread. The degree of exploration is classified into returners and explorers, the distance travelled into short distances and long distances and the number of encounters into low connected and highly connected individuals. Using one month of citywide smart card travel data collected of Sydney, the researchers identify which groups of passengers have a high potential to spread a disease and how this potential changes with varying pathogen suspension time and infection probabilities. The study found that highly connected returners are the most efficient disease spreaders. As pathogen suspension time increases, however, highly connected explorers replaces the former as having the highest disease spreading power. On the other and, an increase in infection probability increases the spreading power of all mobility groups, especially that of short distance returners (Shoghri et al., 2020). Previous studies by the same authors found that explorers were generally more influential in disease spread than returners and long distance travelers more influential than short distance travelers (Shahzamal et al., 2018; Shoghri et al., 2019). However, when only long distance travelers are considered, returners showed a greater potential in spreading the disease than explorers (Shoghri et al., 2020). Their more recent work is novel as it accounted for three different dimensions of mobility behavior simultaneously rather than studying each in isolation of the others. In addition, it also details how pathogen suspension time affects which group of passengers evolve to become the most efficient disease spreader. Thus, not only does it detail the relationship between three different aspects of passenger behavior (degree of exploration, distance travelled and number of encounters of passengers) but it also links passenger behavior to pathogen characteristics influencing disease transmission (suspension time).

To summarize, their research provides a quantitative link between factors relating to passenger behavior and those relating to pathogen characteristics in the context of disease spread on public transportation (Shahzamal et al., 2018; Shoghri et al., 2019, 2020) This research is novel as it accounts for those three different dimensions of mobility behavior simultaneously rather than studying each in isolation of the others. In addition, their research details how pathogen suspension time affects which group of passengers evolve to become the most efficient disease spreaders. Thus, not only do the authors detail the relationship between three different aspects of passenger behavior, but it also links passenger behavior to pathogen characteristics influencing disease transmission. Such work is essential given that it explains, in detail, the complex interplay between different passenger mobility aspects within scenarios of varying environmental and epidemiological nature.

## 2.3 Protection Measures

The previous section detailed various factors affecting disease transmission and spread. However, the quantitative impact of each of these factors on the others and on disease spread remains largely absent from literature. Naturally, this also translates to an absence of models detailing the impact of elements of design, construction, management and use on infectious disease spread in transport environments. Luckily, a good body of knowledge exists on infection control technologies and strategies for indoor spaces, especially those of health care built environments (Azimi & Stephens, 2013; Kowalski, 2012). The same is true for aviation built environment. Those can be adapted to other transport environments thus increasing their resilience to biological hazards. For example, a report by Airport Cooperative Research Programme (ACRP) studying the risk of infectious diseases spread in airports and aircrafts identifies 24 mitigation strategies (TRB, 2013).

Still, preventing and responding to biological threats in transport environments is complex and necessitates a multidisciplinary approach to design and implement appropriate control measures which must be informed by venue and scenario (Nasir et al., 2016). As Faass et al., 2013 stressed in their paper, many of the strategies for preventing infection spread could easily be implemented by organizations such as schools and hospitals but prove to be extremely challenging to apply in a typical mass transit context (e.g. social distancing). This is not surprising given that many of the research and reports available are not constructed with mass transportation in mind. In fact, mass transportation specific guidance for infection prevention remains rare. One exception was an H1N1-transportation specific training conducted by Rutgers University's Center for Transportation Safety, Security and Risk (Faass et al., 2013). Consequently, a crucial element of cities' infrastructure remains ill prepared when it comes to pandemic related emergencies.

This is further complicated by the varying principles/practices of design, construction, operation and management of mass transport built environments adopted worldwide as a result of different economic social, political, technological and climatic conditions. Even within a country's own borders mass transit agencies' disease preparedness vary substantially based on their size and resources. Still, research and practice have successfully identified three categories of control measures necessary to break the chain of disease transmission in artificial environments, including that of mass transportation. The next section focuses on the creation and maintenance of healthy mass transport infrastructure through the adoption of engineering, administrative and personal protection control measures.

### 2.3.1 Engineering Controls

Implementing engineering controls involves making changes to the work environment by isolating people from a hazard or placing a barrier between them. Examples of engineering controls in mass transportation environments include installing physical barriers that separate passengers from workers, especially placing barriers between vehicle drivers and passengers. Such barriers may include glass screens, sneeze guards, theater ropes, and hazard warning tape, etc. In addition, handling cash should be discouraged in favor of cashless payment with its various types. In order to further protect mass transit drivers, rear door boarding have been practiced by many bus agencies worldwide as one form of social distancing.

Engineering controls also necessities disinfection procedures for facilities, shared equipment and spaces, work area, and personal equipment. In particular there is a focus on preventing high touch surfaces (e.g. ticket and cash machines, seats, doorknobs, staircase and escalator railings, grab rails and push buttons) from becoming reservoirs of pathogenic organisms through the use of antimicrobial shielding on surfaces as a form of "self-disinfectants". Various types of coatings have already been tested on different surfaces such as glass, leather, plastic, and steal (Wei et al., 2014; Pollini et al., 2013) largely proving to be efficient even in the most sensitive of built environments, that of health care (Boyce, 2016; Casey et al., 2010; Page et al., 2009). Those anti-microbial coatings can, and should, be implemented by the mass transportation industry. Particularly anti-microbial copper has been already used at border controls in the Arturo Merino Benítez airport and metro train network in Chile (Copper Development Association, 2013, 2014). Latest research, not yet peer reviewed, claims that no viable virus can last on copper surfaces for more than 4 hours

(Doremalen et al., 2020). Other examples of antimicrobial coatings include nano-based disinfectants used to coat surfaces in the Hong Kong metro (Davies, 2007).

Generally speaking, however, there is contention on how often disinfection is required (e.g. at the end of each trip, each day, each three days etc.), the best procedure to execute it (e.g. manual vs automated), and which disinfectants to use (e.g. Antimicrobial shielding, UV light disinfecting, Pesticide disinfecting etc.). While many countries continue to rely on manual labor based disinfection, the Mass Transit Railway (MTR) of Hong Kong recently deployed a VHP (Vaporized Hydrogen Peroxide Robot) on top of the regular cleaning by personnel. The company stated that the robot is designed to conduct deep cleaning and decontamination in train compartments, disinfecting small gaps that are difficult or unreachable by hand (Hui, 2020).

Mass transportation agencies also differ on how often to disinfect. In the current pandemic for example, The MTA of New York announced it will conduct disinfection two times a day, while Singapore subway infects three times a day. The Boston subway system, on the other hand, announced it will disinfect surfaces every four hours (Hui, 2020). Finally there is also a disagreement on what disinfectants to use. For example, the use of upper room ultraviolet light (UVC) have been recommended in a 2013 report by the Airport Cooperative Research Programme (ACRP) (TRB, 2013) and various airlines are, indeed, relying on this disinfection method. In addition, UV disinfection is already used in hospitals and by China's central bank to disinfect bank notes (Sustainable Bus, 2020). Thus and following a guidance issued by the National Health Commission, the mass transit company of Yanggao started using UV lights to disinfect the interior and exterior of its buses. The company claimed the process takes 5 to 7 minutes per bus and kills more than 99.9 per cent of viruses (Sustainable Bus, 2020). However, given that all of the aforementioned are company or country based applications, disagreement remains on what constitutes best disinfection practices amidst the lack of informative research.

Apart from installing physical barriers and conducting disinfection, engineering controls also include the deployment of hand sanitizer stations at strategic/most frequented locations within the built environment, availability of hand free equipment such as and free bathroom appliances and transaction tools (TRB, 2013). Last but not least, engineering controls include the appropriate operation and maintenance of ventilation through installing high-efficiency air filters and increasing ventilation rates in the environment among other measures.

These types of controls are generally regarded as the most effective given that they reduce hazards without relying on worker/passenger behavior. In addition they are of more permanent nature than administrative or Personal Protective Environment (PPE) measures. However, they usually take longer time to implement. Meanwhile, transportation providers can rely on administrative and PPE controls, discussed below.

### 2.3.2 Administrative Controls

Administrative controls, in contrast to engineering controls, require action by the worker or employer. Typically, administrative controls are changes in work policy or procedures to reduce or minimize exposure to a hazard. Perhaps the most important aspect of all administrative measures is having an emergency response protocol that accounts for pandemics and infectious disease spread. Those protocols should account for modification in employees' schedules and tasks in addition to radical changes in service provision including discontinuation of non-essential routes, rescheduling of routes and changes in timetables. Moreover pandemic resilient transportation necessitates formulating and updating a qualitative infectious disease vulnerability profile on the administrative level and ensuring that it maintains influence on all aspects of the decision making process.

Administrative controls is also in charge of developing policies that will encourage sick workers to stay at home without fearing reprisals. In addition, operators should develop emergency communication channels with both employees and passengers providing information on changes in schedules and routes, answering workers and passenger inquiries and processing complaints, and providing easy to understand instructions on how to remain safe while using mass transportation. These communication channels should be up to date and capitalize on the growing number of smart phone users and social media users and platforms. Use of informative posters inside mass transportation vehicles is another example of administrative controls. Moreover, administrative controls include providing employees with up to date training and education on the pandemic characteristic, risk factors and protective behavior (e.g., cough etiquette and care of PPE). Such training should be simple, easy to understand and available in appropriate languages. Passengers and workers alike should be required to abide by social distance rules, wearing masks and maintaining hygiene.

The downside of administrative controls is that they are heavily dependent on the compliance of passengers and employees to be effective. On the positive side, however, organizations can usually implement them more quickly than engineering controls. Administrative controls can be thought off as temporary solutions that bridge the gap until more effective and permanent engineering controls are enacted.

### 2.3.3 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) refer to the protective gear needed to keep workers safe while performing their jobs. Despite PPE being regarded as the least effective among other measures (Nasir et al., 2016), the recent outbreak has proven them to be crucial. Among other reasons, this is due to the speed by which PPE can be deployed. Examples of PPE include gloves, goggles, face shields, face masks, gowns, aprons, coats, overalls, hair shoe covers and respirators (e.g. N95) and protective clothing that put a barrier between the worker and the pathogen. The types of PPE required during any outbreak usually depend on the risk of infection while working and the tasks that may lead to exposure. Recommendations for PPE particular to occupations or job tasks may change depending on geographic location, updated risk assessments for workers, and information on PPE effectiveness in preventing the spread of a given disease. Generally speaking, health workers and first responders are prioritized when it comes to PPE distribution. This is a critical point for transportation agencies to work on, as transportation workers are usually left out of the first respondents' category even though many (e.g. bus drivers) face heightened possibility of infection and are, in essence, essential workers ensuring access to health care and other essential facilities by all members of the public in addition to transporting health workers. Transportation agencies should also provide training on the proper use and limitation of PPE in addition to providing PPE to employees free of charge.

## 2.4 Conclusion

Travel, including intercity transportation, have influenced infectious disease spread throughout history. The twenty first century itself saw a variety of such threats posed by influenza pandemics, SARS, MERS and other infectious diseases. Nonetheless, "For the past decades, those looking at intersections of planning, design, and public health have focused less on infectious diseases and more on chronic diseases" (Forsyth, 2020). This statement is true of all urban planning disciplines including that of transportation planning. Transportation Public Health policies of the twenty first century primarily focused on the impact of transportation on natural resource depletion and degradation and issues relating to global warming in general. The resulting sustainability paradigm of the century focused on energy efficiency, among other policies, while totally discounting for infectious disease spread as a component of public health. Unfortunately, this resulted in changes in design, construction, operation, and management of transportation built environment (e.g. high space usage efficiency) that may have contributed to their vulnerability to infectious disease transmission. However building a healthy and truly sustainable transportation infrastructure is not possible with such a divided and exclusionary approach to public health, as demonstrated by the current pandemic. What is needed instead is research that inspires the development of a holistic, multifaceted public health security index for our cities' transportation infrastructure.

This chapter attempted to shed light on the historical relationship between mass transportation and the transmission of infectious diseases. It also highlighted different factors that influence the process of infectious disease spread in mass transit environments and proposed protection measures that align with the nature and operation of mass transportation systems. Breaking the chain of infection transmission on mass transportation systems is necessary for maintaining aspects of public health other than safety from infectious diseases. A transportation system unable to live up to the current, and perpetual, threat of pathogens will inevitably contribute to an exodus of passengers to private car ridership and ownership. Such a shift will, in turn, contribute to higher rates of accidents, pollution, and chronic disease cause by physical inactivity. This is a testament on the complexity of interplay between different aspects of public health and transportation infrastructure in the urban environment.

Thus, breaking the chain of infection transmission on mass transportation is critical. However ensuring that the sense of safety this entails reaches passengers is an equally important issue for providers given its influence on ridership. In fact, there is a good body of research on the distinction between actual or real safety and safety perceptions of mass transportation passengers. However the majority of such literature tackles the issue from a standpoints of criminology, or passengers' fear of crime. By contrast, very few researches are dedicated to studying transportation perceived safety during a pandemic. The following chapter attempt to contribute to the latter body of research.

# CHAPTER 3

# PROTECTION MOTIVATION THEORY AND AVOIDING MASS TRANSPORTATION AS A PREVENTIVE MEASURE

## 3.1 Introduction

Since the beginning of 2019, the world has been confronted, and continues to be, with a new infectious disease that spread rapidly around the world. Although the first case of COVID-19 was discovered in Wuhan in December of 2019, the disease was declared a Public Health Emergency of International Concern by the WHO on the 30th of January 2020 (WHO, 2020). Every extra day we live with this pandemic is a stark reminder of the shortcomings of the public health-national security paradigm of the 1990s which focused exclusively on the threats posed by non-communicable and chronic diseases. Instead, risks from infectious diseases were sidelined as ‘a thing of the past’. This false sense of safety from, superiority over, infectious diseases stemmed from a series of successes achieved in the 1960s. However, most of those diseases eradicated emerged in new areas or re-emerged in previously affected ones within a span of fewer than two decades. For example, after victory was declared against dengue fever in Africa, it re-emerged as a pandemic of 1.2 million cases in 56 countries in 1998 (Messer et al., 2003). Other more recent outbreaks include those of SARS, MERS, and the avian flu. Those epidemics clearly demonstrated the speed by which such emerging infectious diseases can spread across the world as well as their potentially large consequences for individual and public health in addition to international and local economies.

Thus, prevention and control of infectious diseases is not just a medical or even a public health problem, but it is directly related to the functioning of local authorities, states and international organizations. In fact, two general categories of pandemic control strategies are distinguished: pharmaceutical and non-pharmaceutical. Pharmaceutical strategies include the development and distribution of both vaccines and antiviral drugs. Non-pharmaceutical measures include isolating people and reducing contact between individuals. The effectiveness of non- pharmaceutical measures has been proven historically in an analysis of the effects of the Spanish influenza in cities in the United States (Markel et al., 2007). Non-pharmaceutical measures largely rely on the behavior of the public. Lack of compliance to such safety measures in terms of putting oneself or others in danger has received considerable attention. By contrast, the effects of misjudged precautionary actions in terms of avoiding places and activities that bear low risk for infection is an extremely under-researched area.

Indeed, past outbreaks also serve as examples of how risks can be amplified by policy makers and the general public alike. Questions posed today were also raised during previous outbreaks on whether people responded rationally and in a manner proportional to the objective threat posed or whether they overreacted, panicked even, and took measures when there was little or no risk at all (Menon, 2008). As a result, it became evident that there was little or no understanding of the public's risk perceptions as they relate to infectious disease, especially emerging ones, nor of the impact of such perceptions.

Given that non-pharmaceutical measures are heavily reliant on limiting people's mobility, transportation sectors, especially that of mass transportation, took the hardest hit. This is true in terms of both actual ridership and overall image of the industry. In fact, the available research on the matter, albeit limited, proves mass transportation's vulnerability to perceived risks of infectious diseases. In one cross-cultural study, respondents were asked to imagine that a global influenza epidemic had reached their country. Participants were then given a list of 6 places (mass transportation; entertainment places such as cinemas, restaurants and theaters; shops; work or school; hospital; or home) and asked in which of these they thought they would run the greatest risk for infection. Answers were similar across the 8 regions included in the study (3 Asian and 5 European); mass transportation was identified as the riskiest place by more than 54% of the participants. Participants were next given a list of eight precautionary behavior modifications and asked whether they would adopt any of them: avoid mass transportation; avoid going out for entertainment; limit shopping to the essentials; take leave from work; keep children out of school if they were to remain open; limit physical contact with friends and family; avoid seeing doctors, even when sick from something unrelated to flu; and stay indoors at all times. Once more, avoidance of mass transportation was consistently reported as the most likely precautionary behavior across all regions (Sadique et al., 2007). Such results were in line with actual behavioral changes that took place when SARS hit in 2003 (Bell, 2004; Abdullah et al., 2004). In fact, one research found that each reported new SARS case resulted in an immediate loss of about 1200 people in terms of underground ridership; about 50% of daily ridership was lost during the peak of the 2003 SARS epidemic (Wang, 2014).

Since this is not the first time mass transit finds itself at stake of suffering great economical loss as a result of misjudged precautionary actions during an outbreak, an understanding of health behavior models is proving crucial to the industry. Since a given outcome is not set in stone, understanding the determinants affecting a certain behavior will definitely highlight ways to counter it.

The preventive or precautionary behaviors that a given population engages in not only will determine its victory against the pandemic but also the level of post-pandemic resilience it will enjoy. This will affect all industries, especially those which simultaneously affect the public health and economic status of a society such as mass transit. If the shift from mass transportation to car usage continues well after the pandemic, the resulting economic and public health losses might surpass those caused by the pandemic itself. Those losses include increased traffic casualties (fatality and injury), increased pollution, a sharp decrease in the rates of physical activity and fitness, and the deterioration of a society’s overall mental health. In turn, factors such as increased pollutants and decreased physical activity would lead to proportional increases in the rates of chronic non-communicable diseases (e.g. diabetes and respiratory illnesses). Increased mass transportation use has been proven to increase physical exercise (Lachapelle et al., 2011; Litman, 2011) which in turn leads to significant reductions in mortality rates (Woodcock et al., 2010). Rates of pollutant emissions is an influential factor in the process of climate change which in turn is documented to contribute to an increased number of outbreaks (Litman, 2013).

Given the risks involved both for mass transportation and for societies at large, an understanding of health behavior models proves to be crucial to the industry and should not be regarded solely as the responsibility of health authorities. In order to maintain ridership, satisfaction, image, and loyalty, mass transportation authorities need to understand how people perceive the risk of infectious diseases, how they perceive the effectiveness of different interventions, and the degree of trust residents have of information they receive from different sources.

As discussed above, there is a limited understanding of the public's perception of emerging infectious diseases both in medical circles and outside. This chapter attempts to bridge this gap by summarizing the literature available so far, mostly as it relates to previous outbreaks. Hopefully, those studies serve as a starting point of more in depth multidisciplinary research that focuses on minimizing avoidance of mass transportation as a precautionary behavior and a long lasting "new normal" dominated by the automobile. Relying on Protection Motivation Theory (PMT), this chapter focuses on risk perceptions of infectious diseases in addition to other key determinants of precautionary behavior. Traditionally, PMT is used to maximize effectiveness and acceptance of interventions. However, given its explanatory power of behavioral determinants, it can also be used for the opposite aim, namely to prevent people from engaging in a perceived preventive action which is objectively undesirable or dangerous.

## 3.2 Protection Motivation Theory, a Behavioral Model Applicable to Infectious Disease Risks and Precautionary Behavior

Social sciences recognize two types of behavioral determinants, the first of which is personal determinants. Personal determinants, also referred to as internal determinants include factors like knowledge, risk perception, attitudes, and perceived efficacy. Contextual or external determinants, on the other hand, include social pressure or support as barriers against or incentives for behavior.

Smith distinguishes two main schools in the study of risk: one ‘realistic’, the other ‘social constructionist’ (Smith, 2006). The realistic approach concerns itself with measuring the ‘objective’ risk of a specific danger or threat (Kahneman et al., 1982; Lion, 2001). Studies belonging to this school mostly rely on a psychometric paradigm in order to account for new and emerging risks and the different ways by which people value different threats. Slovic’s work is one of the most prominent in this regard. Slovic and his team developed two main dimensions for measuring risk: dread risk and unknown risk (Slovic, 1987). Dread risk is usually described by attributes such as “uncontrollable”, “global catastrophe”, “fatal consequences”, “not equitable”, “a high risk for future generations”, “not easily reduced” and “involuntary risk” (Slovic, 1987; Lion, 2001) Meanwhile unknown risk variables include: “not observable”, “unknown to those exposed”, “effect delayed”, “new risk” and “a risk unknown to science.” Many of these descriptions are true of emerging infectious diseases. For example, emerging infectious diseases may be perceived as uncontrollable, have the potential of leading to a global catastrophe, lead to fatal consequences in the absence of a treatment and/or a vaccine, and depending on their mode of transmission may be viewed as a form of involuntary risks. All of the aforementioned applies to the current pandemic. In addition, COVID-19 is often unobservable in its initial stage, is mainly of droplet based transmission (although mounting new evidence suggests that airborne or aerosolized transmission may play a role in the transmission of the virus) and is still relatively a new risk only partially understood by scientists and the general public. Thus, one can hypothesize that the general public, including mass transit users, do perceive it as a high risk threat with a general tendency towards a pessimistic, rather than an optimistic, bias. Traditionally, this realist approach has dominated literature on risks relating to infectious diseases.

The main argument of the ‘social constructionist’ approach, on the other hand, is that risks and threats cannot be studied in isolation as they are the products of social and cultural contexts (Smith, 2006; Lion, 2001; Joffe, 2003). Proponents of the social constructivist approach advocate for the inclusion of variables such as worldviews, affects and trust in the study of risk (Slovic, 1999). For the social constructionist then, risk is a subjective, rather than an objective factor. Consequently, different groups of people perceive similar risks differently, and may vary in their interpretation or the amount of importance they attach to a given information as it relates to a given risk. One application of the social constructivist school is the social amplification of risk framework developed by Kasperson et al. (1988). This framework suggests that the interplay between specific risks and psychological, social, institutional and cultural processes can either undermine or intensify perceptions of risks, thus shaping behavior and resulting in secondary social-political or economic effects.

Although studies in risk perception as it pertains to infectious disease are relatively new, a couple of health behavioral models have been constructed in order to make sense of how different behavioral determinants interact with each other and the way they influence behavior. By helping understand risky and preventive behaviors, behavioral theories and models are indispensable when constructing potential behavioral change policies.

Protection Motivation Theory (PMT) is one of the most prevalently used and widely accepted behavioral models applicable to health related risks. The basic hypothesis of PMT is that risk perception is one of the key factors influencing an individual's willingness to adopt a precautionary behavior (Rogers, 1983). Risk perception itself is comprised of two psychological variables: perceived vulnerability and perceived severity. Perceived susceptibility, also referred to as perceived vulnerability, perceived likelihood, and perceived probability refers to an individual's perception of the risk that he/she will contract the disease. In more general terms, it can be defined as "the probability that one will be harmed by the hazard" (Brewer et al., 2007).

The second determinant of how an individual would perceive a given risk is perceived severity. It can be defined in terms of how dangerous an individual perceives contracting the disease to be for his/her health. Put quite simply, perceived severity can be defined as "the extent of harm a hazard would cause" (Brewer et al., 2007)[1].

[1] This is only in partial adherence with Brewer et al.'s preposition. Brewer originally divides perceived risks into 4 categories: perceived severity, perceived vulnerability, perceived susceptibility and perceived risk after taking the precautionary measure. The last category is not included in our analysis. In addition perceived vulnerability and perceived susceptibility are merged under one category as per other research (De Zwart, 2009).

Thus, it could be said that an individual is expected to have the highest perceived threat of COVID-19, for example, when they think that they are likely to contract COVID-19 and that COVID-19 would prove dangerous, or deadly, to them. Although risk perception can be defined in a multitude of ways, this thesis defines risk perception in line with PMT as a combination of severity and vulnerability.

Regardless of the different ways it is defined, risk perception is related to subjective constructs and, thus, it is quite biased. While it is unrealistic to expect respondents to be totally free of personal biases, a researcher can make use of a way to account for these biases. Hence the concept of comparative vulnerability. Comparative vulnerability can be described as a person's perceived likelihood of being harmed by a hazard compared to others of the same age or/and gender. When an individual expresses low comparative vulnerability, they perceive themselves as less vulnerable than others, displaying an "optimistic bias". Conversely, an individual is said to display a "pessimistic bias" when their comparative vulnerability is higher than others of the same age and gender. In addition to providing information on individual biases, comparative vulnerability might also be an indicator of how familiar a given risk is perceived to be. Usually, unrealistic optimism in the form of low comparative vulnerability is displayed towards familiar risks or those perceived to be under control. By contrast, unrealistic pessimism in the form of a high comparative vulnerability is more common in the face of new and unfamiliar risks, or those perceived as uncontrollable. Traditionally, emerging infectious diseases such as COVID-19 have been perceived to be within the latter group (Sjoberg, 2000; Weinstein, 1988; Slovic, 1987).

Risk perception aside, Protection Motivation Theory proposes that response efficacy and self-efficacy influence an individual's participation in a given precautionary behavior (Rogers, 1983). Response efficacy refers to a person's perceived effectiveness of a given preventive measure. Self-efficacy, on the other hand, relates to an individual's perception regarding their capacity, or lack thereof, to carry out the preventive measure in question. Numerous research indicates that a heightened risk perception will not necessarily result in behavioral change unless it is coupled with confidence both in the usefulness (response-efficacy) and feasibility (self-efficacy) of the precautionary action (Rippetoe & Rogers, 1987; Ruiter et al., 2001).

### 3.3 Risk Perception and Infectious Diseases

Studies in risk perception as it pertains to infectious disease is relatively new. However, a rich body of literature has been developed following SARS and is gaining attention as a result of the current pandemic. Many of those studies found risk perception to exercise a significant impact on engaging in precautionary action (Giuseppe et al., 2008; De Zwart et al., 2007b). For example, one study on risk perceptions of SARS in Hong Kong found that participants with a higher level of anxiety and perceived vulnerability engaged in at least 5 out of the 7 recommended preventive measures (Leung et al., 2003). In another study in Hong Kong, an association was found between those who worried more about themselves, or a family member, being infected with SARS and a higher engagement in preventive measures. The same relationship between risk perceptions, specifically perceived vulnerability, and preventive behavior was corroborated for avian influenza (Lau et al., 2007a).

Unfortunately, the majority of studies focus on the relationship between risk perception and precautionary actions in general. What this means is that precautionary measures are dealt with as an abstract bundle; the effect of risk perception is not differentiated per specific measures. The few exceptions that exist differentiate precautionary action by level of engagement but does not attempt to establish relationships illuminating how an individual's risk perception interacts differently with each of those reported precautionary measures.

#### 3.3.1 Differences across Countries

There are few comparative studies that analyze differences in risk perceptions and efficacy beliefs between different countries and across varying (infectious) diseases (Chang & Asakawa, 2003; Renn, 2004; Vartii et al., 2009). For example, Leung et al compared risk perception and precautionary behavior between Hong Kong and Singapore during the SARS 2003 outbreak. They found big differences between levels of perceived likelihood of contracting the virus, 23% in Hong Kong and 11.9% in

Singapore (Leung et al., 2004). Despite differences in percentages of perceived likelihood, it was true in both cities that participants with higher anxiety and greater risk perceptions engaged in more preventive measures. A different study on SARS in Singapore corroborates the relationship between a greater degree of anxiety and preventive measures. However the same research found no significant relationship between perceived vulnerability of SARS and preventive measures (Quah & Hin-Peng, 2004). Another comparison involving Hong Kong was carried in a 2007 research investigating peoples' perceptions that an outbreak would take place in their locality in the upcoming year. The study found that if human to human transmissions occurred, 41.4% of the respondents in Hong Kong would worry about being infected themselves, 52.9% would about family members, and 19.7% would experience a high degree of panic. In fact, 71% to 81% of participants stated that, in the case of either bird to human transmission or human to human transmission, they would engage in preventive behavior including avoiding visits to the hospitals, crowds, going out or going abroad. Still, expectations for such an event to happen in Hong Kong were lower than those in mainland China or other countries (Lau et al., 2007b).

Research has also been conducted in countries outside the Asian Continent. A study investigating risk perceptions in Italy concerning avian influenza in 2005/2006, found that 20% of participants believed that they and/or their families were at risk of contracting the disease. The findings of the study indicated that those with a higher perceived risk, more information about accurate protective measures (e.g. washing hands and using gloves), and more information received from health professionals were more likely to adhere to hygienic practices (Giuseppe et al., 2008). Results of a study carried out in the Netherlands towards the end of the SARS epidemic revealed that although 38.9% worried about SARS as a health problem, only 4.9% worried about getting SARS themselves and 8.3% worried about a family member getting SARS (Brug et al., 2004). Comparatively, concern was much higher in the United States. In fact, respondents in the US worried about themselves or a family member being infected with SARS at around the same rate as they did about being the victim of a terrorist attack, 35% and 42% respectively (Blendon et al., 2004).

These studies demonstrated that the risk of SARS was perceived differently across the globe, in a manner not necessarily representative of the actual objective threat. Hong Kong and Singapore, both centers of the outbreak, experienced different levels of risk perceptions. At the same time, risk perceptions were high in the US but low in Netherlands, although both the United States and Netherlands had almost no cases. Because there was a significant difference in how SARS has affected South-East Asia and Europe, one might hypothesize that this would translate into a higher risk perception of SARS, and infectious diseases in general, in South-East Asian countries. However the opposite has been demonstrated by research. Risk perceptions of SARS in some of the Asian countries were relatively low compared to risk perceptions in the United States (Blendon et al., 2004; Lau et al., 2003; Leung et al., 2003) but similar to levels reported in the Netherlands (Brug et al., 2004). Questions arise, of course, on whether such international differences in risk perceptions are specific to SARS, whether a similar trend exists for other infectious diseases and whether those results indicate a wider trend in global differences in risk perception.

