THE POTENTIAL USE OF SHARED MOBILITY PROGRAMS BY URBAN TEXANS

A Thesis

by

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ABSTRACT

Shared mobility modes, including car-sharing, bike-sharing and dynamic ride-sharing, are beginning to restructure the traditional modes of transportation. These modes have the potential to change an individual's relationship with their private vehicle. This research analyzes key aspects of shared mobility programs, user demographic factors influencing the use of these modes, and how they impact the travel behavior of individuals. A survey was conducted in Texas to understand the opinion of Texas travelers with respect to dynamic ride-sharing, bike-sharing and car-sharing. The survey results showed that Texas travelers are supportive of shared mobility options and these modes are likely to impact future travel in Texas. It was observed that factors, including easy reservations as well as cost and time savings encourage the use of dynamic ride-sharing and car-sharing, whereas bike-sharing is preferred for exercise and leisure. Shared mobility options are often chosen as first and last mile options. However, accessibility of docking stations needs to be improved further to increase the use of shared modes.

DEDICATION

To my parents

ACKNOWLEDGEMENTS

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NOMENCLATURE

SOV	Single Occupant Vehicle
TTI	Texas A&M Transportation Institute
TxDOT	Texas Department of Transportation

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a thesis committee consisting of Professor Mark Burris and Professor Bruce Wang of the Department of Civil Engineering, and Professor Daniel Fragiadakis of the Department of Economics.

The data collection was done in collaboration with Texas A&M Transportation Institute. All other work conducted for the thesis was completed by the student independently.

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1. INTRODUCTION

This research focuses on three major shared mobility programs, which are defined as follows:

- Car-Sharing: Car-sharing programs provide membership based short-term vehicle rental services for individual or business members. The users can collect the shared cars from the docking stations nearby their origin locations using an access card or similar technologies. After the trip, the vehicle has to be returned to the starting location or the car-sharing stations closer to the destination point.
- Bike-Sharing: Similar to car-sharing, bike-sharing also provides membership based bike rental services. Bikes are available at the docking stations in various locations in the bike-sharing region. The users can take the bikes using swipe cards or other accessing options for their trip and return to any other docking stations nearby the destination.
- Dynamic Ride-Sharing: As per FHWA, dynamic ride-sharing is a strategy involving travelers using advanced technologies to arrange a one-time ride in short notice. The drivers and passengers sharing the same origin and destination match their ride by using a smart phone app or other technologies (Bricka, 2015).

Shared mobility options redefine the present owner-vehicle relationship. It reduces the need for a personal vehicle and enhances the chance of multiple individuals using the same vehicle. It also provides certain other environmental, social and economic benefits. Choosing a shared car, bike, or ride affects the usage of traditional modes of transportation. However, the usage depends on the accessibility of the stations near the origins and destination and the cost of travel. There arises the need to study how these shared modes may influence the travel behavior of individuals.

2. SHARED MOBILITY PROGRAMS –AN OVERVIEW

Shared mobility programs are gaining popularity all over the world. From individual carpoolers to bicycle rentals, these alternatives to single occupant vehicles have appealed to travelers across the United States because of their convenience, comfort, accessibility and other social and environmental reasons. Formal ride-sharing, a traditional form of carpooling, started in Washington D.C in 1974. Car-sharing began in Denver, Colorado in 1997 and the nation's oldest bike-sharing program began in Amherst, Massachusetts in 1999 (Bricka, 2015). From time to time, the advent of new and advanced technologies stimulated the growth of car-sharing, bike-sharing and dynamic ride-sharing across the nation. Since 1994, there are 27 ride-sharing programs, 13 car-sharing programs and 81 bike-sharing programs operating in the United States. In the state of Texas, four ride-sharing programs are operating in 10 cities, seven car-sharing programs are operating in over 100 cities, and five bike-sharing programs are operating in 5 cities (Bricka, 2015).

The first ride-sharing program in Texas, SideCar operated in Austin during 2012-2013. It allowed the drivers to set their own prices based on demand and quality of the vehicle. However, this ride-sharing program was shut down due to legal disputes. Another ride-sharing program, Carma Carpool funded by Central Texas Regional Mobility Authority, began in late 2013 and provided toll reimbursements to travelers traveling on the 183A and Manor Expressway in Austin. Since 2013, privately funded companies including Uber and Lyft are operating in Texas cities. A traditional carpool system started in 1999, named eRideShare is also available in Texas. They offer a website to post the rides and match the passenger and driver based on the list information, origin and destination, time, days needed on their website.

Car-sharing in Texas started in 2010 with the launch of Car2Go as a private-public partnership in Austin. Currently, there are 250 vehicles available in Austin and membership is open to anyone. There are five other car-sharing programs including Zip Car, RelayRides, Hertz on Demand, Getaround and Timecar, which are mainly active in Austin, Dallas, Houston and San Antonio. RelayRide is active in about 70 cities across Texas, whereas the only Texas market for Getaround is in Austin. Both these programs operate on a peer-to-peer model.

Bike-sharing programs started in Texas in San Antonio in 2011 through a public-private partnership. Currently, there are five bike-sharing programs in Austin, College Station, Fort Worth, Houston and San Antonio. These are operated by nonprofit organizations whose missions are to promote cycling. Texas A&M University, College Station has a bike-sharing system, MaroonBikeShare, which has nine docking stations across the campus. These three shared modes--car-sharing, bike-sharing and dynamic ride-sharing--may play a significant role in restructuring the traditional transportation industry.

3. RESEARCH OBJECTIVES

The proposed research focuses on shared mobility programs across Texas to:

- Identify and understand shared mobility programs and the public's attitude towards these relatively new options in Texas.
- Examine market conditions that encourage car-sharing, bike-sharing and ride-sharing.
- Study how the characteristics of shared modes impact the decision of an individual to choose a shared-ride or not.
- Examine the characteristics of travelers who tend to choose car-sharing, bike-sharing and dynamic ride-sharing over traditional modes of transportation.

4. LITERATURE REVIEW

This section provides relevant background information to better understand the importance of dynamic ride-sharing, bike-sharing and car-sharing on multi modal transportation planning and how these modes impact the traditional travel behavior of individuals. This section will examine the previous studies conducted on shared mobility programs, their advantages and their key impacts on current travel behaviors. This section is also a review of recent research that has examined travelers' opinion towards shared mobility programs globally.

4.1. Impacts of Shared Mobility Programs

Shared mobility modes offer certain advantages to travelers. Convenience is a key factor in choosing car-sharing, bike-sharing and dynamic ride-sharing over single occupant vehicles. Ride-sharing offers reliability by providing real-time driver location information. These modes have easy payment methods using mobile apps or already saved credit card details. Decreased travel time and parking costs offered by shared modes also attract some travelers. Shared modes can also act as a complement for transit services by providing first and last mile options for the commuters (Bricka, 2015).

Another key aspect of shared modes of transport is safety. Normally all ride-sharing or car-sharing service providers perform driver background checks to ensure safety of members. However, safety concerns can be a reason for the public to avoid car-sharing, bike-sharing and dynamic ride-sharing. Individuals tend to avoid bike-sharing because of concerns regarding sharing the road with other vehicles, lack of bike lane infrastructure and preference of not using a publicly provided helmet. Sometimes, they also tend to be reluctant to share a ride with strangers or unknown drivers (Bricka, 2015)

Travel mode decisions are certainly affected by the cost of travel. Shared mobility programs offer certain cost benefits to travelers. The dynamic ride-sharing mode is generally less expensive than taxis (Bricka, 2015). Car-sharing and bike-sharing users have to pay membership fees. These programs cover several out-of-pocket costs of travel including fuel and gas, parking, tolls and insurance. However, some travelers are reluctant to choose these shared modes as they are not aware whether the costs, such as fuel and gas prices, are included in the fare. Many individuals prefer to use bike-sharing for short distances because of its affordability. Shared modes also tend to provide potential cost savings to employers as well, since they need to provide less parking space for their employees and the amount spent on travel allowances can be reduced (Bricka, 2015).

Shared mobility services may provide more travel choices, enhancing the quality of life. These can be considered as a supplement to or a replacement of a personal vehicle (Bricka, 2015). However, the travel behavior of the public does not change overnight. The use of car-sharing, bike-sharing and dynamic ride-sharing can be promoted by providing sufficient education, advertisement, promotions and public information. Though the convenience of these shared mobility programs may be appealing, safety and security are the key concerns. Further study is needed to determine if these new travel options will improve overall mobility.

4.2. Shared Mobility Program Studies

Shared mobility programs are receiving more and more attention in redefining the transportation industry. As of June 2014, public bike-sharing existed in 712 cities on five continents, operating with approximately 806,200 bicycles at 37,500 docking stations (Meddin, 2015). Similarly, ride-sharing services represent approximately 8-10% of the transportation modes in North America as per 2013 statistics (Shaheen et al., 2013). Shaheen

et al. (2013) found that as of October 2010, car-sharing was operating in more than 1,100 cities, in 26 countries on five continents worldwide. The following sections give an overview of the studies conducted across the globe on dynamic ride-sharing, bike-sharing and car-sharing.

4.2.1. Dynamic Ride-Sharing

According to Masabumi Furuhata et al. (2013), "Ride-sharing is a joint-trip of at least two ridesharing participants who share a vehicle." Successful ride-sharing requires coordination of drivers and passengers regarding their pickup and drop off locations. According to Dailey et al. (1999), ride-sharing services operated by agencies that provide ride-matching opportunities for participants without regard to any previous historical involvements are defined as organized ride-sharing. Advantages of ridesharing for participants (both drivers and passengers) include reducing travel time, saving travel cost, mitigating traffic congestions, conserving fuel, and reducing air pollution (Furuhata et al., 2013; Chan and Shaheen, 2012).

Several studies were conducted to enhance dynamic or real time ride-sharing technologies using mobile technology and GPS and support an automatic ride-matching process between participants on very short notice or even en-route (Chan and Shaheen, 2012; Agatz et al., 2012). According to the SMART 2020 report, employing information and communications technology (ICT) to optimize the logistics of individual road transport could abate 70 to 190 million metric tons of carbon dioxide emissions and, one of the ICT strategies was dynamic ride-sharing.(Global e-Sustainability Initiative, 2008). Despite its many benefits, ride-sharing services face several behavioral barriers. Shaheen et.al (2013) mentioned several threats to the growth ride-sharing services including personal safety concerns, privacy issues and travelers not wanting to sacrifice their own personal vehicles.

