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Establishing a Dual Generational Modality Dataset: Comparing the Ride-Sharing Consumers from Two Generational Cohorts, Millennials & Gen-Xers

Dr. Abhinav Alakshendra, University of Florida
Dr. Allie Thomas, University of North Carolina at Chapel Hill
Dr. Ruth Steiner, University of Florida
Dr. Jesse D. Anderson, University of Florida

STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center
UF | Transportation Institute UNIVERSITY of FLORIDA

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16. Abstract

Ride-hailing services such as Uber or Lyft are the latest tool in sustainable transportation strategies to come under scrutiny. Originally thought to be a way to reduce congestion, these services have actually been shown to increase it in some cases. Although the number of individuals driving around urban centers to find parking appears to decrease with the adoption of ride-hailing, Uber or Lyft drivers are instead circling around waiting for riders. Additionally, ride-hailing services have not led to the abandonment of personal vehicles, but rather to the abandonment of public transit in some cases.

The purpose of this study is to evaluate the use of ride-hailing services in the two largest age cohorts in the United States: Millennials and Generation X-ers, focusing on the Southeast. This study seeks to determine how each generation has adopted these methods to help planners learn how to incorporate these strategies in transportation planning.

The results of this study illustrate that both generations use ride-hailing services, but as seen in previous studies, millennials are more inclined to use them. Ride-hailing also serves as an important commute mode, particularly for millennials. In addition, and of importance to planners, the market has diversified, and more users are coming from the suburbs. Overall usage of ridesharing services will likely continue to increase over time and planning strategies should attempt to predict this change rather than respond to it.
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LIST OF AUTHORS

Lead PI:
Abhinav Alakshendra, Ph.D.
University of Florida, Gainesville
alakshendra@dcp.ufl.edu
ORCID 0000-0003-0153-0233

Co-PI:
Allie Thomas, Ph.D.
University of North Carolina at Chapel Hill
alainna@email.unc.edu
ORCID 0000-0002-8892-2493

Ruth Steiner, Ph.D.
University of Florida, Gainesville
rsteiner@dcp.ufl.edu
ORCID 0000-0001-7276-3742

Additional Researchers:
Jesse D. Anderson, Ph.D.
University of Florida, Gainesville
Jdf65@ufl.edu
ORCID 0000-0002-4401-9497

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ABSTRACT

Ride-hailing services such as Uber or Lyft are the latest tool in sustainable transportation strategies to come under scrutiny. Originally thought to be a way to reduce congestion, these services have actually been shown to increase it in some cases. Although the number of individuals driving around urban centers to find parking appears to decrease with the adoption of ride-hailing, Uber or Lyft drivers are instead circling around waiting for riders. Additionally, ride-hailing services have not led to the abandonment of personal vehicles, but rather to the abandonment of public transit in some cases.

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Keywords:
ride-hailing, ride-sharing, congestion, millennial, Generation X

EXECUTIVE SUMMARY

This study aims to shed light on the rationale behind this transformation to inform future policies which intend to increase the efficiency of transportation systems as well as address the environmental and social costs of transportation. Previous studies on transportation, which this project seeks to expand upon, have focused their efforts on larger urban agglomerations like Los Angeles or, more generally, national transportation patterns (Schaller, 2018). This study focuses on North Carolina and Florida, which have both seen rapid expansion of ride services within the past five years, with bike-sharing programs having only taken off in North Carolina in the late 2020's (Francis, 2018).

Furthermore, both locations have lower density urban areas, large suburban areas, and rural areas. Such characteristics enable the study areas to act as a model for similar areas experiencing the phenomenon this study seeks to understand.

This project's relevance to the STRIDE center's theme of congestion mitigation is through the focus on travel demand versus supply and technological impacts. Both are identified components which affect congestion. The primary research thrust areas are data and users. The latter refers to the project's focus on the users of ride hailing, ride-sharing and ride-matching services in the Southeastern United States and their impacts on traffic congestion. Ride hailing services have been easily adopted, while traditional ride-sharing programs and other alternatives have been less widely accepted, largely due to technological advancements in ride hailing. Millennials are now about a quarter of the United States population, the largest living generation in the United States numbering almost 75 million in 2015 (U.S. Census Bureau, 2015). Generation X is also a large generational cohort which is projected to overtake the Boomers population by 2028 (PEW Research Center, 2018). Given the sheer size of these two groups, their travel behaviors will shape the market. The acceptance of technological advancements in these two generations will further shape the transportation market, already seen in ride hailing usage in the past decade. This project's objectives are to discern sociodemographic data and mobility trends among the two age cohorts. In addition, the project also considers equity issues related to ride services, specifically for underrepresented populations such as African Americans, Hispanic and Asian American consumers. This research uses primary data to understand the travel behavior among two cohorts and further plan for congestion mitigation. The research utilizes a mixed methods approach to analyze the primary and secondary data sources to understand the impact of usages of ride sourcing services by Millennials and Gen X on the congestion.

1.0 INTRODUCTION

Traffic congestion is an unintended consequence of population growth and vibrancy in a city. The impacts of congestion are broad and affect traffic safety, air quality, productivity, fuel consumption, and the economy. In 2017, the United States lost $305 billion (including indirect losses) to traffic congestion (INRIX, 2018). Widespread consensus among scholars and professionals is for interventions to mitigate traffic congestion, but there is not an agreement on what strategies to implement.

1.1 OBJECTIVE

This project takes an innovative approach to understanding the usage of ride-sourcing services by millennials and members of Generation X (Gen X-ers) and how this usage impacts congestion. The focus on North Carolina and Florida will expand upon previous research on ride services, which has mostly focused on specific cities, such as Los Angeles or New York, or overarching national travel behavior patterns. Both Florida and North Carolina have lower density urban areas as well as large suburban and rural areas. The ability to study the interactions between these areas will offer a new perspective in ride-sourcing literature.

1.2 SCOPE

Our main goal is to produce a mobility data sets for two separate generations, millennials and Gen X-ers, for the Southeastern region. This research employs a mixed method approach, using both qualitative and quantitative methods. A comprehensive literature review of the topic focuses on the usage of ride services by millennials and Gen X-ers. The team identified and documented the mechanism of reduction in congestion due to changes in demand for ride-hailing and -sharing services from the available literature. In addition to the review of the literature, we analyze nationally available secondary data sources. We use the primary data and have supplemented the American Time Use Survey available from 2003–2016 along with the 2017 National Household Travel Survey.

An online survey was distributed to understand these cohorts in our respective states. Survey questions included sociodemographic background; mode choices and mobility trends; and perspectives on ride-sharing and in what instances it is most likely to be utilized.

2.0 LITERATURE REVIEW

Congestion is not a novel issue, as it has transformed with changes in settlement patterns and emergence of new technology. Congestion in the United States has been reported to be at an all-time high; thus, there is no time to waste in searching for a sustainable and effective solution (Schrank et al., 2019). Congestion evolves with changes in technology,

with ride-sharing services being one of the latest innovations. Ride-sourcing services are an emerging technology in transportation and must be analyzed for their contributions to congestion in order to modify past transportation efficiency strategies to accommodate this new sector. This project seeks to understand the use of ride-sourcing services by Millennials and Gen X-ers, due to these groups accounting for the majority of the market, followed by exploration of this trend's impact on congestion. Therefore, this literature review stands to summarize past strategies used to mitigate the effects of congestion and how these might be limited if used today with the emergence of ride-sourcing services. Following this summary, the existing literature on ride services, their evolution over time, and Millennials' and Gen X-ers' usage of ride services will be reviewed.

According to the Urban Mobility Report from the Texas A&M Transportation Institute, traffic congestion is at its highest measured levels in most cities in the U.S. (Schrank et al., 2019). This increase in congestion has been attributed to economic growth causing heightened transportation demand without a similar increase in supply of transportation infrastructure (Schrank et al., 2019). Furthermore, low gas prices, among other trends, have contributed to reductions in transit ridership in the United States (Schimek, 1996). Since 1984, the U.S. has historically had lower gas prices than Canada, which has greater usage of public transit (Schimek, 1996).

2.1 Strategies for Mitigating Congestion

As the United States has become increasingly dependent on cars, planners and engineers have sought out means by which to reduce congestion. Some methods encourage better flow or safety of traffic without attempting to impact transportation choice, such as replacing stop signs with roundabouts or expanding highways. Methods such as transit-oriented development (TOD) and construction of rapid transit systems seek to influence users' transportation choices in favor of those that reduce congestion. TOD encourages cities that are conducive to walking and biking in addition to incorporating public transit. The following section will outline the most common strategies used to reduce congestion and their impacts on or limitations regarding ride-sourcing services. No single solution is applicable to every situation and each must be analyzed on a case-by-case basis (Schrank et al., 2019). This following section is a generalization of trends in mobility and congestion mitigation.