One study, helpful in this regard, focused on international differences in perceived threat, risk perception and efficacy beliefs related to SARS and other diseases. Authors found that country was, indeed, significantly associated with levels of perceived threat, vulnerability, severity and comparative vulnerability. SARS was perceived as a more severe problem in Europe compared to Asia while perceived vulnerability to SARS was higher in Asia than Europe. When comparing Asia to Europe, no single pattern of perceived severity emerged. Some diseases (SARS, heart attack, HIV, flu from a new virus, tuberculosis) were perceived to be more severe in Europe while others (food poisoning, the common cold) were perceived to be more severe in Asia. The same is true for perceived vulnerability. The higher level of severity for the aforementioned diseases in Europe might be the result of unfamiliar diseases being perceived as more severe. On the other hand, a higher vulnerability towards some of those very same diseases (SARS, HIV, and tuberculosis) in Asia may be based on the fact that these are more prevalent in Asia. Thus, overall perceived threats of SARS differed between Europe and Asia with perceived severity higher in Europe and perceived vulnerability higher in Asia (De Zwart et al., 2009). Those differences across regions also held true in another study on risk perceptions related to avian influenza. This time, perceived threat proved to be higher in Europe in term of both severity and vulnerability. In addition, various significant differences in risk perceptions were observed between individual European countries (De Zwart et al., 2007a).

Various explanations for those discrepancies are possible. In the case of SARS, higher vulnerability perceptions in Asia might be the result of the region's higher number of SARS cases reported. At the same time, the lower perceived severity in Asia could be explained as the outcome of having lived through and overcame an epidemic; it has become a familiar risk. The same could be said regarding lower overall risk perceptions observed in Asian respondents for the avian influenza. In line with other research (Pidgeon et al., 2003; Poortinga et al., 2004), De Zwart et al. (2007a) hypothesized that proximity to epidemic and previous experience with SARS might explain the lower levels of risk perceptions of AI in Asia as it might have sedimented the notion that even new epidemics of infectious diseases can be contained. More generally, it might be inferred that Asians have an overall tendency to view risks as less severe. Indeed, some authors have attempted to link this to the cyclic way of thinking in Confucianism whereby a good event will follow a bad one so nothing is considered as totally negative (Renn & Rohrmann, 2000; Lai & Tao, 2003; Ji et al., 2004).

However, although the actual levels of perceived threat differed across countries, the pattern of differences in perceived threats across different diseases was the same across all countries; perceived risk was highest for SARS and avian flu and lowest for diabetes. Regardless of country, the level of perceived severity for SARS was high compared to other diseases (e.g. flu from a new strain) while perceived vulnerability for SARS was of an intermediate level vis-à-vis other diseases. One explanation, offered by the authors of the study, is that SARS is a more unfamiliar disease to most as compared to the flu (De Zwart et al., 2009). In any case, research findings suggest that differences in risk perception per country ought to be interpreted with caution as cognitive constructs might not be understood in the same manner across different cultures (Luszczynska et al., 2005). This is further stressed by the uniformity of rankings of risk perceptions across countries. The differences in absolute risk perception levels for different diseases across countries versus the uniformity of the relative risk perceptions for these diseases might translate into cultural differences in the interpretation of survey questions rather than risk perceptions themselves.

The need for precaution when interpreting cultural differences is further justified by contradicting results on how influential cultural or ethnic differences are versus other factors such as country-specific public health systems and media coverage. Studies focusing on Asian communities in Europe or vice versa could prove helpful in weighing the effect of country of residence, versus that of origin, on risk perceptions of infectious diseases. One such study aimed to compare risk perceptions of SARS and avian influenza in the Chinese communities of the UK and Netherlands. Even after controlling for socio-demographic differences between Chinese communities and the general population, the study found that Chinese communities had a lower level of overall perceived threat compared to the general population in both countries. This was due to a lower level of perceived severity, not vulnerability, and was true for both SARS and the Avian Flu (Voeten et al., 2009). This is partially in line with the findings that Chinese Americans tend to display lower risk perceptions for all diseases (e.g. cancers, heart diseases, diabetes, asthma and tuberculosis) than their African American and Hispanic counterparts (Haomiao et al., 2004). However, while Voeten et al., 2009 concluded a lower risk perception as a result of lower perceived severity, Haomiao et al., 2004 found it to be the result of a lower perceived vulnerability.

### 3.3.2 Differences across Time

As detailed in the previous section, a number of cross sectional studies have attempted to understand variation in risk perception of infectious diseases across countries and regions (Fielding et al., 2005; De Zwart et al., 2007a, 2009; Giuseppe et al., 2008). Unfortunately, less attention was given to the issue of how risk perceptions evolve over time as a result of either the mere passage of time or relevant events that happen within a given time period (e.g. changes in media coverage or disease spread). Consequently, there is little information about the stability of risk perceptions and preventive behavior relating to emerging diseases, such as COVID-19, over time. One of the few exceptions was a series of ten sequential surveys conducted by Lau et al.

(2003) covering different phases of the SARS epidemic in Hong Kong. Their findings indicated that, parallel to a decrease in the number of new infections, risk perception declined in the so-called “second wave” of the epidemic. Leung and colleagues also conducted six sequential surveys on the SARS epidemic in Hong Kong. They found a pattern of decreasing anxiety over time after the peak of the epidemic. Moreover, they also found that the number of preventive measures taken at the start of the epidemic remained stable during the epidemic and decreased significantly six months after the epidemic (Leung et al., 2003). Similarly, surveys conducted in Ontario and Toronto, both hit by the outbreak, indicated a decrease in the percentage of respondents being concerned from 69% in early April to 37% in late May (Blendon et al., 2004). The same pattern was replicated in a study on avian influenza in Vietnam. During the first peak of the outbreak (between January and February of 2004), 59% of respondents felt worried for themselves and/or their relatives. However, soon after the end of the first peak of the outbreak (July 2004), almost half of the respondents considered avian influenza as a thing of the past. For example, during the ‘first wave’ of the epidemic 74% stopped eating poultry altogether. In later phases, however, participants reported a higher confidence in their own risk avoidance strategies (e.g. trusting their own judgment or that of the seller on the health of chicken when buying them) (Figuie & Fournier, 2008).

It is unclear, however, if such declines in risk perceptions are a product of the mere passage of time or the actual drop in numbers. Thus, it is unknown if the same patterns (declining risk perceptions) is applicable to the consecutive waves of the current pandemic. After all, many countries, Turkey included, experienced a higher number of cases in the ‘second wave’ of the pandemic than they did in the first. To the knowledge of the author, there is no research on the relationship between how long a pandemic persists and the time it takes risk perceptions to return to “normal” or baseline pre-pandemic levels. It might be the case that the longer a given risk persists the lengthier the post-risk perception recovery period. Conversely, it could be argued that the longer a risk persists, the faster a population gets used to it, moving the threat from the category of dreadful events and incorporating it into “new normal” or a “new reality”. Finally, an objective and constant threshold of maintaining risk awareness might exist, independent of the time length of a given threat, after which it is no longer viewed as risky.

To make matters more complicated, this pattern of decreasing risk perception was not uniform across literature. In a yearlong study focusing on avian influenza in Netherlands, authors found that perceived severity of the disease was high and stable over the time period studied during which few risk related events occurred. Perceived vulnerability was lower and decreased slightly over the course of the study (De Zwart et al., 2010). Even within the effect of time, differences were found between different regions. For example, differences in risk perceptions were established in Hong Kong relating to the course of SARS outbreak (Lau et al., 2003; Leung et al., 2003). However even the introduction of avian influenza in Europe did not result in changes in risk perceptions (Brug et al., 2004).

### 3.3.3 Other Factors Affecting Risk Perceptions of Infectious Diseases

Apart from the aforementioned variables, other factors have been proven to have an effect on risk perceptions pertaining to infection by an emerging disease. Fielding et al (2005) found that perceived risk of avian influenza among Hong Kong residents was negatively influenced by age, while worry, protective practices, avian influenza anxiety and risk of the production and handling of chicken all increased perceived risk. However, it is important to mention that the study was focused on risks relating to live chicken sales; thus the aforementioned factors might be particular to the context specified. In a study of Avian Influenza in Italy, higher levels of risk perceptions were reported for those with a lower socio-economic background, a lower level of education, less or inaccurate knowledge, and a feeling they did not need additional information (Giuseppe et al., 2008). A heightened risk perception of infectious diseases among women and the elderly (De Zwart et al., 2007a, 2007b) is in line with findings that those groups generally perceive risks to be higher (Gustafson, 1998).

Some research explained the higher overall perceived threat among certain sociodemographic groups (e.g. women) through perceived severity (De Zwart et al. 2009). Other studies, however, found that sociodemographic factors tend to affect overall threat perception through perceived vulnerability rather than perceived severity (De Zwart et al., 2010; Gustafson, 1998; Slovic, 1999). For example, De Zwart and colleagues found most demographic factors and knowledge determinants to be significantly associated with perceived vulnerability. Perceived vulnerability was higher for women, for elder respondents, for those with a lower education, and for those with a lower level of knowledge. The same research found that amount of information received was not significantly associated with perceived vulnerability (De Zwart et al., 2010), while another found that the amount of information received, together with gender, exerted a significant influence over comparative vulnerability. Women had a lower comparative vulnerability as compared to men and the same was true of respondents which received more information about SARS as compared to those which received less information (De Zwart et al., 2009).

Still, those factors had less explanatory power than that of country and were themselves affected by it. For example, the aforementioned study found that perceived threat of SARS was higher in participants with lower levels of education in Poland, Great Britain and Spain, while the opposite was true in Singapore. In addition, Singapore was the only country were age was independently linked to degree of perceived threat. Level of urbanization was influential in Poland only where living in areas with less urbanization was linked with a lower threat perception (De Zwart et al., 2009).

The effect of gender and age in addition to the interaction between country and gender and country and age was also corroborated in the case of avian influenza. In all countries included in the study except Singapore, risk perception was higher among women than their male counterparts but this gender gap was smaller in the Asia as compared to Europe. This gap was also true for age in Europe, where risk perception increased with age, but not in Asia (De Zwart et al., 2007a).

The effect of level of knowledge versus that of amount of information received also differed by country. For example, perceived threat of SARS was higher among respondents who received more information about the disease in the Netherlands and Denmark. In Britain, however, perceived threat was higher among those with more accurate knowledge about the disease rather than those who received more information (De Zwart et al., 2009).

Sociodemographic factors aside, mass media is another factor reported to have an influence on infectious disease perception. For example, a study focusing on West Nile virus prevention found that participants relied on television as their main source of information on risks and precautionary behavior (Aquino et al., 2004). This was also true for risk perceptions of avian influenza in the Netherlands where the biggest source of information was television while internet sites, particularly those of the government, were seen as the most reliable (De Zwart et al., 2007b).

In fact, the role of mass media coverage is hypothesized to be one of the alternative determinants behind differences between countries, regions, and communities within the same country instead of, or in addition to, culture. Unfortunately few, if any, research exists on the matter. Some insight could be gained from a study by Voeten and colleagues on the differences in information and health beliefs of the Chinese communities in the United Kingdom and the Netherlands. The study found that the Chinese community in both countries had a lower perceived threat of SARS and AI than the general populations as a result of lower perceived severity. At the same time, the authors found that the media sources those communities consume, and their information sources in general, to be different than those of the general Dutch and British populations (Voeten et al., 2009). This trend of different risk perceptions coupled with different sources of information has also been observed in the US (Haomiao et al., 2004; Person et al, 2004). The tendency of Scandinavian media to report more about risks abroad and less about those within the country has also been hypothesized to be the reason behind level the generally lower level of risk perception in the region (Mullet et al., 2005; Luszczynska et al., 2005; Zwart et al., 2009). Although correlation between media and risk perceptions could be deduced from those studies, none of them established causation.

Here, Ungar's model on media's coverage of "hot crisis" proves useful. According to Ungar, media coverage of "hot crisis" unfolds on two stages (Ungar, 1998). In the first phase of an outbreak, reports focus on the frightening aspect of the epidemic, the novel type of virus, and the threats it presents to humankind. This phase is characterized by the use of labels that amplify risk perception (e.g. deadly virus) and by a pessimistic overall attitude. This is in sharp contrast to the second phase where the outbreak becomes a thing of the past, the faraway and the other. The disease is portrayed mostly as pertaining to other far lands and other extremely unfamiliar peoples. This process is well documented particularly in studies focusing on media coverage of the 2003 SARS outbreak (Smith, 2006; Washer, 2004).

### 3.4 Response Efficacy and Self-Efficacy

While risk perception is a thoroughly researched phenomenon and an important component of various health behavioral models, the actual strength of the relationship between risk perception and precautionary behavior is still debatable. One research conducted a meta-analysis on this issue, concluding that risk perception possess a very small effect on precautionary behavior and that different relations between risk perception and preventive action has been established including negative ones (Brewer et al., 2007). Similar results were arrived at in a cross-regional survey covering five European and three Asian countries. No association was found between either perceived threat, perceived vulnerability or perceived severity of an influenza pandemic and intentions to engage in future precautionary actions, like avoiding mass transportation, limiting shopping or keeping children from school (Sadique et al., 2007). Unfortunately, the study did not include specific analyses per country. Another study found that although Lyme disease was perceived as a serious problem on which knowledge was quite high, levels of engagement in precautionary behavior were far from prevalent (Shadick et al., 1997). Authors concluded that self-efficacy is one of the important determinants influencing participation in protective measures. Other authors have also arrived at the conclusion that efficacy beliefs seem to constitute stronger drivers of preventive action than perceptions of severity, one of the constituents of perceived risk (De Zwart, 2009).

Apart from its direct influence on precautionary action, different components of efficacy has also been proven to indirectly affect engagement in preventive measures through perceived risk. In a study on avian influenza in the Netherlands, for example, a higher level of both response and self-efficacy was associated with a lower level of risk perceptions with the association of self-efficacy with risk perception being the most significant. Thus, more confidence in one's ability led to a lower risk perception while participants with higher risk perceptions engaged in precautionary (or more precautionary) measures. The same study found response efficacy and self-efficacy to be positively associated. However although strong relationships have been proven between risk perception, response efficacy and self-efficacy and participation in precautionary actions, no causal connection could be demonstrated (De Zwart et al., 2007b).

Just like the case with threat perceptions (perceived severity and perceived vulnerability), efficacy has been found to vary across regions. Both response and self-efficacy for SARS and the avian flu were higher in Asia than in Europe (De Zwart et al., 2007a, 2009). The more positive efficacy beliefs in Asia might be the result of more visible, and thus more reassuring, official preventive measures in Asia (Smith, 2006). In addition the authors hypothesize that higher levels of the aforementioned variables in Asia might stem from the direct and closer experience of having outlived and overcame various emerging infectious diseases (De Zwart et al., 2009). Interestingly, the same was found to be true in a study conducted with Chinese communities in the UK and the Netherlands. Even after adjusting for sociodemographic differences, self-efficacy was higher in the Chinese community of both countries as compared to the general population. This was true of both SARS and the avian influenza and might be the result of the Chinese communities' closer involvement with the outbreaks in China strengthening their belief that effective preventive actions are indeed available and that they can personally engage in those measures (Voeten et al., 2009). Other interpretations deduce that higher efficacy beliefs among the Chinese, even those living outside China, are the result of cultural optimism, or the illusion of control (Chang et al., 2001; Renn & Rohrmann, 2000). Once more, we iterate the need to exercise caution when interpreting differences across regions and between communities. This is especially true given that the literature itself is relatively new and thus many research findings are not yet corroborated.

Finally, demographic factors such as gender and age were found to have a significant relationship with self-efficacy but not with response-efficacy. Lower self-efficacy was displayed by women and the young compared to men and older respondents (De Zwart et al., 2007a).

### 3.5 Other Factors Affecting Behavioral Intentions

The previous section focused on risk perception, perceived severity, perceived vulnerability, self-efficacy, and response efficacy as the main behavioral determinants as laid out by Protection Motivation Theory. However, factors outside this model were also proven to be directly influential on precautionary behavior. Many of those factors have also been found to have an indirect effect through risk perception, efficacy or both.

To begin with, sociodemographic factors have been repeatedly reported to directly affect engagement in precautionary actions. This is in addition to its indirect effects observed in previous sections. For example some studies reported that women were more likely to engage in precautionary action (Phillips et al., 2001; McCarthy et al., 2001). However, other studies found gender not to have a direct effect on precautionary action (De Zwart et al., 2010). The effect of age, on the other hand was less contentious. Various studies agree that the young tend to possess lower levels of precautionary actions than the old (Phillips et al., 2001; De Zwart et al., 2010). Conducting a multivariate logistic regression analysis, authors found the following factors were significantly associated with taking preventive measures: higher age, lower level of education, ethnicity, lower level of knowledge, more information about Avian Influenza, and thinking more about Avian Influenza (De Zwart et al., 2010). “Thinking more about a disease” can be regarded as synonymous with “worry about the disease”. Worry about a disease can affect preventative behavior directly or through its effect on risk perception (Sjoberg, 1998; Chapman & Coups, 2006). Direct effect worrying about the disease on precautionary behavior has been studied by Herrington (2004). The study found “Knowing someone with the disease” to have a direct influence on engaging in preventive measures (Herrington, 2004). This interaction underlines that thinking about a disease or worrying about it, should be explored as a separate attribute from risk perceptions.

As detailed before, time has also been found to exercise a direct effect on precautionary behavior (De Zwart et al., 2010). The same was true of the effect of time on precautionary action related to SARS in Hong Kong. Studies found precautionary actions to increase sharply during the first phase of the outbreak, remain high during all the stages of the outbreak, decrease slightly towards the very end of the outbreak and to decrease substantially only after the outbreak was totally over (Lau et al., 2003; Leung et al., 2004). A decline in perceived vulnerability seems to precede a decline in precautionary actions. After an outbreak most precautionary actions do not seem to continue. However this does not necessarily indicate a return to the old pre-pandemic normal. Another study on precautionary action in Vietnam found that although only a small group of people continued to refrain from eating poultry six months after the epidemic, the majority of participants reported eating less poultry than their pre-outbreak normal (Figuie & Fournier, 2008).

Last but not least, trust in authorities and their representatives has a paramount effect on people's behavioral intentions. This is crucial given that societies are reliant on non-pharmaceutical measures until medications and/or vaccines are developed to which the new disease is responsive. Equally, trust is essential in communicating against engagement in misjudged precautionary action which might prejudice one's health (e.g. avoiding hospital visits) and/or slow the process of post-outbreak recovery of essential industries (e.g. avoidance of mass transportation).

## 3.6 Conclusion

Both the current, pandemic dominated, reality and the available research indicate that mass transportation systems are especially vulnerable to the risks paused by infectious diseases' outbreak. Unfortunately research linking risks of infectious disease with mass transportation is quite rare. Where it exists, its primary focus is on objective measures targeted at protecting people's health. While such measures are indeed important, inducing realistic risk perceptions and precautionary actions in the general public is of equal importance to the mass transportation industry. Risk perception is an important determinant of precautionary actions, and precautionary behavior itself is essential for a society to avoid or slow down the spread of a pandemic. However risk perceptions are often biased and unrealistic. Such biases result in refraining from precautions in real risk situations, but they also have been proven to result in unnecessary, and perhaps counterproductive, precautionary actions. Thus and in order for mass transportation systems not to suffer from a lasting loss in ridership and revenue, the industry needs to develop an understanding of the determinants that cause the public to perceive a given action, or its avoidance, as beneficial to their safety against an infectious disease and what drives them to act upon such perceptions.

This chapter attempted to contribute to such an understanding based on the health behavioral model provided by Protection Motivation Theory (PMT). According to PMT individuals engage in general precautionary actions against a health threat when they have high levels of perceived severity and vulnerability in addition to response efficacy and self-efficacy. Research on the effects of each have been detailed in the chapter. However, the majority of research conducted applied those determinants on engagement in preventive actions in general and did not measure them for specific actions (e.g. wearing mask, avoiding mass transit, washing hands etc.) even though literature does acknowledge that those determinants would most probably differ per a given measure and that general assessment of preventive measures as a collective may be of limited use. In addition, PMT has been mostly used to advocate for adoption of legitimate measures rather than as a tool for prevention against unnecessary and misjudged precautionary actions (e.g. avoiding visits to the hospital, avoiding mass transit). Chapter Five attempts to fill both of the aforementioned gaps through applying PMT determinants on multiple specific measures pertaining to mass transportation in Ankara (e.g. avoiding mass transit, reducing frequency of mass transit usage etc.). Before that, however, the next chapter offers a background on the objective characteristics of the mass transit system in the case study, Ankara, both before and as a result of the pandemic.

# CHAPTER 4

# EVOLUTION OF MASS TRANSPORTATION IN ANKARA

## 4.1 History of Mass Transportation in Ankara

The quality of the mass transit system in Ankara is the result of a series of legislative changes from the time the city was proclaimed capital until today. While most of these changes empowered greater municipalities, they did not necessarily translate to an actual improvement in the condition of transport services (e.g. in terms of financial resources, etc.). This gap between expanding jurisdiction and stagnant resources weakened public involvement in the supply of transit services. Instead, supplying transit services was partially left to individual private entrepreneurs organized under chambers and/or cooperatives. Exploiting their lobbying power over transit provision, private entrepreneurs managed to expand their businesses. This cycle of weakened public involvement and increasing private dominance is further worsened by the lack of integration between those two components of Ankara's mass transit system.

After the declaration of Ankara as the capital of the newly founded Republic of Turkey in 1923, Law No.417 established Ankara as a "Şehremaneti' in 1924, the Ottoman equivalent of a modern day municipality (A "Şehremaneti" was mainly in charge of concerned with the cleanliness and beauty of the city in addition to overseeing what is currently the municipal police). Ankara was officially declared a municipality in 1930 through Law No 1580 which gave municipal status to all settlements with a population of 20,000 and above; its municipal borders included today's Altındağ, Çankaya, & Yenimahalle. Law No.1580 did not account for district municipalities.

Ankara's first transit specialized body "Ankara Municipality Bus Administration" was established in 1935. In 1944, this body was renamed "Ankara Bus Operating Unit" and converted into an annexed budget institution in 1944. On the first of January, 1950, “Ankara’s Bus Operations Unit” itself was combined with the electricity and natural gas operations forming “Ankara Electricity, Gas and Bus Operations (EGO). Metropolitan municipality administration in Turkey operates according to two-tier system where the greater municipality functions according to scale economies and this situation was ratified in 1984 with the enactment of Law No.3030. Consequently, metropolitan municipalities or greater municipalities were established in Istanbul, Ankara, and Izmir. Following the enactment of this law, Ankara Greater Municipality experienced 3 successive enlargements in which previously stand-alone municipalities became districts of Ankara’s metropolitan municipalities (Keçiören & Mamak, 1985; Etimesgut & Sincan, 1988; Gölbaşı, 1991). District municipalities function according to scope economies.

By their very nature, mass transportation systems are subject to the economies of scale and are thus supplied by metropolitan municipalities. Naturally, Ankara’s transformation into a greater municipality and the successive expansion of its borders had significant effects on its mass transportation supply. The same was true in many other Turkish localities that grew into metropolitan municipalities since 1984. Perhaps this is best illustrated in the contrast of public versus private shares in mass transportation provision between the pre-1980’s and the 1990s. While the share of private mass transit buses in Ankara did not exceed 20% of the bus fleet during the 1980s, the scene was quite different beginning with the 1990s. The current position of private entrepreneurs in the city’s public transit can be largely attributed to the series of enlargements mentioned above (1984-1991) through two processes. To begin with, every time the borders of The Greater Municipality expanded, the private transit entrepreneurs of those areas added to the pool already existing in the city, increasing the number of both minibuses and private public buses in the city. Simultaneously, the continuous expansion of metropolitan borders strained the public capacity to supply transit services to an ever growing area of jurisdiction. Regardless, this trend continued with Law No. 5216 of 2004 and Law No 6360 of 2012. As a result of the former, Ankara Metropolitan Municipality enlarged to Akyurt, Balâ, Çubuk, Elmadağ, Kalecik and Kahramankazan. The latter, effective as of 2014, expanded the jurisdiction of Metropolitan Municipalities, including Ankara, to provincial borders. All aforementioned laws and ensuing changes in Ankara's borders are summarized in Table 1.

The implications of those laws combined with a delay in the construction of the city's network of metros, due to their high cost, led to a crisis of transit in Ankara in the 2000s. In an attempt to relief the increasingly looming threat of congestion, the city invested in an extensive network of roads and road based mass transportation. While this highway based approach managed to postpone congestion in Ankara, its success was short-lived given the constantly increasing private car ownership and metropolitan area. As a result, a gap arose between the average mass transit trip duration and that of the automobile. On its part, this led to a trend of increased auto mobilization in the city, making Ankara the city with the highest per person car ownership in Turkey.

Table 1: Breaking Points in Ankara's Municipality and Transportation System

| Year | Law | Description |
|---|---|---|
| 1923-1924 | Law No. 417 | Ankara the "Şehremaneti" |
| 1930 | Law No. 1580 | Ankara becomes a Municipality (No district Municipalities) |
| | | Ankara Municipality includes: Altındağ, Çankaya, & Yenimahalle |
| 1942 | | EGO is Established |
| 1950 | | EGO begins to perform services |
| 1984 | Law No. 3030 | Two-tiered Metropolitan Municipalities created in Ankara, Istanbul and Izmir |
| | | District Municipalities established |
| 1985 | | Ankara Metropolitan Municipality expands to Keçiören & Mamak |
| 1988 | | Ankara Metropolitan Municipality expands to Etimesgut & Sincan |
| 1991 | | Ankara Metropolitan Municipality expands to Gölbaşı |

## 4.2 Current Mass Transportation System in Ankara

Today, Ankara's mass transportation system is controlled by two entities; EGO as the supplier of public transit on one hand, and individual private entrepreneurs and their collectives as suppliers of the city's fleet of minibuses/dolmuşes on the other. All these modes are under the general supervision of UKOME, Ankara's Transportation Coordination Board, and the Greater Municipality of Ankara. The shares of each of those modes both in mass and urban transportation are illustrated in Tables 2 and 3.

Table 2: Yearly Passenger Count per Mode*

| Transportation Mode | Feb 2015 | Feb 2016 | Feb 2017 | Feb 2018 | Feb 2019 | Feb 2020 |
|---|---|---|---|---|---|---|
| EGO Public Buses | 746,880 | 732,665 | 728,400 | 766,000 | 778,800 | 769,400 |
| LRT- Ankaray | 128,712 | 126,825 | 130,300 | 128,000 | 123,000 | 130,500 |
| Metro | 274,261 | 283,100 | 307,800 | 334,000 | 345,000 | 358,400 |
| Commuter Rail- Başkentray | 37,000 | 36,000 | 1,700 | 1,700 | 45,200 | 49,500 |
| Minibus-Dolmuş | 960,000 | 982,000 | 1,070,000 | 1,110,000 | 1,125,000 | 1,050,000 |
| Service Vehicles | 670,000 | 792,000 | 796,000 | 810,000 | 825,000 | 830,000 |
| Private ÖHO Buses | 169,150 | 220,000 | 235,000 | 290,000 | 290,000 | 238,500 |
| Private ÖTA Vehicles | 75,950 | 69,300 | 73,500 | 67,500 | 71,000 | 123,400 |
| Private District Vehicles | 28,000 | 29,400 | 30,000 | 44,000 | 48,000 | 75,000 |
| Mass Transportation Total | 3,089,953 | 3,271,290 | 3,372,700 | 3,551,200 | 3,651,000 | 3,624,700 |
| Taxi | 269,500 | 310,000 | 370,000 | 400,000 | 425,000 | 340,000 |
| Private Car | 2,011,030 | 2,143,250 | 2,280,065 | 2,431,900 | 2,493,800 | 2,581,750 |
| Private Transportation Total | 2,280,530 | 2,453,250 | 2,650,065 | 2,831,900 | 2,918,800 | 2,921,750 |
| Urban Transportation Total | 5,370,483 | 5,724,540 | 6,022,765 | 6,383,100 | 6,569,800 | 6,546,450 |

* Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Table 3: Yearly Share in Mass and Urban Transportation per Mode*

| Transport Mode | Feb 2015 | | Feb 2016 | | Feb 2017 | | Feb 2018 | | Feb 2019 | | Feb 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Urban | Mass | Urban | Mass | Urban | Mass | Urban | Mass | Urban | Mass | Urban | Mass |
| EGO Buses | 13.90% | 24.20% | 12.80% | 22.40% | 12.10% | 21.60% | 12.00% | 21.60% | 11.90% | 21.30% | 11.80% | 21.20% |
| Ankaray | 2.40% | 4.20% | 2.20% | 3.90% | 2.20% | 3.90% | 2.00% | 3.60% | 1.90% | 3.40% | 2.00% | 3.60% |
| Metro | 5.10% | 8.90% | 4.90% | 8.70% | 5.10% | 9.10% | 5.20% | 9.40% | 5.30% | 9.40% | 5.50% | 9.90% |
| Baskentray | 0.70% | 1.20% | 0.60% | 1.10% | 0.00% | 0.10% | 0.00% | 0.00% | 0.70% | 1.20% | 0.80% | 1.40% |
| Dolmuş | 17.90% | 31.10% | 17.20% | 30.00% | 17.80% | 31.70% | 17.40% | 31.30% | 17.10% | 30.80% | 16.00% | 29.00% |
| Service Vehicles | 12.50% | 21.70% | 13.80% | 24.20% | 13.20% | 23.60% | 12.70% | 22.80% | 12.60% | 22.60% | 12.70% | 22.90% |
| ÖHO Buses | 3.10% | 5.50% | 3.80% | 6.70% | 3.90% | 7.00% | 4.50% | 8.20% | 4.40% | 7.90% | 3.60% | 6.60% |
| ÖTA Vehicles | 1.40% | 2.50% | 1.20% | 2.10% | 1.20% | 2.20% | 1.10% | 1.90% | 1.10% | 1.90% | 1.90% | 3.40% |
| Private District Vehicles | 0.50% | 0.90% | 0.50% | 0.90% | 0.50% | 0.90% | 0.70% | 1.90% | 0.70% | 1.30% | 1.10% | 2.10% |
| Taxi | 5.00% | NA | 5.40% | NA | 6.10% | NA | 6.30% | 1.90% | 6.50% | NA | 5.20% | NA |
| Private Car | 37.40% | NA | 37.40% | NA | 37.90% | NA | 38.10% | 1.90% | 38.00% | NA | 39.40% | NA |

* Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

The first of Ankara's metro lines, M1, began operation on the 29th of December 1997. The line serves the area between the new city center of Kızılay and the Batıkent area on the western corridor. The 12 stationed line covers an area of 14.66 km (EGO, 2020b). Ankara's second, third, and fourth metro lines were scheduled to open in 2004. However, after around a decade of unfinished construction which started in 2003, The Ministry of Transport, Maritime and Communication took over construction and procurement in 2010. Two of those lines (M2 and M3) were opened in 2014. Ankara's second metro line (M2) connects the new city center of Kızılay with the area of Çayyolu (Kızılay-Çayyolu line). The city's third metro line is essentially an extension of M1 on the western corridor, connecting the Batikent area with that of Sincan. Ankara's final metro line (M4) did not open until the 5th of January 2017. It currently connects Atatürk Cultural Center to Gazino station in Keçiören. Three of M4's stations are still under construction, namely those of Kızılay (the city center), TCDD Hızlı Tren Garı (Ankara's intercity train station) and Adliye (Ankara's court area). Work is underway on a fifth metro line (M5) linking the city center of Kızılay to the city's airport. However, its projected cost, date of opening, and length in kilometers have been the subject of various alterations. For example, statements were made in 2018 that M5 will open to the public in 2023 as part of various projects celebrating the Turkish republic's centennial year. However, many professionals deem this date as unrealistic.