Various types of dynamic ride-sharing programs have been tried in different parts of the United States and, the following lessons were gained from these experiences (Deakin et al., 2010):

- Only a fraction of those who are identified as potential users will use these programs due to safety concerns, strong preference for other means of travel and the need to make stops to and from the workplace.
- For many travelers, the incentives offered by ride-sharing services or cost/time savings do not outweigh the perceived benefits of driving alone.
- Dynamic ride-sharing is appealing to those who are comfortable with the latest technologies including smart phones.
- Registration and screening procedures of ride-sharing services reduces safety and security concerns. However, they limit the ability to share requests to friends, fellow students or members of other affiliated groups.
- Dynamic ride-sharing appeals to people who are willing to share a ride once in a while, but not on regular basis.

A survey was conducted in Berkeley, California to assess the potential of dynamic ride-sharing. The results showed that about one-fifth of commuters who drive alone to the campus would like to use dynamic ridesharing at least occasionally and they were able to find shared rides that matches their trip. However, they would like to arrange a shared ride at least the night before the ride rather than immediately before the trip. However, many of these travelers were unaware of current rideshare services, and they would like to find a regular carpool partner. High parking charges and limited parking spots increase the interest in dynamic ride-sharing if financial incentives and carpool parking subsidies are provided (Deakin et al., 2010). A similar survey conducted in Italy found that it is fundamental to find a trusted driver and to be

sure of the amount of reimbursement before a matching occurs. On the other hand, the respondents are less concerned about the personal information of driver or the details of ride share (e.g., number of passengers in the trip) (Eleonora Gargiulo et al., 2015).

Several studies were conducted regarding privacy concerns with shared autonomous vehicles across the globe (Fagnant, 2015). Wood and Meyer (2015) recently conducted a study in Austin, TX on the practicality of incorporating a ride-sharing program with a toll operator to process toll discounts. The program was active for almost a year on the 183A Toll Road and the US-290 Manor Expressway. Travelers used a smartphone application to track their trip history. 95 unique drivers were provided toll rebates for 2,213 trips during this period. Timely feedback to users and positive customer services were found to be important for customer service (Woods and Mayer, 2015).

4.2.2. Bike-Sharing

Though bike-sharing programs have existed for almost 50 years, their prevalence and popularity have increased in the last decade (Shaheen, Guzman & Zhang, 2010). Contemporary bike-sharing systems involve providing bikes for short term rentals from docking stations. These docking stations are usually unattended, providing access cards for the customers to unlock the bikes. Usually, the first 30 minutes will be free of cost, after which the users pay on an hourly basis. Credit card details of the members that are already stored while performing user registration eases the payment for every trip (Fishman et al., 2013). Literature shows the expansion of bike-sharing systems globally and, these programs are expected to increase substantially in future years (Shaheen et al., 2010).

Several studies have identified the benefits of bike-sharing services including reduced emissions, flexible mobility, reduced fuel usage and congestion and last mile option for public transit services (Shaheen et al., 2010).Though these factors have acted as catalysts to accelerate the growth of bike-sharing programs across the globe, it is essential to understand how these factors affect individuals' decision to use bike-sharing programs. Certain studies conducted in various parts of the world have reported bike-sharing programs have little impact on reducing car use (Midgley, 2011; Murphy, 2010; Transport for London, 2012; Yang et al., 2010). A survey conducted in 2012 for Capital Bike-Share users in Washington, DC showed that only 7% of respondents would like to shift from private car to bike-sharing (LDC Consulting, 2012). However, these studies do not collect information on how these mode substitution rates vary based on trip distance or other current travel characteristics.

Shaheen et al. (2011) conducted a survey in Hangzhou, China that has the world's second largest bike-sharing program. Its goal was to better understand the impacts of these programs in the transport choice of Hangzhou residents. The results revealed that an overwhelming majority of members used walking and public transit prior to bike-sharing services. The studies also found that car-ownership does not lead to a reduced propensity to use bike-sharing programs. Bike-sharing users showed a higher rate of motor vehicle ownership than non-users (Shaheen, 2011). However, these results might be specific to the location of the survey. Mode choices and travel patterns may vary from region to region. In addition, some respondents may have the tendency to choose the options that are socially desirable, however they might not actually behave like the responses they give.

Shaheen et al. (2012) performed an assessment of bike-sharing programs, from both the operator and the user perspectives. They conducted various interviews with industry experts,

government agencies and bike-sharing organizations in the United States and Canada and two surveys with bike-sharing users. The studies revealed that bicycle redistribution/rebalancing and helmet laws in various states pose challenges for operators. Data have shown that bike-sharing users are more likely male, Caucasian, wealthier, younger, and have attained higher educational degrees (Shaheen et al., 2012). The survey also found that bike-sharing is causing a diverse array of modal shifts within the cities. It has reduced the use of public transit and driving in majority of the cities. However, further examining travelers' decision to use shared mobility programs based on their trip distance, purpose and other notable traffic characteristics will prove valuable.

Several studies were conducted on the use rate of bike-sharing trips per day, trip duration and the average speed at which riders travel (Fishman et al., 2013). Jenson et al. (2010) conducted a study in Lyon to examine Velo'v bike-sharing users and found that their travel patterns have more resemblance to that of pedestrians than car drivers (Jenson, 2010). These studies also noted the need for dedicated bicycle infrastructure, bike route choice and travel duration to maximize the attractiveness of a bike-sharing program (Fishman et al., 2013). Little research on the perceptions and attitudes of travelers who do not ride a bicycle and whether they would like to switch to bike-sharing from their traditional modes was found.

A better understanding of the determinants behind bike-sharing usage is essential for expanding the use of this mode. Murphy (2010) found that walking and bike-sharing were used together creating multi-modal travel. The proximity of docking stations to the origin and destination of travelers has a large and positive impact on the use of bike-sharing programs (Fuller et al., 2011a). On the other hand, understanding trip purpose is also important in planning new bike-sharing programs. Yang et al. (2010) conducted a survey on various bike-

sharing programs in China and found that the majority of respondents use shared bikes for their commute trips. A similar survey conducted in Washington, DC stated that the majority of bike-sharing trips were for social/entertainment and errands/personal appointments (LDA Consulting, 2012). These studies also showed the integration of bike-sharing and public transit systems to strengthen the benefits of both modes (Yang et al., 2010; LDA Consulting, 2012).

Several bike-sharing studies found that the members have significantly higher employment rates, have a lower average age, and are more likely to be Caucasian males compared to the general public (LDA Consulting, 2012; Virginia Tech, 2010; Shaheen et al., 2012). Shaheen et al. (2011) found in their research in Hangzhou that the average bicycle ownership of members and non-members were 0.55 and 0.49, respectively. Safety concerns due to lack of bicycle infrastructure and sharing right of way with motor vehicles are often considered as a major barrier to bike-sharing programs (Fishman et al., 2013). However, bike-sharing accident rates were relatively low in North America (Shaheen et al., 2012).

4.2.3. Car-Sharing

Car-sharing has become a mainstream mode of transportation for more than a million users across the globe. Individuals gain the benefits of a private vehicle without handling responsibilities and car ownership costs (Shaheen and Cohen, 2013). Numerous studies were conducted to examine the advantages of car-sharing (Jorge and Correia, 2013). Litman et al. (2000) stated that car-sharing is observed to have a positive impact on urban mobility. Shared vehicles tend to have higher utilization rates than single-user private vehicles, hence diluting the sunk costs (Mitchell et al., 2010). Several studies found that the use of car-sharing has led to a decrease in car ownership and car use (Millard-Ball, 2007; Martin et al., 2010; Shaheen

and Martin, 2011). Shaheen et al. (2011) also noted that the increase in the use of car-sharing programs significantly reduced GHG emissions.

Several studies were conducted to identify the user characteristics of car-sharing programs (Shaheen and Rodier, 2005; Brook, 2004; Millard Ball et al., 2005, Efthymiou et al.; 2012). Most of them were done using user surveys and, they exhibited similar tendencies (Jorge and Correia, 2013):

- Many car-sharing users are frequent public transit users and they live in medium to high density areas (Shaheen and Rodier, 2005; Burkhardt and Millard-Ball, 2006).
- The users tend to be in their mid-30s and mid-40s and are highly educated (Brook, 2004; Lane, 2005).
- Many car-sharing users belong to smaller than average sized households (Brook, 2004; Millard-Ball et al., 2005).
- They tend to be concerned about environmental issues (Costain et al., 2012; Efthymiou et al., 2012).
- The distance between home/work and the nearest station is a critical factor in joining car-sharing programs (Costain et al., 2012; Efthymiou et al., 2012).

Stillwater et al. (2008) examined the factors that support urban car-sharing services and concluded the most significant variables were: street width, percentage of households with one vehicle, percentage of drive-alone commuters, the provision of railway services and the average age of stations. A similar survey was conducted at the University of Wisconsin, Madison to understand the potential of the car-sharing market and predicted the willingness to join car-sharing program using a logistic regression model (Zheng et al., 2009). Zheng et al.

found that the attitude of individuals had a great impact on using car-sharing services. Students were more willing to use these programs compared to faculty and staff. Similarly, people who were concerned about the environment or the cost of owning and driving a vehicle preferred car-sharing more than other travelers (Zheng et al., 2009).

Recently, a study conducted by Lorimier and El-Geneidy (2011) examined the factors affecting vehicle usage and availability of cars in car-sharing stations. They found that size of a station, different months in a year, age of vehicle have a greater impact in using car-sharing programs. Having child seats was a preferred attribute by the individuals to use car-sharing program (Lorimier and El-Geneidy, 2011). Morency et al. (2011) studied the frequency of car-sharing use and distribution of distance traveled and found two distinctive behaviors: urban distances throughout the week and long distances on just one day of the week. Another study was conducted to examine the user behavior of car-sharing members: the probability of each member being active in a given month and the frequency of use of an active member (Morency et al., 2012). They found that some attributes of users, such as gender and age have an impact on their behavior: males and people aged between 35 and 44 years or more favor car-sharing the most (Morency et al., 2012).

A survey was conducted in Austin, Texas to understand users' opinion of the Austin Car Share (ACS) program, expected demand and change in travel patterns, based on two pricing plans (Zhou Bin et al., 2010). The results showed that households having higher vehicle ownership and income-to-adults ratio are less likely to join the program, while level of education exhibits a convex relationship with the probability of joining car-sharing programs (Zhou Bin et al., 2010). Similarly, Costain et al. (2012) examined the user behavior of car-sharing programs in Toronto. The results showed that car-sharing members are in general, environmentally

conscious people and would like to pay for carbon offsetting if given an option and most of the rides are on off peak period or on weekends. The majority of trips were short-distance trips. They also found the impact of car-sharing on providing a segment of the population with enhanced accessibility and mobility (Costain et al., 2012).