2.1.1 Targeting User Behavior

Cities across the world have begun to encourage the reduction of personal vehicle use through a variety of methods, which range from increasing the affordability or efficiency of public transit to prioritizing other modes of transit on the road. A downside to methods that target user behavior is their timeliness, as a newly introduced method may not reveal its full potential within the short timeline preferred by funders or political sponsors. A common strategy is removing parking spaces or increasing parking fees in high-traffic areas to encourage different modes of transportation. Higher parking fees can be

effective at discouraging transportation by personal vehicle, but they can have more pronounced effects on members of low-income households who previously relied on their vehicles but can no longer afford parking. This is largely applicable to large urban areas; however, it could also be applied to medium-sized cities and residential suburban areas. This mitigation strategy works best for the reduction in use of personal vehicles, but if other transportation options are not efficient or convenient enough, congestion could remain due to an increased use of ride-sourcing services.

2.1.2 Targeting Traffic Flow and Safety

Strategies that target traffic flow and safety aim to prioritize pedestrians to increase safety. Such strategies include the construction of protected bike lanes, replacing four-way stops with roundabouts, and widening roads, among others. Each strategy's success will depend on the overall goals of the project and its location. While road-widening schemes are the first line of defense in most congestion mitigation plans, they have been shown to make little difference to congestion upon project completion. Additionally, road-widening often increases traffic delays drivers experience during periods of construction (Font et al., 2014). Human behavior that is as embedded in our collective culture as relying on automobiles for transportation will not change overnight. Thus, in the short term the most effective solutions to congestion may prove to be those that target delay reductions and increasing safety over those that attempt to alter transportation habits.

2.2 Ride-Sharing Services

The offerings within the rapidly expanding sector of ride-sharing services are rapidly evolving. The following section provides definitions as they are understood for the purposes of this study (see Table 2.1), as well as a brief history of different ride services to provide context for our findings. Ride-hailing is a process by which contracted drivers using personal vehicles provide point-to-point transportation for users. Ride-matching is a shared ride service that seeks to organize and connect commuters who have extra capacity with those who are looking for rides in a nearby geographic area or along a single route.

Ride-sharing is a pooling transportation service that organizes more efficient group travel. Car- and bike-sharing are ride services in which users pay a fee for exclusive, but temporary, use of a vehicle typically owned and maintained by a third party. App-based technologies largely enable all of these ride services and collectively they are commonly referred to as transportation network companies (TNCs) (Kortum, 2016). The advent of Uber in 2009 was simply the beginning of a variety of app-based ride-sharing services. Since then, shared ride services, such as ride-hailing services (e.g., Uber and Lyft) and car-sharing services (e.g., Zipcar and Car2Go) have rapidly grown and allowed people to travel with more flexibility. In the following sections, we will review conditions affecting

travel demand, transit use, and congestion as well as the impacts of the travel behaviors of millennials and members of Generation X.

Table 2.1 Definition Table
Definition and Examples of Common Ride Services

Definition Table		
	Definition	**Example**
Ride-Hailing	Contracted drivers provide point-to-point transport	Uber, Lyft
Ride-Matching	Matches commuters with extra capacity with those looking for rides nearby	Share the Ride
Ridesharing	Pooling transportation resources for efficient group travel	Carpools, Vanpools
Car-sharing	Fee-based, exclusive use of a vehicle maintained by a third party	Zipcar, Car2Go
Bike-sharing	Fee based used of a bike, maintained by a third party	Lime Bike

2.2.1 Car/Ride-Sharing Applications and Adoption Rates

While a proliferation of opportunities has arisen, adoption of these services has occurred at a much slower rate than expected. According to Shaheen, Cohen, and Zohdy (2016), the first car-sharing and bike-sharing programs in North America launched in 1994. However, for the first 15 years and until Uber's 2009 market entry, these services were relatively constrained to niche markets, such as college campuses and high-density urban areas (Clewlow & Laberteaux, 2016). The advent of Uber spurred a proliferation of ride-hailing and on-demand transport companies, as well as the ensuing technological advances that accompany and are the hallmark of the vast majority of these services.

In fact, Shaheen, Cohen, and Zohdy (2016) found that by July of 2015, there were 22 active car-sharing programs and over 600 ride-matching services in the United States alone. However, the adoption of these services differs greatly. The rate of adoption for ride-hailing services is significantly higher than their earlier counterpart, car-sharing services (Clewlow, 2017). For example, over the first 15 years of their existence, car-sharing services garnered only 5 million global users, whereas 250 million global users were accrued over just the first 5 years of ride-sharing services. Moreover, half of car-sharing service (Zipcar, Car2Go,

DriveNow, etc.) users have dropped their memberships, with 23% citing ride-sharing services as the main reason for this choice (Clewlow, 2017).

Clewlow and Laberteaux (2016) further found that ride-hailing services are expanding into new markets previously untouched by the car-sharing industry, such as food delivery services. However, there is concern over a potential national monopoly by Uber in regard to the command of market shares for ride-hailing services. Uber has largely dominated the market since its 2009 inception, accounting for over 80% of shares, though recently this proportion has dropped below 75% (Cortright, 2017). While Uber's total market share has only slightly decreased across the nation, several urban markets show Lyft as a worthy competitor, accruing up to 45% of shares. The surge in Lyft's shares in individual urban markets has calmed some of the monopoly conversation surrounding Uber and provides customers with more competitive pricing (Cortright, 2017).

2.2.2 Sociodemographic Variables

Technology and ride service applications are inherently related, and thus, knowledge and utility of these services varies according to sociodemographic variables, as with many new technologies (Smith, 2016). Smith found that only 15% of Americans had used ride-hailing apps; more surprisingly, one-third had never heard of them. Sociodemographic variables are pivotal in explaining the adoption and use of these services. While Smith did not find race or gender as influential factors in regard to the use of these apps, age, education, income level, and type of locale (i.e., urban, suburban, rural) were all found to provide strong explanations. According to Smith's article, 29% of college graduates had used the services compared to only 6% of people with educational attainment levels of high school graduate or lower. Similarly, 26% of people with an annual income in excess of $75,000 had used ride-hailing apps, while only 10% of people with an income less than $30,000 had used them. Moreover, 28% of 18-to-29-year-olds and 19% of 30-to-49-year-olds had used these services, whereas only 4% of 65+-year-olds had (Smith, 2016). In addition to the aspects noted above, the adoption rates among different generations are very telling of changes in these trends. Millennials have been said to have differing travel behaviors and lifestyles at the same stage of life from proceeding generations (Klein & Smart, 2017; McDonald, 2015). These studies have also suggested that decreases in the use of cars by millennials is associated with the economic downturn rather than an environmentally conscious decision to reduce car ownership.

Additionally, a quarter of the ridesharing user population is between the ages of 25 and 34. Over 67% of ridesharing users are below the age of 55. The majority of the ridesharing population is also wealthy. The average annual income in the United States is roughly $50,000; however, less than 25% of ridesharing users make below $50,000 annually. Most ridesharing users make $50,000 annually or

more, with nearly 50% of users earning $100,000 annually in household income (Grahn, et al., 2019).

Table 2.2

The table below illustrates the demographics of ridesharing users.

Ridesharing Usage by Demographic	
Age	**Percentage of Total Population**
18-24	17.4%
25-34	24.6%
35-44	15.5%
45-54	10.1%
55-64	6.2%
65-74	3.4%
75+	1.8%
Annual household income	**Percentage of Total Population**
<$10,000	4%
$10,000-$14,999	2.5%
$15,000-$24,999	4.9%
$25,000-$34,999	5%
$35,000-$49,999	8%
$50,000-$74,999	13%
$75,000-$99,999	12.5%
$100,000-$124,999	11%
$125,000-$149,999	9%
$150,000-$199,999	11%
$200,000+	18%

Note. Source: NHTS & Grahn, et al., 2019

2.3 Travel Behavior

Of note, overlapping influences exist from the non-mutually exclusive sociodemographic factors that appear to explain significant variation in the adoption of ride-hailing programs. For instance, while 7% of all 18-to-29-year-olds use these apps on a daily or weekly basis, this proportion increases to 10% when only accounting for urban 18-to-29-year-olds (Smith, 2016). Despite this, some factors are more influential than others. This is best exemplified through the geographical concentration of these services, with most being fixed to only urban and suburban areas, leaving rural parts largely unserved.