Municipal buses operated by EGO continue to constitute the backbone of Ankara's Public Transportation network. EGO started its operation with 12 routes in 1935; this number reached 311 routes in 2015. The institute has been authorized to plan and oversee all transportation modes, public and private, through its Transport Planning Branch which is the only transportation unit in Ankara Greater Municipality. However, it does not have sufficient staff and qualifications for providing comprehensive transportation planning activity.

In an attempt to overcome some of the financial deficiencies it faced in the past and to avoid subsequent transportation shortages, EGO gave several operation rights to private operators and the municipality allowed their entry into the transportation market while maintaining the authority to alter their operations as it sees fit. Thus private buses were introduced to the transportation network in order to provide supplementary services to those of EGO. However and instead of working to complement the shortcomings of the public transportation systems in Ankara, those private entrepreneurs managed to situate their lines on the most profitable routes in the city and began competing with EGO buses. EGO records, dating as far back as 1983, recognize that the number of passengers using EGO buses significantly decreased after private entrepreneurs entered the transportation scene. In fact those reports claim that all the passengers of ÖHO, one of the two private bus operators in Ankara, are former passengers of EGO (EGO, 1996). This means that the entry of private operators did not help increase bus passenger ridership levels. Instead the same number of bus passengers was redirected into a private variation of the same urban mode. One of the cited reasons for this stark shift in ridership is the lack of integration between EGO buses and other public transportation modes. For example, upon the opening of Çayyolu Metro, all EGO buses operating on the corridor were cancelled. Moreover, EGO buses acting as feeder lines to the metro were not properly designed with acceptable walking distances or waiting times.

Today, the private mass transportation scene in Ankara consists of formal private operators (ÖHO and ÖTA), on one hand, and informal private operators (para-transit) on the other. Özel Halk Otobüsleri (ÖHO) began operating its buses in 1982 with 30 vehicles on 8 lines.[2] Less than a year later, their fleet expanded to include 199 vehicles. If anything, this demonstrates the profitability of ÖHO operations. According to a decision made by the central government, ÖHO buses' operations are to be renewed every 10 years beginning with the year 1999. However and according to the head of Ankara's ÖHO Chamber, this 10 year renewal is an almost automatic standard procedure today (Yıldız, 2015). This suggests the continuation of good relations between ÖHO and the municipality to this day. In fact, research claims that Ankara's bus routes and timetables are not decided upon based on transportation planning studies but rather prepared in accordance with the demands of ÖHO operators (Yıldız,

[2] Private ÖHO bus operators are organized under The Urban Public Bus Operators Chamber for ÖHO or Ankara Şehiriçi Özel Halk Otobüsleri Esnaf Odası in Turkish. This chamber was established in 1991 within the Confederation of Turkish Tradesmen and Craftsmen or Türkiye Esnaf ve Sanatkarlar Odaları Birliği (TESK) in Turkish.

2015). The role of the municipality is to secure the profitability of ÖHO's operations and to ensure a conflict free coexistence among the private operators of urban transportation. Meanwhile its buses, EGO buses, continue to be the only urban transportation vehicles serving unprofitable areas with low demand.

Another private bus operator entered Ankara's urban transportation system in 2008. Özel Toplu Taşım Aracı (ÖTA) started operations in 2008 with 222 vehicles. Private ÖTA bus operators are organized under The Association of Ankara's Province and District Midibus and Privately Operated Buses (Ankara İli ve İlçeleri Midibüs ve Halk Otobüsleri Derneği in Turkish). While ÖHO is organized under TESK, ÖTA's association is under the jurisdiction of the Ministry of Interior. Another difference between ÖHO and ÖTA is that the latter is often unable to implement fines and suspension on its operators. This inability stems from the close relationships of kinship tying the association members with the operators they are tasked with supervising. Both ÖTA's association members and its operators come from the Haymana District of Ankara. Thus, many of ÖTA's drivers are often recruited based on personal relationships without being subjected to any sort of training. This translates to disorderly operations and a decreased service quality. Given this, it is no surprise that ÖTA did not cultivate the same close relationship with the municipality that ÖHO enjoys (Yıldız, 2015).

This is obvious in the Municipality's previous decision to replace ÖTA's standard sized buses with lower capacity midibuses which lowered their transportation service quality to a level parallel to that of paratransit. In addition, the municipality restricted ÖTA operations to specific points in the city center and North West residential areas in an attempt to gain better control over their operations. Initially, ÖTA operated on 8 lines serving the areas of Sincan and Eryaman. However, the municipality soon had to reintroduce its buses on lines parallel to those of ÖTA as a result of passengers' objection to being restricted to use ÖTA services. Unfortunately, the competition arising from EGO's and ÖTA's operation on the same lines resulted in the proliferation of accidents on those routes. Following this unrest, the municipality reallocated some of ÖTA's vehicles back to various parts of the city including some of its most profitable lines. Naturally, such arrangements granted ÖTA operators a significant bargaining and lobbying power on the detriment of citizens. Furthermore, this weakened the already vulnerable position of municipality officials; Only 10 municipal officials are responsible for the supervision of all 222 ÖTA vehicles (Yıldız, 2015). Needless to say, this ratio of supervisors to vehicles is insufficient for effective operations control. Moreover the amount and frequency of fines enacted on ÖTA operators do not support the officials' position; fines are not very common and the amount of fines are not high to act as a deterrent.

Private buses aside, Dolmuş vehicles continue to be the most prominent component of Ankara's urban transportation network (Tables 2 and 3). Dolmuş vehicles are Turkey's most notable form of paratransit. Just like its counterparts worldwide, paratransit in Turkey is a mixture of unique deficiencies and advantages.

To begin with, paratransit modes of transportation are often linked to informal, often illegal, sectors such as squatter developments. In addition, paratransit is a sector where profit maximization and poor regulation meet resulting in a form of competitiveness that does not translate into improved service quality. Quite contrary, safety issues, for example, decrease in importance for the operator. Instead, other indicators, such as headway counts and service speed, gain importance (Cervero, 2000; Wright, 1986). In addition drivers usually lack education and are the subject of limited control by public authorities. Moreover, long working hours of paratransit drivers increases the physiological tension they suffer from. This in turn leads to decreased attention to traffic coupled with an 'over eagerness' during peak hours. Consequently traffic accidents are more likely. Another drawback inherent to paratransit operations is unreliability of schedules and routes. Kılınçaslan (2012) highlights the difficulty of understanding paratransit services (e.g. routes, stops, etc.) as one of its most prominent disadvantages. Some argue that this is unsolvable given that it is the defining characteristic of paratransit operations, without which paratransit will lose its advantage over the scheduled and formal transportation sector.

Moreover, Paratransit disproportionately contributes to traffic congestion in two ways. The first is through their request oriented routing and stopping characteristics; the other has to do with the low capacity of paratransit vehicles. Last but not least, proponents of this view cite the impossibility of negotiation with paratransit operators given their fragmented ownership structure. Various private operators can indeed create a challenge since public authorities have to deal with numerous individuals when planning routes, pricing, integration etc. Given all of the above, advocates of such an argument call for a completely formalized and publicly operated transportation system as the key to a sustainable urban transportation network. There is no place for Dolmuş vehicles within such a system.

On the other hand, proponents of the opposite argument points out to the continued dominance of paratransit vehicles over the urban transportation scene in Turkey, as well as in various other countries. It might be true that Dolmuş services began as a migrant solution to accessibility problems in squatter areas. However the service has evolved since then to meet the transportation needs of other sections of the urban demographic. Otherwise, the existence of the Dolmuş in the current urban transportation network is unexplainable. In addition, its flexibility, profit maximization and efficient operations make it's a reasonable balance to the deficiencies of conventional modes. The flexibility of paratransit operations is evident in how quickly service patterns change to meet the daily needs of users. Moreover, even the size of paratransit vehicles is easily adaptable to such changes. Since paratransit vehicles carry fewer passengers and stop only on demand, their trip duration is less than that of their scheduled counterparts (Grava, 2003). Physical advantages also include the relative comfort of paratransit vehicles, especially in off-peak hours. In addition, paratransit operations are also adaptable to the financial needs of their customers.

Another competitor of EGO buses are "service vehicles" which refer to privately operated employee, school, and university buses. 'Service vehicles' vary in size ranging from a car to an entire bus fleet. Their entry into the urban transportation scene of Ankara began as an attempt to fill the transportation needs of public and private institutions, schools and universities located at places with limited public transport services. In addition, those vehicles serve employees whose working shifts are not in tandem with the service hours of public transportation (e.g. employees with late night shifts). Moreover, those door to door services have the advantage of route and schedule flexibility in addition to guaranteed seated trips with no transfers. However, those very same advantages of route, schedule, and vehicle size flexibility contribute to the city's problematic traffic congestion. Nevertheless, service vehicles quickly proliferated in number, expanded in coverage area, and became a permanent private component of the city's urban transportation network. In fact, yearly average increase of service vehicles is 6 times more than that of publicly owned EGO busses (Yıldız, 2015).

As detailed above, the current transportation scene in Ankara is characterized by a diversity of modes. Ideally, this multi-modality would have translated into an efficient, equitable, and resilient mass transit system. Unfortunately, however, the current mass transportation system in Ankara suffers from ineffectiveness, inefficiency, and lack of integration, all of which outset those benefits. An ineffective mass transportation system cannot provide users with a better customer experience while an inefficient one supplies expensive service with high production costs. This translates into an urban reality were private operators maintain their businesses by lucrative lines, high costs, cash payments, and restricted supply leading to crowded minibuses. Finally, Ankara's mass transit system is poorly integrated in terms of routes, timetables, and payment method. Lack of integration does not exclusively refer to that between the public and private components of the system, but also to that within the public component itself (e.g. poor or delayed integration between some metro and bus lines). On a related note, Ankara was too late in introducing a smart card based payment system. By the time it adopted this technology, other Turkish cities, such as Istanbul and Izmir, have already been using it for decades. Moreover, it was not until 2017 and 2019, respectively, that EGO extended Ankarakart usage to ÖTA and ÖHO in addition to 448 of its publicly operated buses. This was a huge missed opportunity on the part of local authorities; a more extensive data collection and analysis, facilitated by an electronic fare collection system, would have resulted in a more informed transportation planning. Moreover, dolmuşes remain unintegrated into this unified payment system.

### 4.3 Effect of Covid-19 on Mass Transportation in Ankara

COVID-19 (SARS-CoV-2) virus was first discovered in Wuhan, China on December 31st, 2019. In Turkey, the first case was discovered on the March 11, 2020. On the same day COVID-19 was declared as a pandemic by the World Health Organization. In order to slow down the spread of the pandemic, countries enacted various measures such as discontinuing in person education, encouraging telework, restricting or completely stopping inter and intra-city movement, including that of mass transportation.

Similar to cities worldwide, Ankara halted all forms of face-to-face education (primary and secondary schools, high school, and university) in favor of online education. Flexible working practices such as remote work and rotational work have been introduced for those working in public institutions and organizations. In order to minimize mobility, various curfews have been imposed starting with citizens aged 65 and over, children and young people under the age of 20 and those with chronic diseases. All entries and exits to 30 metropolitan cities (including Ankara and Zonguldak) by land, air and sea were first suspended on the 4$^{th}$ of April 2020 for 15 days and this entry-exit restriction was extended several times. Moreover, General curfews on weekends and holidays in Ankara started to be implemented as of April 11, 2020.

Specific to mass transportation, a decision was made to reduce passenger capacity by 50% on the 24$^{th}$ of March, 2020. This decision, important in terms of maintaining social distance, has been changed several times. Based on the last digits of the license plate, a limitation was imposed on commercial taxis on the 30$^{th}$ of March 2020 but was later terminated on the May 5$^{th}$, 2020. Moreover, a mask wearing mandate was imposed on all inter and intra-urban mass transportation vehicles in addition to taxis, service vehicles, and all kinds of commercial vehicles. Some of the measures directly affecting the mass transportation system in Ankara are detailed in chronological order in Table 4. It should be pointed out that various measures have been taken and continue to change even as this chapter is being finalized.

Table 4: List of COVID-19 Related Restrictions*

| | | |
|---|---|---|
| First Wave - Administrative Measures | | |
| 16-Mar-20 | Education is suspended in all schools and universites. Shortly afterwards, distance learning/online education commences. | |
| 21-Mar-20 | Citizens aged 65 and over and those with chronic illnesses are restricted from leaving their residences and prohibited from going out. | İçişleri Bakanlığı 2020/5762 Genelgesi ve 21.03.2020/5 UHKK* |
| 22-Mar-20 | Public Instritutions and Organizations enact flexible work measures (e.g. teleworking, rotational shifts) | Cumhurbaşkanlığı 2020/4 Genelgesi |
| 24-Mar-20 | Passenger Capacity dropped to 50% in all in all urban and inter-city mass transportation vehicles | 24.03.2020/7 UHKK |
| 4-Apr-20 | Children and young adults under the age of 20 are banned from going out. | İçişleri Bakanlığı 2020/6235 Genelgesi ve 03.04.2020/17 UHKK |
| 11-12-Apr 2020 | A 2-day weekend curfew | 10.04.2020/20 UHKK |
| 13-Apr-20 | A mask wearing mandate imposed in public transportation vehicles, intercity and inter-district transportation vehicles, taxis, all kinds of commercial vehicles and service vehicles. Mass Transportation vehicles are to accomodate 50% of the "passenger seating capacity" and and up to 25% of their "standing passengers capacity". | 12.04.2020/21 UHKK |
| 18-19 April 2020 | A 2-day weekend curfew | 16.04.2020/23 UHKK |
| 23-26 April 2020 | A 4-day curfrew (Official Holiday and weekend) | 21.04.2020/25 UHKK |
| 1-3 May 2020 | A 3-day curfew (Official Holiday and weekend) | 29.04.2020/27 UHKK |
| 9-May-20 | Measures of social distance and personal hygiene are enacted at taxi stops and inside taxi vehicles. | 09.05.2020/32 UHKK |
| 9-10 May 2020 | A 2-day weekend curfew | 07.05.2020/30 UHKK |
| 16-19 May 2020 | A 4-day curfew (weekend and Official Holiday) | 13.05.2020/34 UHKK |
| 23-26 May 2020 | A 4-day curfew (weekend and Ramadan Holiday) | 21.05.2020/37 UHKK |
| 29-May-20 | The curfew on young adults between the ages of 18-20 has been lifted | İçişleri Bakanlığı 2020/8483 Genelgesi ve 29.05.2020/39 UHKK |
| 30-31 May 2020 | A 2-day weekend curfew | 29.05.2020/39 UHKK |
| Second Wave – Adminstrative Measures | | |
| 1-Jun-20 | Return to a controlled Social Life Begins (Normalization) | |
| 10-Jun-20 | The curfew for those under 18 has been completely lifted. Citizens aged 65 and over were allowed to go outside the residence between 10:00 and 20:00 every day. | İçişleri Bakanlığı 2020/9138 Genelgesi ve 10.06.2020/46 UHKK |
| 18-Jun-20 | The use of masks was made mandatory in all open areas throughout the province.. | 17.06.2020/48 UHKK |
| 20 June 2020, 27-28 June 2020 | Curfew between 09:00 and 15:00, 09:30-15:00; and 09:30-18:30 respectively in parralel with National Exams (LGS ans YKS) | 19.06.2020/49 UHKK |

Table 4 (Continued)

| | | |
|---|---|---|
| 10-Jul-20 | Children and those under 18 are no longer required to be accompanied by an adult. | İçişleri Bakanlığı 2020/11173 Yazısı ve 10.07.2020/61 UHKK |
| 8-Sep-20 | A requirement to wear masks without exception was imposed in all areas throughout the province (except residential areas).<br>Standing passengers are banned in urban public transport where social distance rules cannot be applied, such as minibuses and midibuses etc. | 08.09.2020/71 UHKK |
| 21-Sep-20 | Face-to-face education starts on certain days for pre-school and primary school 1st graders. | Milli Eğitim Bakanlığı yazıları ve duyuruları |
| 30-Sep-20 | Decision to integrate the in-city electronic / smart public transport passenger cards with the Ministry of Health Hayat Eve Sığar (HES) application. | 30.09.2020/74 UHKK |
| 12-Oct-20 | Face-to-face education commences on certain days for educational levels (2nd, 3rd, 4th, 8th, and 12th graders) | Milli Eğitim Bakanlığı yazıları ve duyuruları |
| 2-Nov-20 | Face-to-face education commences for more educational levels (5th and 9th graders) | Milli Eğitim Bakanlığı yazıları ve duyuruları |
| 10-Nov-20 | Citizens aged 65 and over are once more banned from going out every day, except between 10:00 and 16:00. | 10.11.2020/80 UHKK |
| 11-Nov-20 | The consumption of cigarettes and tobacco products is prohibited in areas were residents are concentrated (e.g. streets, squares, and Mass Transportation stops) | 11.11.2020/81 UHKK |
| Third Wave - Adminstrative Measures | | |
| 17-Nov-20 | Distance/online education re-introduced in all educational establishments. | |
| 20 November 2020, | Citizens aged 65 and over are only allowed outside between 10:00 and 13:00; Children and those under the age of 20 are only allowed outside between 13: 00-16: 00. | 18.11.2020/82 UHKK |
| 21-23 November 2020 | Curfew on 21-22 November between 20:00-10:00 and on 22-23 November between 20:00-05:00. | 18.11.2020/82 UHKK |
| 1-Dec-20 | Weekly Weekday curfews introduced between 21:00 and 05:00.<br>Weekly Weekend curfews introduced from Saturday at 20:00 to Sunday at 10:00 and from Sunday at 20:00 to Monday at 05:00<br>Citizens aged 65 and above in addition to those who are 20 and under are restricted from using Mass Transportation vehicles. | İçişleri Bakanlığı 2020/20076 ve 20077 Genelgeleri ve 01.12.2020/85 UHKK |
| 31 December 2020-1-4 January 2021 | A 4- day curfew from 9:00 p.m. on December 31, to 5:00 a.m. on January 4, 2021. | 15.12.2020/88 UHKK |
| 15-Feb-21 | Face-to-face education commences 5 days a week in certain educational establishments. | Milli Eğitim Bakanlığı yazıları ve duyuruları |
| 1-Mar-21 | Face-to-face educaion commences for certain educational levels and certain educational institutes on certain days of the week. | Milli Eğitim Bakanlığı yazıları ve duyuruları |

*Prepared by scanning the Presidency and Ministry of Internal Affairs Circulars and the Ankara Governorship Provincial General Hygiene Board Decisions (UHKK).

In general, the table above divides the pandemic process into three main periods parallel to the increase/ decrease in case load and the restriction/ease of protective measures and prohibitions. The first period covers the first ‘wave’ of the pandemic in Turkey. As briefly mentioned above, restrictions in this period were applied to Turkey's 30 metropolitan cities, including Ankara, and Zonguldak. The peak of this period was reached on the 11th of April, 2020 with a case load of 13,976. Almost all kinds of social activities were halted during this period. Shopping centers, hairdressers and barbers, gyms, swimming pools, spas, game halls, amusement parks, theaters, cinemas, and concert halls were closed. Food and beverage places remained open for takeaways and deliveries only. The second period covered in Table 4 is the normalization period which started on the 1st of June 2020. During this period of controlled return to social life, protection measures continued but restrictions and prohibitions (e.g. curfews) were relaxed.

In an attempt to stem the spread of COVID-19 'second wave', restrictions and prohibitions were returned as of the 20th of November 2020. This is the third, and final period, covered in Table 4. The highest number of cases in the second wave was reached on the 8th of December, 2020 with a caseload of 33,198. Face-to face education, which had previously commenced on certain days of the week as of the 21st of September, was halted once more on the 17th of November 2020 in favor of online education. Aged based mobility restrictions were also re-introduced on the 20th of November 2020. Restrictions on inter-city mobility were not re-imposed during this period except for citizens aged 65 and above who were required to display a "Travel Permit Certificate" when traveling between cities. A general curfew was re-enacted on the 1st of December 2020 between 21:00 and 5:00 on weekdays and from 21:00 on Friday until 05:00 on Monday (See Table 4).

All of the measures listed in Table 4 had an effect on mass transportation either directly (through mass transportation specific pandemic regulations) or indirectly (through unprecedented restrictions on general mobility). Measures necessary to combat the pandemic, most notably that of social distancing, were objectively opposed to the very nature of mass transportation, namely transporting people *en masse.* In the first studies on COVID-19 and transport behaviors, flexible working patterns, teleworking and the closure of social areas have all been demonstrated to cause a decrease in urban mobility (De Vos, 2020). Thus, the next sections explore the effect of these measure on mass transportation in terms of various mass transit indicators (e.g. Ridership levels, peak hours, frequency, schedules, commute time, waiting time, trip distance, need for transfer, car ownership). Moreover, incentives to use mass transportation are also detailed.

### 4.3.1 Ridership Levels

Looking at Table 5, it is very easy to notice the stark decrease in mobility (both mass and private) in Ankara as a result of the pandemic. While the number of trips made by motor vehicles were around 7 million in March (prior to the pandemic), it dropped to around 1.5 million in the first month of the pandemic (April). This 78% drop is the highest decrease in mobility across all months of the pandemic (Table 6). Comparing the decrease rates, the vulnerability of mass transit to pandemics become apparent. In all of the months examined, mass transit lost ridership at levels much greater than those of individual transit (e.g. car). In fact, ridership of private transit surpassed pre-pandemic levels by August 2020. Meanwhile, ridership of mass transit continued to fluctuate across the time period examined with decrease percentages ranging from 82% in March 2020 to 45% in March 2021 (Table 6)

Moreover, the pattern of both total mass transit decrease and decrease in individual modes is consistent with the 3 periods of the pandemic defined in table 4. Thus, the number of mass transit passengers directly reflects the course of the pandemic. As can be seen in figure 1, the greatest decrease in mass transit use is experienced in the months of April and May (first wave). This is followed by a relative increase in the months of June-November (normalization and controlled social life) and then another decrease as strict measures and bans were re-implemented (second wave).

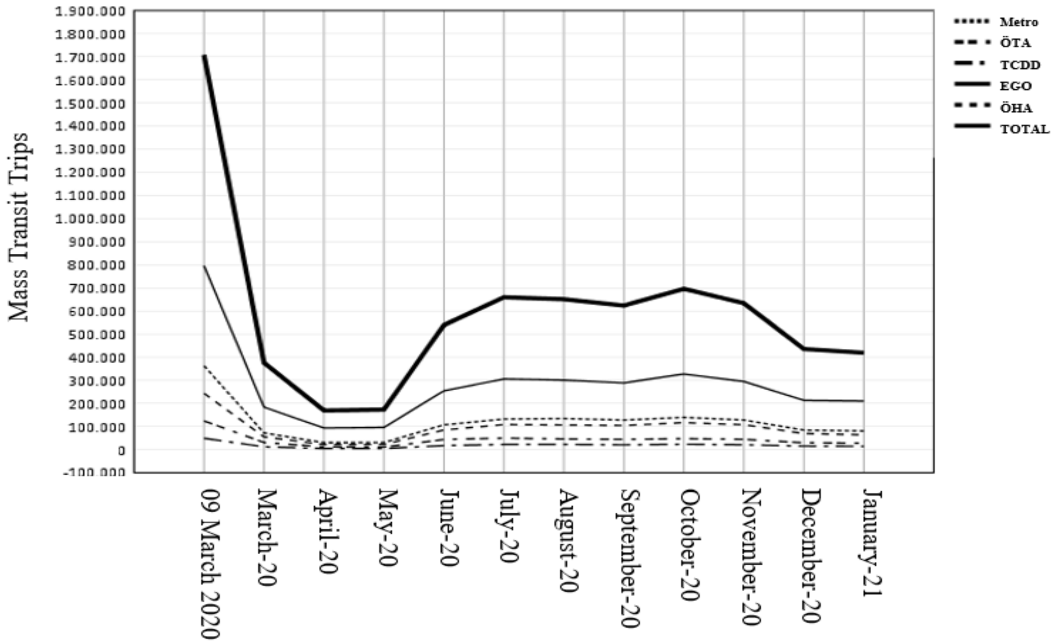


Figure 1: Mass Transit Trips before and during the Pandemic

The disproportionate effect of COVID-19 on mass transportation is further illustrated in Table 5. While the share of mass transit to private transit was 56% to 43% in March 2020, this figure was transformed by March 2021 into 39% to 60%, respectively. The decline in Ankara's mass transit ridership is further corroborated by the results of a survey conducted by MOOVIT on the effects of COVID-19 on mass transit across various cities worldwide. Mass transit users were asked a series of questions including "How has COVID-19 affected your mass transportation usage?" In the case of Ankara, around 60% of respondents reported that they either no longer use mass transit at all or that they use it at a lower frequency than before; 30% reported that COVID-19 did not affect their frequency of use; 4% reported using mass transit more as a result of the pandemic and 3.8% reported switching to an alternative mode of transport (Moovit Insight, 2020).

Table 5: Breakdown of Motorized Trip before and during the Pandemic by Mode- Weekdays*

| Mode | March-20 | Apr-20 | May-20 | Jun-20 | Jul-20 | Aug-20 | Sep-20 | Oct-20 | Nov-20 | Dec-20 | Jan-21 | Feb-21 | Mar-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass Transport | 3,782,200 | 653,700 | 863,873 | 1,405,950 | 1,764,870 | 1,728,950 | 1,700,700 | 1,828,540 | 1,824,500 | 1,481,600 | 1,505,500 | 1,605,680 | 2,045,415 |
| Private Transport | 2,935,000 | 772,000 | 1,702,000 | 2,725,000 | 2,907,000 | 2,940,000 | 2,955,000 | 2,974,000 | 2,998,250 | 2,995,000 | 3,010,000 | 3,035,000 | 3,110,000 |
| Total | 6,717,200 | 1,425,700 | 2,565,873 | 4,130,950 | 4,671,870 | 4,668,950 | 4,655,700 | 4,802,540 | 4,822,750 | 4,476,600 | 4,515,500 | 4,640,680 | 5.155,415 |
| Mass Transit (%) | 56.3% | 45.9% | 33.7% | 34.0% | 37.8% | 37.0% | 36.5% | 38.1% | 37.8% | 33.1% | 33.3% | 34.6% | 39.7% |
| Private Transit (%) | 43.7% | 54.1% | 66.3% | 66.0% | 62.2% | 63.0% | 63.5% | 61.9% | 62.2% | 66.9% | 66.7% | 65.4% | 60.3% |
| Total (%) | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

*Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Table 6: Decrease in Ridership per Mode as a Result of the Pandemic- Weekdays*

| Mode | Apr-20 | May-20 | Jun-20 | Jul-20 | Aug-20 | Sep-20 | Oct-20 | Nov-20 | Dec-20 | Jan-20 | Feb-21 | Mar-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass Transport (%) | 82.7% | 77.2% | 62.8% | 53.3% | 54.3% | 55.0% | 51.7% | 51.8% | 60.8% | 60.2% | 57.5% | 45.9% |
| Private Transport (%) | 73.7% | 42.0% | 7.2% | 1.0% | +0.2% | +0.7% | +1.3% | +2.2% | +2.0% | +2.6% | +3.4% | +6.0% |
| Total decrease (%) | 78.8% | 61.8% | 38.5% | 30.4% | 30.5% | 30.7% | 28.5% | 28.2% | 33.4% | 32.8% | 30.9% | 23.3% |

*Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Naturally, this decrease in mass transit ridership was not uniform across all modes (Tables 7 and 8). Prior to the pandemic (March 2020), the highest share of passengers within mass transit belonged to Dolmuşes followed by service vehicles and EGO buses. Although all three modes lost ridership as a result of the pandemic, their shares remain the highest as of March, 2021 (Tables 7). For a more informative picture, however, rates of ridership decrease per month per mode have to be examined (Table 8).The highest decrease in ridership during the pandemic period was that of Ankaray (93.8%) and Metro (88.3%) in March 2020 while the lowest was that of Başkentray suburban rail (35.8%) in March followed by that of the Dolmuş (37.5%) in November 2020. Ankaray suffered from the highest rates of ridership decrease in 10 out of the 12 months examined (Table 8). Ankaray might have been the hardest hit by loss of ridership because of the closure of AŞTİ, the intercity bus terminal and one of the most passenger intensive stations of the line. By contrast, Dolmuş maintained the lowest decrease in ridership across 8 of the 12 months examined (Table 8). That being said, no single mode emerge as one with the highest or lowest rates of decrease across all the months examined. Due to the measures taken throughout the year, rates of decrease among the different mode differed by month; no uniform pattern of ridership decrease per mode emerged. As stated before, mass transportation modes collectively lost the most ridership in March 2020 and achieved the highest ridership rates of the pandemic in March 2021.