Research was performed across the globe to understand the impact of many alternative mobility programs, dynamic ride-sharing, bike-sharing or car-sharing in a given region. However, these studies were context-specific, and local and regional characteristics make standardization of their results more complex. These studies reveal user preferences and provide new insight that can be used to enhance shared mobility programs in other regions (Jorge and Correia, 2013). This paper attempts to understand a general view of Texas travelers on shared mobility options as a whole. Using an online survey, the author examines the travel behavior pattern of Texans and public opinion of three shared mobility programs, dynamic ride-sharing, bike-sharing and car-sharing, their key factors and impacts on number of trips taken and vehicle ownership.

5. DATA

A web-based survey, named 'New Travel Options Survey', was conducted to better understand travelers' decision-making regarding the use of car-sharing, bike-sharing and dynamic ride-sharing. The survey was administered across the state of Texas, focusing on major cities because shared mobility programs are expected to have a larger impact on cities compared to rural locations. The major topics covered in the survey were:

- Current travel behavior.
- Awareness of dynamic ride-sharing, car-sharing and bike-sharing.
- Initial impressions of the new travel options.
- Factors affecting their decision to choose or not to choose dynamic ride-sharing, car-sharing and bike-sharing.
- Understanding of the role of dynamic ride-sharing or car-sharing on auto ownership.
- Socio-economic and demographic information of the respondent.

The respondents of the survey were comprised of individuals primarily from 6 major cities in Texas – Houston, Austin, Dallas, Fort Worth, San Antonio and El Paso. The first section of the survey examined the current travel behavior of the respondents in relation to their most recent long (greater than three miles) and short (less than three miles) trips. This was performed by gathering data regarding time of travel, origin and destination, mode of travel and frequency of the trip. Next, the respondents were asked if they had ever used dynamic ride-sharing, car-sharing or bike-sharing. If they had, follow up questions regarding that trip were asked.

The survey continued with questions to garner the respondents' reaction to the alternate travel modes of dynamic ride-sharing, car-sharing and bike-sharing. Respondents were asked to

estimate the probability of their choosing these modes for both their short and long trips. Respondents then ranked the reasons for choosing to use, or not use, a shared mode for those trips. Next, the survey examined the potential impact of dynamic ride-sharing, car-sharing or bike-sharing on the number of trips taken, as well as on auto ownership. The last section of the survey collected demographic and socio-economic information on the respondents, including age, household type, education, income and number of vehicles owned.

5.1. Survey Development and Administration

As a part of the survey development, a rough draft of the survey was created based on the literature review, the research objectives and inputs from the TxDOT project monitors. The online version was created using Lime Survey, an open office software, and customized using Java Script. After many internal tests, the survey was launched on January 16, 2015 for public input and closed on February 16, 2016.

The online version of the survey was made available through the website www.travelsurveys.org website. The survey was monitored using the Lime Survey website. Several methods were used to promote the web survey including,

- Past participants in the TTI database: Around 2000 emails were sent to past participants from the database. Members of TxDOT project committee and TTI research team also circulated the survey link. A sample email is shown in Figure 1.
- TTI Press Release targeting transportation media outlets across the state (See Figure 2).
- Social media including Facebook, Twitter, Google+ and YouTube. (See Figure 3).

Ride-share, bike-share, car-share – would alternative mobility programs help your area?

Texas is one of the fastest growing states in the nation and its growth is expected to continue. The challenge of prioritizing limited transportation resources requires a proactive approach to managing these resources. On behalf of the Texas Department of Transportation (TxDOT), the Texas A&M Transportation Institute (TTI) is conducting a statewide web survey to collect opinions about, perceptions of, and use of alternative mobility programs like ride-sharing, car-sharing, and bike-sharing.

Results from the statewide survey will help TxDOT and its partners identify how to incorporate these programs into planning and mobility efforts and help improve mobility for Texans.

We welcome you to participate in the survey, and to share the link with friends, family, and colleagues in Texas. Please visit http://travelsurveys.org and take the survey today!

Thank you!

Figure 1. Email Promoting New Travel Options Survey

Texas A&M Transportation Institute

For Immediate Release | Date Here

TTI, TxDOT seek participants in statewide web survey

Ride-share, bike-share, car-share – would alternative mobility programs help your area?

(College Station, TX) – Texas is one of the fastest growing states in the nation and its growth is expected to continue. The challenge of prioritizing limited transportation resources requires a proactive approach to managing these resources. On behalf of the Texas Department of Transportation (TxDOT), the Texas A&M Transportation Institute (TTI) is conducting a statewide web survey to collect opinions about, perceptions of, and use of alternative mobility programs like ride-sharing, car-sharing, and bike-sharing.

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We welcome you to participate in the survey. Please visit http://travelsurveys.org.

Figure 2. TTI Press Release Announcing Web Survey

Figure 3. Twitter Tweets Promoting New Travel Options Survey

5.2. Data Cleaning

Once the survey was closed, Lime Survey classified the responses into two categories: completed responses, indicating the respondent have completed the survey and hit the submit button, and incomplete responses, indicating the respondent did not hit the submit button at the end of the survey. 511 responses were examined to eliminate:

- Respondents who entered minimal information and hit the 'submit' button, therefore counting it as a completed survey. Four survey responses of this kind were removed.
- Respondents who entered erroneous data. No examples of this kind were found.
- Respondents who took the survey multiple times. The IP addresses of the respondents were examined and in a few cases there were multiple responses from the same IP address. This can occur if more than one individual at a residence responds to the survey or in cases of businesses or libraries that have the same IP address. In all of these cases the responses were different, indicating the likely scenario of different individuals using the same IP address.

This left 507 surveys available for in-depth analysis as discussed in the next section.

6. ANALYSIS

6.1. Survey Analysis – Overview

An initial analysis of survey results was performed. The results were compared with literature findings on shared mobility options to check for similarities and differences.

The current travel behavior of the respondents was examined based on their last short trip (less than three miles) and last long trip (greater than three miles). Cars/trucks, biking and walking were the most common modes used in short trips, whereas automobiles dominated long trips (see Figure 4). Surprisingly, 11.2 percent of respondents were using biking as a mode of transport for their long trips.

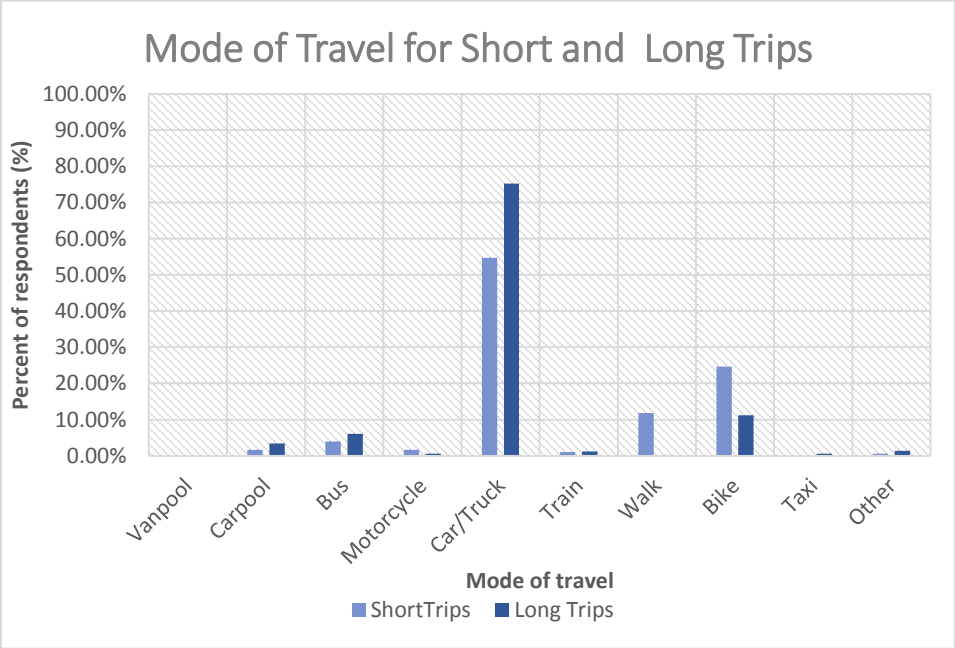

Figure 4. Modes Used for Short and Long Trips

The most common trip purposes for short trips were shopping and personal errands (49.5%), while for long trips, it was commute to/from work (37.9%). The majority of the survey respondents drove alone. Questions were also asked regarding their origin and destination, time of travel and travel costs.

More than 80 percent of respondents had heard of dynamic ride-sharing, bike-sharing and car-sharing prior to the survey. The survey respondents were asked to indicate how likely they would use these modes for their short and long trips. The most commonly noted factors that would encourage the respondents to choose dynamic ride-sharing, bike-sharing and car-sharing modes were 'lower trip fares than traditional taxi cabs', 'for fun' and 'being able to reserve using smart phones', respectively. On the other hand, the most common factors that would discourage using these programs were 'uncertain reliability/availability of a ride home or to next destination', 'it would not work for the trips they take' and 'car-sharing stations are not located near their origin/destination'. Detailed analysis and results are provided in the following sections.

6.2. Analysis Procedure

The following section gives an overview of the analysis methodology performed, including a step-by-step procedure.

1. Detailed analysis of the demographics of all respondents was performed in Microsoft Excel.

   The percentage of the total survey respondents in each demographic category (e.g., percentage of male/female respondents, percentage of respondents by profession, income

level, education, etc.) was calculated to see whether the sample contains an appropriate mix of respondents from different categories that reflects Texas travelers.

2. A descriptive analysis of survey responses based on user characteristics was performed in Microsoft Excel and JMP.

   The respondents were analyzed based on their current travel behavior and willingness to choose shared mobility programs for their short and long trips. A comparison of user characteristics for car-sharing, bike-sharing and dynamic ride-sharing obtained from the survey was conducted.

3. Factors influencing the use of shared mobility programs were analyzed.

   Respondents were asked to rate the factors for choosing or not choosing car-sharing, dynamic ride-sharing and bike-riding. The factors that the most/least number of respondents chose were identified. These results were compared with findings from the literature.

4. The impact of shared mobility programs on vehicle ownership was examined.

   The percentage of people who responded that shared modes may impact their ownership of a vehicle was calculated, and the results were compared with previous studies.

5. The impact of shared mobility programs on the number of trips taken was analyzed.

   The percentage of respondents who indicated that shared modes may impact their number of trips taken was calculated from survey results and was compared with the results of previous studies.