As a result, rural usage rates are significantly lower than their urban and suburban counterparts (Smith, 2016). While the explanatory aspect of Smith's article is weak, due to the lack of quantitative analysis, several findings from the survey data are helpful in understanding the adoption and usage trends of these services. In addition to the geographical aspect noted above, the adoption rates among different generations also are very telling of changes in these trends. Millennials are often said to have differing travel behaviors and lifestyles at the same stage of life from proceeding generations (Circella, Alemi, Tiedeman, Handy, & Mokhtarian, 2018). Examples of these differences range from further urbanization to delaying driving licensure, among others (Circella et al., 2018). However, the impacts on the national transportation sector from these changes are still largely unknown. In response to this gap in knowledge, Circella et al. (2018) examined the differences in travel mode choice between millennials and Gen X-ers in California.

From a data set including 2,155 young adults and members of the proceeding generation Circella et al. (2018) found that compared to Gen X-ers, Millennials are two times more likely to ride a bike, three times more likely to use Uber or Lyft, and five times more likely to use a work or school shuttle. Although Millennials are more likely to adopt alternative modes of transport, it should be noted that no more than 4% of those surveyed adopted any other mode of choice than a car (Circella et al., 2018). Nonetheless, millennials are not only more likely to adopt alternative modes of transport, they are also more likely to engage in multimodal and intermodal trip behaviors (Circella et al., 2018). Both the Smith (2016) and Circella et al. (2018) studies overlook the use of ride-hailing programs as ride-sharing services. The real social, environmental, and even economic value stems from the potential of these programs to be used as ride-sharing applications, thus having multi-consumer occupancy, as opposed to single-consumer occupancy trips. Ride-hailing and car-sharing services are surrounded by a heated debate concerning their impacts on congestion, vehicle miles traveled (VMT), and other transportation-related variables that impact the social, economic, and environmental nature of a geographical area. In this respect, it is more pivotal to assess the type of trips made, as well as the occupancy levels of such ride-hailing trips to determine their impact on the aforementioned variables. This background information clearly points towards the importance of a study that analyzes the usage of ride-sourcing services of two large cohorts (millennials and Gen X-ers) and its impact on congestion, particularly in the Southeastern region.

2.3.1 Millennials and Gen X-ers: Characteristics and Transportation Choices

Millennials, individuals born from 1981 to 1996, are often referred to as the "green" generation because they are less likely to own cars. However, studies have found that car ownership differs by less than 1% between Millennials and previous generations. Additionally, on average, millennials have higher VMT than other age cohorts (Knittel & Murphy, 2019). Millennials began to enter the

workforce around the time of the Great Recession in 2008. During this time, unemployment rates and gas prices were high in addition to the housing market crash. These factors affected Millennials' life choices and purchases such as buying a house, choosing when to have children, or purchasing and owning a vehicle (Klein & Smart, 2017; Schaller, 2018). Generation X, on the other hand, which includes individuals born 1965 to 1980, started families and gained home ownership earlier than Millennials. A possibility for this is that Gen X-ers are characterized as being hesitant to take risks. This could mean Gen X-ers are hesitant to try new technologies if they are perceived as risky. However, they are also characterized as being tech savvy and bringing the internet into the mainstream (Reisenwitz & Iyer, 2009). Generation X's members are adaptable to technology but will typically adopt new technology more slowly than millennials, who are more willing to take risks.

While millennials are more likely to live in urban areas and slightly less likely to own cars, car sales have not significantly decreased (see Figure 1) (Klein & Smart, 2017; Knittel & Murphy, 2019). According to anecdotes, millennials are more likely to travel by public transit or ride-sharing. However, the majority of Millennials and Generation X-ers still own personal vehicles; thus, research must be done to determine the reasons millennials and Gen X-ers are using ride services. Klein and Smart (2017) proposed that this decline in personal vehicle usage may have been due to economic circumstances rather than personal preference and may reverse in the future. Malik, et al (2021) compared Millennials' and Gen X-ers' preferences on personal vehicles. Their findings mirror Klein and Smart's claims that the lack of car ownership is likely not due to personal preference. This study asked respondents questions to determine their sentiments about owning a car. Those who said they must own a car were referred to as "car lovers." Compared to millennials, the estimated difference for members of Generation X was only 0.03, compared to 0.43 for baby boomers (J. Malik et al., 2021). The difference in car ownership preference between Gen X-ers and previous generations was not statistically significant and is likely attributable to personal wealth or other factors.

Research has shown that in large cities, wealthier individuals use ride services more often even though they have personal vehicles (Schaller, 2018). A survey conducted in Boston, Chicago, Denver, Los Angeles, New York, San Francisco, Seattle, and Washington, D.C. showed that people with personal vehicles use ride services when parking is a hassle or when they are avoiding drinking and driving (Schaller, 2018). This STRIDE study aims to find out if these trends observed in large urban areas are mirrored in medium-sized and small cities in the South.

2.3.2 Conditions Affecting Ride-Sharing Services

As of 2019, 93% of millennials and 90% of Gen X-ers owned smartphones (Vogels, 2019). Access to the internet and other various factors limit the geography of ride-sharing services. Most ride-sharing services are tied to urban areas and are limited by lack of access by users in rural areas (Jiang, 2019). The Pew Research Center reported that, according to their survey, in rural areas, only 19% of residents have used ride-sharing, while in urban and suburban areas the numbers are 45% and 40%, respectively (Jiang, 2019). This could be because of a lack of incentives for drivers to be present in the area due to inconvenient travel times or, in some communities, a lack of internet access. The Pew Research Center also reported that among groups that are more likely to use ride-sharing services in general, for example those with bachelor's degrees or those between the ages of 18 and 34, individuals are still less likely to use them if they live in rural areas (Jiang, 2019).

2.3.3 Impact of Ride-Sharing Services on Congestion

The explosive growth in ride-hailing services may be worsening traffic congestion in the United States (Schaller, 2018). In a survey of three major metropolitan areas, ride-hailing users said that without such a service available, they would not have taken 61% of trips for which they used ride-sharing services (Clewlow & Mishra, 2017). For other trips, users claimed they would have walked, biked, or used transit services if ride-hailing were not available (Clewlow & Mishra, 2017). In short, the presence of convenient ride-hailing and ride-sharing services may be increasing overall VMT for its users (Henao & Marshall, 2019). However, this data was gathered in major metropolitan areas and is not representative of the entire scope of congestion in the United States. The implications for medium-sized urban areas and suburban areas are yet to be discovered.

Despite ride-hailing being created to reduce personal vehicle usage, it took riders away from public transportation, walking, and bicycling instead. Ride-hailing services also increased the number of vehicles on the road due to pooling options being less preferred to private rides. Overall, ride-hailing has led to an increase in vehicle miles traveled rather than the initial plans to mitigate or decrease VMT (Schaller, 2021). Additionally, a study done in Canada studied both the benefits and harms of Uber and similar services. Canada specifically has banned Uber in many areas due to the increase in congestion created, in addition to complaints regarding safety and worker pay and benefits (Zwick & Spicer, 2018). The study found that Uber often offers peak pay to its drivers during the most congested times of the day, only worsening congestion. This is referred to as price surging and is responsible for creating extreme congestion during the business rush hour in many Canadian cities. Similar findings were found in San Francisco ((Erhardt et al., 2019).

MIT conducted a study to measure Uber's and Lyft's effects on congestion by modeling congestion for 44 metropolitan statistical areas (MSAs) in the United States. Each MSA selected had either Uber or Lyft, or both, in 2016. The results showed that congestion increased by 0.9% with the first ride-sharing service and when a second service entered the market it increased by 4.5%. This increase was seen not only in the length of congestion times but also in the severity of congestion. Regarding specific MSAs, it was found that the TNCs increased VMT by 3.5% in New York City and that congestion delays increased by 69% during the weekdays in San Francisco due to ride-sharing services. Additionally, entry of two TNCs reduced public transportation ridership by 10% (Diao, Kong, & Zhao, 2021). The reduction of public transportation ridership will also lead to increased congestion if the ridership is not regained over time.