Table 7: Share in Urban Transportation per Mode before and during Pandemic % - Weekday*

| Mode | Mar-20 | Apr-20 | May-20 | Jun-20 | Jul-20 | Aug-20 | Sep-20 | Oct-20 | Nov-20 | Oct-20 | Jan-21 | Feb-21 | Mar-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EGO Buses | 11.7% | 8.9% | 6.6% | 7% | 7.3% | 7.1% | 6.8% | 7.6% | 7.3% | 6% | 6.4% | 7% | 8.8% |
| Ankaray- LRT | 1.9% | 0.5% | 0.5% | 0.8% | 0.9% | 0.9% | 0.8% | 0.9% | 1% | 0.7% | 0.7% | 0.9% | 1% |
| Metro | 5.5% | 3.1% | 2.4% | 3% | 3.2% | 3.2% | 2.9% | 3.2% | 3.1% | 2.6% | 2.8% | 3.1% | 3.6% |
| Suburban Train | 0.7% | 0.5% | 0.5% | 0.5% | 0.6% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.6% |
| Minibus-Dolmuş | 15.5% | 14.7% | 12.3% | 10% | 13.5% | 13.3% | 13.4% | 13.3% | 13.5% | 12.3% | 11.7% | 11.6% | 13.2% |
| Service Vehicles | 12.2% | 11.6% | 6.5% | 6.8% | 6% | 5.8% | 5.9% | 6.2% | 6.2% | 5.6% | 5.5% | 5.4% | 5.6% |
| ÖHO buses | 3.6% | 2.2% | 1.7% | 2.4% | 2.6% | 2.6% | 2.4% | 2.6% | 2.6% | 2.1% | 2.2% | 2.4% | 2.8% |
| ÖTA buses | 1.8% | 1.2% | 0.7% | 1.3% | 1.2% | 1.1% | 1.1% | 1.1% | 1.1% | 0.9% | 1% | 1.1% | 1.4% |
| Private District Vehicles | 1.1% | 1.1% | 0.9% | 0.8% | 0.7% | 0.7% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.9% |
| Private Companies Service Vehicles | 2.2% | 2.0% | 1.6% | 1.5% | 1.8% | 1.8% | 1.8% | 1.8% | 1.8% | 1.8% | 1.8% | 1.7% | 1.7% |
| Mass Transport Total | 56.3% | 45.9% | 33.7% | 34% | 37.8% | 37% | 36.5% | 38.1% | 37.8% | 33.1% | 33.3% | 34.6% | 39.7% |
| Taxi | 5.1% | 4.9% | 4% | 4.8% | 5.1% | 5.1% | 5% | 4.9% | 5% | 4.9% | 5.1% | 5.1% | 5% |
| Private Car | 38.6% | 49.2% | 62.4% | 61.1% | 57.1% | 57.8% | 58.4% | 57.0% | 57.2% | 62% | 61.6% | 60.3% | 55.3% |
| Private Transport Total | 43.7% | 54.1% | 66.3% | 66% | 62.2% | 63% | 63.5% | 61.9% | 62.2% | 66.9% | 66.7% | 65.4% | 60.3% |
| General Total | 100% | 100.% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

*Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Table 8: Decrease in Ridership per Mode % - March as a Base Month*

| Mode | Apr-20 | May-20 | Jun-20 | Jul-20 | Aug-20 | Sep-20 | Oct-20 | Nov-20 | Oct-20 | Jan-21 | Feb-21 | Mar-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EGO Buses | 83.8% | 78.5% | 63.2% | 56.3% | 57.8% | 59.5% | 53.6% | 55.2% | 66% | 63.3% | 58.5% | 42.2% |
| Ankaray - LRT | 93.8% | 90% | 73.9% | 66.1% | 67.3% | 69.8% | 66.2% | 60.2% | 76.4% | 74.8% | 68% | 59.1% |
| Metro | 88.3% | 83.7% | 66.7% | 59.8% | 60.1% | 63.1% | 59% | 60.3% | 69.1% | 66.2% | 60.9% | 49.3% |
| Suburban Train | 85.1% | 72.8% | 58.8% | 48.5% | 50.2% | 53.2% | 49.2% | 51.2% | 59.8% | 56.6% | 50% | 35.8% |
| Minibus-Dolmuş | 79.8% | 69.7% | 60.1% | 39.4% | 40.4% | 39.9% | 38.5% | 37.5% | 47.1% | 49% | 48.1% | 34.6% |
| Service Vehicles | 79.8% | 79.8% | 65.9% | 65.9% | 67.1% | 66.5% | 63.4% | 63.4% | 69.5% | 69.5% | 69.5% | 64.6% |
| ÖHO buses | 86.9% | 81.6% | 58.5% | 49.5% | 49.3% | 52.8% | 47.4% | 49% | 60.8% | 58.7% | 53% | 40.4% |
| ÖTA vehicles | 86% | 85.1% | 58% | 54.2% | 58.5% | 60% | 57.6% | 57.5% | 67.3% | 64.5% | 58.4% | 42.8% |
| Private District Vehicles | 80% | 70% | 58.7% | 54.7% | 53.3% | 52% | 46.7% | 46.7% | 53.3% | 53.3% | 53.3% | 40% |
| Private Companies Service Vehicles | 81.3% | 72% | 58.7% | 45.3% | 43.3% | 43.3% | 43.3% | 43.3% | 46.7% | 46.7% | 46.7% | 40% |
| Mass Transport Total | 82.7% | 77.2% | 62.8% | 53.3% | 54.3% | 55% | 51.7% | 51.8% | 60.8% | 60.2% | 57.5% | 45.9% |
| Taxi | 79.7% | 70.4% | 42% | 30.4% | 30.4% | 31.9% | 31.9% | 30.4% | 36.2% | 33.3% | 31.9% | 24.6% |
| Private Car | 72.9% | 38.2% | 2.5% | +3% | +4.2% | +5% | +5.8% | +6.5% | +7.1% | +7.3% | +8.1% | +10% |
| Private Transport Total | 73.7% | 42% | 7.2% | 1% | +0.2% | +0.7% | +1.3% | +2.2 | +2% | +2.6% | +3.4% | +6% |
| Total Decrease | 78.8% | 61.8% | 38.5% | 30.4% | 30.5% | 30.7% | 28.5% | 28.2% | 33.4% | 32.8% | 30.9% | 23.3% |

*Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

### 4.3.2 Frequencies, Peak Hours and Other Mass Transit Indicators

The effect of COVID-19 on mass transit is multifaceted and should not be narrowed down to a mere focus on ridership loss. Even if ridership levels were to surpass pre-pandemic levels, measures enacted during the pandemic would have a permanent effect on the way mass transit operates. For example, the experiment with flexible work and school hours means that mass transit can gradually transition away from the traditional rush hour based operational mode. Thus, it would be useful to also look into the effect of COVID-19 on the timetables, frequencies and peak hours of Ankara's mass transit system. Looking at passenger flow per hour (Tables 10 and 11), we notice that there is no difference between the morning and evening peak hours of before and after the pandemic. Both in March (before the pandemic) and the months following it (during the pandemic) the morning peak hours are 07:00-09:00 and the evening peak hours are 16:00-19:00. This is quite an interesting finding as considering the different measures enacted during the pandemic such as the closure of schools, and the introduction of flexible working schedules. Changes regarding frequency and mass transit timetables, especially relating to the city's subway system, can be seen in Table 9. Naturally, those changes in turn affected other mass transit characteristics such as wait time, Commute time and distance, and number of transfers (Figures 2 to 5). As can be seen in those graphs, average commute distance decreased by one kilometer and total commute time dropped by 3 minutes while average waiting time increased by one minute (Figures 2,3, and 4). Moreover, the breakdown of passengers per number of transfers needed per trip is displayed in Figure 5.

Table 9: Ankara Metro Operating Program (Lines M1-M2-M3) March 2020 – Janury 2021*

**9 March 2020**

| | | | |
|---|---|---|---|
| **Weedays** | 06:00 | 07:00 | 9 min |
| | 07:00 | 09:30 | 4 min |
| | 09:30 | 16:00 | 7 min. |
| | 16:00 | 20:00 | 4 min. |
| | 20:00 | 23:00 | 9 min |
| | 23:00 | 01:00 | 15 min. |
| **Saturday** | 06:00 | 07:30 | 9 min. |
| | 07:30 | 20:00 | 7 min. |
| | 20:00 | 23:00 | 9 min |
| | 23:00 | 01:00 | 15 min. |
| **Sunday** | 06:00 | 12:00 | 9 min. |
| | 12:00 | 20:00 | 8 min. |
| | 20:00 | 23:00 | 9 min. |
| | 23:00 | 01:00 | 15 min. |

Last train;
OSB/Törekent – Koru 24:10
Koru – OSB/Törekent 24:35
Kızılay - Koru 01:00
Kızılay – OSB/Törekent- 01:00

**First Wave (April – May 2020)**

| | | | |
|---|---|---|---|
| **Weedays** | 06:00 | | |
| | 07:00 | 09:30 | 7 min. |
| | 09:30 | 16:00 | 15 min. |
| | 16:00 | 20:30 | 7 min. |
| | 20:30 | 00:00 | 15 min. |
| The day before curfew* | Last train; OSB/Törekent–Koru 21:40 Koru–OSB/Törekent 22:05 Kızılay-Koru 22:30 Kızılay–OSB/Törekent 22:30 | | |
| Curfew Weekdays** | Metro is closed. EGO buses between 07:00 – 20.00 | | |
| Curfew Weekends and Holidays*** | Metro is closed EGO buses between 07:00 – 09:00 and 16.30-20.00 | | |

*10 April; 17 April; 22 April; 30 April; 8 May; 15 May; 22 May; 29 May
**23-24 April; 1 May; 18-19 May; 23 May
***11-12 April; 18-19 April; 25-26 April; 2-3 May; 9-10 May; 16-17 May; 24-26 May; 30-31 May

**Second Wave**

| | | | |
|---|---|---|---|
| **Weekdays** | 06:00 | 07:00 | 9 min. |
| | 07:00 | 09:30 | 4 min. |
| | 09:30 | 16:00 | 7 min. |
| | 16:00 | 20:00 | 4 min. |
| | 20:00 | 23:00 | 9 min. |
| | 23:00 | 00:00 | 15 min. |
| **Saturday** | 06:00 | 07:30 | 9 min. |
| | 07:30 | 20:00 | 7 min. |
| | 20:00 | 23:00 | 9 min. |
| | 23:00 | 00:00 | 15 min. |
| **Sunday** | 06:00 | 12:00 | 9 min. |
| | 12:00 | 20:00 | 8 min. |
| | 20:00 | 23:00 | 9 min. |
| | 23:00 | 00:00 | 15 min. |

Last train;
OSB/Törekent – Koru 23:10
Koru – OSB/Törekent 23:35
Kızılay - Koru 24:00
Kızılay – OSB/Törekent- 24:00

**Third Wave (Dcember 2020 – Febrauary 2021)**

| | | | | |
|---|---|---|---|---|
| **Weekdays** Curfew between 21:00-5:00 | | 06:00 | 07:00 | 9 min. |
| | | 07:00 | 10:00 | 5 min. |
| | | 10:00 | 15:00 | 7 min. |
| | | 15:00 | 20:00 | 5 min. |
| | | 20:00 | 21:00 | 10 min. |
| | | Las train; OSB/Törekent–Koru 21:00 Koru–OSB/Törekent 21:25 Kızılay-Koru 21:50 Kızılay–OSB/Törekent 21:50 | | |
| Curfew Weekends and Holidays * | **Lines 500-522** | 06:00 | 08:00 | 30 min. |
| | | 08:00 | 16:00 | - |
| | | 16:00 | 20:00 | 30 min. |
| | | 20:00 | 23:00 | - |
| | **Line 600** | 06:00 | 08:00 | 15 min. |
| | | 08:00 | 16:00 | 60 min. |
| | | 16:00 | 20:00 | 15 min. |
| | | 20:00 | 23:00 | 60 min. |

*Metro is closed. EGO buses
500 – OSB/Törekent – Batıkent
522 – Koru – Ümitköy – Şehir hastanesi
600 – Koru - Kızılay
As of December 1st, curfews were imposed from 21:00-05:00 on weekdays and from Friday 21:00-Monday 05:00 on weekends

* The information was obtained by scanning the EGO General Directorate website (https://www.ego.gov.tr/tr/haberler).

Table 10: Daily Peak Hours before and during the Pandemic by Month- Absolute*

| Hours | March | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| 06-07 | 65,964 | 14,204 | 16,276 | 30,520 | 34,478 | 34,139 | 31,038 | 32,394 | 32,417 |
| 07-08 | **174,901** | **25,688** | **32,760** | **57,428** | **67,045** | **66,608** | **63,443** | **70,943** | **80,405** |
| 08-09 | **156,527** | **20,647** | **29,821** | **50,771** | **59,448** | **60,181** | **58,523** | **67,282** | **78,541** |
| 09-10 | 91,105 | 12,485 | 21,138 | 32,876 | 36,399 | 35,721 | 33,854 | 36,800 | 40,321 |
| 10-11 | 74,516 | 9,337 | 18,219 | 29,736 | 35,792 | 35,184 | 30,528 | 33,168 | 35,810 |
| 11-12 | 78,049 | 9,414 | 17,183 | 29,852 | 34,946 | 35,205 | 31,233 | 33,105 | 37,106 |
| 12-13 | 92,315 | 9,998 | 18,293 | 31,571 | 37,251 | 38,042 | 34,019 | 37,627 | 42,813 |
| 13-14 | 92,637 | 11,414 | 19,216 | 34,226 | 38,852 | 39,462 | 36,449 | 40,731 | 50,565 |
| 14-15 | 95,24 | 12,741 | 19,216 | 36,071 | 41,151 | 42,239 | 37,878 | 42,282 | 52,122 |
| 15-16 | 129,503 | 13,219 | 22,086 | 35,664 | 41,677 | 43,342 | 39,374 | 45,676 | 50,756 |
| 16-17 | **140,057** | **15,642** | **23,572** | **39,136** | **47,561** | **48,201** | **44,365** | **52,667** | **57,419** |
| 17-18 | **151,098** | **21,043** | **29,645** | **51,758** | **62,516** | **62,768** | **56,207** | **65,636** | **71,044** |
| 18-19 | **137,528** | **22,616** | **31,244** | **52,970** | **66,946** | **67,210** | **62,095** | **70,291** | **71,827** |
| 19-20 | 89,858 | 12,352 | 17,051 | 35,024 | 45,639 | 45,283 | 42,471 | 46,408 | 45,210 |
| 20-21 | 51,522 | 7,693 | 6,467 | 23,022 | 28,148 | 26,987 | 23,158 | 24,411 | 23,576 |
| 21-22 | 38,702 | 3,986 | 6,901 | 15,399 | 23,227 | 21,153 | 18,753 | 19,344 | 18,951 |
| 22-23 | 30,757 | 1,985 | 4,892 | 10,223 | 16,115 | 16,722 | 13,963 | 14,489 | 13,981 |
| 23-00 | 10,531 | 692 | 1,940 | 3,573 | 6,404 | 6,292 | 5,089 | 5,134 | 4,517 |
| TOTAL | 1,700,810 | 225,156 | 335.92 | 599,820 | 723,595 | 724,739 | 662,440 | 738,388 | 807,381 |

*Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Table 11: Daily Peak Hours before and during the Pandemic by Month- Percentage*

| Hour | March | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| 06-07 | 3.9% | 6.3% | 4.8% | 5.1% | 4.8% | 4.7% | 4.7% | 4.4% | 4% |
| 07-08 | **10.3%** | **11.4%** | **9.8%** | **9.6%** | **9.3%** | **9.2%** | **9.6%** | **9.6%** | **10%** |
| 08-09 | **9.2%** | **9.2%** | **8.9%** | **8.5%** | **8.2%** | **8.3%** | **8.8%** | **9.1%** | **9.7%** |
| 09-10 | 5.4% | 5.5% | 6.3% | 5.5% | 5% | 4.9% | 5.1% | 5% | 5% |
| 10-11 | 4.4% | 4.1% | 5.4% | 5% | 4.9% | 4.9% | 4.6% | 4.5% | 4.4% |
| 11-12 | 4.6% | 4.2% | 5.1% | 5% | 4.8% | 4.9% | 4.7% | 4.5% | 4.6% |
| 12-13 | 5.4% | 4.4% | 5.4% | 5.3% | 5.1% | 5.2% | 5.1% | 5.1% | 5.3% |
| 13-14 | 5.4% | 5.1% | 5.7% | 5.7% | 5.4% | 5.4% | 5.5% | 5.5% | 6.3% |
| 14-15 | 5.6% | 5.7% | 5.7% | 6% | 5.7% | 5.8% | 5.7% | 5.7% | 6.5% |
| 15-16 | 7.6% | 5.9% | 6.6% | 5.9% | 5.8% | 6% | 5.9% | 6.2% | 6.3% |
| 16-17 | **8.2%** | **6.9%** | **7.0%** | **6.5%** | **6.6%** | **6.7%** | **6.7%** | **7.1%** | **7.1%** |
| 17-18 | **8.9%** | **9.3%** | **8,8%** | **8.6%** | **8.6%** | **8.7%** | **8.5%** | **8.9%** | **8.8%** |
| 18-19 | **8.1%** | **10%** | **9.3%** | **8.8%** | **9.3%** | **9.3%** | **9.4%** | **9.5%** | **8.9%** |
| 19-20 | 5.3% | 5.5% | 5.1% | 5.8% | 6.3% | 6.2% | 6.4% | 6.3% | 5.6% |
| 20-21 | 3.0% | 3.4% | 1.9% | 3.8% | 3.9% | 3.7% | 3.5% | 3.3% | 2.9% |
| 21-22 | 2.3% | 1.8% | 2.1% | 2.6% | 3.2% | 2.9% | 2.8% | 2.6% | 2.3% |
| 22-23 | 1.8% | 0.9% | 1.5% | 1.7% | 2.2% | 2.3% | 2.1% | 2% | 1.7% |
| 23-00 | 0.6% | 0.3% | 0,6% | 0.6% | 0.9% | 0.9% | 0.8% | 0.7% | 0.6% |

*Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

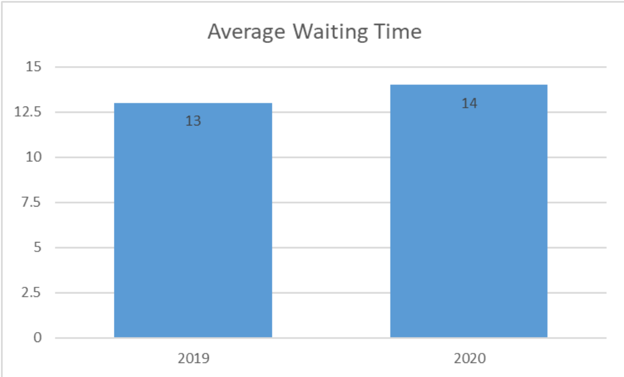


Figure 2: Average Mass Transit Waiting Time (min)

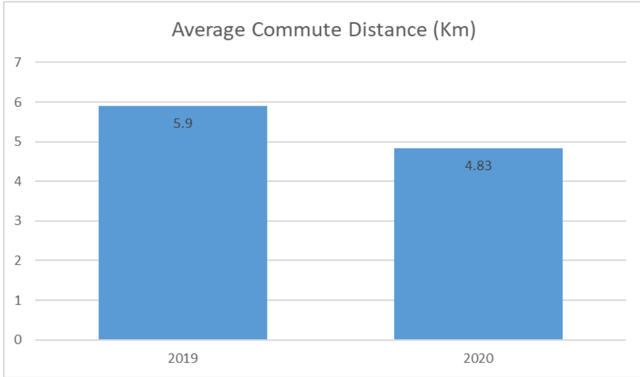


Figure 4: Average Mass Transit Commute Distance

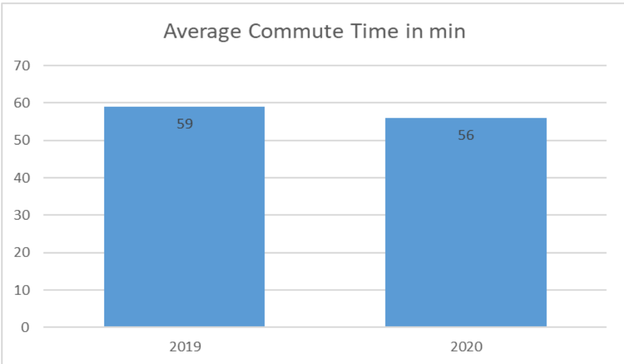


Figure 3: Average Mass Transit Commute Time

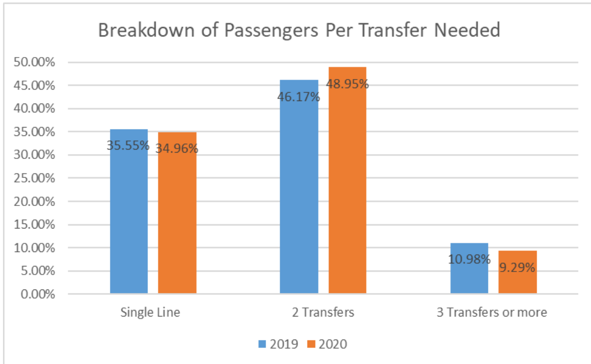


Figure 5: Mass Transit Passengers Breakdown per Number of Transfers

### 4.3.3 Car Ownership

The adverse effects of COVID-19 on mass transit has been coupled with an increase in car ownership worldwide (McKinsey & Company, 2020; Phelan, 2020) including Turkey. Naturally, this trend disproportionally affects individuals with a lower socio-economic status. After all, individuals from a lower economic stratum are less likely to own a car or to be able to afford daily commute with a taxi. Moreover, this segment of society is also less likely to be able to telework. That being said, it would be a mistake to regard the drop in mass transit ridership and the paralleled increase in car usage as an "exodus of the well-off". Even the most captive of users are building their new transportation routines around avoidance of mass transit in line with the now growing perception of mass transit as "risky" or "unsafe. This is evident in the explosion of demand for second hand cars around the world (Baudette, 2020) to which Turkey is no exception (Oxford Business Group, 2020).

Ankara was the "car capital" of Turkey prior to the pandemic. Research indicates that the disparity will also manifest itself in terms of the rate at which car ownership increases in Ankara versus that of Turkey as a whole following the pandemic (Tables 12,13, and 14). The higher rate of increase in Ankara compared to the country wide average might be explained by the fact that COVID-19 effects were more adverse in big cities. Another explanation might have to do with disparity in level of income.

Table 12 details the number of private cars in Ankara between January and October of 2019 (before the pandemic) and between January and October of 2020 (after the pandemic). While the figure was 1,481,966 in October 2019, this value reached 1,568,874 in October of 2020; a yearly increase of 5.9 percent. For Monthly percentage increases per year, see Table 13. While the number of cars added was 33,634 between January and October of 2019 (2.3 percent increase), this number jumped to 68,459 vehicles for the same months of 2020 (4.47 percent increase). The increase in car ownership, wither new or secondhand, as a result of the pandemic thus becomes clear.

Table 12: Number of Private Cars and Yearly Increase Rate (2020-2019) *

| Month | 2019 | 2020 | Increase % |
|---|---|---|---|
| January | 1,448,332 | 1,500,415 | 3.6 |
| February | 1,451,397 | 1,507,622 | 3.9 |
| March | 1,455,649 | 1,514,535 | 4.0 |
| April | 1,460,366 | 1,517,273 | 3.9 |
| May | 1,463,845 | 1,520,254 | 3.9 |
| June | 1,463,884 | 1,527,453 | 4.3 |
| July | 1,469,672 | 1,539,702 | 4.8 |
| August | 1,472,397 | 1,548,924 | 5.2 |
| September | 1,476,393 | 1,558,400 | 5.6 |
| October | 1,481,966 | 1,568,874 | 5.9 |

* Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Table 13: Increase in Private Cars Month on Month by Year in Ankara Province*

| Month | 2019 | 2020 | 2019 Increase % | 2020 Increase % |
|---|---|---|---|---|
| January-February | 3,065 | 7,207 | 0.21 | 0.48 |
| February-March | 4,252 | 6,913 | 0.29 | 0.46 |
| March-April | 4,717 | 2,738 | 0.32 | 0.18 |
| April-May | 3,479 | 2,981 | 0.24 | 0.20 |
| May- June | 39 | 7,199 | 0.00 | 0.47 |
| June-July | 5,788 | 12,249 | 0.40 | 0.80 |
| July-August | 2,725 | 9,222 | 0.19 | 0.60 |
| August-September | 3,996 | 9,476 | 0.27 | 0.61 |
| September- October | 5,573 | 10,474 | 0.38 | 0.67 |
| Total | 33,634 | 68,459 | 2.30 | 4.47 |

* Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

Left unchecked, this pattern of increased car ownership coupled with a decrease in mass transit usage risks to become the “new normal” of transportation behavior. In fact, Pendyala et al. 2000) explains that people's daily transportation preferences are in fact routines that repeat themselves. Schönfelder and Axhausen (2010) reached a similar conclusion in their research on transportation behavior. They stated that transportation behavior is based on routines and behaviors that do not change frequently. Although transportation habits usually form and change over a longer period of time, comparing data from over 131 countries demonstrated a rapid change in transportation behavior as a result of COVID-19 (Morita et al., 2020).

Table 14: Increase in Private Cars in Ankara and Turkey (2020) *

| Month | Ankara | Turkey | Ankara % | Turkey % |
|---|---|---|---|---|
| January-February | 7,207 | 31,342 | 0.48 | 0.25 |
| February-March | 6,913 | 42,745 | 0.46 | 0.34 |
| March-April | 2,738 | 19,395 | 0.18 | 0.15 |
| April-May | 2,981 | 22,682 | 0.20 | 0.18 |
| May-June | 7,199 | 30,897 | 0.47 | 0.24 |
| June-July | 12,249 | 82,591 | 0.80 | 0.65 |
| July- August | 9,222 | 56,378 | 0.60 | 0.44 |
| August-September | 9,476 | 54,075 | 0.61 | 0.42 |
| September-October | 10,474 | 70,458 | 0.67 | 0.55 |
| Total | 68,459 | 410,563 | 4.47 | 3.22 |

* Prepared with data from Ankara Metropolitan Municipality, Department of Transportation.

### 4.3.4 Mass Transit Usage Incentives

The demise of mass transit as a result of COVID-19 in favor of higher rates of car usage and ownership is not inevitable. However, measures aiming at reducing the actual risk of infection on board, although necessary, are not enough. In order to break this vicious loop, a renewed understanding of passenger risk and safety perception is needed, a topic further explored in Chapters 3 and 5. In addition, this should be coupled with an understanding of mass transit usage incentives. Both pandemic related mass transit risk perceptions and incentives should be analyzed on a local level as they are subjective constructs that are influenced by factors such as culture, place of origin, and place of residence (Chapter 3). Unfortunately, not many studies exist on pandemic related mass transit risk perceptions and usage incentive in the context of Ankara. One exception is a MOOVIT survey in which participants were asked "What would encourage you to use mass transit more often?" both in 2019 and 2020. Moreover, participants were also asked "Specifically in light of COVID-19, what would encourage you to use public transit more often during the pandemic?" (Moovit

Insights, 2020). The results acquired might help policy makers in Ankara understand the effect of COVID-19 on mass transit usage incentives in turn leading the sector to achieve a smoother transition into the “new normal”.

Comparing participants’ responses across 2019 and 2020, there was an increase in the percentages of participants who valued “Uncrowded vehicles”, “Accurate & reliable estimated arrival time”, “Cleanliness”, “Closer transit stations”, “Feeling safer when using mass transit” and “Convenient ticketing”. With the exceptions of “Closer transit stations” and “Convenient ticketing”, all three aforementioned variables also gained priority vis-à-vis other interventions. On the other hand, there was a decrease in the percentages of participants who valued “Higher frequency/Shorter waiting time”, “Lower fares”, “Shorter trip duration”, “Fewer transfers”, “Comfort”, “A solution to first/last mile problem”, “Better accessibility to people with special needs”, and “Car parking areas near stations”. Relative to other incentives, however, there was no significant change in demand for “Higher frequency/Shorter waiting time”; both this measure and “Uncrowded vehicles” were the two most prioritized interventions in both 2019 and 2020. Moreover, although “Lower fares” decreased in percentage, it climbed up the list of priorities relative to other measures (e.g. “Shorter trip duration”). Furthermore, “Solution to first/last mile problem”, “Better accessibility to people with special needs” and “Car parking areas near stations” maintained their position vis-à-vis other measures as the least prioritized in both 2019 and 2020, although they also experienced a decrease in percentage of supporters year on year. Finally, both “Comfort” and “Fewer transfers” fell down the list of incentives vis-à-vis other measures in addition to having experienced a decrease in percentage of supporters year on year. Policy makers might want to take into consideration the low level of support prevalent across all incentives offered; the highest percentage garnered by a measure of those listed below is under 11% (Figure 6). Although unlikely, this might indicate that no amount of incentives can encourage residents to use mass transit in Ankara. More realistically, the list might be missing the incentives most meaningful to the residents of the city. The second explanation is indeed corroborated by the findings of the second question “Specifically in light of COVID-19, what would encourage you to use public transit more often during the pandemic?” with percentages of support ranging from around 20% to 70% (Figure 7). Out of the 11 choices offered in the second question, only 3 are repetitions of measured offered in the first question (comparing 2019 and 2020). Those are "Higher Vehicle Frequency", "Accurate and Reliable ETA" and "Mobile Ticketing". In a manner similar to the findings of the first survey, "Higher Vehicle Frequency" garnered the highest level of support as an incentive (67%); "Real Time Arrival Info" ranking changed only slightly (from 4$^{th}$ to 5$^{th}$ place) and "Mobile Ticketing" was among the measures with the least percentage of support (≈30%). Although real time ETA and crowdedness levels were among the top 5 incentives, these "smart" solutions were preceded by more traditional measures (e.g. increase in frequency, frequent disinfection, and adherence to social distancing) This indicates that smart, yet costly, solutions are not necessarily the most effective to people. Although these findings are quite important, they are the results of surveying mass transit users alone. However it is equally important to understand incntives that would attract non-users to the system. To the knowledge of the author, information on possible mass transit usage incentives for both users and non-users alike is not yet available in Ankara.