6. User comments on car-sharing, bike-sharing and dynamic ride-sharing were analyzed.

6.3. Respondent Demographics

A total of 507 survey responses were selected for detailed analysis. The respondents represented Texas travelers of different age groups, gender, occupation, income level, education and ethnicity. 87.5 percent of the total survey respondents were 25 to 64 years old (See Table 1). According to the 2014 U.S Census Bureau Report, 11.5 percent of Texas residents were 65 years or older and 26.3 percent of them were under 18 years old (US Census Bureau Report, 2014). However, only 7.3 percent of survey respondents were 65 years or older. According to Table 1, the survey sample slightly under-represented Texan residents who were above 65 years old and over-represented the percentage of 25 to 64 year olds.

The survey data set contained an equal distribution of males and females, resembling the Texas population. The 2014 U.S Census report stated that 50.4 percent of Texan residents were females (U.S Census Bureau Report, 2014). Regarding the ethnicity of survey respondents, the survey data set underrepresented certain races including Hispanic/Latino (39%), African American (12.5%) and Asian (4.7 %) (The percentage values in parentheses are based on the 2014 US Census Bureau Report). According to the 2014 US Census Bureau Report, the average number of persons per household was 2.83, whereas that of the 'New Travel Options Survey' was 2.39 (US Census Bureau Report, 2014). Most of the survey respondents were married with/without children, and 47.7 percent of survey respondents had 2 people in their household. The average number of vehicles owned by the survey respondents was 2.05.

Comparing the data provided by the Bureau of Labor Statistics, the survey sample overestimated those who were in the professional/managerial sector and underestimated those who were in the business sector (Bureau of Labor Statistics OES Data, 2014). The data set slightly overestimated the percentage of those who have completed a college education or

higher, whereas 81.4 percent of Texan residents possess an education level of high school or above (US Census Bureau Report, 2014). Similarly, the percentage of Texans who possess a bachelor degree or higher was 27.1 percent, whereas that of survey respondents was 84.7 percent (US Census Bureau Report, 2014). This might have happened because the survey was circulated via emails and social networking sites in a university environment. Although there were some differences in the respondents' demographics compared to that of all Texan residents, the respondents had many similarities as well.

Table 1. Demographics of Respondents (%)

User Demographic Characteristics	Percent of respondents
What is your age? (N^1=504)	
16 to 24	5.2%
25 to 34	30.2%
35 to 44	20.6%
45 to 54	21.0%
55 to 64	15.8%
65 and over	7.3%
What is your gender? (N=501)	
Male	50.1%
Female	49.9%
What is your ethnicity? (N=497)	
White/Caucasian	76.5%
Hispanic/Latino	14.5%
African American	1.6%
Asian American	2.0%
Native American	1.0%
Other	4.4%

Table 1 Continued. Demographics of Respondents (%)

User Demographic Characteristics	Percent of respondents
Including you, how many people live in your household? (N=495)	
1	19.8%
2	47.7%
3	12.5%
4	14.7%
5	4.0%
6	1.0%
7	0.2%
Please describe your household type? (N=406)	
Single Adult	5.2%
Unrelated adults(e.g., room-mates)	14.5%
Married without child	36.5%
Married with child(ren)	36.5%
Single parent family	2.0%
Other	5.4%
Altogether, how many motor vehicles (including cars, vans, trucks, and motorcycles) are available for use by members of your household? (N= 495)	
0	3.2%
1	25.1%
2	47.9%
3	14.3%
4	8.1%
5	0.6%
6	0.4%
7	0.2%
8	0.2%
What category best describes your occupation? (N=501)	
Professional / Managerial	52.3%
Technical	9.0%
Sales	2.0%
Service (restaurants, retail, etc.)	1.8%
Administrative / Clerical	5.8%
Manufacturing / Construction	4.4%
Stay-at-home parent / homemaker	2.2%
Student	8.4%
Self employed	5.4%
Unemployed / Seeking work	1.2%
Retired	7.6%
Other	0.0%

Table 1 Continued. Demographics of Respondents (%)

User Demographic Characteristics	Percent of respondents
What is the last year of school you have completed? (N=498)	
Less than high school	0.0%
High school graduate	1.6%
Some college / Vocational	13.7%
College graduate	47.2%
Post graduate	37.6%
What was your annual household income? (N=500)	
Less than $10,000	1.4%
$10,000 to $14,999	1.0%
$15,000 to $24,999	3.0%
$25,000 to $34,999	4.2%
$35,000 to $49,999	8.6%
$50,000 to $74,999	17.4%
$75,000 to $99,999	11.0%
$100,000 to $149,999	21.0%
$150,000 to $199,999	9.8%
$200,000 or more	9.2%
Prefer not to answer	13.0%
It is easier to note wage/hr ($/hr)	0.4%

[1]Represents the total number of responses obtained for a particular question.

6.4. Survey Responses: Detailed Analysis

6.4.1. Current Travel Behavior

The respondents were asked to choose a major Texas City closest to where they live or they spend a considerable amount of time travelling. Table 2 describes the distribution of survey respondents based on their city of preference. It was observed that a majority of the survey respondents were from Austin.

Table 2. Respondents' Distribution Based on Location (%)

City (N=507)	Percent of Total Respondents
Austin	47.1%
Dallas	15.0%
El Paso	3.6%
Fort Worth	6.1%
Houston	22.5%
San Antonio	5.5%
Other	0.2%

The travel characteristics of the survey respondents for short trips and long trips are shown in Table 3 and Table 4. This includes mode of travel, trip purpose, and number of passengers in the vehicle.

The most common mode of travel was car/truck irrespective of trip length, indicating typical Texan travel behavior (USDOT State wise Transportation Statistics, 2015) (See Table 3 and 4). The survey over-represented the percentage of transit riders in Texas, whereas actual Texan transit ridership in 2015 was 1.6% of all trips (APTA Ridership Report, 2015). The reason for a higher percentage of transit riders might be the survey was focused in 6 major cities in Texas, which have more transit services than in rural areas (See Table 3). The survey also underestimated the percent of carpoolers compared to state transportation statistics, which stated 10.7% of Texans carpooled or vanpooled to work (USDOT State wise Transportation Statistics, 2015) (See Table 3 and 4).

Many respondents used biking and walking for their short and long trips. This indicated the scope for implementing more bike-sharing services for short and long trips. Certain studies stated that the number of bike riders and pedestrians increase the growth potential of bike-sharing services (Midgley 2011). However, the survey over-represented the number of bike-

riders and pedestrians according to latest statistics. According to State Transportation Statistics 2015, 1.6% of Texas travelers walked and 0.3% of them used bikes (USDOT State wise Transportation Statistics, 2016) (See Table 3 and 4).

According to the statistics of trip purpose obtained by the National Household Travel Survey 2009, a majority of trips were for personal errands or commuting, which was similar to the trip purpose of a major share of respondents (Passenger Travel Facts and Figures, 2009). Short trips were mainly shopping and personal errands, whereas long trips were commuting trips. Most of the respondents traveled by themselves.

Table 3. Current Travel Behavior of Respondents Based on Short Trips (%)

Survey Question		All Respondents (N =507)	SOV Respondents (N=191)	Transit Riders (N=24)	Others[1] (N=219)	Commuters (N=103)	Non Commuters (N=404)	Male (N=251)	Female (N=250)
What was the mode of travel for your trip?	Vanpool	0.0%							
	Carpool	1.7%			4.1%	2.9%	1.3%	0.8%	2.5%
	Bus	3.9%		79.2%		7.8%	2.9%	3.4%	4.6%
	Motorcycle	1.7%			4.1%	2.9%	1.3%	2.5%	0.8%
	Car/Truck	54.7%	100.0%			42.7%	57.9%	48.3%	61.0%
	Train	1.0%		20.8%		3.9%	0.3%	1.7%	0.4%
	Walk	11.8%			29.2%	5.8%	13.4%	12.2%	11.2%
	Bike	24.6%			61.0%	33.0%	22.4%	29.8%	19.5%
	Taxi	0.0%							
	Other	0.6%			1.5%	1.0%	0.5%	1.3%	
	All[2]	483	191	24	195	103	380	238	247
What was the purpose of the trip?	Commuting to or from my place of work	21.4%	20.5%	50.0%	24.2%	100.0%		21.9%	21.3%
	Recreational/Social/Entertainment	19.5%	13.2%	16.7%	24.7%		24.9%	18.6%	20.0%
	Shopping/Personal errand	49.5%	58.4%	12.5%	40.7%		63.0%	49.4%	49.6%
	Work related trips	6.0%	5.8%	8.3%	6.7%		7.7%	7.2%	5.0%
	To attend class at school	2.7%	0.5%	12.5%	3.1%		3.4%	1.7%	3.8%
	Other	0.8%	1.6%	0.0%	0.5%		1.1%	1.3%	0.4%
	All	481	190	24	194	103	378	237	240

Table 3 Continued. Current Travel Behavior of Respondents Based on Short Trips (%)

Survey Question		All Respondents (N =507)	SOV Respondents (N=191)	Transit Riders (N=24)	Others[1] (N=219)	Commuters (N=103)	Non Commuters (N=404)	Male (N=251)	Female (N=250)
How many people, including you, were there in the vehicle on that trip?	1	70.9%	100.0%		42.9%	83.7%	68.1%	75.4%	66.9%
	2	22.3%			57.1%	10.2%	24.9%	18.0%	26.0%
	3	2.9%				4.1%	2.6%	1.6%	3.9%
	4	2.9%				2.0%	3.1%	3.3%	2.6%
	5+	1.1%					1.3%	1.6%	0.7%
	All	278	191		14	49	229	122	154
Were you the driver or a passenger on that short trip?	Driver	70.4%			25.0%	37.5%	74.0%	86.7%	60.8%
	Passenger	29.6%			75.0%	62.5%	26.0%	13.3%	39.2%
	All	81			8	8	73	30	51
Did you pay toll?	No	94.3%	98.9%			83.1%	97.1%	93.9%	94.5%
	Yes	5.7%	1.1%		100.0%	17.0%	2.9%	6.1%	5.5%
	All	297	189		140	59	238	132	163
Did you have to pay to park at your destination?	No	94.6%	95.2%		92.9%	85.7%	96.5%	97.5%	92.2%
	Yes	5.5%	4.8%		7.1%	14.3%	3.5%	2.5%	7.8%
	All	275	189		140	49	226	120	153

[1] Others represent all respondents except those who drove alone and used transit services.

[2] 'All' row represents total number of responses obtained for a question.