3.0 Ride-Hailing in Florida and North Carolina

How are ride-hailing services such as Lyft or Uber used in the Southeastern United States? Unlike in other parts of the United States, car dependence continues to be high, even among millennials. Despite an upsurge in ride-hailing research, little is known about Southeastern users and their motivations for using ride-hailing services. This study looks at ride-hailing habits in North Carolina and Florida of two generations – Gen X-ers and millennials. In addition, it looks at race and ethnicity to see how these ride-hailing habits are similar or different in the two states.

3.1 Literature Review

Ride-hailing's impact on congestion reduction is unclear. VMT has gone up in places or remained the same despite ride-hailing services (Schaller, 2021). A study of San Francisco ride-hailing services found that those services contributed significantly to increased congestion (Erhardt et al., 2019). While car ownership is seen as a proxy for use, these studies found that the miles are being transferred to other users.

Ride-hailing's role as a complement to public transit is also mixed and context specific. With prices in some markets competitive with public transit, some studies point to ride-hailing as increasing transit ridership (Hall, Palsson, & Price, 2018) and used to access public transit hubs. The relationship between declining public transit use and the rise of ride-hailing services, however, is murky. A recent study by Malalgoda and Lim (2019) found that public transit was already on the decline previous to ride-hailing entering the market. Barajas and Brown (2020) found ride-hailing services helped to close gaps in some underserved areas in Chicago.

Ride-hailing users cannot be easily defined. Early studies point to ride-hailing users as likely being young, high income, and living in urban areas (Circella et al., 2018; Clewlow & Mishra, 2017). The data for these studies are now over five years old. While most users may still have these characteristics, they may not be using ride-hailing services the most. For example, Brown's (2019) study of Los Angeles County ride-hailing use illustrated that the suburbs are a growing market. She found that while most users may be in higher income areas, the people who use it the most are in lower income neighborhoods.

A disconnect exists between national and regional ride-hailing studies (Edwards, 2020). Smaller scale studies point to more frequent use by minorities and low-income groups (Brown, 2019; Lavieri & Bhat, 2019); this is often left out of national studies (Sikder, 2019). Despite the diversity of users, concerns are still raised about who is served by ride-hailing, as it requires the use of a smartphone and online banking. Ride-hailing seems to serve communities already flush with transportation amenities (Barajas & Brown, 2021; Jiao & Wang, 2021; Schaller, 2021), either public transit or personal vehicles.

Ride-hailing research has largely ignored the southeastern United States. Previous studies have focused on one specific place Chicago (Barajas & Brown, 2021), South Florida (Roy, Perlman, & Balling, 2020), Toronto (Young & Farber, 2019), San Francisco (Erhardt et al., 2019; Rayle, Dai, Chan, Cervero, & Shaheen, 2016), Dallas-Fort Worth (Lavieri & Bhat, 2019), Austin, Texas (Edwards, 2020), Los Angeles County (Brown, 2019) or multiple places Boston, Chicago, Washington, D.C., Los Angeles, New York, Philadelphia, San Diego, San Francisco, and Seattle (Clewlow & Mishra, 2017). With exception of Roy et al (2020), few have looked at the Southeast.

This study aims to add to this literature by looking at ride-hailing in the Southeast. Florida and North Carolina represent the diversity of Southern states. Florida has a population of 21 million, twice North Carolina's population. They have similar median incomes (~$52,000), per capita incomes, and rates of poverty. Both states have an array of ridesharing services including ride-hailing, bikesharing, and electric scooter sharing. Neither state has high density urban centers known in the West or Northeast. Except for one study of South Florida, little is known about the ride-hailing users and their attitudes.

3.2 Methodology

This research employs a mixed method approach, using both qualitative and quantitative methods. A comprehensive literature review of the topic focuses on the usage of ride services by millennials and Gen Xer's. The team identified and documented

the mechanism of reduction in congestion due to changes in demand for ride hailing and sharing services from the available literature. In addition to the review of literature, we analyze nationally available secondary data sources.

An online survey was distributed to understand these cohorts in our respective states. The survey was conducted from March 2020 through June 2020 with the surveying company Qualtrics. Qualtrics was asked to gather a targeted number of respondents in each generational cohort (e.g., millennial [b. 1981–1996], Generation X [b. 1960–1980]), in each state, and by race and ethnicity (non-Hispanic White, non-Hispanic Black, and Hispanic). A total of 2,108 responses were collected; responses that were incomplete or did not belong to one of the target racial or ethnic groups that were eliminated. In total, 1,908 responses were collected. We acknowledge that COVID-19 related lockdowns and restrictions may have affected the respondent's behavior.

3.3 Results

3.3.1 Socio-demographic data

A table of all socio-demographic data for this study is below in Table 1. Overall, by generation, more Gen X-ers took part in the survey than millennials. Because of differences in Hispanic populations, more Hispanic respondents came from Florida. Most respondents were from urban or suburban areas, though North Carolina had a larger proportion of Gen X-ers living in small towns or rural areas.

TABLE 3.1 DESCRIPTIVE STATISTICS FOR FLORIDA AND NORTH CAROLINA DATASET: GENDER

	Non-Hispanic (NH) Black	**Non-Hispanic White**	**Hispanic**	**Total Responses**
Florida	N=303 Generation X (n=201) Millennial (n=102)	N=219 Generation X (n=108) Millennial (n=111)	N=489 Generation X (n=152) Millennial (n= 337)	1,011
North Carolina	N=315 Generation X (n=159) Millennial (n= 156)	N=358 Generation X (n=216) Millennial (n= 142)	N=219 Generation X (n=98) Millennial (n= 121)	892
Gender	**Female**	**Male**	**Non-binary**	**Prefer not to state**
Florida	Generation X=300 Millennial=319	Generation X=163 Millennial=204	Millennial=4	Generation X =1
North Carolina	Generation X=319 Millennial=213	Generation X=153 Millennial=204	Generation X=1 Millennial=2	

Table 3.1 shows the gender of survey respondents broken down by race and state in which the respondent resides. The majority of survey respondents from both Generation X and Millennials identified as female across all races.

Table 3.2 Educational Attainment Level of Respondents

The table below illustrates the educational attainment levels of survey respondents.

Education	Generation X			Millennial		
Florida	NH Black (n=201)	NH White (n=111)	Hispanic (n=152)	NH Black (n=102)	NH White (n=108)	Hispanic (n=337)
Some grade/high school	6%	3%	2.6%	4%	3%	2%
High school diploma/ GED	24%	11%	11.8%	31%	14%	14%
Some college/technical school	42%	40%	28.9%	32%	27%	32%
Bachelor's degree	17%	21%	36.8%	23%	30%	34%
Professional degree	1%	10%	7.2%	1%	13%	5%
Graduate degree	10%	16%	12.5%	10%	12%	13%
North Carolina	NH Black (n=159)	NH White (n=216)	Hispanic (n=100)	NH Black (n=156)	NH White (n=142)	Hispanic (n=121)
Some grade/high school	4%	3%	6%	4%	5%	3%
High school diploma/ GED	15%	18%	15%	28%	17%	13%
Some college/technical school	44%	33%	29%	40%	34%	32%
Bachelor's degree	25%	30%	28%	20%	27%	35%
Professional degree	1%	4%	7%	2%	4%	3%
Graduate degree	12%	11%	15%	7%	13%	14%

Most of the respondents surveyed had some college experience across all races and in both Generation X and Millennials, as seen in Table 3.2. The educational attainment levels of Millennials and Gen Xers is relatively similar, with Generation X having higher educational levels amongst non-Hispanic Blacks. Millennial Hispanics have higher rates of some college or technical school and bachelor's degrees, but lower professional and graduate degree rates. Non-Hispanic whites are also slightly higher educated as Millennials.

Table 3.3 Desired Future Neighborhood Type of Respondents

The table below demonstrates the type of neighborhood that Gen Xers and Millennials desire to move to in the future.

Neighborhood Type	**Generation X**			**Millennial**		
Florida	NH Black (n=201)	NH White (n=111)	Hispanic n=152	NH Black (n=102)	NH White (n=108)	Hispanic (n=337)
Urban area	32%	31%	48%	32%	30%	43%
Suburb	43%	41%	42%	43%	37%	44%
Small town	13%	14%	5%	13%	16%	7%
Rural area	11%	15%	5%	11%	18%	5%
North Carolina	n=159	n=216	n=100	n=156	n=142	n=121
Urban area	19%	13.4%	24%	28%	27%	36%
Suburb	43%	31.5%	47%	40%	37%	42%
Small town	25%	23.1%	17%	15%	18%	12%
Rural area	13%	31.9%	12%	18%	19%	10%

Table 3.3 shows a desire of Generation Xers that are non-Hispanic Black or Hispanic to move into urban areas and suburbs. Gen Xers in North Carolina prefer small towns much more than those in Florida. In fact, non-Hispanic White North Carolina Gen Xers actually prefer rural areas the most. However, all Millennials surveyed preferred urban areas and suburbs, with suburbs being the most preferred option.