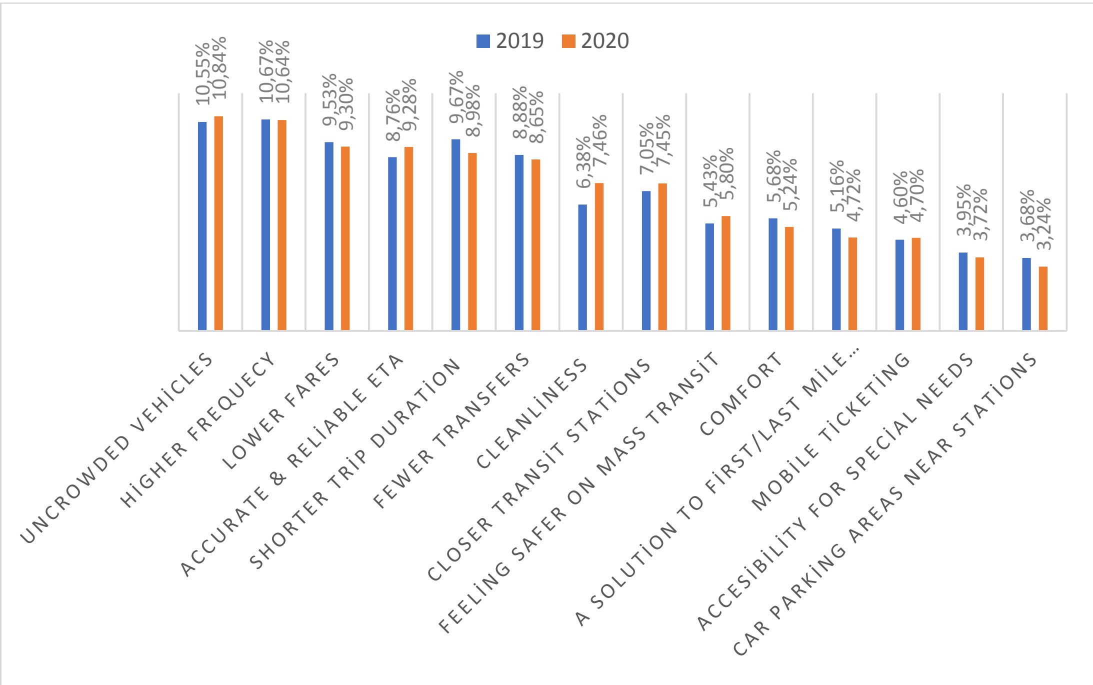


Figure 6: Mass Transit Usage Incentives in Ankara (2019/2020)

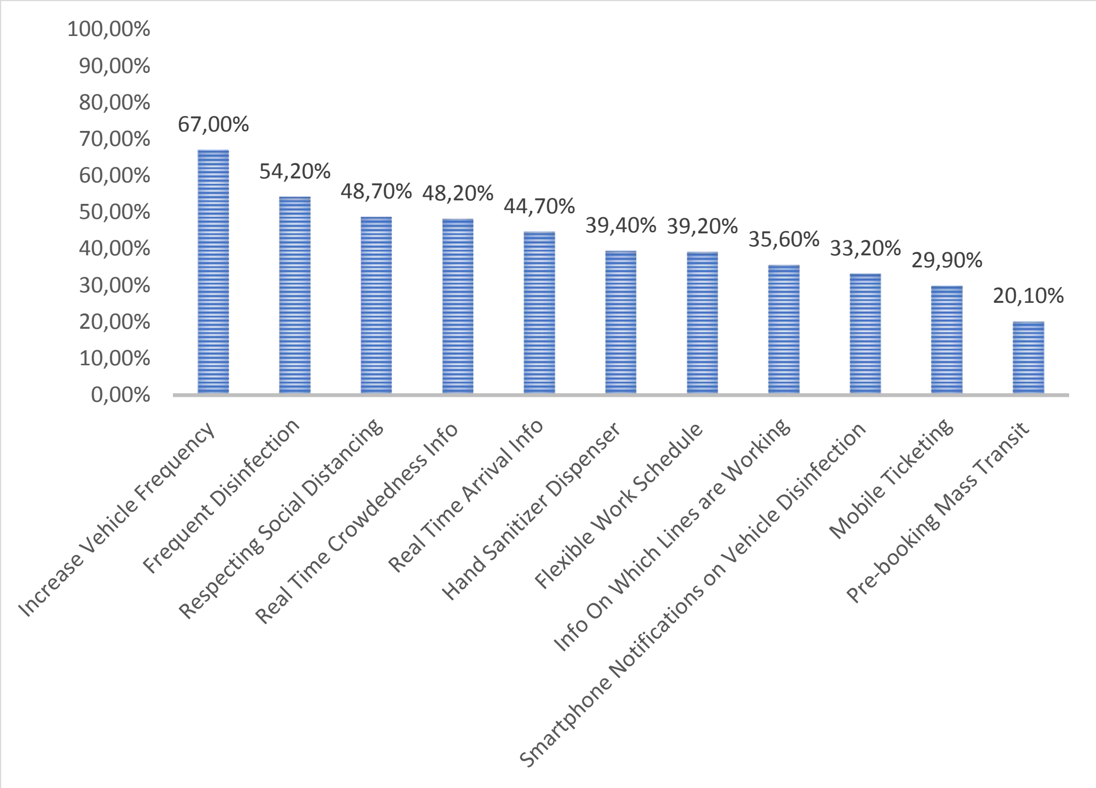


Figure 7: COVID-19 Specific Mass Transit Usage Incentives

### 4.4. Measures Taken to Combat the Threat of Covid-19 on Mass Transit in Ankara

The final section of this chapter details the measures already taken in Ankara to combat the threat of COVID-19 on mass transit some of which have already been specified in previous sections. In addition the list of adminstrative changes listed under sections 4.3 and 4.3.2, it would be useful to detail some of the technical measures adopted in Ankara regarding the threat of COVID-19 on mass transit.

First of all, disinection routines were increase in mass transit vehicles, stations and stops through out the months of the pandemic using the dry pulverization method. Starting April 6th 2020, Ankara Metropolitan Municipality began cleaning the wagons of its LRT and metro systems using sodium hypochlorite produced by ASKI after each trip. In addition, around 1,320 EGO buses are cleaned and disinfected daily (Figure 8).

Figure 8: Cleaning and Disinfection Routines in Mass Transportation Vehicles (EGO, 2020a)

As part of the measures taken, air conditioners were turned off in the city's public buses (EGO), and Light Rail (Ankaray) and metro systems as of March 20, 2020. In line with recommendations of the Scientific Advisory Board of the Ministry of Health, arrangements were later made to switch away from air conditioners that rely on indoor air circulations. Moreover, EGO arranged for stickers reading "For your own health please maintain social distance" in order to encourage abidance with social distancing regulations by passengers on board. Similar stickers were also placed on metro and bus floors to facilitate social distancing among standing passengers (Figure 9). In addition, the previous 'reciprocal seating arrangement' on the city's LRT was modified in favor of a seating arrangement that is more conducive of social distancing (UHKK 01.06.2020 / 41).


Figure 9: Seat and Floor Stickers and Passenger Capacity Information Labels in Mass Transit Vehicles (EGO, 2020b)

In order to protect the drivers and to minimize the contact between the passenger and the driver as much as possible, a transparent cover was placed in the driver section of EGO buses. In addition, the transparent cabin application initiated by the Ankara Metropolitan Municipality in taxis, minibuses and service vehicles was also extended to EGO buses (Figure 10). Moreover, disinfecting products were distributed to all mass transit vehicles both public and private (e.g. ÖHO ve ÖTA).

In order to reduce face-to-face cash transactions, the working hours of Ankarakart Processing Centers were temporarily changed and transactions were re-directed to 'Başkent Mobile' (Ankara municipality's mobile application), EGO CEP (EGO's mobile application) or online to the address 'www.ankarakart.com.tr'. Visa transactions for student cards were made free of charge at the Smart and Mini counters at the rail system stations. Needless to say, use of masks were mandatory among passengers and staff alike. Moreover, the Ministry of Health's (HES) code became a necessity for passengers to have in order to be allowed on mass transit vehicles. HES code (abbreviation of Hayat Eve Sığar) is a 10 to 12 digit code issued by Turkey's Ministry of Health in ordered to identify and provide information on individuals who have been exposed to COVID-19 or who have been in contact with COVID-19 patients.

Figure 10: Transparent Screen and Cabin Applications in Mass Transportation Vehicles (EGO, 2020c)

## 4.5 Conclusion

This chapter attempted to offer a detailed picture of the mass transportation in Ankara before and after the start of the pandemic. Comparing those two pictures, it becomes quite clear that COVID-19 had a significant negative impact on mass transportation ridership and mobility behavior in Ankara. Decrease in mass transportation ridership fluctuated across different months of the period covered in line with the different measures and restrictions adopted to combat the pandemic. These measures affected mass transportation directly through mass transportation specific restrictions (e.g. limiting capacity, changing schedules etc.) and indirectly through measures aiming to limit the general spread of the virus (e.g. limitations on mobility, social distancing, sanitization etc.).

While those measures will undoubtedly have significant long-term effect on public transportation, a certain degree of recovery is evident as soon as those objective restrains are lifted. This is illustrated in the fluctuation of ridership levels per month depending on restrictions in place. Dealing with the behavioral changes resulting from the now increasingly prevalent perception of public transportation as unsafe, on the other hand, might not be as straight forward. It requires knowledge of behavioral models, and the role perceptions play in influencing behavior in general and travel behavior in particular. Moreover special attention should be given to the role that risk perceptions, especially that relating to health risks in general and infectious disease threat in particular, play in influencing travel behavior. Chapter Five attempts to contribute to such understanding by analyzing residents' perceptions of the mass transit system in Ankara during, and as a result of, the pandemic.

# CHAPTER 5

# ANALYSIS

## 5.1 Hypothesis and Research Questions

The Main research question this thesis attempts to explore is "How has COVID-19 affected Mass Transportation in Ankara?" This question itself diverges into two components, each with a corresponding sub-question. The first deals with the objective effects of the pandemic on the Mass Transportation system in Ankara (e.g. changed schedules, frequencies, ridership levels overall and ridership levels per mode, and pandemic specific measures such as social distance enforcement, mask mandates, and regular disinfection etc.). The second sub-question, on the other hand, focuses on the way the pandemic affects residents' efficacy and risk perceptions.

While the two sub-questions tackle the issue from a different perspective, the interplay between them is unmistakable. For example, a drop in Mass Transportation ridership level might be a reflection of mobility restrictions but it might also be the result of the negative health perceptions attached to mass transportation systems as a result of the pandemic. Indeed, restrictions on mobility translated to a decreased in usage frequency across all modes of transportation. However, negative perceptions toward mass transportation might cause it to lose ridership in a greater, or more permanent, manner than that resulting only from lockdown measures. For this reason, both the objective and subjective components are equally important to gain insights on the overall effect of COVID-19 on the mass transportation systems in cities worldwide including Ankara.

## 5.2 Methodology and Data Collection

In order to answer the research questions detailed in 5.1, a desktop research was conducted followed by an online survey. This two-step methodology is a reflection of the objective-subjective dichotomy of the two research sub-questions detailed above. The results of the desktop research yielded the literature review presented in Chapter Two, Three and Four. It included the following topics:

1) History of transportation and disease spread.

2) Measures needed for the creation and maintenance of a pandemic resilient mass transportation system.

3) Mass transportation related risk perception.

4) Risk perceptions of infectious diseases

.

5) Effects of previous infectious disease outbreaks on mass transportation ridership and performance.

6) Health risk behavioral models applicable to the context of mass transportation.

7) Protection Motivation Theory and its components (risk perception, perceived severity, perceived vulnerability, self-efficacy, and response-efficacy).

8) The characteristics of Ankara's mass transportation system and its performance pre and during pandemic.

To answer the second sub-question, an online survey was conducted in the Province of Ankara. Two separate but identical surveys were prepared, one in English and the other in Turkish. The surveys were designed and responses were collected using the professional survey website "Survey Monkey". The website generated two internet based links which were shared through e-mail and social media accounts (e.g. Facebook, twitter, Instagram etc.) and personal messaging apps (e.g. WhatsApp). The link can be viewed on any device (e.g. Desktop

Computers, Laptops, Tablets, Smart phones etc.) provided it has access to the internet. The English survey was created on the 16th of November while the Turkish version was launched a week later, on the 22nd. Both were concluded on the last day of the year, December 31st 2020.

In order not to create a bias, the link was shared randomly to groups/accounts across those platforms provided that they belong to, or have subscribers/ members from, residents of Ankara Province. This meant that the link was equally accessible to all residents regardless of their area of residence, socio-economic status, education, age, etc. However the randomness of this approach also meant that there was almost no control of the sample on part of the author which made it difficult to ensure that such representativeness did indeed occur. Moreover, an online survey excluded residents who may not have access to the internet or those who are not very familiar with its usage (e.g. elderly residents).

Despite some of the limitation listed above, the survey was conducted online due to the continued spread of the COVID-19 pandemic, especially more strict restriction starting from 20th of November, 2020. Apart from actual restrictions on movement, the survey was conducted online as a reflection of the author's belief that each resident had a responsibility to live up during the pandemic including reducing contact as much as possible, were such a luxury is feasible. The survey includes those who live and/or work not only in the city on Ankara but in the province as a whole, which would not have been possible in an offline survey. There was no limit on the age of participants; the youngest participant was 14 years of age while the oldest was 65. Still, the fact that the survey required participants to have access to and/or willingness to use the internet (e.g. a friend or family member having access to the internet) naturally translated into an under-representation of the elderly segment in the survey (See Table 15).

The Survey consisted of 21 questions. As per the insights provided by the website "Survey Monkey", the average time spent by the respondent to the English version was 7 minutes and 8 seconds while the respondent to the Turkish version averaged 5 minutes and 12 seconds. Initially, 402 replies were collected but those dropped to 379 after basic data cleaning (e.g. discarding responses outside The Province of Ankara, discarding respondents who skipped almost all of the questions, discarding repetitive entries etc.). As some of the participants did not answer all questions, thus the Total Number of Responses (N) differentiates per question. The English and version of the survey questions is attached in appendix A.

Roughly speaking, the survey questions could be classified under three sub-headings.

A) Question 1-6: Transportation Routines before and after COVID-19 (e.g. Mode frequencies, most used mode, need for transfer between modes).

B) Question 7- 11: Perception of Mass Transportation during the pandemic based on the PMT model (e.g. Perceived Vulnerability, Perceived Severity, Self-Efficacy, Response-Efficacy, Perceived Vulnerability of Mass Transportation to COVID-19 compared to Perceived Vulnerability of other places/modes, Perceived Vulnerability of COVID-19 versus other threats on Mass Transportation such as terrorist attacks, accidents, and crime).

C) Question 12-21: Demographics and COVID-19 related knowledge (Knowledge about COVID-19, Age, Gender, Level of Education, Employment, Occupation, Area of Residence, Area of Work/School, Number of Cars per Household, and Ability to Telework during the Pandemic).

The list of socio-demographic variables investigated was selected based on findings from the literature review regarding which factors are likely to affect health risk perceptions (e.g.: Age, Gender, Level of Education, Ability to Work/Study from Home etc.), mobility patterns (Car ownership, Area of Residence, Area of Work/School, Employment status/sector etc.), or both. One possibly influential variable not included in the survey was that of income or income level.

Knowledge about COVID-19 was investigated through asking participants to determine if the following statements were true or false. The first of these statements was “COVID-19 is more dangerous than the seasonal flu” (True), the second was “A higher dose of Vitamin C is proven to protect you against COVID-19” (False) and the third was “The recommended duration to wash your hand with soap is 10 seconds” (False). A knowledge score (0 to 3) was calculated for each participant based on the number of correct answers they gave.

There is a couple of points to be made here regarding the format of questions. First of all, no time specific phrases were added to any of the questions. The only time related phrases incorporated into the questionnaire were "Before COVID-19" and "After COVID-19 (Now)". This meant that the survey dealt with the pandemic duration as a single unit, starting from the discovery of the first case in Turkey (March 11th 2020) up until the closing date of the survey (December 31st 2020). Thus, the survey does not investigate the change/fluctuation in movement patterns and/or perceptions across different time periods of the pandemic. This lack of time limit to the survey meant that different respondents could have answered according to a different time period they had in mind. In fact, the same respondent could have answered different questions with different months of the pandemic in mind. Still, this approach has the benefit of providing perspective on mobility patterns across different 'waves' of the pandemic rather than ones pertaining to a specific lockdown. Finally, this method might have reduced the effect of recall bias when a participant is limited to offering insights on a certain time period which he/she might not remember accurately.

Most questions were formulated as multiple choice or as matrixes/tables. However, the question for Age, Employment, and Occupation were left open. Initially, "Occupation" and "Employment" were included as separate fields within the survey, formulated in an open-ended manner rather than as multiple choice questions. This approach proved problematic when data analysis was carried out given that majority of survey-takers did not seem to distinguish between both items. The result was two almost identical columns of data for both fields. Thus, those two sets of data were combined, cleaned and classified under the single variable of "Employment" (See Table 15).

Ideally, employment/occupation would have been categorized into "Academic Sector", "Transportation Sector", "Health Sector", and "Other". This logic was a combination of both the possible movement patterns of each of these sectors and the unique perceptions they could offer on health related risks in Mass Transportation. For example, most of those working in the Academic Sector had the ability to telework (fully or partially) regardless of the ownership of the institute they worked in (public or private). On the other hand, health workers and those working within mass transportation would have a unique insight on the each of their respective fields and perhaps on the interplay between both during the pandemic. Unfortunately, this proved impossible given the size of the sample and the quality of information provided on employment and occupation. Next, an attempt was made to distinguish between those employed by the "Academic Sector", "Public Sector", "Private Sector" and "Unemployed". The logic behind this had to do strictly with movement patterns; students and those working in the academic sector mostly enjoyed the ability to work/study from home. Moreover, even though workers in the public sector might not have enjoyed the same degree of flexibility their academic counterparts did, they still had a considerable advantage over those who worked in the private sector (e.g. flexible working schedules). Unfortunately, even this categorization proved problematic. After all, the majority of survey-takers did not specify wither they worked in the public or private sector. To solve this dilemma, Employment was finally divided into "Academic Sector", "Employed" (all other sectors apart from Academician, both public and private), and "Unemployed". "Academic Sector" included students, regardless of degree/level, along with those who were employed *by* the Academic sector (e.g. teachers, university professors, faculty members, researchers etc.).

Employment and Occupation aside, minor, if any, data manipulation was exercised on the other categories. For example, in the category "Area of Residence" and " Area of Work/School" any answer under "Other" which was followed by the respondent specifying an area *within* the areas offered was moved to that respective category (e.g. "Other" followed by "Kizilay" was moved to "Çankaya"). Typically, the choice "Other" for "Area of Residence" includes values for those who reside in The Province of Ankara, rather than in Ankara as a city. On the other hand, "Other" in "Area of Work/Study" included both values for places (e.g. those who work/study in The Province of Ankara, but not the city itself) and values for employment/study status (e.g. "I do not go", "Unemployed", "Retired", "Housewife" etc.). No other changes were made to those two categories even when some answers appeared to be contradictory, especially in the field "Area of Work/School" (e.g. a respondent classifying themselves as "Unemployed" in the

“Employment/Occupation” field but offering an answer to the field of “Area of Work/School”). The reason data manipulation was kept to a minimum had to do with the nature of the survey questions; the fact that the survey questions dealt with the pandemic duration as a single unit meant both a possible time disparity between the answers of different respondents and between the different answers of the same respondent. Thus, any alteration on the part of the author to ‘correct’ what appears to be contradictory answers might end up misinterpreting and misrepresenting what the participants’ actually meant with those answers.

Finally, questions on mass transportation frequency and perceptions were evaluated on a 5 point Likert scale, ranging from “Never” to “Everyday” for frequency; “Very Low” to “Very High” for perceived vulnerability and perceived severity; and “Strongly Disagree” to “Strongly Agree” for comparative vulnerability and efficacy perceptions.

### 5.3 Participants Socio-Demographic Composition

The majority of respondents (88.92%) were either Turkish citizens or fluent speakers of the Turkish language. This is quite normal given that Ankara is Turkey’s capital. Moreover, females constitute the vast majority of survey-takers (63.23%). As to the education level of participants, most had acquired a degree from High School or above, with almost half of the respondents being university graduates (43.09%).

As theorized in the previous section of this chapter, conducting the survey online resulted in a sharp age bias. The majority of respondents (73.91%) came from the age group of 21 to 39 years old. The second largest age segment represented was that of respondents aged 20 and below (14.13%). In contrast, the lowest two percentages belonged to the age groups of 40 to 59 years old and 60 years and older. Even when combined, those two age groups constitute less than 12% of the overall participants.

The logic behind the age groups selected was influenced by a couple of factors. To begin with, COVID-19 itself is a disease that manifests differently in different age groups. The risk for death and severe illness from COVID-19 is best predicted by age. The likelihood of death and/or severe illness increases exponentially with age among those who contract the virus. Although attention has globally been focused on those 65 years and older, a research found that the mortality rate increases sharply after age 50 in all 5 countries examined (Crimmins, 2020). By contrast, those who are younger in age are less likely to be in danger themselves. However, those 20 years and younger have been labeled as “Super-spreaders” of the disease and are thus more likely to present a danger to others. It is worth investigating if those objective differences in both the likelihood of infection and the complications suffered upon being infected would manifest into differences in perceived vulnerability and perceived severity by age group. Moreover, already evidence of age difference in health related risk perception and risk perception in general had already been found and detailed in Chapter Three. To add upon these factors, age-based movement restrictions have been enacted worldwide (Turkey included) targeting those younger than 20 and older than 65. It would not be wrong to hypothesize that those actual restrains on mobility might have resulted in age specific mobility related risk perceptions. Unfortunately, an internet based survey resulted in a significant under-representation of the elderly. However, one could argue that an offline survey would not have necessarily yielded different results. After all, the limited access the elderly have to the internet is now paralleled with an equally limited access to shared outdoor spaces. At the same time, residents in their 40s typically have the access and the ability to use Social Media and Messaging Applications but where under-represented in the survey nevertheless.

Respondents predominantly belonged to the “Academic Sector”. In fact, the percentage of respondents with an academic background alone (48.08%) exceeded those belonging to all other sector combined (41.00%). One explanation to this bias might have to do with a more favorable tendency towards answering surveys in the academic community. Another might be linked with age, given that students are included within the category “Academic Sector”. Since students, regardless of level/degree, tend to be younger in age they are more likely to be active on social media websites and messaging applications. As a result this sub-segment within the category “Academic Sector” might have been more likely to encounter the survey’s link and thus more likely to participate, leading to an over-representation of the overall group.

Moreover, the category "Unemployed" included retirees, and stay in home mothers in addition to the unemployed.

Almost half of the participants (46.17%) had a single car per household while more than a quarter had none (28.50%). This means that *at least* a quarter of participants are captive users. This rate would increase if we accounted for the fact that a certain proportion of those who own one car per household may also be captive users of Mass Transportation either fully or in certain days of the week or times of the day. After all, captivity is not only the result of the number of cars per household but also the number of mobile individuals in a given household, a demographic not included in this questionnaire. Regardless, the sample can be characterized by low car ownership; almost 75% of the survey-takers had either no cars or a single car per household. The remaining quarter, almost 25%, had two or more cars per household. Only around 7 percent of participants had more than 2 cars per household.

The majority of respondents were able to work/study from home, either totally (35.54%) or to some extent (40.85%). Only ≈16% did not have the ability to work or study from home. This flexibility in work routine partially owes to the fact that almost half of the respondents were either students or employees of the academic sector. Finally, participants had a high level of COVID-19 related knowledge with almost half of survey takers scoring 3 correct answers out of 3.

Table 15: Participants' Distribution by Socio-Demographic Factor

| LANGUAGE | N | % |
|---|---|---|
| Turkish | 337 | 89 |
| English | 42 | 11 |
| AGE | N | % |
| ≤ 20 | 52 | 14 |
| 21-39 | 272 | 74 |
| 40-59 | 38 | 10 |
| 60 ≥ | 6 | 1.6 |
| GENDER | N | % |
| Male | 139 | 37 |
| Female | 239 | 63 |

Table 15 (Continued)

| LEVEL OF EDUCATION | N | % |
|---|---|---|
| Literate | 9 | 2.4 |
| Primary/Elementary School | 14 | 3.7 |
| High School | 102 | 27 |
| Bachelor | 162 | 43 |
| Master/PHD | 89 | 24 |
| EMPLOYMENT | N | % |
| Academic Sector | 163 | 48 |
| Employed | 139 | 41 |
| Unemployed | 37 | 11 |
| RESIDENCE | N | % |
| Altındağ | 15 | 4 |
| Çankaya | 150 | 40 |
| Etimesgut | 35 | 9.3 |
| Gölbaşı | 8 | 2.1 |
| Keçiören | 59 | 16 |
| Mamak | 21 | 5.6 |
| Pursaklar | 10 | 2.7 |
| Sincan | 13 | 3.4 |
| Yenimahalle | 56 | 15 |
| Other | 10 | 2.7 |
| WORK/SCHOOL | N | % |
| Altındağ | 12 | 3.3 |
| Çankaya | 178 | 49 |
| Etimesgut | 5 | 1.4 |
| CARS PER HOUSEHOLD | N | % |
| 0 | 108 | 29 |
| 1 | 174 | 46 |
| 2 | 70 | 19 |
| More than 2 | 25 | 6.6 |
| WORK/STUDY FROM HOME | N | % |
| Yes, Fully | 134 | 36 |
| Yes, Partially | 154 | 41 |
| No, I could not work/study from home | 59 | 16 |
| I had no work/school during the pandemic | 30 | 8 |
| COVID-19 Knowledge Score | N | % |
| 0/3 | 3 | 0.8 |
| 01-Mar | 58 | 15 |
| 02-Mar | 149 | 39 |
| 03-Mar | 169 | 45 |

## 5.2 Findings

### 5.4.1 Mass Transportation Movement Patterns before and during the Pandemic

Three variables were used to measure the effect of COVID-19 on Mass Transportation. Those are frequency of use, modal split, and need for transfer. Comparing both periods, there is a clear drop in usage frequency of Mass Transportation within the sample (Figure 11). Prior to the pandemic, around 58% of respondents reported using Mass Transportation at least once a week. Following the pandemic, however, this figure dropped to 27%.

Next, participants were asked to identify which mode of mass transportation they used the most before and during the pandemic (micro mobility included). The modal split of before and during is presented in Figure 12.

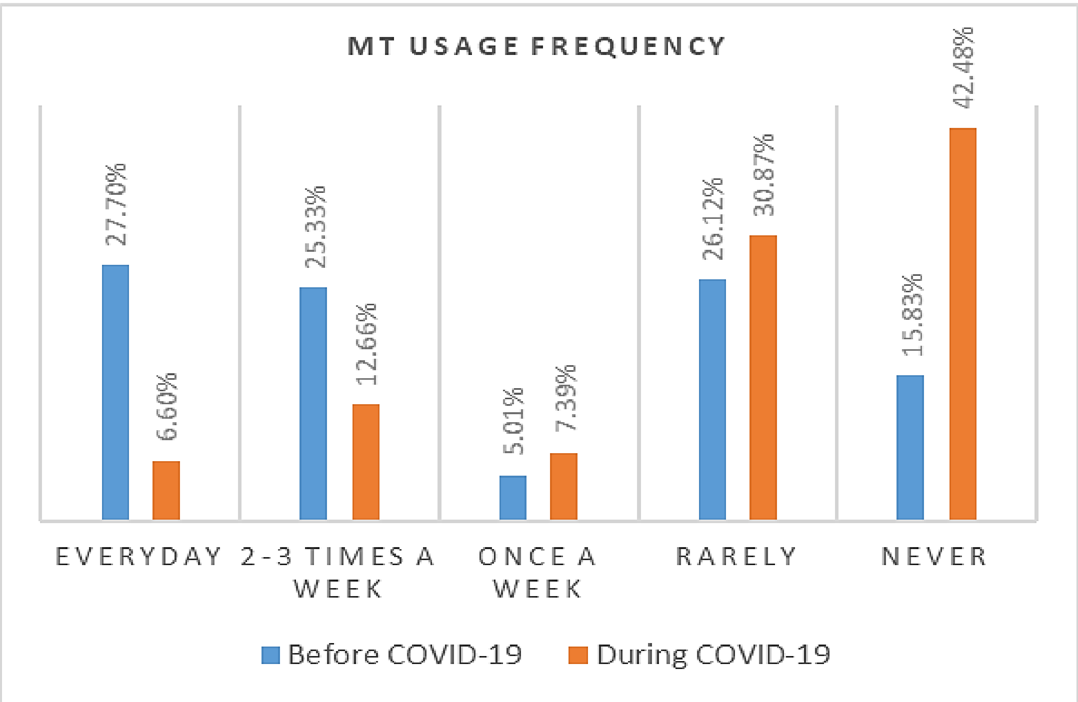


Figure 11: Mass Transportation Usage Frequencies before and during the Pandemic

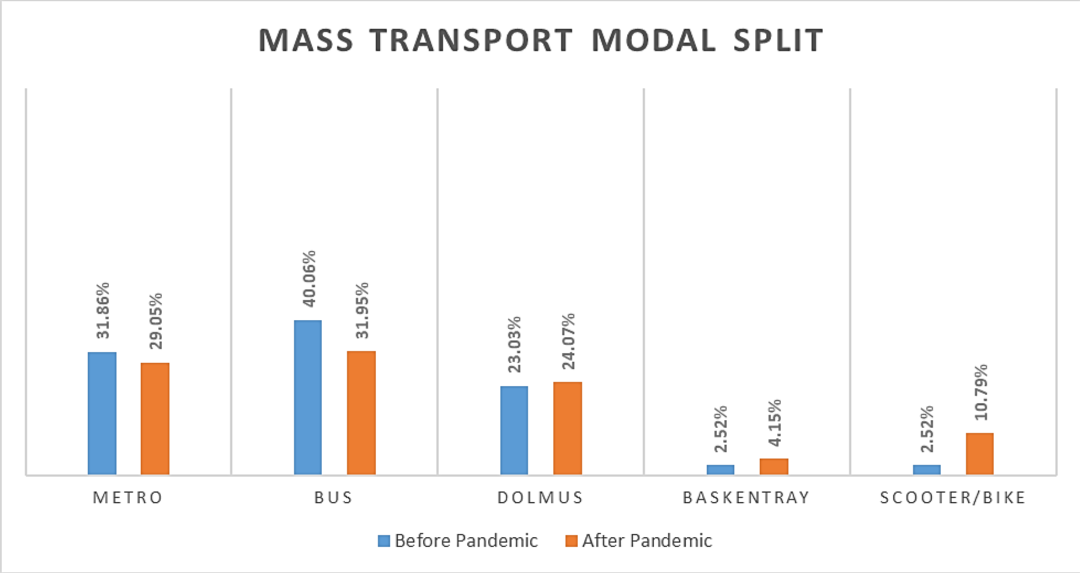


Figure 12: Mass Transportation Modal Split before and during the Pandemic

The most used modes before the pandemic are Metro and Bus, Dolmuş comes in the 3rd place. This is not necessarily an accurate representation of the general population, given that Dolmuş is the mode that carried the highest percentage of passengers in Ankara prior to the pandemic (See Chapter 4). Thus we can assume that Metro and Bus users are over-represented in the sample surveyed. However, even with this initial bias present, those two modes appear to lose ridership in favor of the other modes represented (Dolmuş, Başkent Banliyö, and Scooter/Bike) as a result of the pandemic. While the share of Dolmuş and Başkent Banliyö increased slightly, the biggest change is observed in the shares of micro mobility (Scooter/Bike) which grew from 3% to 13%. Although the order of prioritized modes did not change, a continuation of this pattern would lead to an eventual change of the overall modal split.