Table 4. Current Travel Behavior of Respondents Based On Long Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=256)	Transit Riders (N=36)	Others (N=86)	Commuters (N=185)	Non Commuters (N=303)	Male (N=251)	Female (N=250)
What was the mode of travel for your trip?	Vanpool	0.0%							
	Carpool	3.5%			19.8%	3.8%	3.3%	2.9%	3.7%
	Bus	6.1%		83.3%		7.6%	5.2%	8.2%	4.1%
	Motorcycle	0.6%			3.5%	0.5%	0.7%	1.2%	
	Car/Truck	75.3%	100.0%			73.5%	76.3%	68.6%	82.3%
	Train	1.2%		16.7%		2.7%	0.3%	1.6%	0.8%
	Walk	0.2%			1.2%	0.5%	11.4%		0.4%
	Bike	11.2%			64.0%	10.8%	1.0%	15.5%	7.0%
	Taxi	0.6%			3.5%			1.2%	
	Other	1.4%			8.1%	0.5%	2.0%	0.8%	1.7%
	All	493	256	36	86	185	308	245	243
What was the purpose of the trip?	Commuting to or from my place of work	37.9%	49.2%	52.8%	35.3%	100.0%		38.9%	36.8%
	Recreational/Social/Entertainment	26.8%	15.0%	11.1%	35.3%		43.2%	24.2%	29.7%
	Shopping/Personal errand	18.4%	16.5%	13.9%	9.4%		29.7%	18.9%	18.0%
	Work related trips	10.7%	15.0%	5.6%	10.6%		17.2%	11.9%	9.2%
	To attend class at school	4.1%	3.2%	8.3%	5.9%		6.6%	3.3%	5.0%
	Other	2.1%	1.2%	8.3%	3.5%		3.3%	2.9%	1.3%
	All	488	254	36	85	185	303	244	239
How many people, including you, were there in the vehicle on that trip?	1	66.6%	100.0%		13.6%	88.0%	54.3%	68.5%	65.2%
	2	22.9%			63.6%	10.6%	30.0%	19.7%	25.6%
	3	6.2%			13.6%	0.7%	9.3%	7.3%	4.8%
	4	3.6%			9.1%	0.7%	5.3%	4.5%	2.9%
	5+	0.8%					1.2%		1.5%
	All	389	256		22	142	247	178	207

Table 4 Continued. Current Travel Behavior of Respondents Based On Long Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=256)	Transit Riders (N=36)	Others (N=86)	Commuters (N=185)	Non Commuters (N=303)	Male (N=251)	Female (N=250)
Were you the driver or a passenger on that short trip?	Driver	70.5%			47.4%	76.5%	69.6%	82.1%	62.0%
	Passenger	29.5%			52.6%	23.5%	30.4%	17.9%	38.0%
	All	129			19	17	112	56	71
Did you pay toll?	No	83.4%	86.5%	31.4%	86.4%	79.9%	85.6%	80.2%	86.6%
	Yes	16.6%	13.6%	68.6%	13.6%	20.1%	14.4%	19.8%	13.4%
	All	416	251	35	22	159	257	197	216
Did you have to pay to park at your destination?	No	90.9%	89.0%		100.0%	87.9%	92.7%	92.0%	89.9%
	Yes	8.8%	10.6%			12.1%	6.9%	8.0%	9.7%
	I don’t remember	0.3%	0.4%				0.4%		0.5%
	All	386	255		19	141	245	175	207

6.4.2. Time, Cost and Frequency of Trips

Additional information on traveler characteristics, including time of travel, cost and frequency of trips, are shown in Table 5. These are broken into short trips and long trips. The values represent number of responses obtained for particular question asked. The trips were grouped into different time frames based on the start time of the trip and trip duration was calculated based on the difference between start time and end time mentioned. The number of responses obtained for questions regarding preferred carpool partner, extra time to pick up passengers, parking costs and toll costs were too small to use to make notable conclusions.

Most respondents traveled during the morning hours between 7.00 AM to 10.00 AM and evening hours between 3.00 PM and 7.00 PM. According to previous studies, if shared mobility programs such as car-sharing can attract these respondents, it may significantly reduce the number of trips in peak hours and provide environmental benefits (Fellow, 2000; Katsev, 2003; FimKom, 2011). However, the exact peak hours of a particular roadway might vary based on location.

Table 5. Travel Time, Cost and Frequency of Trips

Characteristics		Short Trips	Long Trips
Time of travel	12.00 AM to 7.00 AM	35	59
	7.00 AM to 8.00 AM	47	95
	8.00 AM to 9.00 AM	51	67
	9.00 AM to 10.00 AM	39	37
	10.00 AM to 3.00 PM	147	116
	3.00 PM to 5.00 PM	46	37
	5.00 PM to 7.00 PM	63	44
	7.00 PM to 12.00 AM	43	23
Time taken for the trip	0 min	12	21
	< = 15 min	169	51
	< = 30 min	72	121
	< = 60 min	73	96
	< = 2 hours	48	59
	< = 4 hours	30	50
	> 4 hours	27	86
Preferred Carpool Partner	Co-Worker	1	7
	Neighbor		2
	Adult family member	6	8
	Child		
	Other	1	5
Toll/Fair Paid	< = 2 dollars	8	19
	< = 5 dollars	2	30
	> 5 dollars	0	15
Parking Cost	< = 5 dollars	8	21
	< = 10 dollars	3	16
	> 10 dollars	2	1
Frequency of trips in a week	< 5	179	244
	5 to 10	141	105
	10 to 20	136	130
	< 20	24	11
Extra time to pick up passengers	0 minute	7	7
	< = 5 minutes		4
	< = 15 minutes		5
	> 15 minutes	1	1

6.4.3. Willingness to Choose Shared Mobility Programs

The respondents were asked regarding their opinion of shared mobility programs. Table 6 shows their responses to dynamic ride-sharing, bike-sharing and car-sharing with respect to their short trips and long trips.

Many respondents answered that they would like to choose dynamic ride-sharing, bike-sharing and car-sharing irrespective of their trip length. Out of these three shared modes, bike-sharing was preferred the most for short trips (less than three miles), whereas car-sharing was preferred the most for long trips (more than three miles). De Luca (2014) conducted an ex-ante analysis of the acceptability of an inter-urban (short distance) car-sharing program. He found that about three fourths of respondents would like to use car-sharing. However, these users preferred to drive their own cars for long distance trips (De Luca, 2014). Further analysis was performed regarding the important factors that encouraged or discouraged the use of shared mobility programs in the next section.

Table 6. Respondents Who Are Willing To Switch Shared Modes (%)

Chance of using shared mode	Short trips			Long trips		
	Dynamic Ride-sharing (N=504)	Bike-Sharing (N=506)	Car-Sharing (N=505)	Dynamic Ride-Sharing (N = 504)	Bike-Sharing (N=505)	Car-Sharing (N=499)
0 - I am not sure	2.8%	2.0%	1.8%	2.4%	1.0%	1.8%
1 - Definitely Not	34.5%	20.8%	31.8%	22.6%	41.6%	23.5%
2 - Probably Not	30.2%	19.0%	27.6%	23.8%	28.3%	21.0%
3 - Maybe	17.1%	22.7%	20.4%	28.2%	15.8%	27.5%
4 - Probably Yes	8.3%	18.2%	10.0%	14.1%	7.1%	15.0%
5 - Definitely Yes	7.1%	17.4%	8.4%	8.9%	6.1%	11.2%

6.5. Factors Influencing the Use of Shared Mobility Programs

Respondents were asked to rate the importance of various factors in their decision to probably use/not use dynamic ride-sharing, bike-sharing and car-sharing. The options provided were 'very important', 'probably important', 'somewhat important', 'probably not important' and 'not important'. The ratings provided by the respondents for each factor is shown in Tables 7, 8, 9, 10, 11 and 12. In the analysis, the combined percentage of respondents who chose the options 'very important -5' and 'probably important - 4' is used to represent the most encouraging factors.

6.5.1. Dynamic Ride-Sharing

Major factors that would encourage the use of dynamic ride-sharing were lower trip fares than traditional taxi cabs, the ability to schedule trips with a smartphone and no need to find parking (save time) (see Table 7). The survey results confirmed previous studies regarding the benefits of dynamic ride-sharing including cost savings, travel-time savings and reduced commute stress (Shaheen, 2012). The least important reason by a large margin was to meet new people. The survey did not provide enough evidence to support the finding that shared modes like dynamic ride-sharing can be used as a social networking platform for youth (Shaheen, 2012). 28.4 percent of respondents chose other reasons to likely use dynamic ride-sharing that were not listed. The most common other reasons they provided were their ability to use multiple modes, environmentally- friendly modes and affordable options.

Table 7. Reasons for Choosing Dynamic Ride-Sharing (%)

	Percentage of Respondents who Indicated this Level of Importance for Each Factor				
Factors	Not Important	Probably Not Important	Maybe	Probably Important	Definitely Important
Avoiding/reducing the costs of car ownership	19.2%	13.3%	21.3%	21.3%	24.8%
Avoid parking fees	14.6%	9.6%	17.0%	21.0%	37.8%
No need to find parking for car (save time)	12.0%	8.0%	18.7%	21.9%	39.5%
Being able to schedule trips with my smartphone	11.4%	7.4%	20.7%	26.0%	34.5%
Not having to exchange payment with driver	12.6%	9.1%	24.6%	23.0%	30.8%
Not having to ride in a taxi cab	26.8%	11.6%	22.2%	14.3%	25.1%
Lower trip fares than traditional taxi cabs	12.8%	4.0%	19.0%	20.9%	43.3%
Ride-sharing makes using transit more convenient	14.1%	7.1%	29.0%	24.9%	24.9%
Meeting new people	57.3%	17.6%	16.0%	4.8%	4.3%
Not having to drive myself	19.8%	7.4%	21.7%	17.5%	33.6%
Not having to prearrange a carpool	15.7%	7.5%	21.9%	25.1%	29.9%
Other	46.7%	4.4%	20.4%	3.7%	24.8%

Table 8 shows the factors chosen by the respondents behind their decision to probably not use dynamic ride-sharing. A major share of respondents chose ‘uncertain reliability/availability of a ride home or to next destination’, ‘trip home or to next destination is time sensitive’ and ‘personal safety concerns as prominent factors behind their decision to probably not use dynamic ride-sharing for short and long trips. Previous studies stated that individuals preferred to arrange a shared ride at least a night before rather than immediately before the trip was made (Deakin et al. 2010). Confirming these findings, the survey results indicated that many travelers were concerned about the uncertainty of dynamic ride-sharing trips. The least common reasons chosen by the respondents were ‘I do not have a credit card, ‘I do not have a smart phone’ and ‘using an app is so complicated’. It was interesting to note that only a few

survey respondents chose ‘privacy issues (GPS location)’ as a reason that discouraged them from using dynamic ride-sharing, as some studies found privacy factors were one of the major concerns that affect the growth of shared modes (Stach, 2011). However, 43% percent of respondents chose personal safety concerns as an important factor behind their decision to probably not use dynamic ride-sharing, confirming the findings of previous studies (Shaheen et al., 2010). Many respondents chose other reasons that were not listed, the common factors being difficulty in travelling with kids, and needing to carry cargo at times along with them. The survey results suggested that one way to enhance ride-sharing services would be to accommodate the needs of travelers with kids, cargo and disabilities.