Table 3.4 Annual Household Income of Respondents

The table below illustrates the annual household income of those surveyed.

Annual Household Income	Generation X			Millennial		
Florida	NH Blacks	NH White	Hispanic	NH Blacks	NH White	Hispanic
Less than $25,000	30%	17%	17%	24%	27%	20%
$25,001 to $49,999	35%	24%	28%	30%	35%	28%
$50,000 to $99,999	26%	33%%	35%%	31%	32%	35%
$100,000 to $149,000	6%	14%	15%	12%	4%	13%
$150,000 or more	2%	11%	5%	3%	2%	4%
North Carolina	NH Blacks	NH White	Hispanic	NH Blacks	NH Whites	Hispanics
Less than $25,000	25.2%	19.0%	20%	35.3%	23.2%	24%
$25,001 to $49,999	37.7%	21.8%	28%	32.1%	29.6%	29%
$50,000 to $99,999	24.5%	36.1%	35%	26.3%	29.6%	32%
$100,000 to $149,000	6.9%	16.7%	12%	3.2%	8.5%	9%
$150,000 or more	5.7%	6.5%	12%	3.2%	9.2%	6%

Table 3.4 demonstrated that that Millennials are less wealthy than Gen Xers. The Gen Xers that were surveyed were wealthier in North Carolina, but the Millennials were wealthier in Florida. The non-Hispanic Whites surveyed were wealthier as Gen Xers and Millennials than either non-Hispanic Blacks or Hispanics. The non-Hispanic Blacks had the highest percentage of respondents that made less than $49,999 in all categories except non-Hispanic white Millennials in Florida.

3.3.2 Vehicle ownership and access

Respondents were asked if they possessed a driver's license and if they had a car. Previous studies have pointed to many ride-hailing users as owning a car or lacking access to a car. Studies have shown that those without vehicles are more likely to use these services. Only those that possessed a driver's license were asked if they had a personal vehicle or access to one. Table 2 shows the breakdown by race and generation. Non-Hispanic Blacks were less likely to have a driver's license or possess a personal vehicle.

TABLE 3.5 POSSESS A DRIVER'S LICENSE AND PERSONAL VEHICLE

	Florida		**North Carolina**	
Possess a driver's license	**Generation X**	**Millennial**	**Generation X**	**Millennial**
NH Black	86%	83%	86%	76%
NH White	91%	91%	91%	89%
Hispanic	96%	95%	86%	91%
Possess a Personal Vehicle*	**Generation X**	**Millennial**	**Generation X**	**Millennial**
NH Black	84%	87%	92%	87%
NH White	90%	99%	95%	99%
Hispanic	89%	93%	95%	94%

*Only of those asked with a driver's license

While some respondents may not possess a car, they may still have access to a car, either inside their home, through borrowing from a friend, or using a rental. A small percentage had no access to vehicles, the most being non-Hispanic Black Gen-xer's from Florida with 8%.

3.3.3 Use of Ride-Sharing Services

Respondents were asked if they had ever used any of the following ride-sharing services: bike-sharing, electric scooter (e-scooter) sharing, or ride-hailing (Uber, Lyft). As shown in Table 3.6, more Hispanics than any other cohort used some type of ride-sharing service. Table 3.6 shows the breakdown of all services used. (Note: Respondents could choose more than one response, so different services are counted more than once in some cases.) The differences in use between the states could relate to availability. Florida is larger and has more urban areas, and therefore more ride-sharing services. North Carolina has a smaller population

with fewer metropolitan areas; thus, fewer cities may have these services available.

TABLE 2.6 EXPERIENCE WITH RIDE-SHARING SERVICES

Question: Have you ever used any of the following services?	**Generation X**			**Millennial**		
Florida	NH Black (n=201)	NH White (n=303)	Hispanic (n=152)	NH Black (n=102)	NH White (n=111)	Hispanic (n=332)
Ride-hailing only or with another service	49%	50%	54%	59%	63%	67%
Bike-sharing only or with another service	50%	53%	57%	61%	69%	71%
Electric scooter only or with another service	3%	4%	12%	8%	4%	14%
North Carolina	NH Black (n=159)	NH White (n=111)	Hispanic (n=98)	NH Black (n=156)	NH White (n=108)	Hispanic (n=121)
Ride-hailing only or with another service	35%	37%	49%	41%	50%	59%
Bike-sharing only or with another service	35%	38%	50%	44%	54%	62%
Electric scooter only or with another service	4%	6%	4%	10%	11%	19%

3.3.4 Use of the Ride-Sharing Service in Both States

To understand the impact of ride-sharing in both states, respondents were asked if they had used any of these services within their state. (Note: Because of concerns about COVID-19's impact on the survey, no questions were asked about frequency of use.)

TABLE 3.7 EXPERIENCE USING A RIDESHARING SERVICE IN YOUR STATE

Question: Which of these have you used in your home state?	**Generation X**			**Millennial**		
Florida	NH Black (N=201)	NH White (N=102)	Hispanic (N=152)	NH Black (N=159)	NH White (N=216)	**Hispanic (N=337)**
Ride-hailing alone or with another service	48%	50%	**53%**	57%	61%	**67%**
Bike-sharing alone or with another service	3%	4%	**5%**	5%	8%	**6%**
Electric scooter alone or with another service	2%	2%	**7%**	6%	2%	**8%**
North Carolina	NH Black (N=159)	NH White (N=216)	Hispanic (N=100)	NH Black (N=156)	NH White (N=142)	Hispanic (N=121)
Ride-hailing alone or with another service	35%	37%	**48%**	40%	50%	**58%**
Bike-sharing alone or with another service	1%	1%	**3%**	4%	5%	**7%**
Electric scooter alone or with another service	4%	4%	**3%**	8%	8%	**13%**

3.3.1 Trip Purpose

Respondents were then asked about a ride-hailing trip they had made within the past six months in their home state and its purpose (see Table 3.8). Overall, a high percentage of cohorts had used ride-hailing. In some cases, significantly more respondents used ride-hailing in Florida than in North Carolina. This may have to do with the availability of ride-hailing services for North Carolinians. As seen in previous studies, more millennials are using ride-hailing than Gen X-ers. The percentages are still higher than previous research has found, particularly for non-Hispanic Blacks.

TABLE 3.8 USE OF UBER/LYFT IN PAST SIX MONTHS IN HOME STATE

Use of Uber/Lyft in Past Six Months in Home State						
	Generation X			**Millennial**		
	NH Black	NH White	Hispanic	NH Black	NH White	Hispanic
Florida	48%	50%	53%	57%	61%	66%
North Carolina	36%	38%	48%	40%	50%	58%

Of those who used ride-hailing, commuting was the most common trip purpose in Florida. For North Carolina, while Black Gen X-ers and Millennials used it to commute, White Gen X-ers and millennials and Hispanic Millennials, the main purpose was to go to or from a bar, see table 3.9.

TABLE 3.9 TOP THREE TRIP PURPOSES BY RACE, ETHNICITY, AND LOCATION

	Florida		North Carolina	
	Generation X	Millennial	Generation X	Millennial
NH Black	**Commute, 29%**; Airport, 23%; Shopping 13.5%	**Commute, 33%**; Airport, 19%; Shopping 19%	**Commute, 19%**; Social Event, Shopping, 16%; Other 16%	Social Event, 27%; **Commute, 21%**; Bar, 16%
NH White	**Commute, 22%**; Airport, Shopping, Bar: 16%	**Commute, 23%**; Bar, 18%; Social Event, 18%	Bar, 34%; Airport, 25%; Social Event, 11%	Bar, 29%; Airport, 27%; **Commute, 21%**
Hispanic	**Commute, 23%**; Airport, 22%; Bar, 15%	**Commute, 26%**; Airport 23%; Bar 17%	Airport, 26%; Bar, 22%; Commute, 14%	Bar, 26%; **Commute, 23%**; Airport, 18%;

The survey asked respondents their motivation for using a ride-hailing service for this specific trip. They were given several choices. The responses varied depending on generation and ethnicity (see Table 3.10). A main motivation for non-Hispanic White Gen X-ers and Millennials in Florida was to avoid drinking and driving. These responses mirror answers about trip purpose. Interestingly, avoiding expensive parking was another motivation for using ride-hailing.