The last component of transportation routines investigated was the need for transfers. The difference in need for transfers before the pandemic versus during the pandemic is presented in Figure 13.

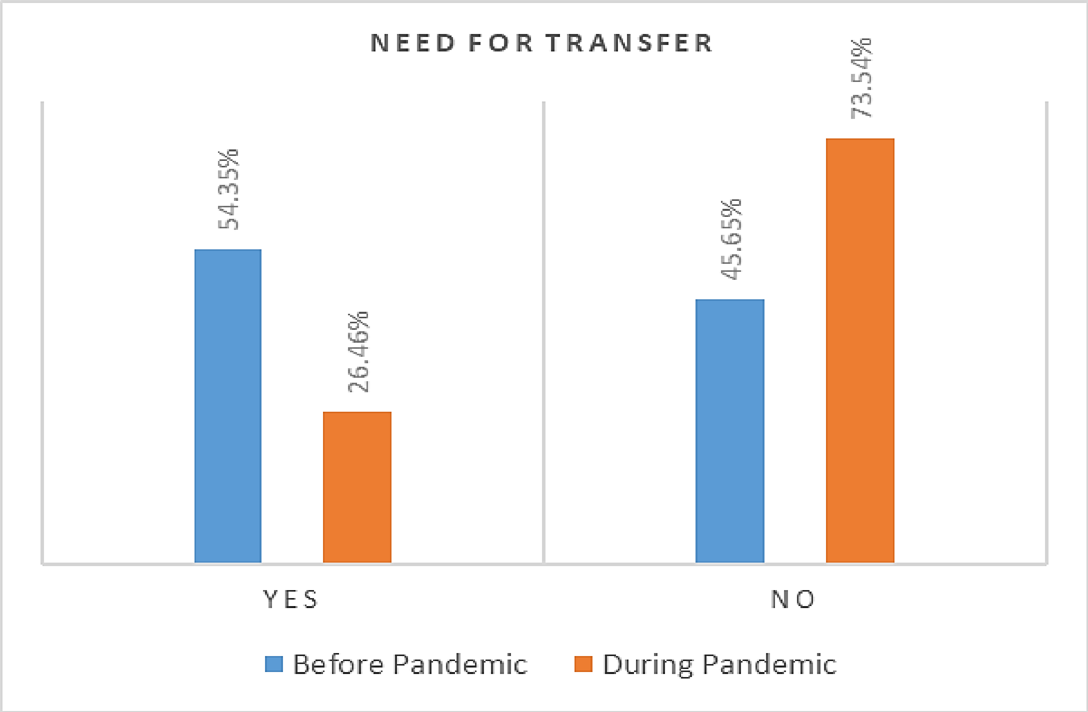


Figure 13: Need for Transfer before and during the Pandemic

Prior to the pandemic, almost half of the sample underwent at least one transfer in their average trip. Following the start of the pandemic, however, less than a third of respondents reported at least one transfer in their average trip. This is not surprising given that people's mobility has decreased significantly as a result of the pandemic. Certain movements restrictions enacted in Ankara limit residents' to within-neighborhood trips for necessities (e.g. Supermarket). Such distances are walkable and require no transfers. Moreover, even when such measures are not in place, many individuals practice self-restriction consciously shortening the distance needed to travel for any given purpose when possible. In addition, the need for transfers is usually a result of using Mass Transportation. When the use for Mass Transportation experiences a significant decrease so does the need for transfers. Even when individuals use Mass Transportation it makes sense that they try to avoid transferring between multiple vehicles given concerns for social distancing, hygiene, ventilation etc.

### 5.4.2 Risk and Efficacy Perceptions of Mass Transportation during the Pandemic

Participants risk and efficacy perceptions were investigated in line with the main premises of Protection Motivation Theory. First, perceived severity and vulnerability (the two components of perceived threat according to Protection Motivation Theory) to COVID-19 were measured. The means for both are displayed in figure 14.

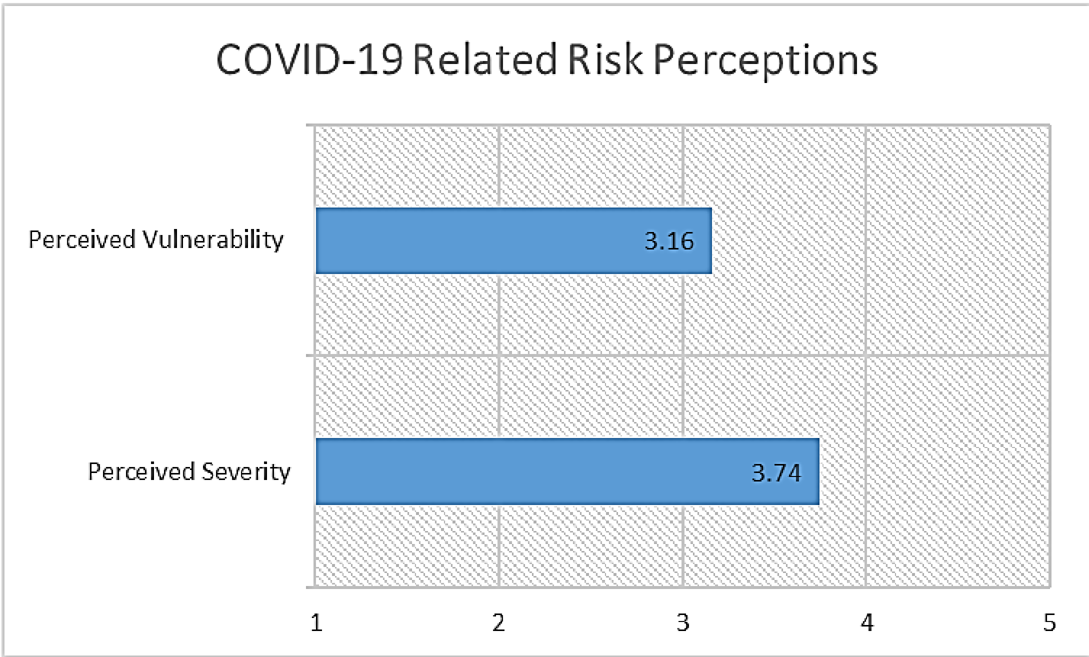


Figure 14: COVID-19 Related Risk Perceptions

Perceived Severity was relatively high while perceived vulnerability was closer to average. This finding is in line with literature on perceived severity and perceived vulnerability of other infectious diseases (De Zwart et al., 2009; De Zwart et al., 2010). Perceived vulnerability of SARS and Avian Influenza was lower than perceived severity in both studies. The first study found this pattern (of higher perceived severity versus perceived vulnerability) to be true internationally through investigating 8 different countries (4 European, 3 Asian). The second study investigated the prevalence of this effect over time, concluding that perceived severity remained high while perceived vulnerability decreased slightly with the passage of time (De Zwart et al., 2010). Its findings indicate that perceived vulnerability seems to be related to the magnitude of a pandemic decreasing slightly as the pandemic proceeds and declining rapidly only after the outbreak is contained (De Zwart et al., 2010).

Thus, one can conclude that the lower perceived vulnerability within Ankara's sample is in line with tendencies in other countries. It might also be the result of the time the survey was conducted (16th of November- 31st of December) which might be considered as a relatively late stage of the pandemic, thus yielding lower perceived vulnerability as a result of the passage of time. However it is important to keep in mind that although an effect of time over perceived vulnerability was found, it was very limited (De Zwart et al., 2010).

Next, mass transportation was compared to other places (school/work, hospital, shopping, and park) and transportation mode (personal Car, taxi, scooter/bike) in terms of perceived vulnerability to COVID-19. Comparative vulnerability to COVID-19 was also explored in comparison to other mass transportation related risks (crime, accident, and terrorist Attack). The aim is to measure how risky Mass Transportation is perceived *compared to* other places/modes and how the threat of contracting COVID-19 compares to other, more familiar, threats on Mass Transportation (Crime, Accident, and Terrorist Attack). Finally, Participants' self-efficacy and response-efficacy were studied across different pandemic related mass transportation avoidance measures (avoiding Mass Transportation all together, Reduce Mass Transportation trip duration, Reduce the number of trips taken by Mass Transportation, Change Mass Transportation trip time/schedule). All perceptions were measured on 5-point Likert Scale with the value of "1" denoting the lowest possible agreement with a given statement and the value of "5" denoting the highest possible disagreement with it (Figure 15).

| Comparative Vulnerability | | | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| a. | Per Place | A1. Work/School | 3.4% | 9.5% | 13.5% | 43.8% | 29.8% |
| | | A2. Hospital | 7.4% | 12.7% | 12.7% | 36.8% | 30.4% |
| | | A3. Supermarket/Mall | 2.7% | 10.4% | 16.5% | 44.9% | 25.5% |
| | | A4. Park | 12.5% | 23.9% | 22.1% | 25.5% | 16.0% |
| b. | Per Mode | B1. Personal Car | 32.0% | 31.0% | 10.8% | 9.8% | 16.4% |
| | | B2. Taxi | 2.7% | 18.0% | 31.8% | 36.1% | 11.4% |
| | | B3. Scooter/Bike | 22.0% | 29.4% | 18.5% | 17.7% | 12.4% |
| c. | Per Threat | C1. Crime | 18.6% | 23.7% | 20.5% | 22.9% | 14.4% |
| | | C2. Accident | 15.2% | 25.1% | 25.9% | 25.3% | 8.5% |
| | | C3. Terrorist Attack | 26.9% | 20.8% | 22.9% | 17.3% | 12.0% |
| **Efficacy Perceptions** | | | | | | | |
| r. | Response Efficacy | R1. Avoid MT Totally | 2.6% | 10.1% | 22.5% | 41.8% | 23.0% |
| | | R2. Reduce Number of MT Trips | 2.1% | 3.7% | 10.6% | 50.3% | 33.3% |
| | | R3. Use MT for Shorter Trips | 17.0% | 23.7% | 17.8% | 27.7% | 13.8% |
| | | R4. Change MT Trip Schedule | 7.7% | 18.0% | 22.8% | 36.9% | 14.6% |
| s. | Self-Efficacy | S1. Avoid MT Totally | 6.1% | 15.4% | 14.1% | 29.0% | 35.4% |
| | | S2. Reduce Number of MT Trips | 5.0% | 7.7% | 8.0% | 43.8% | 35.5% |
| | | S3. Use MT for Shorter Trips | 17.6% | 23.5% | 14.9% | 24.8% | 19.2% |
| | | S4. Change MT Trip Schedule | 12.3% | 17.6% | 16.3% | 32.3% | 21.6% |

Figure 15: Participants Risk and Efficacy Perceptions of Mass Transportation during the Pandemic

A few observations become apparent when comparing means across the different categories of Comparative Vulnerability (Figure 16). The highest means result from comparing Mass Transportation to other places. With the only exception of park, all places listed (work/school, hospital, and supermarket/mall) had means visibly higher than neutrality value of “3.00”. In addition, the means for those three places were almost identical. This uniformity indicates that it is less likely that the results represent a “safety-bias” towards any of the places listed but rather a consensus on the perceived riskiness of mass transportation. Interestingly, the opposite is true when comparing mass transportation to other modes. The means for both “Personal Car” and “Scooter/Bike” indicate that participants disagreed with the belief that they are more likely to contract COVID-19 on mass transportation compared to those modes. The only mode scoring a mean above neutrality was “Taxi” on which participants felt more likely to contract COVID-19 compared to Mass Transportation.

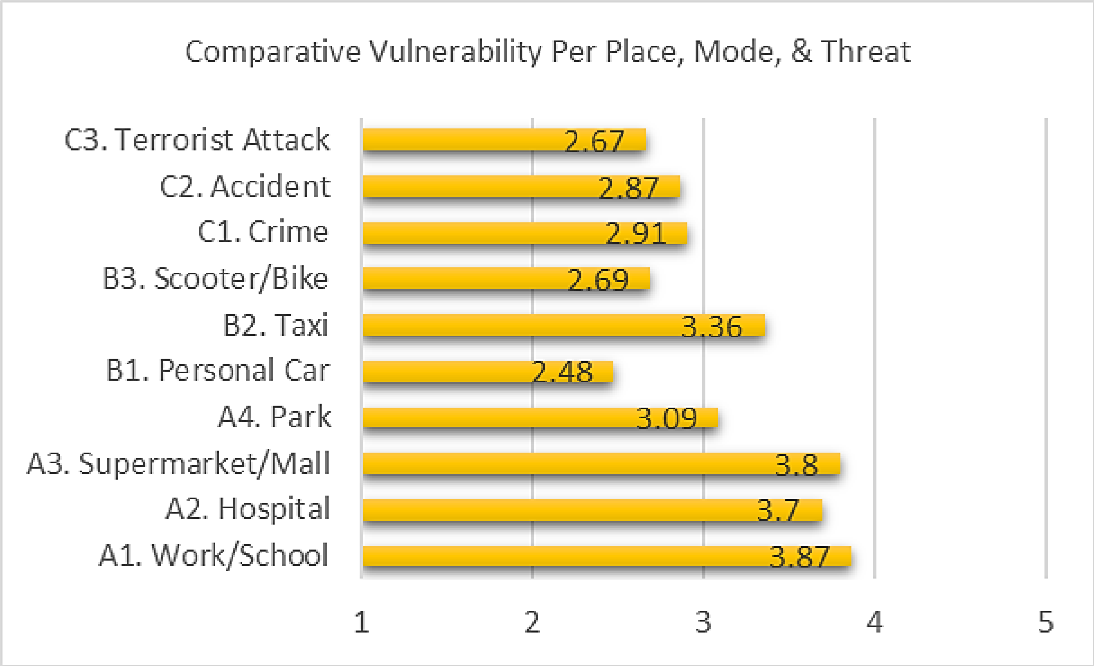


Figure 16: Participants Risk Perceptions of Mass Transportation during the Pandemic

Comparing perceived vulnerability for different risks *within* mass transportation, indicate that participants consider the likelihood of contracting COVID-19 on Mass Transportation as less than that of an Accident or a Terrorist Attack (the means for all threats are less than neutrality value of 3.00). This result might appear counter-intuitive, especially as it relates to the likelihood of a terrorist attack being perceived as more likely on Mass Transportation than contracting COVID-19. Perceived vulnerability tends to be higher for familiar risks and low for unfamiliar ones. It could be that, nine months into the pandemic, COVID-19 is still perceived as unfamiliar/rare risk compared to a terrorist attack. More accurately, the results might indicate that COVID-19 is perceived as an unfamiliar risk *on Mass Transportation* as compared to the threat of a terrorist attack *on Mass Transportation* rather than generally. One reason might be that Ankara's Mass Transportation System was indeed the target of a few terrorist attacks while no COVID-19 outbreak has been traced back to Mass Transportation. However, the relationship between perceived vulnerability and familiarity of risk is a complex one in literature. On one hand, a higher perceived vulnerability for certain threats have been associated with the prevalence of those threats within a given population. For example, Zwart and colleagues found that perceived vulnerability for threats such as HIV, tuberculosis, and SARS was higher in Asia in comparison to other regions (De Zwart et al., 2009). One explanation the authors offered was the fact that those disease were indeed more prevalent in Asia than other regions. On the other hand, a plausible explanation for lower levels of perceived vulnerability might be the result of the passage of time (De Zwart, 2008). Indeed, the survey was conducted almost nine months after the discovery of the first case in Turkey. In other words, the reported low level of perceived vulnerability in relation to other risks might be the result of perceiving the given threat as unfamiliar or rare. In contrast, it could be the result of the threat becoming too familiar (with the passage of time).

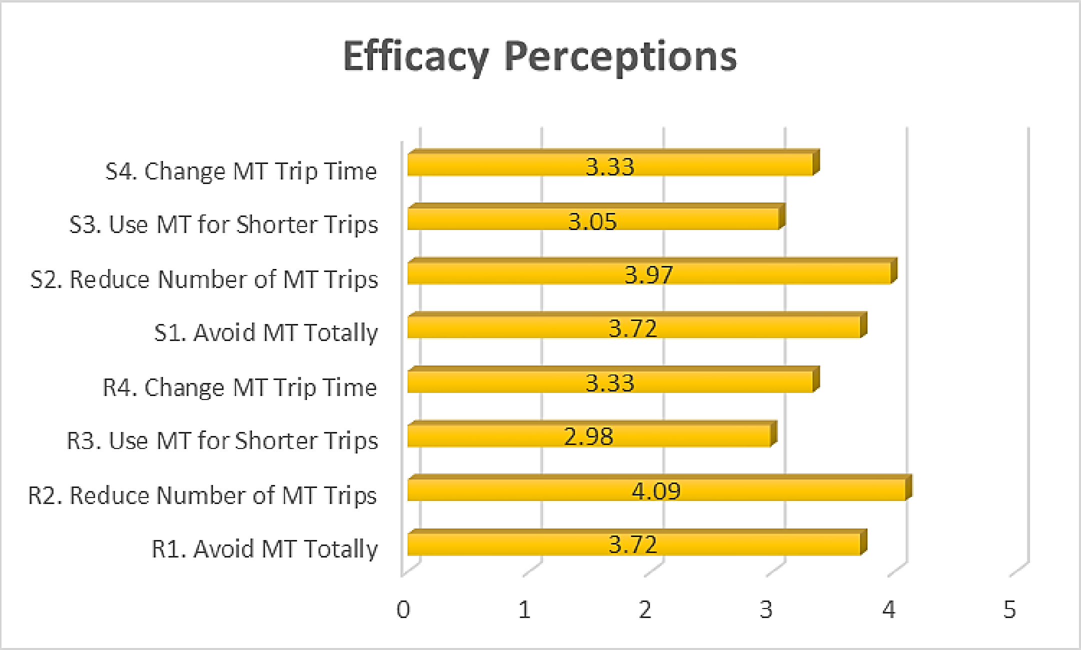


Figure 17: Participants Efficacy Perceptions of Mass Transportation during the Pandemic

However, Protection Motivation theory forecasts that a high risk perception (perceived severity and perceived vulnerability) will not lead to engagement in a preventive measures unless both response efficacy and self-efficacy are also high. Response efficacy refers to an individual's belief in the effectiveness of a certain measure (e.g. avoiding mass transportation) in protection against the threat. Self-efficacy, on the other hand, refers to a person's belief in their ability to carry out a given measure (e.g. avoiding mass transportation). In line with Protection Motivation Theory, participants' response efficacy and self-efficacy to a list of Mass Transportation related measures (e.g. avoiding mass transportation all together, changing Mass Transportation trip schedule). The means for Response and Self-Efficacy per measure are listed in Figure 17. Results indicate that efficacy believes of participants regarding different mass transportation avoidance measures are, generally, higher than the risk perceptions they associate with mass transportation (Figures 16 and 17).

Within the list provided, measures resulting in a drop in usage frequency (reducing the number of trips taken using mass transportation and avoiding mass transportation all together) enjoyed a higher level of support from participants than measures that include a change of habits in mass transportation usage (using mass transportation for shorter trips and changing mass transportation trip time). This indicates that participants do, indeed, perceive avoidance of mass transportation as an effective measure against COVID-19.

The same exact order was true for Self-efficacy with participants most confident in their ability to reduce the number of trips they take using mass transportation and avoiding mass transportation all together. Conversely, respondents were the least confident in their ability to use mass transportation for shorter trips or to change the time on which they use mass transportation. This latter lack of confidence in changing trip schedule is reflected in the fact that peak hours of mass transportation usage in Ankara did not change as a result of the pandemic (Chapter 4).

However, the difference between Response-efficacy and Self-efficacy was not uniform across measures. Respondents equally agreed with total avoidance of mass transportation as an effective preventive measure as they did with their own ability to engage in this action. The same was true for the measure "Change trip time" albeit at a much lower level of agreement. Although participants felt strongly about the effectiveness of reducing the number of mass transportation trips they take as means to protect themselves against COVID-19, they had a lower confidence in their own ability to act on this belief. Conversely, participants had a higher confidence in own their ability to use mass transportation for shorter trips but did not perceive this measure as particularly effective in protecting them against the risk of contracting the virus.

### 5.4.3 Factors Affecting Mass Transportation Usage during the Pandemic

In order to better understand the effect of COVID-19 on mass transportation in Ankara, factors influencing mass transportation ridership frequencies during the pandemic were investigated. This included socio-demographic factors of participants (Gender, Age, Education Level etc.), their risk perceptions (Perceived Severity and Perceived Vulnerability) and their efficacy believes. Results are displayed in Figure(s) 18.

An important point should be made here. The influence of these factors are studied on Usage Frequencies during the pandemic, not on the *change* of Usage Frequencies as a result of the pandemic. This approach is adopted because it is more inclusive; it accounts for all ridership patterns during the pandemic including those ridership patterns that did not necessarily experience a change as a result of COVID-19. After all, Mass Transportation policy would ideally be formulated around the new normal as a whole which includes, but is not limited to, transportation patterns that have undergone a change as a result of the pandemic. Moreover, it would not be wrong to assume that usage frequency of mass transportation *during the pandemic* reflects *the change* in mass transportation usage (before and during the pandemic) given the stark variation in ridership frequencies reported (Figure 11).

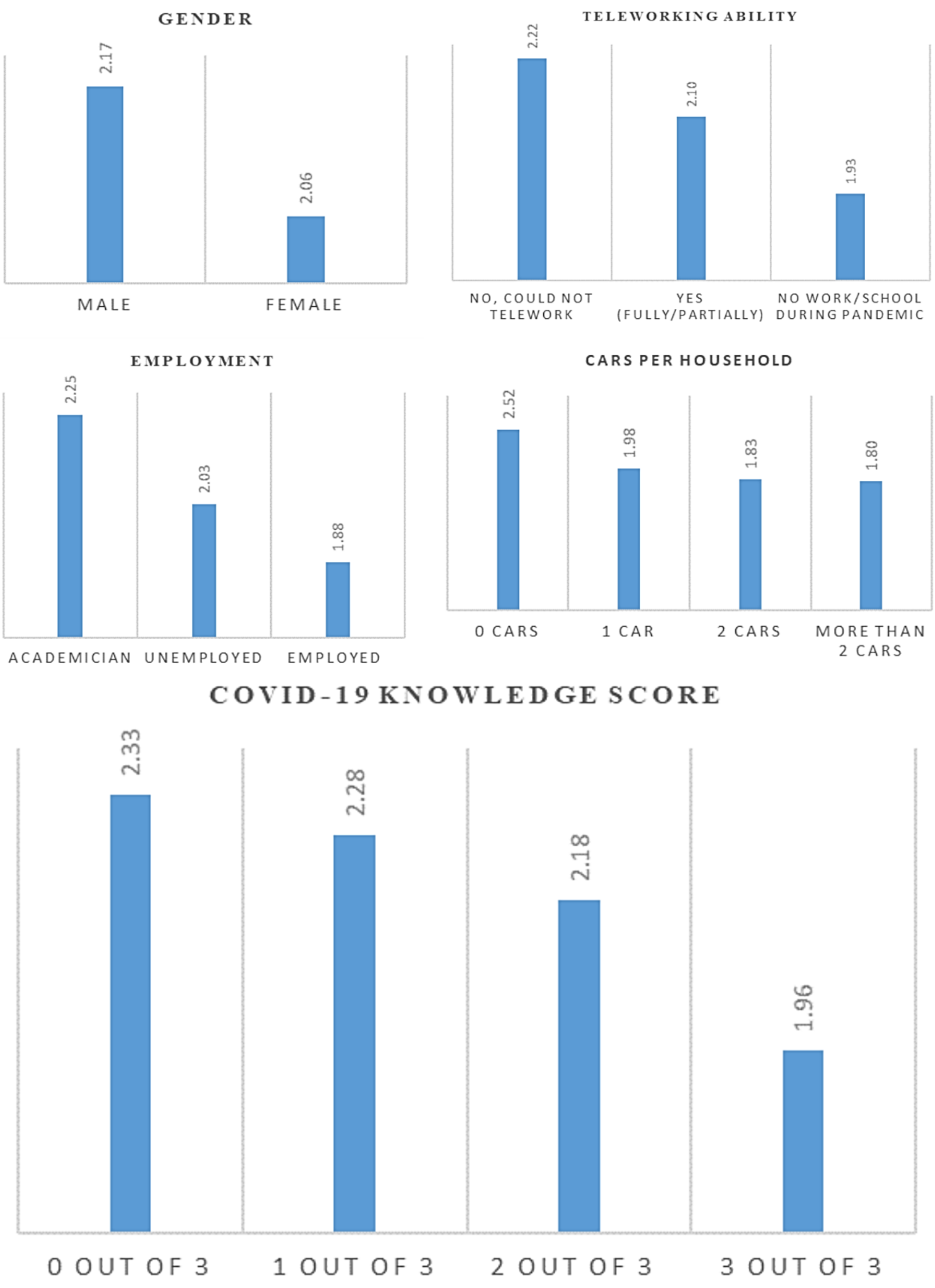


Figure 18: Means of Mass Transportation Ridership during the Pandemic

Mass transportation usage frequency differentiated across five of the socio-demographic factors investigated (Figure 18). Those are gender, employment, teleworking ability, number of cars per household, and COVID-19 knowledge score. Mass transportation usage during the pandemic was visibly less among females in comparison to males. The discrepancy in mass transportation usage patterns across gender might stem from socio-political differences such as differences in daily routines based on gender (e.g. men work more often away from home). Indeed, almost 14% of females within the sample reported being unemployed compared to 6% of males. Moreover, 10% of the females sampled had no work/school during the pandemic compared to 4% within the male sample. Finally, 24% of the male sample reported not being able to work/study from home (either fully or partially) while this rate was just above 10% among females.

This explanation is further supported by the pattern observed between teleworking ability and mass transportation usage frequency during the pandemic. Those who could not telework had the highest mass transportation usage frequency while those with no work/school during the pandemic had the lowest (Figure 18).

A link was also observed between employment, itself, independent of teleworking ability, and mass transportation usage during the pandemic. Academicians had the highest mean of mass transportation usage frequency during the pandemic while those employed in all other sectors had the lowest. The latter group had a frequency of Mass Transportation Usage even lower than those who were unemployed. The higher usage frequency of Mass Transportation within the Academic sector might stem from the inclusion of students within the sample. School students are underage in terms of acquiring a driving license while university students are most likely unable to afford a car from a financial perspective. Still, the high mass transportation usage frequency among academicians is somewhat surprising. After all, academicians had the ability to telework more than their counterparts in other sectors and, as observed above, those with the ability to work/study from home generally had a lower mass transportation frequency than those who didn't. Thus, the relationship between employment, teleworking ability and mass transportation usage frequency warrants further investigation.

Quiet expectedly, number of cars per household emerged as one of the influential factors investigated. The relationship between car ownership and Mass Transportation usage frequency during the pandemic was perhaps the most straightforward. Those with 0 Cars had the highest frequency and the lowest frequency of Mass Transportation usage was among those with 2 and more cars (Figure 18).

Finally, an association was also found between participants' COVID-19 knowledge score and their mass transportation usage frequency during the pandemic. Unfortunately, those with the least number of correct answers regarding the disease were also among the most frequent mass transportation users during the pandemic.

Socio-demographic factors aside, associations between risk and efficacy perceptions and mass transportation usage frequency were also explored (Figure 19). Perceived severity seems to be influential on mass transportation ridership frequency during the pandemic; mass transportation usage frequency is highest among those with low to very low perceived severity and is lowest among those with high to very high severity perceptions. This linkage between perceived severity and Mass Transportation ridership has its advantages and disadvantages. On one hand, this might indicate that frequency of Mass Transportation usage would increase as perceptions of severity begin to decline. Forecasting the time needed for ridership to return to pre-pandemic levels, if ever, requires a more thorough investigation of the relationship between the two variables. One negative aspect of this relationship, however, is the lower levels of perceived severity observed among the most frequent users of Mass Transportation. Lower levels of Perceived Severity may negatively influence abidance by protective measures (e.g. Social Distancing, Wearing a Mask etc.) inside Mass Transportation. This warrants even more attention when combined with the finding that COVID-19 knowledge is lowest among the most frequent users of mass transportation (figure 18).

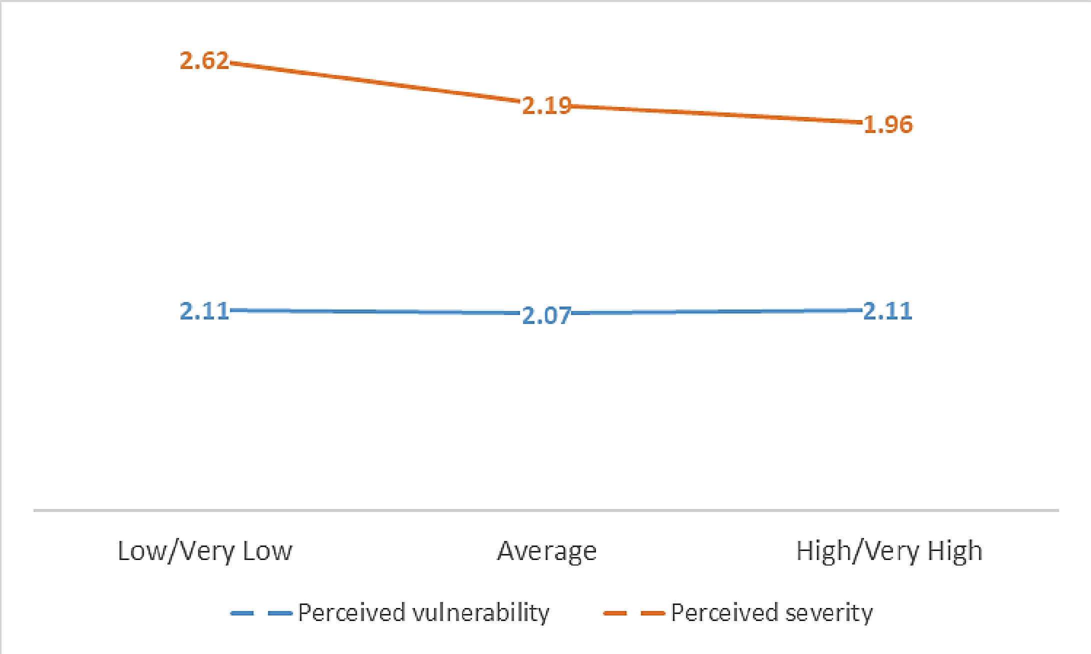


Figure 19: Perceived Vulnerability, Severity and Mass Transportation Ridership Frequency during the Pandemic

By contrast, perceived vulnerability appears to be uninfluential on mass transportation ridership frequency during the pandemic in the sample surveyed; participants with low to very low perceived vulnerability had an equal ridership frequency to those with high to very high perceived vulnerability. In order to better understand the relationship between perceived vulnerability and mass transportation frequency during the pandemic, relationships between comparative vulnerability (per place, mode, and threat) were also explored. As discussed in "Methodology and Data Collection", comparative vulnerability and efficacy perceptions were initially measured on a 5 point Likert scale. With the aim of simplification, however, the associations below are displayed in a manner that combines the values of "Strongly Disagree" together with those of "Disagree" and the values of "Strongly Agree" with those of "Agree".