Table 8. Reasons for NOT Choosing Dynamic Ride-Sharing (%)

	Percentage of Respondents who Indicated this Level of Importance for Each Factor				
Factors	Not Important	Probably Not Important	Maybe	Probably Important	Definitely Important
Personal safety concerns	26.3%	12.7%	18.3%	14.6%	28.2%
Financial safety concerns (must register credit card)	39.4%	12.6%	15.4%	12.6%	20.0%
Privacy concerns (GPS location)	42.5%	13.9%	17.2%	9.5%	16.9%
Ride-sharing would not work for the trips I take (Examples: you make frequent stops or you take short trips within walking distance)	21.4%	12.5%	21.7%	15.6%	28.8%
It is too expensive	20.6%	13.2%	21.5%	16.0%	28.6%
Using an app to get a ride is too complicated	62.0%	11.8%	14.3%	5.6%	6.2%
I like to drive	40.7%	12.7%	18.6%	11.5%	16.5%
I do not have a smartphone	80.0%	2.8%	5.6%	1.6%	10.0%
I do not have a credit card	89.2%	3.8%	3.5%	0.3%	3.2%
Uncertain reliability/availability of a ride home or to next destination	17.5%	5.7%	15.7%	18.1%	42.9%
Trip home or to next destination is time sensitive	17.3%	6.8%	22.5%	16.1%	37.4%
Other	45.7%	1.1%	7.5%	11.7%	34.0%

6.5.2. Bike-Sharing

Table 9 lists the factors chosen behind respondents' decision to probably use bike-sharing for their trips. The most frequently chosen factors by the survey respondents were 'for fun', 'getting exercise', 'bike-sharing allows to reach more destinations in a close range than walking' and 'no need to find parking for car (save time)' as important features for using bike-sharing. Previous bike-sharing studies in various parts of the world found that a majority of bike-sharing trips were diverted from walking, supporting the preference of the present survey respondents to choose bike-sharing over walking (Krykewycz et al. 2011, Hampshire et al. 2011). The survey results also supported the findings of Maurer on the potential of bike-sharing in pursuit of improved public health (Maurer, 2012). Many respondents (46%) considered that 'avoiding/reducing the costs of car ownership' was important behind their decision to probably use bike-sharing, indicating the potential of bike-sharing to impact vehicle ownership. Half of the respondents chose other reasons that were not listed to probably use bike-sharing over traditional modes and, the most common factors identified by them were flexibility, ease of scheduling and environmental benefits. 64% percent of respondents indicated that bike-sharing programs make using public transit more convenient. Respondents chose similar factors for car-sharing as well, indicating the potential of bike-sharing and car-sharing as last mile options (Shaheen et al., 2010; De Luca, 2014).

Table 9. Reasons for Choosing Bike-Sharing (%)

	Percentage of Respondents who Indicated this Level of Importance for Each Factor				
Factors	Not Important	Probably Not Important	Maybe	Probably Important	Definitely Important
Avoiding/reducing the costs of car ownership	27.1%	12.3%	14.5%	31.3%	14.8%
Avoiding/reducing the costs of bike ownership	48.3%	12.9%	16.7%	14.4%	7.8%
Not worrying about getting bike to/from home as it is already where you need a bike	12.2%	4.3%	18.8%	42.9%	21.9%
No need to find parking for car (save time)	11.1%	4.5%	14.2%	46.2%	24.1%
Bike-sharing allows me to reach more destinations in close range than walking	8.3%	4.6%	15.7%	43.9%	27.6%
Avoiding parking fees	19.7%	4.9%	12.6%	43.1%	19.7%
Getting exercise	5.9%	4.0%	17.0%	47.2%	26.0%
Bike-sharing makes transit more convenient	9.9%	5.4%	20.7%	36.9%	27.0%
It's fun	8.8%	4.3%	13.6%	44.2%	29.2%
Other	33.3%	4.6%	12.1%	42.4%	7.6%

Table 10 lists the factors frequently chosen by the respondents that they would probably not use bike-sharing for their short/long trips. The most common factors chosen by the respondents were ‘I do not feel safe biking’, ‘bike-sharing would not work for the trips I take’ and ‘I prefer driving my own car’. The survey results confirmed the previous studies’ findings that stated future demand, safety, limited cycling infrastructure and user convenience as obstacles to the growth of bike-sharing facilities (Shaheen et al., 2010). The least common factors chosen were ‘not having credit card’ (similar to that of dynamic ride-sharing), ‘I do not like to bike’ and ‘I prefer walking’. Sixty seven percent of respondents chose other reasons that were not listed behind their decisions and the common answers were already owning a bike, having kids or other people to travel with, and safety reasons. The percentage of respondents who chose other

reasons was higher than that of the rest of the factors listed in the survey, indicating the importance of these factors.

Table 10. Reasons for NOT Choosing Bike-Sharing (%)

	Percentage of Respondents who Indicated this Level of Importance for Each Factor				
Factors	Not Important	Probably Not Important	Maybe	Probably Important	Definitely Important
Financial security concerns (must register credit card)	59.9%	12.1%	11.4%	6.9%	9.7%
Bike-sharing would not work for the trips I take (Example: you take long trips that require a car)	21.5%	5.0%	18.1%	14.1%	41.3%
It is too expensive	54.7%	13.2%	13.6%	7.7%	10.8%
I prefer driving my car	43.2%	9.8%	14.2%	10.5%	22.3%
I prefer walking	53.5%	16.4%	19.2%	5.6%	5.2%
I do not like to bike	68.4%	8.5%	9.5%	4.4%	9.2%
I do not have a credit card	90.7%	5.4%	2.9%	0.0%	1.1%
I do not feel safe biking	42.6%	7.4%	11.4%	15.4%	23.2%
Other	29.0%	1.8%	2.6%	3.5%	63.2%

6.5.3. Car-Sharing

The reasons that were cited in respondents' decisions to probably use car-sharing for their short/long trips are listed in Table 11. Most of the respondents chose being able to reserve vehicles with a smartphone, avoiding parking fees and avoiding/reducing the cost of car ownership. A similar survey conducted for Austin travelers found that scheduling reliability, overall convenience and program cost were the most important factors in their decision to join (or not to join) the Austin Car-Sharing program (Zhou, Bin et al., 2011). Another study found that the primary reason to join Leiden's car-sharing program in the Netherlands was the high

cost of car ownership (Meijkamp, 1998). The expected financial savings were chosen as one of the most important reasons for joining car-sharing program in Portland (Katzev, 2003).In our study, about 49% of respondents chose other reasons that were not listed in the survey. The most common answers identified by them were incentives provided by employers and no drivers' license. Not being able to rent a car due to being less than 25 years old or not having insurance and enjoy driving a different vehicle than their own were not important to most survey respondents. Similarly, environmental considerations, condition and type of vehicles, and current gasoline prices were not chosen as key factors in a similar survey conducted in Austin (Zhou, Bin et al., 2011).

Table 11. Reasons for Choosing Car-Sharing (%)

	Percentage of Respondents who Indicated this Level of Importance for Each Factor				
Factors	Not Important	Probably Not Important	Maybe	Probably Important	Definitely Important
Avoiding/reducing the cost of car ownership	17.4%	8.0%	21.5%	18.6%	34.5%
I enjoy driving a different vehicle than my own	59.3%	15.9%	13.5%	6.6%	4.8%
Being able to reserve vehicles with my smartphone	13.1%	5.0%	19.8%	22.7%	39.4%
Avoiding parking fees	17.0%	7.0%	15.3%	21.7%	39.0%
Car-sharing makes public transit more convenient	16.1%	10.1%	26.2%	22.6%	25.0%
I cannot rent a car at a regular car rental place because I am younger than 25 years old	90.4%	1.8%	2.7%	1.5%	3.6%
I cannot rent a car at a regular car rental place because I do not have car insurance	83.4%	5.4%	3.9%	2.7%	4.5%
Other	31.2%	1.6%	19.7%	6.6%	41.0%

Table 12 lists the factors chosen by the respondents for their decision to probably not use car-sharing for their short/long trips. The most frequently chosen factors were ‘car-sharing stations were not located near my origin/destination’, ‘car-sharing would not help on the trips I take’ and ‘I prefer driving my own car’. This results supported De Luca’s finding that as the distance from car-sharing station increases, the chance of being interested to car-sharing services decreases (De Luca et al., 2014). In a recent survey conducted in Austin, 38.0 percent of respondents suggested that they could not join because they need a car too often and 15.3 percent stated that the program was too costly. The respondents’ opinions were also dependent on their origin and destination locations as well (Zhou, Bin et al., 2011). ‘Not having a credit card’, ‘using an app for car-sharing is too complicated’ and ‘privacy concerns’ were generally not important reasons for Texas travelers to probably not use car-sharing. This contradicted certain studies that found privacy issues as an obstacle to the growth of shared mobility programs (Stach, 2011). 49 percent of respondents chose other reasons that were not listed, the most common answers provided by them were using their own car was more cost effective, uncertainty of availability of cars in the docking stations, needing car seats for kids.

Table 12. Reasons for NOT Choosing Car-Sharing (%)

	Percentage of Respondents who Indicated this Level of Importance for Each Factor				
Factors	Not Important	Probably Not Important	Maybe	Probably Important	Definitely Important
Financial security concerns (must register credit card)	56.6%	11.5%	11.2%	6.8%	13.9%
Privacy concerns (GPS location)	56.5%	14.0%	10.6%	5.1%	13.7%
Car-sharing would not help on the trips I take.(Example: you take short trips within walking distance)	29.4%	8.2%	17.8%	16.0%	28.7%
It is too expensive	31.9%	9.4%	25.4%	13.2%	20.1%
Using an app for car sharing is too complicated	69.7%	9.1%	10.1%	3.8%	7.3%
I prefer driving my own car	30.0%	8.7%	17.7%	11.3%	32.3%
I do not have a credit card	91.6%	2.8%	1.8%	1.1%	2.8%
Car-share stations are not located near my origin/destination	16.5%	3.3%	13.5%	13.9%	52.8%
Other	42.9%	2.0%	6.1%	6.1%	42.9%

Key insights obtained on the factors chosen by the survey respondents to probably use/not use dynamic ride-sharing, bike-sharing and car-sharing for their short/long trips were:

- The survey results showed that shared mobility programs could play an important role in reducing vehicle ownership, supporting literature findings (Meijkamp, 1998). 46.1, 46.2 and 53.1 percent of respondents chose ‘avoiding/reducing the cost of car ownership’ as a factor that would encourage them to probably use dynamic ride-sharing, bike-sharing and car-sharing respectively.
- A major share of respondents indicated that they would like to use shared mobility programs to reduce parking costs. 58.8 and 62.9 percent of respondents chose the factor ‘avoiding parking costs’ behind their decision to probably use dynamic ride-sharing and

car-sharing. Similarly, 61.3 percent of respondents mentioned that they would probably use bike-sharing because there would be 'no need to find parking for car (save time)'.