TABLE 3.10 MOTIVATIONS FOR RIDE-HAILING USE

Florida						
Generation X				Millennial		
	NH Black (n=96)	NH White (n=55)	Hispanic (n=80)	NH Black (n=58)	NH White (n=65)	Hispanic (n=222)
Private vehicle was not available	29%	16%	11%	9%	15%	17%
Parking was expensive	18%	16%	19%	14%	20%	19%
To save time	15%	16%	9%	19%	17%	13%
To avoid drinking and driving	5%	18%	33%	14%	23%	23%
To get around at night safely	3%	5%	6%	12%	8%	
Public transit was inconvenient	7%	9%	4%	5%	5%	3%
To save money	6%	4%	5%	12%	2%	4%
Public transit was not available	7%	4%	8%	7%	3%	4%
Other	6%	7%	4%	3%	3%	4%
To carry heavy things	3%	4%	3%	5%	5%	4%
North Carolina	NH Black	NH White	Hispanic (n=48)	NH Black	NH White	Hispanic (n=70)
Private vehicle was not available	29%	16%	29%	9%	15%	9%
Parking was expensive	18%	16%	21%	14%	20%	21%
To save time	15%	16%	13%	19%	17%	14%
To avoid drinking and driving	5%	18%	21%	14%	23%	31%
To get around at night safely	3%	5%	2%	12%	8%	4%
Public transit was inconvenient	7%	9%	4%	5%	5%	7%
To save money	6%	4%	-	12%	2%	7%
Public transit was not available	7%	4%	2%	7%	3%	-
Other	6%	7%	4%	3%	3%	1%
To carry heavy things	3%	4%	4%	5%	5%	4%

Taking this ride-hailing trip into consideration, respondents were asked what they would use if they were unable to use Uber or Lyft. Table 3.11 illustrates how ride-hailing has become a part of their personal transportation. For this particular trip, after driving or getting a ride, respondents would have used taxi or public transit to make the trip. Some stated they would not make that trip.

Since commuting was a major reason for ride-hailing use, respondents stating they would not make the trip bears further study. In terms of substitution, differences exist between the generations. Millennials are more likely to choose public transit over taxi. Twenty-three percent of non-Hispanic Black millennials stated they would use public transit instead of ride-hailing. And, as noted in previous research, ride-hailing is a substitute for taxi use, especially for members of Generation X.

3.3.1 Ride-Hailing and Its Impact on Travel Behavior

In Table 3.12, responses indicate that ride-hailing is acting as a substitute for both public transit and taxis, but not personal cars. This is similar to previous findings by (Rayle et al., 2016; Schaller, 2021). In addition, more sustainable modes of transportation, such as public transit or biking, are being replaced by ride-hailing. Unfortunately, because of surveying limitations we do not how often the respondents are using ride-hailing to understand the full impact of ride-hailing.

TABLE 3.11 SUBSTITUTIONS FOR RIDE-HAILING

Question: Considering your last trip, if this service was not available, please choose the means of transportation that you would most likely have used instead.	**Generation X**			**Millennial**		
Florida	NH Black	NH White	Hispanic	NH Black	NH White	Hispanic
Drive alone (I would have driven by myself)	29%	31%	38%	34%	45%	37%
Carpool (I would have gotten a ride with a friend)	20%	25%	13%	28%	20%	26%
Taxi	**15%**	**20%**	**23%**	**9%**	**11%**	16%
Public transit (e.g. bus, light rail, etc.)	**18%**	**7%**	**6%**	**19%**	**5%**	**7%**
I would not have made this trip	**11%**	**7%**	**13%**	**5%**	**11%**	**9%**
Bike or walk	3%	5%	8%	5%	9%	5%
Other (please specify):	4%	4%	1%	0%	0%	0%
North Carolina	**Generation X**			**Millennial**		
Drive alone (I would have driven by myself)	17%	34%	29%	31%	42%	36%
Carpool (I would have gotten a ride with a friend)	19%	25%	21%	26%	23%	26%
Taxi	**20%**	**23%**	**23%**	**10%**	**14%**	**17%**
Public transit (e.g. bus, light rail, etc.)	**13%**	**5%**	**4%**	**23%**	**8%**	**9%**
I would not have made this trip	**19%**	**5%**	**8%**	**3%**	**8%**	**10%**
Bike or walk	6%	5%	8%	3%	3%	3%
Other (please specify):	7%	3%	4%	5%	1%	0%

When respondents who had used ride-hailing services in the past six months were asked how their travel would be impacted if ride-hailing no longer existed, they overwhelmingly stated they would drive more. No significant differences existed among the different cohorts. Differences did exist when respondents were asked if they would use public transit more. Non-Hispanic Blacks and Hispanics were more likely to use public transit.

TABLE 3.12 HOW RIDE-HAILING HAS CHANGED RESPONDENTS' TRAVEL BEHAVIOR

Q: Since you use services like Uber or Lyft, how has that affected how you travel? *	**Florida**					
	Generation X			**Millennial**		
	NH Black	NH White	Hispanic	NH Black	NH White	Hispanic
I use my car less.	29%	24%	27%	28%	31%	29%
I use my bike less.	28%	18%	19%	50%	15%	27%
I use public transit less.	30%	27%	33%	26%	21%	37%
I take a taxi less .	46%	38%	43%	33%	52%	53%
	North Carolina					
I use my car less.	15%	16%	16%	27%	24%	26%
I use my bike less.	15%	18%	25%	31%	18%	33%
I use public transit less.	30%	27%	36%	27%	31%	27%
I take a taxi less	33%	38%	38%	44%	48%	53%
*Percentage of respondents that agreed with the statement						

Unsurprisingly, the role of ride-hailing as a substitute for taxi use is clear. Many respondents reported using taxis less, particularly millennials in both Florida and North Carolina (see Table 3.12).

3.4 Conclusion

At the onset of ride-hailing, most users were said to be higher educated, living in urban environments, and white. These early findings correlate with where the first ride-hailing services were available – urban centers. Yet, as the markets have expanded and TNCs have moved into less urban environments, the users have changed. More and more suburbanites are using these services.

While the use of ride-hailing differs between generations, overall more people are using ride-hailing and are familiar with it. The markets are encompassing more suburban markets. At the same time, the high use of ride-hailing for airport trips should give planners pause. Investments in parking may need to be revisited (Dong & Ryerson, 2020).

In Florida, the main purpose for ride-hailing trips of millennials was commuting. In fact, significant numbers of users from both states in the Black and Hispanic communities used these services, particularly millennials, to commute. This supports previous studies that found ride-hailing was used as a stop gap (Brown, 2019)

The dependence on ride-hailing for commuting signals a need for better links between economic centers and transit lines. In the short term, ride-hailing partnerships with transit agencies may be one way address transit deserts. Partnering with taxi companies may be another way. Perceptions about ride-hailing services may need to be taken into consideration, particularly for disadvantaged communities (Jiao & Wang, 2021).

3.5 Recommendations/Next Step

More small-scale studies of ride-hailing markets need to be conducted to understand the differences. Neither Florida's nor North Carolina's urban metropolitan areas resemble the traditional urban environments that gave rise to ride-hailing services, yet Uber and Lyft continue to expand their services.

This study was unable to learn the difference in frequency of ride-hailing users. Future studies that look at frequency and work with ride-hailing companies are recommended to get a fuller picture of use.

4.0 CONCLUSION

Congestion has been a leading driver in planning for nearly a century. New innovations such as ride-hailing services were seen as an effective congestion mitigation strategy, however, the evidence suggests it may not be an effective solution especially in big cities. Ride-sharing companies have long argued that the sheer number of personal vehicles on the roads and almost 3 out of 4 workers commuting to work alone is the biggest factor adding to the congestion on the roads. However, this defense is weakening as share of ride-sharing VMT has been increasing steadily. As per an independent survey commissioned by the San Francisco County Transportation Authority, the ride-sharing VMT accounts for about 6.5 percent of the total VMT. In San Francisco, this share goes up to almost 13 percent of the total VMT. Similarly, in New York city the deadheading (no passenger in the car) is amounting to a third of VMT.

Ride-hailing is used mostly by wealthy, younger populations in the United States. The Pew Research Center found similar results in the demographics of ridership as this study. Most users are less likely to own a personal vehicle, are highly educated, and are wealthier (Pew Research Center, 2016). While ride-hailing could potentially increase mobility in older populations, the necessity of smartphones to utilize the service results in a younger ridership.