Looking at the three graphs in the figure 20, the prevalence of neutrality among the most frequent mass transportation users becomes apparent; neutrality is associated with a higher mass transportation usage in 6 out of the 10 variables presented. Ideally, the system would aim for its most frequent users to disagree with statements indicating a lesser sense of safety in comparison to other places and modes. Still, neutrality may offer a good starting point for policy makers given that it allow room to influence perceptions before they solidify.

One of the important exceptions to this prevalent neutrality within mass transportation users was observed in the association between comparative vulnerability to COVID-19 on mass transportation versus the car. The most frequent users of mass transportation during the pandemic were also the ones most in agreement with the higher likelihood of contracting COVID-19 on mass transportation compared to when using a car. This might merely reflect a calculation of likelihood based on mode most used. Alternatively, it might indicate that the most frequent users of mass transportation during the pandemic are captive users or users who, despite judging a car to be safer, cannot afford to act upon their perceptions of safety. This latter conclusion seems to be supported by the findings presented in figure 21; participants with most frequent mass transportation ridership were neutral to response efficacies for measures such as “Avoid Mass Transportation Totally” and “Reduce Number of Trips Using Mass Transportation” but expressed disagreement to their own ability to carry out such measures (low self-efficacy).

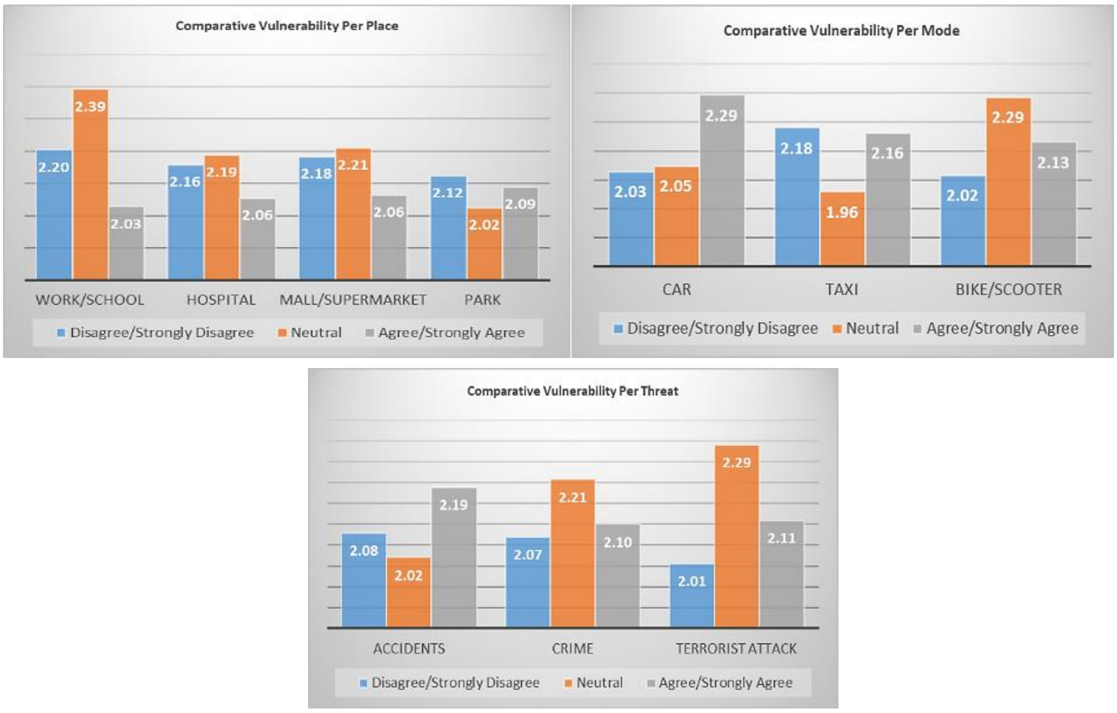


Figure 20: Comparative Vulnerability and Mass Transportation Pandemic Ridership Frequency


Figure 21: Efficacy Perceptions and Mass Transportation Pandemic Ridership Frequency

## 5.5 Conclusion

This chapter attempted to analyze the effect of COVID-19 on Mass Transportation in Ankara both in terms of ridership patterns (frequency, modal split, and need for transfer) and passenger risk and efficacy perceptions.

Even prior to the pandemic, the majority of participants could be classified as mass transportation dependent individuals with low rates of car ownership. Still, a sharp decline in mass transportation usage frequency was observed within the sample. Moreover, the most frequent users of mass transportation during the pandemic reported the lowest degrees of self-efficacy for measures as total avoidance of mass transportation and reduction in number of trips taken using mass transportation. Combined, those observations indicate that Ankara's mass transportation system during the pandemic lost ridership even within what would have been previously classified as captive users such as the ones presented within the sample. Thus, the most frequent users of the system during the pandemic were not the captive users of before, but the most captive of users within this sub-segment. This drop in mass transportation combined with multiple lockdowns and movement restriction also resulted in an observed decline in the need for transfers.

Users of Bus and Metro prior to the pandemic were over-represented within the sample. Although they continued to be the most used during the pandemic, those two modes lost ridership within the sample surveyed in favor of other modes (Dolmuş, Başkent Banliyö, and Scooter/Bike) as a result of the pandemic. If corroborated through additional research and persistent across time, this pattern threatens to worsen the status of publicly operated mass transportation modes vis-à-vis paratransit modes in Ankara.

Perceived Severity was relatively higher than perceived vulnerability within the sample. This finding is in line with previous research on perceived severity and perceived vulnerability of other infectious diseases (De Zwart, 2009; De Zwart et al., 2010). Perceived vulnerability of COVID-19 was compared to other more traditional risks within mass transportation. Moreover, mass transportation was compared to a list of places (work/school, mall/supermarket, hospital and park) and modes (personal car, taxi, and scooter/bike) in terms of perceived vulnerability to COVID-19. The means reported ranged from relatively low (2.48) to relatively high (3.87) with most values clustering around the neutrality mean of "3.00". The highest comparative vulnerability perceptions were reported vis-à-vis other places while the opposite was true when comparing mass transportation to other modes. With the exception of park, all places had an almost identical comparative vulnerability perceptions vis-à-vis mass transportation. Thus, we can stipulate that those perceptions represent an agreement on the riskiness of mass transportation rather than a "safety-bias" towards any of the given places.

Interestingly, the lowest level of comparative vulnerability of mass transportation was reported against the car. Unfortunately, however, the most frequent users of mass transportation during the pandemic were also the ones most in agreement with the statement that mass transportation is riskier than a car in terms of the likelihood of contracting COVID-19. This observation further corroborates our finding, listed above, that mass transportation ridership during the period investigated was heavily reliant on the system's most captive users.

Excluding comparative vulnerability against the car and self-efficacies for "Avoiding mass transportation totally" and "Reducing the number of trips using mass transportation", a prevalent neutrality to risk and efficacy perceptions seem to characterize the most frequent users of mass transportation during the pandemic. Although unideal, this neutrality, especially when combined with low self-efficacy of users, might offer a good starting point for policy makers; policy interventions would prove most effective before users formulate response-efficacies unfavorable to mass transportation and/or engage in actions to increase their self-efficacy (e.g. purchasing second hand cars).

Finally, the low levels of perceived severity among the most frequent mass transportation users during the pandemic, if corroborated, warrants special attention on the part of policy makers. This is exacerbated by the lower COVID-19 related knowledge observed within the most frequent mass transportation users. Together, those two factors might contribute to lower abidance by protective measures (e.g.

Social Distancing, Wearing a Mask etc.) inside Mass Transportation and/or increase engagement in misjudged precautionary actions both of which would negatively influence safety and/or ridership of the system and its post-pandemic recovery process.

The findings listed in this chapter have to be interpreted with care taking into account the biases present within the sample surveyed but more importantly that they are an attempt to document a moving target. Perceptions on COVID-19 (both related and unrelated to mass transportation) continued to form and evolve even after our questionnaire was concluded and our chapter finalized. Most definitely this would also be the case long after the pandemic is declared over. The significance of this work would be less in its findings which might soon prove obsolete, if not already, and more in attempting to integrate health-based behavioral models into the context of mass transportation. The aim is to provide a framework of health as safety (HaS) on mass transportation that proves viable as the world progresses into a new, and unknown, normal.

# CHAPTER 6

# CONCLUSION

Mass transportation is by far one of the most important infrastructures of urban life. It provides people with mobility and access to the most essential services, such as employment and healthcare, at a much cheaper rate than the alternative of owning a private car. Thus, mass transit provides a basic mobility service to all individuals without access to or ownership of a car. However, the benefits of mass transportation should not be understood as strictly concerning those within the lower economic strata. Mass transportation is the most efficient choice space usage wise, given that it carries a larger number of individuals in much less space than private automobiles. This extra space, combined with the correct land use planning approaches, can then be used to create other urban spaces that bring communities together (e.g. parks, community centers etc.) contributing to a sense of community and enhancing neighborhood safety and security. Public transportation also contributes to the reduction of urban sprawl, congestion, travel times, air pollution and energy consumption. Many of those factors prove helpful in the fight against climate change and its adverse effects in addition to against the rise and spread of new infectious diseases as a result of deforestation and urban sprawl. Thus, the role of mass transportation in minimizing the possibility of future outbreaks should be recognized.

The role of mass transportation once an outbreak occurs, however, is more complex. On one hand, mass transportation plays an important role in providing mobility for essential workers and ensuring accessibility to health, and other essential, facilities. On the other hand, mass transportation also plays a role in the spread of infectious diseases once they emerge as have been detailed in Chapter 2 of this thesis. Understanding the relationship between travel patterns and infrastructure, including urban travel and mass transportation, is proving more crucial as the world continues to live through the adverse effects of COVID-19. Indeed, a body of research is currently being formulated on the effects COVID-19 had, and is having, on mass transportation systems worldwide. The aim of this thesis has been to contribute to this body of research, particularly as it relates to Ankara. Most of the focus in literature has, so far, been granted to the objective effects of the pandemic on mass transportation (e.g. rates of ridership lost, disruptions in schedules and routes etc.) and interventions to minimize this threat from an objective standpoint (e.g. disinfection, cashless payment etc.). This is quite normal given the novelty of the threat in question compared to other more traditional risks on mass transportation (crime, accidents, and terrorist attacks) whose subjective effect was also extensively studied (e.g. relationship between fear of crime and mass transportation ridership in different cities worldwide). Consequently, the aim of the thesis has not only been to contribute to a newly forming body of research but also to contribute to it *differently.* While parts of this thesis did cover the objective threat of infectious diseases on mass transportation, its main objective is to provide an understanding of mass transportation related risk and efficacy perceptions during the pandemic.

*Chapter Two,* did, indeed, reflect an analysis of the objective threat infectious diseases pose on mass transportation systems and the different interventions needed to minimize mass transportation vulnerability this particular risk. To this end, the first chapter detailed both the factors affecting disease transmission in mass transportation systems and the protection measures needed to be taken by the industry to objectively minimize this risk. From that point onward, however, the remaining chapters focused on analyzing subjective risk perceptions and how they influence travel behavior during a pandemic. This entailed the need to find a behavioral model suitable for the nature of the new threat encountered and applicable in the context of mass transportation. After considerable research into different behavioral models, Protection Motivation Theory was judged to be the most suitable for the task at hand. *Chapter three* details the main tenants of Protection Motivation Theory (e.g. perceived severity, perceived vulnerability, self-efficacy, response-efficacy etc.), the factors that affect those variables (socio-demographics, time, culture etc.), and their overall effect on engagement in a given precautionary measure (recommended or misjudged) during a disease outbreak. The basic assumptions of Protection Motivation Theory were then used as the main variables for surveying perceptions of mass transportation in the capital city of Ankara during the pandemic. The survey and its findings are presented in *Chapter Five.* Before that, however, *Chapter Four* provided a comprehensive background on the characteristics and ridership of Ankara's mass transportation system prior to and during the pandemic. Finally, this thesis concludes with a general discussion on the future of mass transportation and some policy recommendations.

## 6.1 A Discussion on Pandemics and the Future of Mass Transportation: Some Policy Recommendations

Given the effect of COVID-19 on mobility, discussions are being held on how to achieve an ideal transition into the 'new normal' for a service as vital as mass transportation. Naturally, resuming "business as usual" has its share of advocated. However, it's becoming apparent that such an approach is unfeasible. Changes in people's habits, such as increased rates of online shopping and telework, have changed in a way that is altering key components of mass transportation planning (e.g. trip purpose, trip frequency, trip distance, trip timing etc.). A challenge emerges, thus, to re-think previous mobility approaches while taking into account the constraints of existing infrastructure and service provision.

Increasingly, the role of active travel and micro-mobility is recognized as one such solution. Walking, cycling and 'scootering' are now recognized by localities worldwide as an opportunity to quickly restructure mobility infrastructure in line with new patterns of movement and at a relatively low cost. Although not traditionally falling within the realm of mass transportation, they still help mitigate an otherwise eminent explosion in automobile usage and ownership. Moreover, even prior to the pandemic, policy makers were exploring the use of different micro-mobility modes to deliver individuals to and from mass transport station, alleviating the first and last-mile problem of mass transport usage. Still, the pandemic forced transport planners to re-imagine the scale of micro-mobility usage; in towns and cities worldwide, 'pop-up' bike lanes and pedestrianized streets have been swiftly created to accommodate for a larger number of pedestrians and cyclists. However, even if bike lanes, workplace showers and storage areas are provided, active travel and micro-mobility remain constrained by distance and weather consideration. Although diversification of modes is definitely one of the ways to go, it should not be thought of as an alternative to implementing changes *within* the more traditional modes of mass transportation.

In order to make such informed decisions, however, policy makers need to rely on data resulting from an active and continued monitoring of local travel behaviors. As such, data collection could be regarded as "the mother of all policies" without which transportation agencies will neither be able to quantify nor plan for ensuing changes in travel behavior. To this end, mass transportation operators should seek information on a myriad of metrics such as traffic counts, transit ridership, average trip time, average trip distance, number of transfers required per trip, significant reductions in certain trip purpose categories etc. Those can either be extracted from big data sources of mass transportation (e.g. smart transportation cards) or through surveys and internal studies. Those metrics will aid mass transportation authorities in detecting patterns of atypical travel behavior and can provide real or near real-time insight into travel changes. As demonstrated throughout this thesis, mass transportation should also invest a considerable effort in understanding the forces influencing travel behavior (e.g. risk perceptions, efficacy believes etc.). For example, respondents could be surveyed on which modes they prefer, under what circumstances, on what days or times of the day and why. These questions will allow for a deeper understanding of the effect of COVID-19 not only on travel behaviors but also on the drivers behind those movement patterns. Moreover, such data is also crucial in aiding relevant authorities in their contact tracing efforts for those who are infected. On the other side of the equation, users are also demanding transit agencies to provide reliable up to date information on their services (e.g. service changes, real-time arrivals, vehicles' occupancy rates and disinfection frequency etc.) as a way to slowly regain trust in the safety of the system. Naturally, mass transportation agencies should process data in a manner that respects, guarantees, and protects the privacy of their users. Despite the unmistakable importance of such interventions, policy makers should be careful not to elevate digital transport based intervention above more mundane, but sometime equally or more effective, solutions. This is especially true given the negative effect

COVID-19 had on mass transportation revenues as a result of decreasing ridership and the cost of new safety measures aimed at minimizing the threat of infection within the system. Examples of some of those required engineering and administrative controls have already been detailed in Chapter One.

To reiterate, some of the engineering controls mentioned included better ventilation, installment of physical barriers between workers and users, encouragement of cashless payment in its various forms, disinfecting procedures including the gradual transition to the use of anti-microbial shielding and self-disinfecting surfaces, and the deployment of hand sanitizers in accessible areas across the system. Moreover, administrative controls included drafting emergency protocols and vulnerability profile that account for pandemics and the general threat of infectious diseases on mass transportation, drafting policies that encourage sick employees to stay at home without fear reprisal, constructing emergency communication channels both within the agency and between the agency and its users, providing informative posts inside mass transportation vehicles and stops, ensuring an up to date employee training on the threat of infectious disease spread tailored to the specific characteristics of mass transportation environments and designating mass transportation workers as essential workers.

Some mass transit agencies responded to the resulting budget shortfalls by reducing frequencies, slashing routes, delaying expansions and laying off employees. However, such policies run the risk of creating a negative feedback loop in which fewer and less frequent routes attract less users. Consequently, this causes the system to earn less revenue which means there is less money to maintain infrastructure and services. In turn, more users would move away from mass transportation as it becomes less and less convenient. Once an individual is compelled to buy a car because of the deteriorating status of mass transit, they are most likely to continue using this car even if mass transit manages to bounce back. Such an impact will fall disproportionately on low-incomers given that they have the least access to alternative forms of transport (e.g. personal car, taxi, ride-shares etc.) and are more likely to be essential workers without the option of teleworking. However, even those who exit the system would continue to be negatively impacted by its worsening condition; if enough mass transit users purchase a car or grow more dependent on ride-sharing services, road infrastructure would struggle to adapt with this newly gained infrastructure. Moreover, laying off employees during a pandemic means you have to train new ones as you ramp up post-lockdown services. Thus, although cost cutting measures seem to be the appropriate reaction to drop in revenue, adopting such measures would most probably end up impairing mass transit for decades to come. This would in turn have a city-wide ripple effect, increasing congestion and pollution levels, worsening inequalities, delaying infrastructure maintenance, and hindering economic recovery across sectors at large.

Many cities have, indeed, adopted policies in the opposite direction. Instead of reducing frequencies and slashing routes, cities, such as Barcelona, focused on reducing passenger density per vehicle by increasing frequencies especially during rush hours. In order to be able to implement such an approach, those cities installed temporary bus and LRT priority lanes through repurposing road space and/or park spaces. As the initial emergency response period expired, some cities, such as Seattle and London, are turning those temporary transit priority lanes into permanent ones. Rather than delaying prior expansion plans, those cities capitalized on the low levels of traffic to achieve previously set goals in addition to investing in new ones (e.g. permanent street reallocation for buses, LRT, bicycles, scooters, and walking).

The difference between both strategies outlined above represents one of the chronical weaknesses of mass transportation planning across time, namely the industry's obsession with maintaining the status quo. Most of the investments made go to ensuring that people continue to travel in the same ways they did decade ago. This is true for COVID times as much it is for times before it. Even as society continues to undergo fundamental changes as a result of the pandemic, many of the support programs and mass transit 'solution' are focused on how to bring the system and its ridership levels *back* to normal rather than on imagining and working for a *new* one. Faced with the threat of dwindling revenues, mass transit operators should not jeopardize efficiency by sticking to traditional economic model. Instead, mass transit systems should find *new* sources of revenue as the system transitions into a *new* normal. Alternative sources of revenue might include congestion fees and parking taxes in order to pull riders out of their cars and into mass transportation. Where they already exist, congestion fee's coverage could be expanded as well as its prices increased to adapt with the influx of new cars on the road as a result of the pandemic. Needless to say, the status of mass transportation in each city largely depends on which of the aforementioned approaches its policy makers adopt.

Rethinking mass transit also needs to be combined with re-imagining what the system will be used for. Experiments conducted with hybrid work and study models during the pandemic is expected to, at least, modestly shift travel demand away from the peak hour oriented paradigm that previously dominated mass transportation planning of cities worldwide. While some planners equate this change with a drop in the numbers of daily ridership, this is not necessarily the case. Instead, those new work/study routines present mass transport systems with the opportunity to spread demand equally throughout the day mitigating the negative effects of traditional rush hour planning (e.g. crowdedness). In fact, 'flattening the curve' of mass transportation has been a goal of many Transport Demand management (TDM) advocates even prior to the pandemic. Indeed, some cities were already incentivizing off-peak hour travel through differentiating ticket prices across rush and non-rush hours (e.g. Singapore). The existential crisis rush hour mobility is facing should be seen as a chance to improve quality, reliability and cost efficiency of travel; a chance to have a more pleasant trip, to make more efficient use of the system and to re-think the previous model of "crowded as efficient".

Parallel to all of those aforementioned policies, local authorities need to support a larger-scale, longer-term shift away from private automobile use. In cities where para-transit still plays an important role in urban mobility, as in the case with Ankara, this means developing institutional, policy and financial packages to help informal transit providers even if some of these policies might translate into a lower transit ridership on the shorter term. Given the volume of passengers transported by Dolmuşes in Ankara, the sudden failure of this system would force a large segment of residents into either car or mass transportation usage. While this might initially sound like good news to the mass transit, it is doubtful that the system as it stands today in Ankara would be capable to accommodate such a sudden increase in demand. Moreover, developing packages to support paratransit and its workers could also help strengthen formalization efforts.

In line with the topic presented in this thesis, policy makers need to recognize the dichotomy between measures that objectively minimize the threat of infectious diseases on board and measures that target individuals' safety perceptions. While both are definitely related, they are not the same. Adopting measures that objectively decrease the threat of contagion on board should not be assumed to automatically translate into a better sense of safety among passengers. Conversely, there are measures that would be adopted solely for the purpose of increasing individuals' confidence in the system even if they prove objectively ineffective in reducing the systems' vulnerability to infectious diseases. While objective safety measures should rely on the expertise of professionals within technical fields, measures targeting perceptions would be more dependent on feedback received from the people themselves. Moreover, objective safety measures can be replicated across cities worldwide while safety perceptions – and measures targeting them- tend to be more localized. Hence, the contribution of this thesis.

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## APPENDICES

### A. SURVEY QUESTIONS

1. Before COVID-19, how often did you use the following:

| | Everyday | 2-3 times a week | Once a week | Rarely | Never |
|---|---|---|---|---|---|
| Private Car | | | | | |
| Taxi | | | | | |
| Mass Transportation (Dolmuş, Metro, Bus, Başkentray Banliyö)? | | | | | |
| Scooter/Bicycle | | | | | |

2. After COVID-19 (Now), how often do you use the following:

| | Everyday | 2-3 times a week | Once a week | Rarely | Never |
|---|---|---|---|---|---|
| Private Car | | | | | |
| Taxi | | | | | |
| Mass Transportation (Dolmuş, Metro, Bus, Başkentray Banliyö)? | | | | | |
| Scooter/Bicycle | | | | | |

3. Before COVID-19:

| | Metro | Bus | Dolmuş | Scooter/Bicycle | Başkentray Banliyö |
|---|---|---|---|---|---|
| Which mode did you use the most? | | | | | |

4. After COVID-19:

| | Metro | Bus | Dolmuş | Scooter/Bicycle | Başkentray Banliyö |
|---|---|---|---|---|---|
| Which mode do you use the most? | | | | | |

5. Before COVID-19:

| | Yes | No |
|---|---|---|
| Did your average trip require transferring between different modes? | | |

6. After COVID-19:

| | Yes | No |
|---|---|---|
| Does your average trip require transferring between different modes? | | |

7. With 1 being the lowest and 5 being the highest, please answer the following

| | 1 (very low) | 2 (low) | 3 (average) | 4 (high) | 5 (very high) |
|---|---|---|---|---|---|
| How dangerous would it for you if you contracted COVID-19? | | | | | |
| How likely to do you think you are to contract COVID-19? | | | | | |

8. When riding Mass Transportation (Dolmuş, Metro, Bus, Başkentray Banliyö), I am much more likely to contract COVID-19 than

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I am at work/school | | | | | |
| I am visiting the hospital | | | | | |
| I am shopping (e.g. supermarket, mall) | | | | | |
| I am at the park | | | | | |
| I am riding a taxi | | | | | |
| I am riding a bike scooter | | | | | |
| I am riding a personal car | | | | | |

9. When riding Mass Transportation (Dolmuş, Metro, Bus, and Başkentray Banliyö), I am much more likely to contract COVID-19 than being the victim of a ……..............

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Crime (theft, sexual assault etc.) | | | | | |
| Accident (fatality or injury) | | | | | |
| Terrorist Attack | | | | | |

10. People will protect themselves against COVID-19 if they:

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Wear a mask | | | | | |
| Take a higher dose of Vitamins | | | | | |
| Avoid Mass Transportation all together | | | | | |
| Reduce the number of trips they take using Mass Transportation | | | | | |
| Reduce their Mass Transportation trip duration | | | | | |
| Change Mass Transportation travel time/ travel schedule | | | | | |

11. I believe I personally can:

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Wear a mask | | | | | |
| Take a higher dose of Vitamins | | | | | |
| Avoid Mass Transportation all together | | | | | |
| Reduce the number of trips I take using Mass Transportation | | | | | |
| Reduce my Mass Transportation trip duration | | | | | |
| Change Mass Transportation travel time/ travel schedule | | | | | |

12. Please Indicate if the following statements are true or false

| | True | False |
|---|---|---|
| COVID-19 is more dangerous than the seasonal flu | | |
| A higher dose of Vitamin C is proven to protect you against COVID-19 | | |
| The recommended duration to wash your hand with soap is 10 seconds | | |

13. How old are you? ………………….

14. What is your Gender

- Male
- Female

15. What is your level of education?

- Literate
- Elementary School Graduate
- High School Graduate
- Bachelor Degree
- Masters/PHD

16. What is your Employment Sector? ................................

17. What is your occupation? ..............................

18. Where do you reside?

- Altındağ
- Çankaya
- Etimesgut
- Gölbaşı
- Keçiören
- Mamak
- Pursaklar
- Sincan
- Yenimahalle
- Other ………………………..
-

19. Where do you go to work/school ?

- Altındağ
- Çankaya
- Etimesgut
- Gölbaşı
- Keçiören
- Mamak

- Pursaklar
- Sincan
- Yenimahalle
- Other ………………………..

20. How many cars does your household have?

    - 0
    - 1
    - 2
    - More than 2

21. During the pandemic, were you able to work/study from home?

    - Yes
    - No
    - Partially

I did not have work/school during the pandemic

## B. TURKISH SUMMARY / TÜRKÇE ÖZET

## ANKARA TOPLU TAŞIMA SİSTEMİNE YÖNELİK ALINAN COVID-19 PANDEMİSİ ÖNLEMLERİNİN DEĞERLENDİRİLMESİ

### Genişletilmiş Özet

Covid-19 (Yeni Koronavirüs Hastalığı) Salgınına neden olan hastalık ilk olarak 2019 yılının Aralık ayında Çin'in Wuhan kentinde görülmüş ve hastalık hızla dünyanın diğer ülkelerine ve bölgelerine yayılmıştır. 30 Ocak 2020'de Dünya Sağlık Örgütü tarafından Covid-19 Salgını 'Uluslararası Önem Arz Eden Halk Sağlığı Acil Durumu' olarak ilan edilmiştir. 1990'lardan bu yana özellikle bulaşıcı olmayan kronik hastalıkların oluşturduğu çevrelere odaklanan halk sağlığı ve ulaşım sistemlerindeki terörist saldırılara odaklanan ulusal güvenlik, Covid-19 salgınına hazırlıksız yakalanmıştır. Çünkü bulaşıcı hastalıkların ve salgınların 'geçmişte kaldığı' düşünülmekteydi. Birinci Dünya Savaşı'nın sonundaki İspanyol gribinden bu yana kontrol edemediğimiz bir hastalığın herkesi ve her yeri etkileyebileceği hiç düşünülmemiştir (Batty, 2020). Bu noktada dünya çapında bir salgınla karşı karşıya kalan ülkeler ve yönetimler, virüsün yayılmasını engellemek ve yayılma hızını yavaşlatarak kontrol etmek amacıyla hem tıbbi alanda hem de toplum sağlığının her alanında çeşitli önlemler almaya başlamıştır. Ancak tıp dışı önlemlerin çoğu, insanların hareketliliğini sınırlandırmıştır ki dünya çapında toplu taşıma sistemleri ağır bir darbe almıştır. Bu doğrultuda Covid-19 Pandemisi'nin toplu taşıma sistemlerine etkileri de araştırılmaya başlanmıştır.

Bu tez de Covid-19 Pandemisi'nin Ankara toplu taşıma sistemi üzerine olan etkilerini analiz ederek giderek büyüyen bu çalışma alanına katkıda bulunmayı amaçlamıştır.

Buna merkezi ve yerel yönetimlerce alınan çeşitli önlemler dahil Covid-19 hastalığının ve alınan kararların Ankara'nın toplu taşıma sistemi üzerindeki doğrudan ve dolaylı etkilerinin detaylandırılması da dahildir. Diğer araştırmalarla uyumlu olarak tez, pandeminin toplu taşıma üzerindeki etkilerini yolcu kaybı, tarifelerdeki değişiklikler, işe gelip-gitme saatleri, bekleme süreleri, ortalama mesafeler gibi değişkenler üzerinden nesnel olarak araştırmaktadır. Buna ek olarak görece daha az incelenmiş bir konu olan Covid-19'un toplu taşıma üzerindeki öznel etkileri de bu tezde yolcuların pandemi döneminde toplu taşımaya yönelik risk ve etkinlik algıları ile incelenmektedir. Ankara toplu taşıma sisteminin genel özellikleri ile pandemi öncesi dönemdeki yapısı ve karşılaşılan zorluklar kısa bir arka plan olarak tezde sunulmuştur. Daha sonra Covid-19 Pandemisi'nin Ankara toplu taşıma sistemi üzerine nesnel ve öznel etkileri araştırılmıştır.