- When asked to write down 'other reasons' to probably use/ not use dynamic ride-sharing, bike-sharing and car-sharing, respondents pointed out that shared mobility programs were environmentally-friendly. They also mentioned that extending ride-sharing services to disabled travelers and those with kids would increase accessibility

6.6. Travelers' Willingness to Choose Shared Modes by Traveler Group

The sample set was categorized based on vehicle occupancy, gender, trip purpose, drivers and passengers, and respondents who had prior experience with shared mobility programs. Each group's opinions and their potential use of shared rides were then examined.

6.6.1. Survey Responses: Mode-wise Comparison

Most of the survey respondents (70.9 percent on short trips and 66.6 percent on long trips) indicated that they drove alone. The survey respondents were categorized into three groups: single occupant vehicle drivers (those who traveled alone and used car/truck mode for their trip), transit riders (those who used train or bus for their trip) and others. In this analysis, 'all other modes' category includes car/truck with more than one traveler, vanpool, car pool, motorcycle, walk, bike, taxi and other modes. Table 13 and Table 14 show their trip purpose based on short and long trips.

49% of single occupant vehicle trips greater than three miles (long trips) were commute trips. Most of the short trips made by single occupant travelers were for shopping and personal errands. The majority of transit riders were commuting to/from home to work place. The most

common trip purpose for all other vehicles were shopping/ personal errands for short trips and commuting and recreational activities for long trips.

Table 13. Trip Purpose for Single Occupant Vehicle Drivers-Short Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=191)	Transit Riders (N=24)	Others (N=268)
What was the purpose of the trip?*	Commuting to or from my place of work	21.4%	20.5%	50.0%	19.5%
	Recreational/Social/Entertainment	19.5%	13.2%	16.7%	24.3%
	Shopping/Personal errand	49.5%	58.4%	12.5%	46.4%
	Work related trips	6.0%	5.8%	8.3%	6.0%
	To attend class at school	2.7%	0.5%	12.5%	3.4%
	Other	0.8%	1.6%	0.0%	0.4%
	All[1]	481	190	24	267

1: 'All' row represents the number of responses obtained in each section. *symbol represents the trip purpose of three different categories - are significantly different.

Table 14. Trip Purpose for Single Occupant Vehicle Drivers-Long Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=199)	Transit Riders (N=36)	Others (N=258)
What was the purpose of the trip?*	Commuting to or from my place of work	37.9%	49.0%	52.8%	20.8%
	Recreational/Social/Entertainment	26.8%	14.9%	11.1%	45.2%
	Shopping/Personal errand	18.4%	16.9%	13.9%	21.3%
	Work related trips	10.7%	14.9%	5.6%	6.1%
	To attend class at school	4.1%	3.1%	8.3%	4.6%
	Other	2.1%	1.2%	8.3%	2.0%
	All[1]	488	197	36	255

*symbol represents the trip purpose of three different categories – SOV, Transit Riders and All other modes - are significantly different at a confidence level of 95%.

Table 15 and Table 16 describe the user demographics of respondents based on the modes they use. Chi-squared tests at a confidence level of 95% were also performed to determine if there was a statistical difference in respondent characteristics based on their mode of travel.

Table 15. Demographics of Different Mode Users - Short Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=191)	Transit Riders (N=24)	Others (N=268)
Age*	16 to 24	5.2%	2.1%	12.5%	6.5%
	25 to 34	30.2%	18.5%	54.2%	35.7%
	35 to 44	20.6%	16.4%	16.7%	23.7%
	45 to 54	21.0%	29.6%	0.0%	17.2%
	55 to 64	15.7%	20.6%	12.5%	12.7%
	65 and over	7.3%	12.7%	4.2%	4.1%
Gender	Male	50.1%	46.0%	50.0%	52.8%
	Female	49.9%	54.0%	50.0%	47.2%
Ethnicity	White/Caucasian	76.5%	78.5%	66.7%	76.0%
	Hispanic/Latino	14.5%	16.7%	16.7%	12.9%
	African American	1.6%	0.0%	4.2%	2.4%
	Asian American	2.0%	1.6%	4.2%	2.1%
	Native American	1.0%	0.5%	0.0%	1.4%
	Other	4.4%	2.7%	8.3%	5.2%
Number of people in the household	1	19.8%	23.8%	33.3%	16.1%
	2	47.7%	48.6%	41.7%	47.6%
	3	12.5%	10.3%	8.3%	14.3%
	4	14.8%	13.0%	12.5%	16.1%
	5	4.0%	3.8%	4.2%	4.2%
	6	1.0%	0.5%	0.0%	1.4%
	7	0.2%	0.0%	0.0%	0.3%
Household type*	Single Adult	5.2%	3.4%	6.3%	6.1%
	Unrelated adults(e.g. room-mates)	14.5%	9.0%	31.3%	16.7%
	Married without child	36.5%	43.4%	37.5%	32.2%
	Married with child(ren)	36.5%	37.9%	12.5%	37.1%
	Single parent family	2.0%	2.8%	6.3%	1.2%
	Other	5.4%	3.4%	6.3%	6.5%

Table 15 Continued. Demographics of Different Mode Users - Short Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=191)	Transit Riders (N=24)	Others (N=268)
Occupation*	Professional / Managerial	52.3%	57.1%	41.7%	50.0%
	Technical	9.0%	4.8%	12.5%	11.5%
	Sales	2.0%	0.0%	4.2%	3.1%
	Service (restaurants, retail, etc.)	1.8%	1.6%	0.0%	2.1%
	Administrative / Clerical	5.8%	7.4%	8.3%	4.5%
	Manufacturing / Construction	4.4%	5.3%	0.0%	4.2%
	Stay-at-home parent / homemaker	2.2%	1.6%	0.0%	2.8%
	Student	8.4%	3.2%	33.3%	9.7%
	Self employed	5.4%	6.9%	0.0%	4.9%
	Unemployed / Seeking work	1.2%	2.1%	0.0%	0.7%
	Retired	7.6%	10.1%	0.0%	6.6%
	Other	0.0%	0.00%	0.00%	0.00%
Education	Less than high school	0.0%	0.00%	0.00%	0.00%
	High school graduate	1.6%	1.6%	0.0%	1.7%
	Some college / Vocational	13.7%	12.8%	0.0%	15.4%
	College graduate	47.2%	52.7%	50.0%	43.4%
	Post graduate	37.6%	33.0%	50.0%	39.5%
Annual Income	Less than $10,000	1.4%	0.5%	4.2%	1.7%
	$10,000 to $14,999	1.0%	0.5%	8.3%	0.7%
	$15,000 to $24,999	3.0%	0.5%	0.0%	4.9%
	$25,000 to $34,999	4.2%	3.7%	8.3%	4.2%
	$35,000 to $49,999	8.6%	8.5%	8.3%	8.7%
	$50,000 to $74,999	17.4%	16.9%	12.5%	18.1%
	$75,000 to $99,999	11.0%	14.3%	4.2%	9.4%
	$100,000 to $149,999	21.0%	20.6%	16.7%	21.6%
	$150,000 to $199,999	9.8%	10.1%	12.5%	9.4%
	$200,000 or more	9.2%	10.6%	4.2%	8.7%
	Prefer not to answer	13.0%	13.2%	20.8%	12.2%
	It is easier to note wage/hr. ($/hr.)	0.4%	0.5%	0.0%	0.3%

*symbol represents the corresponding demographic characteristic of three different categories – SOV, Transit Riders and All other modes - are significantly different at a confidence level of 95%.

Table 16. Demographics of Respondents - Long Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=256)	Transit Riders (N=36)	Others (N=86)
Age*	16 to 24	5.16%	3.5%	11.1%	6.1%
	25 to 34	30.16%	30.5%	44.4%	27.4%
	35 to 44	20.63%	14.8%	19.4%	27.8%
	45 to 54	21.03%	24.6%	13.9%	17.9%
	55 to 64	15.67%	17.2%	11.1%	14.6%
	65 and over	7.34%	9.4%	0.0%	6.1%
Gender	Male	50.10%	46.9%	66.7%	51.2%
	Female	49.90%	53.1%	33.3%	48.8%
Ethnicity	White/Caucasian	76.46%	77.3%	58.3%	78.6%
	Hispanic/Latino	14.49%	14.5%	19.4%	13.6%
	African American	1.61%	2.4%	2.8%	0.5%
	Asian American	2.01%	1.6%	2.8%	2.4%
	Native American	1.01%	0.8%	2.8%	1.0%
	Other	4.43%	3.5%	13.9%	3.9%
Number of people in the household	1	19.80%	23.2%	30.6%	13.9%
	2	47.68%	46.0%	30.6%	52.6%
	3	12.53%	12.8%	19.4%	11.0%
	4	14.75%	13.6%	16.7%	15.8%
	5	4.04%	3.2%	2.8%	5.3%
	6	1.01%	1.2%	0.0%	1.0%
	7	0.20%	0.0%	0.0%	0.5%
Household type	Single Adult	5.17%	3.0%	12.0%	6.6%
	Unrelated adults(e.g. room-mates)	14.53%	15.1%	16.0%	13.7%
	Married without child	36.45%	40.2%	28.0%	33.5%
	Married with child(ren)	36.45%	35.7%	40.0%	36.8%
	Single parent family	1.97%	1.0%	0.0%	3.3%
	Other	5.42%	5.0%	4.0%	6.0%

Table 16 Continued. Demographics of Respondents - Long Trips (%)