Ride-hailing primary uses are for pleasure trips, such as going to bars or downtown areas to avoid high parking prices. This is evident from the fact that the weekend VMT of ride-hailing services are higher than weekdays VMT. Also, apart from high parking prices, the stress deter self-driving (Henao & Marshall, 2019). Its original intent was to act as a new transportation mode that could discourage owners of using personal vehicles, however personal vehicle usage was not reduced by ride-hailing's emergence. This is due in part to ride-hailing putting additional vehicles on the road and taking ridership from public transit, as opposed to taking individuals using their own vehicle off of the road.

The two modes of travel affected by ride-hailing's growing ridership were taxis and public transit. Ride-hailing services, similar to taxis, only transport individuals or mutual groups, rather than large numbers of individuals. Congestion cannot be reduced by transporting small groups as opposed to larger groups that public transit can provide rides to. Due to this, congestion is increased as more individual ride-hailing vehicles are on the streets as opposed to public transit vehicles with higher ridership. Congestion is inevitable in a country that is dominated by personal vehicles. Losses in time, productivity, and pollution are all costs of congestion, which result in monetary losses as well.

This research has shown both Generation X and Millennials have different travel behaviors, yet both have rapidly adopted to the usage of ride-hailing services. Millennials are slightly

less likely to own personal vehicles but have substituted the use of public transit for ride-hailing services at similar rates to Gen Xers. The usage of public transportation is higher amongst Millennials due to this cohort being less wealthy than Generation X. Additionally, less Millennials prioritize car ownership, encouraging the use of alternate modes, such as ride-hailing services. However, since Millennials also are more likely to own smartphones, the preference of using ride-hailing prevails over the usage of public transit services.

As these groups continue to make up the majority of the transportation market, a continued migration from public transit, bikes, or taxis will continue to increase congestion. The affordability and efficiency of ride-hailing services are appealing to both Millennials and Gen Xers in addition to convenience. As our research showed, smartphone ownership and usage are high in both of these cohorts, making ride-hailing extremely convenient. Additionally, ride-hailing is also quicker and more flexible than other transit modes.

Morning and evening commutes are the most congested periods in the daily transportation network. Therefore, identifying ways to alleviate the number of cars on the road during these times is of the upmost importance. According to the survey results, commuting was the most cited reason for using ride-hailing services in our study areas. For example, all but one demographic group (non-Hispanic white from North Carolina) identified commuting as one of their top three reasons for choosing this mode type (table 3.9). As such, this survey has demonstrated that ride-hailing services have the ability to capture some of the daily commuting trips.

Public transit must make multiple stops and take routes with specific arrival times. Contrarily, ride-hailing services take riders from one destination to another without stopping. Additionally, ride-hailing services can be called at any time, rarely with any wait. This level of efficiency is impossible to achieve in public transportation; however, increased investment, additional services, and other increased facilities in public transit systems can help compete with the convenience of ride-hailing services.

While ride-hailing services will remain and likely continue to grow in popularity, cities and public transit providers will need to improve systems and incentivize riders in order to remain. Following the decline in ridership that also followed from the COVID-19 pandemic, efficiency improvements and perceptions of cleanliness on public transit systems both must occur to regain losses in ridership and ultimately reduce congestion.

5.0 RECOMMENDATIONS

As such, there is likely to be different outcomes concerning congestion and VMT in these non-traditional urban environments. Adoption rates and mode substitution are just two factors in which the impacts of ride-hailing may produce different outcomes. For example, the sample population from Florida has used ride hailing services at least once within their state significantly more than the sample population from North Carolina. In fact, the percent of users' experience with ride hailing within their own state was higher in Florida across all demographic groups surveyed, with an average increase of 6.8% per group. Such a finding highlights the variations of experience with and use of ride-hailing services in differing urban areas.

Moreover, the population demographics of urban areas may also exacerbate such differences. For instance, Millennials are also shown to have experienced ride hailing within their own state in both Florida and North Carolina more so than the sample Generation X population. In Florida and North Carolina, the average increase among all racial groups surveying as millennials is 11.3% and 12.3%, respectively. Furthermore, the Hispanic population surveyed revealed higher recent experience (within the last six months) with ride hailing services within their state (56.3%) compared to their white (49.8%) and black (45.3%) counterparts. However, the typical income of ride-hailing users appears relatively consistent across studies with the annual income of $50,000 or more accounting for 73.3% of users in this study and 74.5% of users in the study by NHTS & Grahn, et al. (2019).

As such, the expansion of ride-hailing services is causing significant shifts in transportation behaviors. Consequently, their emergence is resulting in many unanswered questions surrounding the effects of these services in differing urban areas. For example, there is a growing debate surrounding the impacts of ride-hailing on VMT, congestion, and mode substitution, which are highlights of the following analysis.

If the trend of declining us of public transit continues, cities will have a difficult time managing congestion and combatting ride-hailing increases. Planners and policy makers must now find ways to incentivize the shared use of ride-hailing services. Partly subsidizing shared or pooled rides, particularly during peak commuting periods, is one example of how local governments can incentivize higher occupancy rates on the road network.

Transportation mode substitution

There are many ways in which ride-hailing can negatively impact VMT and congestion. Transportation mode substitution in favor of ride-hailing services frequently shows how these services may result in increases in each. For example, Table 8 shows that 10.3% of respondents would have utilized public transit if not for the presence of ride-hailing

services. Moreover, 29.3% conveyed that the presence of ride-hailing services will reduce their use of public transit (Table 9.). These findings are further supported by Rayle, Shaheen, Chan, Dai and Cervero (2014), who found, from a survey in San Francisco, that 33% of riders would have otherwise used the bus or rail if ride-hailing services were unavailable.

Furthermore, ride-hailing services take away from other more sustainable modes, such as bicycling and walking, again causing an increase in VMT and congestion. In this study, another 5.3% of respondents would have alternatively biked or walked for their last trip using a ride-hailing service, had it not been for the services availability (Table 8). Moreover, 24.8% convey that ride-hailing services will reduce their traveling by bicycle or walking (Table 9). Other studies, such as Clewlow and Mirshra (2017), corroborate this finding by stating 49%-61% of ride-hailing trips are trips that would have never been made or would have been made by walking, biking, or using public transit (Clewlow & Mishra, 2017).

Sperling and Brown (2018) suggest that a shift from mass transit should be expected, due to ride-hailing services, as they offer many of the same advantages as mass transit. However, there is vast uncertainty surrounding the implications of changing mode preference in response to the expanding ride-hailing services. For instance, ride-hailing services have also reduced the likelihood of someone using their own vehicle. Table 9 shows that 23% of respondents intend to use their car less frequently with the availability of ride-hailing services. However, there is significant variation in the geographical responses associated with this type of mode substitution. While 28% of Florida respondents said that ride-hailing would reduce their use of a personal vehicle, only 20.7% of North Carolina respondents conveyed the same (Table 9).

Deadheading

Ride-hailing services may either increase VMT and congestion through added vehicles on the road and the deadheading of ride-hailing drivers or decrease through the utility of these on-demand modes of transportation. Depending on the direction of this relationship there may be either an expansion or contraction in maintenance activities, due to added wear and tear on the road infrastructure or a reduced need for these activities through reduced VMT and congestion.

One example of increasing VMT and congestion through ride-hailing is the added number of driver service operators deadheading. which results from ride-hailing services driving without passengers. This study found that 43.3% of survey respondents intend to use taxi services less frequently with the presence of ride-hailing (Table 9). Moreover, 16.8% of respondents chose a ride-hailing service over a taxi for their most recent ride-hailing trip (Table 8). This type of mode substitution is the worst possible outcome for congestion and VMT, as it increases the number of dead headed drivers on the road. In particular, the increasing competition for ridership between taxis and ride-hailing service operators causes more of these drivers to operate without passengers for

longer periods of time and result in longer distances to the next pickup. This type of impact on VMT and congestion is highlighted by Clewlow and Mishra (2017), who suggest that ride-hailing services are increasing VMT in major cities across the U.S. Schaller (2017) similarly finds evidence of added VMT from ride-hailing services. Specifically, the study examines deadheading through the unoccupied time between trips for typical ride-hailing platforms. Schaller (2017) finds that 45% of operation time is spent unoccupied, resulting in an increase in VMT and congestion by increasing the number of vehicles on the transportation network. However, Schaller (2017) did not account for the added deadheading of existing taxis competing for ridership, which only further exacerbates the issue of deadheading.