**Ankara Toplu Taşıma Sistemi**

Bu tezde Ankara toplu taşıma sistemi iki nedenden dolayı örnek çalışma alanı olarak seçilmiştir. Birincisi Ankara 2020 yılı itibariyle 5.663.322 olan nüfusu ile büyükşehir olarak Dünya'daki metropoliten alanlarla benzer özellikler taşımaktadır. Covid-19 Pandemisi az yoğun küçük yerleşmelerden ziyade ekonomik ve sosyal faaliyetlerin yoğunlaştığı kalabalık büyükşehirleri daha çok etkilenmiştir. Bunun sebebi, servis sektörünün büyüklüğü yanı sıra faaliyetlerin tümünün araçlı yolculuklar gerektirmesidir. Diğer taraftan da büyükşehirler organizasyon kapasitesi ile imkanlarının büyüklüğü nedeniyle pandemi sürecinde örgütlenebilmiş ve çeşitli önlemlerle kentsel yaşamı devam ettirmişlerdir. Dünyada büyükşehirlerin önemli bir kısmında toplu taşıma hizmetine ilişkin idari ve teknik önlemler alınmıştır. Türkiye'de de hem merkezi hem de yerel yönetimlerce benzer önlemler alınmıştır. Ankara toplu taşıma sistemi EGO Genel Müdürlüğü'nce yönetilmektedir. Her ne kadar gelişmiş ülkelerdeki toplu taşıma örgütlenmeleri ile karşılaştırıldığında orta düzeyde bir örgüt olarak görülse de tarihi ve işleyişi açısından kurumsallaşmış olan EGO Genel Müdürlüğü de Covid-19 gibi bir salgın karşısında gerekli önlemleri gelişmiş ülkelerdeki muadilleri ile beraber almıştır. Bu açıdan tezde Ankara toplu taşıma sistemi örnek alan çalışması olarak alınmış ve Covid-19 Pandemisi'nin sistem üzerine etkileri araştırılmıştır.

Ankara'nın tezde örnek çalışma alanı olarak seçilmesinin ikinci nedeni ise hızla değişen Ankara'nın giderek gelişen toplu taşıma sistemine sahip olmasıdır. Türkiye'de son dönemde toplu taşımada lastik tekerlekli sistemler yanı sıra yüksek kapasiteli raylı sistemlerin de kendine yer edinmeye başladığı görülmektedir. Ankara 1990'lı yıllar sonrasında raylı sistemler ile tanışmıştır. Banliyö sistemi dışında büyük ölçüde otobüs ve dolmuş hatlarına dayalı olan toplu taşıma sistemi raylı sistemlerin metropoliten alanın önemli merkezlerine erişim sağlamasıyla nitelik değiştirmeye başlamıştır. Karayolundan ayrı yolları kullanan, genel trafikten ayrışmış metro gibi raylı sistemler (gelişmekte olan ülkelerde derinleşen) trafik sıkışıklığı problemi karşısında en etkin seyahat etme yolu olarak kendini göstermektedir. Bu nedenle raylı sistemlerin hayata geçmesi sonucu kısa zamanda yolcu sayılarında önemli artışlar görülmüştür. Ankara'da görece kısa bir etapta yer alan Ankaray Hafif Raylı Sistemin hizmete girdiği 1990'lı yıllardan sonra M1, M2, M3 ve M4 metro hatlarının işletilmeye başlanılmasıyla toplu taşıma sisteminde raylı sistemler lehine önemli gelişmeler olmuştur. Yakın gelecekte ortak istasyon sayısının da artması ile raylı sistemler gelişmiş ülkelerdeki muadillerinden farksız bir hizmet ve erişim düzeyine erişeceği düşünülmektedir. Dolayısıyla Ankara, küresel salgın karşısında alınan tedbirlerin etkinliğinin ölçülmesi açısından önemli bir örnektir.

## Toplu Taşıma Sistemleri ve Covid-19 Pandemisi

Covid-19 salgın hastalığı, yüksek bulaşıcı solunum yolu hastalığıdır. Hastalık solunum yollarından havaya karışan zerreciklerde bulunan virüs etkisiyle bulaşıcılığını sağlamaktadır. Virüs özellikle hava akımının olmadığı ya da düşük olduğu kapalı ortamlarda, havada asılı kalarak ya da temas edilen yüzeylerde belirli bir süre kalarak bulaş riskinin en üst düzeyine erişmektedir. Ulaşım sistemleri dahil yapılı çevrede hava aracılığıyla yayılan hastalıkların bulaşması, patojenlerin iletimi ve yayılması, hastalar, taşıyıcılar, ortamın kullanıcıları ve fiziksel çevre arasındaki bir dizi ardışık etkileşime bağlıdır (Faass vd., 2013). Bu konudaki mevcut literatür, mutlak olmamakla birlikte, biyolojik tehlikelere maruz kalma riskini etkileyen faktörler hakkında bize temel bilgiler sunmaktadır. Bu faktörler genel olarak patojen iletiminin, toplu taşıma sisteminin ve yolcu hareketliliğinin özellikleri başlıkları altında incelenmektedir. Ancak gruplamanın net ayrımlarla yapılamayacağı da not edilmelidir. Zira bulaş, katedilen mesafe, örneğin, hem sisteminin tasarımına ve işletimine hem de kişisel tercihlerine de bağlıdır.

Her ne kadar faktörlerin etkileri, toplu taşımanın çok değişkenli ortamlarında net bir şekilde ölçülemese de bulaşmayı ve yayılmayı kontrol edici önlemleri geliştirmek mümkündür (Kowalski, 2012). Biyolojik tehditlere karşı kontrol önlemlerini doğru senaryo ile doğru yerde uygulamak gerekmektedir. Faass vd. (2013) yayılımı önlemeye yönelik stratejilerin çoğu okul ve hastane gibi yerlerde görece kolayca uygulanabilirken hareketliliğin ve geçişlerin yoğun olduğu ortamlarda (sosyal mesafe ilkesi gibi) uygulamanın zorlaştığını belirtmiştir. Yine de araştırmalar ve uygulamalar yapılı çevrelerde hastalığın bulaşma zincirini kırmak için gerekli olan kontrol önlemlerini üç ana grupta tanımlamıştır. İdari ve teknik önlemler yanı sıra kişisel korunma, sağlıklı ulaşım için olmazsa olmaz, gerekli ama yeterli olmayan koşullar olarak ileri sürülmektedir. Kişiler arasında sosyal mesafenin sağlanması, solunum yollarının yüz siperleri ve/veya maskeyle korunması, yüzeylere temas edilmemesi, el ve yüzün sıkça dezenfekte edilmesi gibi önlemler, Covid-19 salgınında uygulanan önlemlerin başında gelmektedir. Riskten kaçınma ise toplu bulunulan ortamlardan sakınma ile gerçekleşmektedir.

Türkiye'de de Covid-19 salgınına karşı Cumhurbaşkanlığı, İçişleri Bakanlığı ve Ankara İl Umumi Hıfzıssıhha Kurulu (UHK) tarafından ilk hasta vakasının görüldüğü 11 Mart 2020 tarihinden itibaren hızla bir dizi idari önlem alınmıştır. Kişiler arası teması azaltmak ve sosyal mesafeyi korumak için ilk olarak (ilk ve ortaokullar ile liseler ve üniversitelerde) yüzyüze eğitim-öğretim faaliyetlerine ara verilerek uzaktan eğitime geçilmiştir. Kamu kurum ve kuruluşlarında çalışanlar için uzaktan çalışma, dönüşümlü çalışma gibi esnek çalışma uygulamaları başlatılmıştır. Salgının, hızla yayılma gösterdiği ilk aylarda alınan en öncelikli önlem, bir çok hareket kısıtlarını içeren sokağa çıkma yasaklarıdır. Bu dönem, salgının yayılması ile hasta ve risk gruplarındaki kişilerin sokağa çıkmasını engelleyerek hastalığın tam kontrolünü hedeflemektedir. 65 yaş ve üstü vatandaşlar ile kronik rahatsızlıklara sahip olanlardan başlanarak 20 yaş altı çocuklar ve gençler de dahil edilerek aralıklarla sokağa çıkma yasakları getirilmiştir. Ankara dahil 30 büyükşehir ile Zonguldak iline 4 Nisan 2020 tarihinde kara, hava ve deniz yolu ile yapılacak tüm giriş-çıkışlar 15 gün süre için durdurulmuş, bu giriş-çıkış kısıtlaması birkaç kez uzatılmıştır. Ankara’da hafta sonları ve tatil günleri genel sokağa çıkma yasakları uygulanmaya başlamıştır.

Kapalı ortamda, birçok kişinin bir arada bulunduğu ve bu kişilerin farklı yerlere dağılarak hastalığın yayılma sürecine katkı verebildiği toplu taşıma yolculukları, hastalığın yayılımını kontrolü hususunda en öncelikli alanlardan birisini teşkil etmektedir. Toplu taşıma sektöründe öncelikle yolcu kapasitelerinin %50 oranında azaltılmasına ilişkin 24 Mart 2020’de karar alınmıştır. Sosyal mesafenin korunması açısından önemli olan bu karar, bir kaç kere değiştirilmiştir. Ticari taksilerin trafiğe çıkışlarında plakasının son hanesine göre 30 Mart 2020’de Ankara İl UHK tarafından sınırlamaya gidilmiş; ancak 5 Mayıs 2020 tarihinde uygulaması sonlandırılmıştır. Ulaşım sektöründe en temel koruyucu önlem, 13 Nisan 2020 tarihinde getirilen tüm toplu taşıma araçları ile şehirlerarası ve ilçeler arası yolcu taşıyan ulaşım araçları, taksiler, her türlü ticari araçlar ve servis araçlarında maske kullanılması zorunluluğudur. Toplu taşıma ortamları dışında önce kamusal alanlarda maske takma özendirilse de ilerleyen süreçte il genelinde meskenler hariç tüm alanlarda istisnasız maske takma zorunluluğu getirilmiştir.

Düşük kapasitede sunulan hizmette araçların sıkça dezenfekte edildiği, yolcuların sosyal mesafeyi koruması için sürekli uyarıldığı, yolculuk deneyimi esnasında el dezenfektanlarının erişilebilir her yere konulduğu, asansör gibi dikey hareketlilik araçlarının durdurulduğu durumlarla toplu taşıma sistemlerinde sıkça karşılaşılmaktadır. Pandemi dönemindeki en önemli idari önlem, riskli grupların toplu taşıma sistemini kullanmamasına ilişkindir. Belirli aralıklarla bu idari önlem gevşetilse de genel olarak salgının tüm dönemlerinde bu tür kısıtlar sıkı bir şekilde uygulanmıştır. Önlemlerin uygulanması raylı sistemlerde daha kolay yürütülmüştür. Raylı toplu taşıma sistemlerinin kontrol edilebilir alanlarının daha fazla olması, araç sayısının az olması alınan tedbirlerin lastik tekerlekli sisteme nazaran etkin bir şekilde hayata geçirilmesine katkıda bulunmuştur. Lastik tekerlekli türlerde ise bu tedbirlerin etkinlik düzeyi raylı sistemlere nazaran her zaman sorgulanmıştır.

### Yolcu Algıları ve Covid-19 Pandemisi

Bu tez, Covid-19 Pandemisi döneminde toplu taşıma sisteminin yukarıda özetlenen genel işleyişi ve önlemleri karşısında yolcuların risk algı düzeylerindeki değişimi ve bu değişimin kişilerin toplu taşıma ile olan ilişki biçimlerini ne şekilde etkilediğini de içermektedir. Risk ile riskin algılanması arasında kişiden kişiye farklılıklar mevcuttur. Kimi yolcular yönetimlerin aldığı idari ve teknik önlemleri yeterli görürken, kimileri kişisel ek önlemler almaktadır. Kimi yolcular ise artık toplu taşımayı kullanmayı bırakmakta ya da kullanım zamanını ve mekanını değiştirmektedir. Kalabalık ortamlardan, yoğun araçlardan ve olağan işe geliş-gidiş saatlerinde seyahat etmekten kaçınmaktadır. Gidilecek yerin riskin düşük olduğu alt bölgelerde seçilmesi toplu taşıma kullanımını önemli ölçüde değiştirmektedir. Bu değişim salgın sürecinde gerek kişiler gerekse de toplu taşıma hizmetini sunan yönetim tarafından süreklilik kazanmıştır. Özellikle pandeminin farklı dönemlerinde bu davranışsal farklılaşmalar yakından gözlenmiştir.

Covid-19 Pandemisi'nin Ankara'daki toplu taşıma sistemi üzerindeki nesnel etkileri (araç kapasite kısıtları, tarife ve sıklık değişiklikleri, işe gelip-gitme zamanı farklılaşmaları vb.) bu tezde öncelikle incelenmiştir. Nesnel etkiler analiz edildikten sonra, pandeminin toplu taşımaya etkileri yolcu algıları (özellikle güvenlik ve etkinlik algıları) üzerinden de araştırılmıştır. Toplum sağlığıyla ilgili en belirgin risk davranış modellerinden birisi olan Koruma Motivasyon Teorisi temel alınarak Covid-19'un Ankara toplu taşıma sisteminde risk ve etkinlik algılarına yansımaları hem kullanıcılar hem de kullanıcı olmayanlar hedeflenerek araştırılmıştır. Bu doğrultuda çevrimiçi bir anket hazırlanmıştır. Koruma Motivasyon Teorisine dayanan tezin kuramsal yaklaşımı da kişilerin riskler karşısındaki algısı (şiddet düzeyi, savunmasızlık düzeyi) ile tedbirler karşısındaki algısına (tedbirin etki düzeyi, kişisel uyumluluk düzeyi) etki eden unsurlar üzerinden geliştirilmiştir.

Her riskin şiddet düzeyinin kişiden kişiye algılanmasında önemli farklılıklar mevcuttur. Mutlak ölümle sonuçlanan terör saldırısı ile hırsızlığa maruz kalma arasında her ikisinin gerçekleme olasılıkları nispetinde algılanan şiddet düzeyleri mevcuttur. Burada kritik olan olasılığın kişiler ve yönetim düzeyinde ne ölçüde dikkate alındığıdır. Öte yandan kişisel özniteliklerle ilişkili olarak kişilerin savunmasızlık boyutunda da algıları farklıdır. Bu algı düzeyleri cinsiyet, yaş gibi kişisel özellikler yanı sıra yönetimin almış olduğu tedbirlerle de değişebilmektedir. Dolayısıyla kişilerin riskler karşısındaki algılarının alınan tedbirlerin etki düzeyinin algısı ile yakından ilgili olduğu ileri sürülebilir. Kişiler bu tedbirlere uymakta ya da uygulamakta ne kadar uyumlu oldukları idarenin almış olduğu tedbirlerin kişiler özelindeki uygulamaya geçirilebilecek olanlarına göre değişim gösterebilmektedir. Dolayısı ile bu dört boyutun çalışma kapsamında uygulanan anketle Ankara özelinde ortaya çıkarılması amaçlanmıştır.

**Ankara Toplu Taşıma Sistemine Yönelik Alınan Covid-19 Pandemisi Önlemleri ve Etkileri**

Covid-19 Pandemisi koşulları ve alınan tedbirler nedenleriyle yolcu algılarını ölçmeye yönelik tasarlanan anket çalışması çevrimiçi ortamda Ankara metropoliten alanında ikamet eden kişiler arasında gerçekleştirilmiştir. Bu amaçla kişilere yaşadıkları yer sorulmuş, Ankara dışında yaşadığı yönünde cevap verenlere soruların geri kalan kısmına geçmeden teşekkür edilmiştir. Kişiler ile ilgili sosyo-demografik özelliklerine ilişkin bilgiler sonrasında anketin algı düzeylerini ölçemeye yönelik değişkenlere ilişkin soruları sorulmuştur. Bu bölümde farklı riskler göz önüne alınarak risklerin algı düzeyleri ile ilgili derecelendirmeyi içeren değerlendirmelere yönelik seçimler yapması katılımcılardan istenmiştir. Anket çalışması 16 Kasım 2020 tarihinde başlamış ve 31 Aralık 2020 tarihinde sonlandırılmıştır. Bu nedenle pandeminin ilk aylarını, 'kısmi normalleşme dönemini' ve yeniden kısıtların uygulanmaya başlandığı dönemi içermekte, salgının başladığı ilk aylara göre günlük rutinlerin yeniden şekillendiği dönemi de kapsaması anket sonuçları üzerinden pandeminin yolcu algılarına etkilerini de araştırmaya imkan tanımıştır.

Anket çalışmasının bulguları Covid-19 Pandemisi'nin Ankara toplu taşıma sistemini hem nesnel hem de öznel olarak etkilediği hipotezini desteklemektedir. Pandeminin ilk döneminde (Nisan – Temmuz 2020), tüm kent içi yolculuklarda bir düşüş gözlenmiştir. Bu düşüş toplu taşımada kamu ve özel tüm toplu taşıma türlerini içermektedir. İkinci döneminde (Ağustos 2020-Mart 2021), özel araçla ulaşımda pandemi öncesi döneme göre bir artış görülürken toplu taşımada düşük yolcu sayıları görece bir artışla düşük düzeyde devam etmiştir. Ankara’da toplu taşıma için en yüksek yolcu kaybı pandeminin başladığı Mart 2020’de görülürken en yüksek toplu taşıma yolcu seviyelerine de Mart 2021'de ulaşılmıştır. Covid-19 Pandemisi toplu taşımanın en devamlı yolcularını dahi etkilemiş ve sistemde yolcu sayılarında keskin bir düşüşe sebep olmuştur.

Pandemi döneminde toplu taşıma yolcu sayılarındaki düşüş, ulaşım türleri arasında farklılaşmaktadır. Otobüs, metro ve hafif raylı sistemdeki yolcu sayıları, dolmuş gibi özel olarak işletilen muadillerinin sayılarına göre daha yüksek oranda düşüşle karşılaşmıştır. Yine de, incelenen tüm aylarda (Mart 2020 – Mart 2021) düşüş oranı belirgin bir şekilde diğer türlerden farklılaşan bir ulaşım türü ortaya çıkmamıştır. Yolcu kaybının yanı sıra pandemi, ortalama bekleme süreleri, işe gidip gelme süreleri, yolculuk mesafeleri ve aktarma sayıları gibi toplu taşıma öğelerinin tamamını etkilemiş; sadece yolcu talebinin zamana göre dağılımını (yani yoğun saatleri) etkilememiştir. Yolcu algılarına etkiler tarafında Covid-19'un toplu taşımadaki diğer öğelere karşı algılanan savunmasızlığı çoğunlukla tarafsızlık ile açıklanmıştır.

Toplu taşıma ortamları içerdikleri risk düzeyleri ve güvenlik açığı algıları açısından alışveriş merkezi, park gibi yerlere göre en yüksek ortam olarak belirtilirken toplu taşıma türleri, diğer özel ulaşım veya bisiklet/motorsiklet gibi türlerle karşılaştırılırken toplu taşımanın ayrışmadığı ortaya çıkmıştır. Buna karşın toplu taşımayı sıkça kullanan kişilerin toplu taşıma ortamlarına aşina olduklarından riski yönetme konusunda kendilerine olan güvenlerinin yüksek düzeyde olduğu görülmektedir. Aynı kişilerin alınan tedbirler açısından verdikleri cevaplar, idarenin bu konulardaki politikalarını gözden geçirmesine neden olacak mahiyette çarpıcıdır. Toplu taşımanın karşılaştırmalı kırılganlığının en düşük seviyesi otomobile karşı rapor edilmiştir. Bununla birlikte, pandemi sırasında toplu taşıma kullanıcıları, toplu taşımanın Covid-19 hastalığına yakalanma olasılığı (karşılaştırmalı güvenlik açığı) açısından toplu taşımada seyahat etmeyi özel araçla seyahat etmekten daha riskli bulduklarını ifade etmişlerdir.

Toplu taşıma kullanıcılarındaki tarafsızlık, ankete katılanların pandemi döneminde toplu taşıma kullanımına ilişkin kişisel önlemlerinde veya tercihlerinde de devam etmiştir. Örneğin, toplu taşımadan tamamen kaçınmak, toplu taşımada yolculuk sayılarını azaltmak, yolculuk süresini kısaltmak, aktarama sayılarını azaltmak veya daha kısa yolculuklar için toplu taşımaya kullanmak gibi kişisel önlemler arasında belirgin farklılıklar gözlenmemiştir. Sadece toplu taşımadan tamamen kaçınmak ve toplu taşımada yolculuk sayılarını azaltmak katılımcılar arasında düşük öz-yeterlik seviyesi ile öne çıkmaktadır. Son olarak, pandemi sırasında toplu taşımayı sık kullananlar arasında hem Covid-19'a karşı ile algılanan ciddiyet hem de bilgi seviyeleri düşük gözlemlenmiştir. Birleşik olarak bu iki faktör toplu taşımada sosyal mesafenin korunması, maske takılması gibi önlemlere karşı duyarlılığın azalmasına ve önlemlere uyumun azalmasına katkıda bulunabilecek niteliktedir. Her ikisi de sistemin güvenliğini tehdit edebilecek ve/veya yolcuları toplu taşımaya karşı negatif yönde etkileyebilecek bulgulardır. Bu nedenle pandemi sonrası normalleşme dönemi de düşünüldüğünde politikaların bu doğrultuda geliştirilmesi önemlidir. Toplu taşıma idaresinin bilgilendirmeleri artırması ve ek önlemler alması gerektiği vurgulanabilir.

**Sonuçlar**

Kentlerin en önemli özelliklerinden birisi yoğunlukları ve ölçek olarak büyüklükleridir. Kentlerin tanımındaki bu temel değişkenlerin ortaya çıkışı ise ekonomik ve sosyal faaliyetlerin çeşitliliği ve işleyiş biçimi ile açıklanmaktadır. Kentlerde farklı bireylerin biraraya gelmesi bir işbirliğini ortaya çıkarmaktadır. Bu işbirliği sayesinde kentte toplu olarak icra edilen birçok faaliyetle kent işlemeye veya yaşamaya devam etmektedir. Toplu taşıma hizmetleri de bu faaliyetlerden birisi, hatta kentteki bütün faaliyetleri bir birine bağlayan olduğu için en önemlisidir. Toplu taşıma bir birini tanımayan ve bir araya gelmek için sözleşmeyen kişilerin, özel araca göre yüksek kapasiteli bir seyahat aracında rastgele bir araya gelerek beraber belirli bir süre seyahat etmesine dayanmaktadır. Toplu taşıma özel ulaşımdan farklı olarak ücretini ödeyen herkese açık olduğu için kamusal ya da ortaklaşılan bir hizmet olarak da görülebilir. Önceden kurgulanmış veya tasarlanmış bir sisteme dayalı olarak sunulan hizmet kentin tüm ana bölgelerine erişim sağlamaya yönelik bir erişimi de tarif etmektedir.

Toplu taşıma hizmetleri, özel araçla seyahat edilen karayolu ağı üzerinde kendine özel araçlar ve (varsa) yol alanı üzerinde ya da demiryolları üzerinde, askılı sistemlerde, deniz üzerinde verilebilmektedir. Ulaşımın gerçekleştiği teknolojiye dayalı olarak da sistemin kurgusu söz konusudur. Temel sistem elemanları toplu taşımaya erişim noktaları (durak, istasyon, iskele), toplu taşıma yolu (karayolu, demiryolu, deniz/su), toplu taşıma araçları (minibüs, otobüs, tramvay, metro, banliyö, vapur vb.) olarak üç ana grup altında toplanabilir. Bu sistem elemanları talebe dayalı olarak hat/güzergah, zaman tablosu, kapasite gibi değişken unsurlarla toplu taşıma sistem tasarımına ve işletimine imkan vermektedir.

Kentin sağlıklı işleyebilmesi ve faaliyetlerin devam edebilmesi için toplu taşıma hizmetlerinin aksamadan sunulması gerekmektedir. Aksi durumda özel ulaşıma erişimi olup da toplu taşıma kullananlar özel ulaşıma geri dönecek, özel ulaşıma erişimi olmayanlar ise sadece yaya olarak erişebildikleri bölgelerde hareket etmek ile yetinmek zorunda kalacaklardır. Toplu taşımanın alışılageldik hizmet düzeyi ve kalitesinden olan azalmalar kullanımını önemli ölçüde etkilemektedir. Özel ulaşıma göre toplu taşımanın talep esnekliği daha yüksek olduğundan, toplu taşımanın kullanımının belirli bir seviyenin üzerinden tutulması için hizmet düzey ve kalitesinin de belirli bir seviyenin üzerinden tutulması gerekmektedir. Buna karşın toplu taşıma kullanmak zorunda olan kentli grupları için ise hizmet ve kalite düzeylerinden azalma yaşam kalitesinde mutlak azalmalar olarak kendini göstermektedir.

Öznitelik olarak zaman ve mekanda paylaşımı gerektiren toplu taşımanın temel sistem elemanları her zaman risklere maruz kalmıştır. Terör saldırıları, afetler ve salgın hastalıklar gibi büyük ölçekli olaylar yanı sıra hırsızlık, taşkınlık gibi görece küçük ölçekli olaylar toplu taşıma sistemlerini daha fazla etkilemektedir. Bu durumlarda toplu taşımanın temel öğelerinde ya da değişken öğelerinde düzenlemelerin yapılması ya da önlemlerin alınması söz konusu olabilmektedir. Bir istasyonun kapatılması, hat güzergahının değiştirilmesi, araçların belirli bir doluluk oranlarının altında tutulması, araçların temizlenmesi, güvenlik kontrolleri gibi ek idari ve teknik önlemlerle sistemin açık olduğu risklerin kontrol edilmesi söz konusudur. Alınan önlemlerin ikili bir işlevi olmaktadır. Birincisi, risk ve tehdidi azaltmayı ya da bertaraf etmeyi amaçlamakta ikincisi ise riski yönetmeyi hedeflemektedir. Her ikisinin birbiriyle örtüştüğü noktalar olmasına rağmen birbirinden farklılaştığı durumlar da mevcuttur. Örneğin bir terör saldırısı riskine karşı alınan, güvenlik kameralarının kurulması, güvenlik görevlilerinin sayısının arttırılması, devriyelerin oluşturulması, göz kontrolleri yanı sıra üst araması gibi fiziksel kimi ek önlemlerin, terör saldırısı tehdidini azaltmayı ya da bertaraf etmeyi amaçladığı açıktır. Artırılan güvenlik önlemlerinin görünür/hissedilir olmasının ise aynı zamanda terör tehdidi algısını azaltmayı ve toplu taşıma kullanımını normal seyrinde devam etmesini sağlamayı amaçladığı da açıktır. Burada alınan önlemlerin, her iki hedefe yönelik alındığını ve uygulandığını söyleyebiliriz.

Bu çalışma, toplu taşımanın salgın hastalıklar dahil maruz kaldığı tehdit ve risklere karşı alınan tedbirlerin etkinliğini ölçmeye yönelik geliştirilmiştir. 2019 yılında Çin'de ortaya çıkan ve 2020 yılında Dünya'ya yayılan Covid-19 salgını neticesinde kentler ve kentsel yaşam en üst düzeyde etkilenmiştir. Ekonomik ve sosyal faaliyetlerin çoğuna ara verilmek zorunda kalınmış ve bir çoğu da değişmiştir. Birbirini tanıyan/tanımayan insanların belirli bir süre bir araya gelmesinin hastalığın yayılmasına neden olması toplu olarak yapılan tüm faaliyetleri durdurmuştur. Bu faaliyetlerin başında toplu taşıma gelmektedir. Salgının küresel nitelik kazanmasıyla birlikte Dünya'nın birçok kentinde toplu taşıma hizmetleri öncelikle askıya alınmıştır. Toplu taşıma hizmetlerinin durması karantina ve/veya sokağa çıkma kısıtlamalarını da destekleyici nitelikte olmuştur. Buna karşın kısıtlamaların gevşetildiği dönemlerde ise toplu taşıma eski seviyesini yakalayamamıştır. Bunun arka planında faaliyetlerin azalması yanı sıra insanların riskli ortamlardan uzaklaşması gibi tkişisel tercihlerinin de olduğu açıktır. İnsanların riskli ortamlarda güvende kalmalarını ya da hissetmelerini sağlayacak tedbirlerin alınarak toplu taşıma sistemlerinin eski düzeylerini yakalamasına yönelik uygulamaların hayata geçirilmesi toplu taşıma gibi yüksek maliyet içeren kentsel hizmetlerinin sürdürülebilirliği için büyük önem arz etmektedir. Bu tedbirlerin etkisinin ölçül(ebil)mesinin, alınacak önlemlerin tasarımında kolaylıklar sağlayacağı da kuşku götürmemektedir.

Tezin sonuçları toplu taşıma ortamlarının ve deneyimlerinin riskin doğru algılanması ve alınan tedbirlere uyulmasına yönelik olduğunu göstermektedir. Toplu taşımayı sık kullanan kişilerde yer alan kanıksanmış riskin salgına karşı olan risk algısına da sirayet ettiği görülmektedir. Her ne kadar görünürde tedbirlere uyulsa da algının belirli bir düzeyin üzerine çıkamamasının derinlemesine incelenmesini gerektiren kimi alt nedenlerinin olduğu düşünülmektedir. Öte yandan toplu taşıma idaresi ve işletmeleri yolcu sayılarındaki önemli düşüş karşısında taşıma/bilet ücretlerinden maliyetleri karşılayamaz bir duruma gelmiş ve büyük bir bütçe açığıyla karşı karşıya kalmıştır. Bu durumda idare yolcu seviyesi düşük hatların kaldırılması, sefer sayılarının azaltılması, yeni yatırımların ertelenmesi ya da iptal edilmesi gibi yeni kararlar almıştır. Bu çalışmadan görülmektedir ki toplu taşıma idaresinin almış olduğu bu yeni kararlar ve ek önlemler karşısında kullanıcılar hızla başka türlere kaymakta, özellikle özel ulaşımı tercih etmektedir. Bu nedenle toplu taşıma idarelerinin salgın karşısındaki önlemlere ek olarak olağan çalışma biçimini değiştirmemesi, hatta sefer sayılarını artırarak kişilerin maruz kaldığı risklere karşı etkin önlemler aldığı algısının inşasına katkıda bulunan çalışma düzenine geçmesi önerilmektedir. Böylece toplu taşıma sisteminin gelecekteki potansiyel kayıplarının önüne geçmesi söz konusu olabilir.

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**YAZARIN /** AUTHOR

**Soyadı** / Surname : Shahin
**Adı** / Name : Hind
**Bölümü** / Department : Kentsel Politika Planlaması ve Yerel Yönetimler / Urban Policy Planning and Local Governments

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