Congestion, adoption rates, and commuting patterns

Moreover, the tipping point in both the number of operators and in the adoption of ride-hailing services further increases the uncertainty surrounding the impacts of these services on congestion. Throughout the U.S, various adoption rates are occurring across the diverse urban environments, which is exemplified in this study. For example, 56% of Florida respondents convey having experience with ride-hailing platforms, whereas only 44.7% of those surveyed in North Carolina responded the same way. Alexander and Gonzàlez (2015) support these findings in a study exploring different adoption rates, which similarly concludes that moderate to high adoption rates relate to reduced congestion and travel times. Similarly, Li, Hong and Zhang (2016a) find that the entry of Uber (the largest and most quickly adopted ride-hailing service) in U.S metropolitan areas resulted in reduced congestion. Thus, it is clear that there is no definitive understanding of the impacts of ride-hailing on mobility and transportation choice, specifically in the context of VMT and congestion.

Parking Cost, ride-hailing and congestion

As alluded to above, achieving a successful reduction in VMT and congestion through ride-hailing is more likely to occur through higher adoption rates. One way to incentive ride-hailing in mass is to increase the cost of parking. For example, this study showed that high parking costs caused 18% of respondents to utilize ride-hailing services (Table 7). Increased costs in parking will reduced the number of parked cars, resulting in a lowered presence of cars in highly congested areas, such as downtowns. Therefore, ride-hailing services still have the potential to reduce congestion and VMT from various platforms.

Ride-hailing vs ridesharing, and congestion

Another factor that can influence the overall impact of ride-hailing is through the notion of ridesharing. In fact, ridesharing is highlighted as the most significant factor in enabling a reduction in congestion and VMT through the presence of ride hailing by facilitating multi-passenger pooling (Clewlow & Mishra, 2017; Li et al., 2016a; Sperling & Brown, 2018). As such, it is recommended that future studies focus on the differing implications stemming from ride-hailing and ridesharing, respectively, as they relate to congestion and VMT. One short coming of this study is that it did not separately account for single-

user ride-hailing trips and shared ride-hailing (ridesharing) trips. Accounting for these different trip types would significantly bolster the understanding of the implications for congestion. For example, the most frequently conveyed reason for using ride-hailing services among Florida respondents is for commuting purposes (Table 6). Commuting is typically the largest contributor to VMT and congestion. Therefore, if the trip types are shared, then this results in a lower number of drivers on the transportation network. As such, future studies should concentrate on the factors that influence shared ridership through ride-hailing platforms, as well as the differing impacts of ride-hailing versus ride-sharing.

Impact of COVID-19 on ridesharing

The COVID-19 restrictions around the globe have caused a massive decline in the usage of ride-sharing services. During the first month of lockdown, the number of trips for Uber saw a drop of up to 75-80 percent in major US cities. The decline has been even more in major European cities due to harsher COVID-19 related restrictions. The riders are coming back, however, the pandemic will cause a significant shift in the travel behaviors of millions of people. Public transit shares of total rides have gone down and likely will stay lower than the pre-pandemic level. Many surveys have pointed out that private vehicle VMT is likely to increase due to the fear spreading infection. However, the anticipated paradigm shifts in travel behaviors are not necessarily going entirely in the wrong direction from the point of view of traffic congestion on roads. All major cities in the US have seen increased adoption of bike-sharing, and now more and more people are walking in the US. It is still too early to predict the magnitude, direction, and longevity of the shift in travel behavior. Further studies will be needed to fully understand the impact of COVID-19 on travel behaviors.

6.0 REFERENCE LIST

Barajas, J. M., & Brown, A. (2021). Not minding the gap: Does ride-hailing serve transit deserts? *Journal of Transport Geography, 90*, 102918. doi:https://doi.org/10.1016/j.jtrangeo.2020.102918

Brown, A. (2019). Redefining Car Access. *Journal of the American Planning Association, 85*(2), 83-95. doi:10.1080/01944363.2019.1603761

Circella, G., Alemi, F., Tiedeman, K., Handy, S., & Mokhtarian, P. L. (2018). *The adoptation of shared mobility in California and its relationship with other components of travel behavior* Retrieved from https://ncst.ucdavis.edu/wp-content/uploads/2016/10/NCST-TO-033.1-Circella_Shared-Mobility_Final-Report_MAR-2018.pdf

Clewlow, R. R., & Mishra, G. S. (2017). *Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States.* (Research Report UCD-ITS-RR-17-07). Retrieved from University of California, Davis,: https://escholarship.org/uc/item/82w2z91j#main

Diao, M., Kong, H., & Zhao, J. (2021). Impacts of transportation network companies on urban mobility. *Nature Sustainability*. doi:10.1038/s41893-020-00678-z

Dong, X., & Ryerson, M. S. (2020). Taxi Drops Off as Transit Grows amid Ride-Hailing's Impact on Airport Access in New York. *Transportation Research Record, 2675*(2), 74-86. doi:10.1177/0361198120963116

Edwards, M. (2020). Nonstandard ridehail use in Austin. *Journal of Transport Geography, 86*, 102746. doi:https://doi.org/10.1016/j.jtrangeo.2020.102746

Erhardt, G. D., Roy, S., Cooper, D., Sana, B., Chen, M., & Castiglione, J. (2019). Do transportation network companies decrease or increase congestion? *Science Advances, 5*(5), eaau2670. doi:10.1126/sciadv.aau2670

Hall, J. D., Palsson, C., & Price, J. (2018). Is Uber a substitute or complement for public transit? *Journal of Urban Economics, 108*, 36-50. doi:https://doi.org/10.1016/j.jue.2018.09.003

Henao, A., & Marshall, W.E. (2019). The impact of ride hailing on parking (and vice versa). Journal of Transport and Land Use, 12(1), 127-147

Henao, A., & Marshall, W.E. (2019). The impact of ride-hailing on vehicle miles traveled. Transportation, 46, 2173-2194

Jiao, J., & Wang, F. (2021). Shared mobility and transit-dependent population: A new equity opportunity or issue? *International Journal of Sustainable Transportation, 15*(4), 294-305. doi:10.1080/15568318.2020.1747578

Klein, N. J., & Smart, M. J. (2017). Millennials and car ownership: Less money, fewer cars. *Transport Policy, 53*, 20-29. doi:https://doi.org/10.1016/j.tranpol.2016.08.010

Knittel, C. R., & Murphy, E. (2019). Generational Trends in Vehicle Ownership and Use: Are Millennials Any Different? *National Bureau of Economic Research Working Paper Series, No. 25674*. doi:10.3386/w25674

Lavieri, P. S., & Bhat, C. R. (2019). Investigating objective and subjective factors influencing the adoption, frequency, and characteristics of ride-hailing trips. *Transportation Research Part C: Emerging Technologies, 105*, 100-125. doi:https://doi.org/10.1016/j.trc.2019.05.037

Malalgoda, N., & Lim, S. H. (2019). Do transportation network companies reduce public transit use in the U.S.? *Transportation Research Part A: Policy and Practice, 130*, 351-372. doi:https://doi.org/10.1016/j.tra.2019.09.051

Rayle, L., Dai, D., Chan, N., Cervero, R., & Shaheen, S. (2016). Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco. *Transport Policy, 45*, 168-178. doi:https://doi.org/10.1016/j.tranpol.2015.10.004

Roy, S. S., Perlman, J., & Balling, R. C. (2020). Analysis of urban mobility in South Florida using Uber Movement. *Case Studies on Transport Policy, 8*(4), 1393-1400. doi:https://doi.org/10.1016/j.cstp.2020.10.003

Schaller, B. (2018). *The New Automobility: Lyft, Uber and the Future of American Cities*. Retrieved from New York:

Schaller, B. (2021). Can sharing a ride make for less traffic? Evidence from Uber and Lyft and implications for cities. *Transport Policy, 102*, 1-10. doi:https://doi.org/10.1016/j.tranpol.2020.12.015

Sikder, S. (2019). Who Uses Ride-Hailing Services in the United States? *Transportation Research Record, 2673*(12), 40-54. doi:10.1177/0361198119859302

Young, M., & Farber, S. (2019). The who, why, and when of Uber and other ride-hailing trips: An examination of a large sample household travel survey. *Transportation Research Part A: Policy and Practice, 119*, 383-392. doi:https://doi.org/10.1016/j.tra.2018.11.018