Survey Question		All Respondents (N =507)	Single Occupant Vehicles (N=256)	Transit Riders (N=36)	Others (N=86)
Occupation*	Professional / Managerial	52.30%	57.3%	44.4%	47.6%
	Technical	8.98%	8.6%	16.7%	8.1%
	Sales	2.00%	1.6%	0.0%	2.9%
	Service (restaurants, retail, etc.)	1.80%	1.6%	0.0%	2.4%
	Administrative / Clerical	5.79%	4.7%	2.8%	7.6%
	Manufacturing / Construction	4.39%	5.5%	8.3%	2.4%
	Stay-at-home parent / homemaker	2.20%	0.8%	0.0%	4.3%
	Student	8.38%	5.5%	22.2%	9.5%
	Self employed	5.39%	5.9%	2.8%	5.2%
	Unemployed / Seeking work	1.20%	1.2%	0.0%	1.4%
	Retired	7.58%	7.5%	2.8%	8.6%
	Other	0.00%	0.00%	0.00%	0.00%
Education	Less than high school	0.00%	0.00%	0.00%	0.00%
	High school graduate	1.61%	1.6%	0.0%	1.9%
	Some college / Vocational	13.65%	13.8%	8.3%	14.4%
	College graduate	47.19%	49.4%	44.4%	45.0%
	Post graduate	37.55%	35.2%	47.2%	38.8%
Annual Income *	Less than $10,000	1.40%	0.4%	2.8%	2.4%
	$10,000 to $14,999	1.00%	0.8%	5.6%	0.5%
	$15,000 to $24,999	3.00%	1.2%	5.6%	4.8%
	$25,000 to $34,999	4.20%	3.5%	8.3%	4.3%
	$35,000 to $49,999	8.60%	10.6%	0.0%	7.6%
	$50,000 to $74,999	17.40%	17.3%	13.9%	18.1%
	$75,000 to $99,999	11.00%	9.4%	13.9%	12.4%
	$100,000 to $149,999	21.00%	21.3%	22.2%	20.5%
	$150,000 to $199,999	9.80%	12.2%	2.8%	8.1%
	$200,000 or more	9.20%	9.1%	2.8%	10.5%
	Prefer not to answer	13.00%	13.8%	19.4%	11.0%
	It is easier to note wage/hr. ($/hr.)	0.40%	0.4%	2.8%	0.0%

*symbol represents the corresponding demographic characteristic of three different categories – SOV, Transit riders and All other modes - are significantly different at a confidence level of 95%.

Table 17 and Table 18 depict the potential use of dynamic ride-sharing, bike-sharing and car-sharing by respondents who drove alone, carpooled or used other modes like public transit.

Table 17. Willingness to Choose Shared Modes by SOV, Carpool and Other Mode Travelers –Short Trips (%)

Shared Mode	Options	SOV	Transit	Other Modes
Dynamic Ride-Sharing	I am not sure	2.6%	4.2%	2.8%
	1 – Definitely Not	37.4%	20.8%	33.8%
	2 – Probably Not	31.6%	20.8%	30.0%
	3 – Maybe	15.8%	25.0%	17.2%
	4 – Probably Yes	7.9%	4.2%	9.0%
	5 – Definitely Yes	4.7%	25.0%	7.2%
Bike-Sharing*	I am not sure	2.1%	0.0%	2.1%
	1 – Definitely Not	29.3%	16.7%	15.5%
	2 – Probably Not	16.8%	8.3%	21.3%
	3 – Maybe	23.0%	25.0%	22.3%
	4 – Probably Yes	18.8%	12.5%	18.2%
	5 – Definitely Yes	9.9%	37.5%	20.6%
Car-Sharing*	I am not sure	1.6%	0.0%	2.1%
	1 – Definitely Not	37.6%	33.3%	27.9%
	2 – Probably Not	25.4%	25.0%	29.3%
	3 – Maybe	22.8%	16.7%	19.2%
	4 – Probably Yes	7.4%	0.0%	12.5%
	5 – Definitely Yes	5.3%	25.0%	9.1%

*symbol represents the percentage of respondents based on three different categories – SOV, Transit Riders and All other modes in using dynamic ride-sharing, bike-sharing and car-sharing- are significantly different at a confidence level of 95%.

Table 18. Willingness to Choose Shared Modes by SOV, Carpool and Other Mode Travelers –Long Trips (%)

Shared Mode	Options	SOV	Transit	Other Modes
	I am not sure	2.7%	0.0%	2.4%
	1 – Definitely Not	27.2%	11.4%	18.9%
	2 – Probably Not	23.7%	20.0%	24.5%
	3 – Maybe	26.8%	37.1%	28.3%
	4 – Probably Yes	14.4%	8.6%	14.6%
Dynamic Ride-Sharing*	5 – Definitely Yes	5.1%	22.9%	11.3%
	I am not sure	1.2%	2.8%	0.5%
	1 – Definitely Not	48.6%	19.4%	36.8%
	2 – Probably Not	26.8%	30.6%	29.7%
	3 – Maybe	14.4%	25.0%	16.0%
	4 – Probably Yes	5.4%	2.8%	9.9%
Bike-Sharing*	5 – Definitely Yes	3.5%	19.4%	7.1%
	I am not sure	1.6%	0.0%	2.4%
	1 – Definitely Not	23.5%	19.4%	24.0%
	2 – Probably Not	23.5%	11.1%	19.7%
	3 – Maybe	26.3%	30.6%	28.4%
	4 – Probably Yes	16.9%	16.7%	12.5%
Car-Sharing	5 – Definitely Yes	8.2%	22.2%	13.0%

*symbol represents the percentage of respondents based on three different categories – SOV, Transit Riders and All other modes in using dynamic ride-sharing, bike-sharing and car-sharing- are significantly different at a confidence level of 95%.

Major insights include:

- It was surprising to note that SOV respondents were more likely to use bike-sharing for their short trips than other shared modes to replace their short SOV trips. However, SOV respondents would like to use bike-sharing the least for their long trips compared to other shared modes. In the comments section, many SOV respondents mentioned their

willingness to use bike-sharing programs because these modes were safe for the environment. More than one-third of these respondents were 45 to 54 year olds. Surprisingly, half of likely bike-sharing users had two members (54%) and two motor vehicles (51%) per household, indicating they already own enough motor vehicles, but are still willing to use shared bikes.

- Respondents who carpooled and those who used other modes were more likely to switch to shared mobility programs than single occupant vehicle travelers.
- Respondents would probably use bike-sharing for short trips the most, irrespective of the modes they travel.

Table 19 and 20 depict the most common factors that would encourage and discourage the respondents to use shared mobility programs based on the mode of travel for short trips. Chi-squared tests were performed to find out whether there were any significance differences between the categories at a confidence level of 95% and results were shown in the tables.

Table 19. Reasons for Choosing Shared Modes, by Current Mode-Short Trips

		Percentage of Respondents who Indicated this Level of Importance for Each Factor														
Shared Mode	Factors	SOV (%)					Transit Riders (%)					Other Modes (%)				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Avoiding/reducing the costs of car ownership	22	16	24	17	21	23	5	27	23	23	17	13	19	24	27
	Avoid parking fees	20	8	16	18	38	9	14	14	27	36	12	10	18	22	38
	No need to find parking for car (save time)	16	5	20	18	41	9	9	18	27	36	10	10	18	24	39
	Being able to schedule trips with my smartphone	11	6	24	24	36	0	9	32	14	46	13	8	18	29	33
	Lower trip fares than traditional taxi cabs	11	4	18	16	51	14	9	14	27	36	14	4	20	23	40
	Ride-sharing makes using transit more convenient	17	8	27	27	22	9	0	59	9	23	13	7	27	26	27
Bike-Sharing	Avoiding/reducing the costs of car ownership*	26	17	21	30	7	30	15	10	30	15	27	9	12	33	20
	Avoiding/reducing the costs of bike ownership	42	9	20	18	11	35	15	20	20	10	53	15	15	12	6
	Not worrying about getting bike to/from home as it is already where you need a bike	11	7	15	48	19	5	0	30	30	35	14	3	20	41	22
	Avoiding parking fees	18	5	20	42	16	25	10	5	45	15	20	4	9	44	23
	It's fun	8	8	18	35	33	5	0	20	55	20	10	3	11	48	28
Car-Sharing	Avoiding/reducing the cost of car ownership	22	7	24	19	28	10	10	40	15	25	16	8	18	19	39
	Being able to reserve vehicles with my smartphone	12	5	21	21	41	15	0	20	30	35	14	5	19	23	39
	Avoiding parking fees	16	4	18	19	44	15	20	15	20	30	18	8	14	23	37
	Car-sharing makes public transit more convenient	16	8	32	16	27	5	15	25	25	30	17	11	23	26	23

*symbol represents the corresponding factors of three different categories – SOV, Transit Riders and All other modes - are significantly different at a confidence level of 95%.

Table 20. Reasons for NOT Choosing Shared Modes, by Current Mode -Short Trips

		Percentage of Respondents who Indicated this Level of Importance for Each Factor														
Shared Mode	Factors	SOV (%)					Transit Riders (%)					Other Modes (%)				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Personal safety concerns	21	13	22	14	30	23	8	23	23	23	31	13	15	14	27
	Financial safety concerns (must register credit card)	35	15	13	14	24	31	0	23	15	31	43	12	17	12	17
	I like to drive*	28	14	19	12	26	62	15	8	8	8	48	12	19	11	10
	Uncertain reliability/availability of a ride home or to next destination*	9	4	13	22	51	15	8	31	31	15	24	7	16	14	39
	Trip home or to next destination is time sensitive*	9	3	20	18	50	23	0	39	15	23	23	10	23	15	29
Bike-Sharing	Financial security concerns (must register credit card)	56	12	10	8	15	55	18	9	9	9	64	12	13	6	6
	Bike-sharing would not work for the trips I take (Example: you take long trips that require a car)*	12	6	15	16	51	36	9	27	9	18	28	4	20	13	35
	It is too expensive	55	12	10	8	14	55	36	0	0	9	54	12	17	8	8
	I prefer driving my car*	27	9	14	13	36	64	9	9	18	0	55	10	15	8	13
	I do not feel safe biking	30	8	15	22	26	36	18	0	18	27	53	6	10	10	21
Car Sharing	Privacy concerns (GPS location)*	50	15	10	6	19	58	0	17	25	0	61	15	11	3	11
	Car-sharing would not help on the trips I take.(Example: you take short trips within walking distance)	24	9	17	15	36	50	8	25	8	8	32	8	18	18	25
	It is too expensive	30	11	30	11	19	42	0	25	33	0	32	9	23	13	23
	I prefer driving my own car*	15	4	19	15	47	33	0	33	17	17	41	13	16	8	23
	Car-share stations are not located near my origin/destination	12	3	11	12	62	33	0	17	33	17	18	4	15	14	49

*symbol represents the corresponding factors of three different categories – SOV, Transit Riders and All other modes - are significantly different at a confidence of 95%.

The factors most commonly chosen by SOV respondents who would probably use dynamic ride-sharing were ‘ride-sharing makes transit more convenient’, ‘lower fare than traditional taxi cabs’ and ‘avoiding parking fees’. These factors indicated the interest of SOV respondents to switch to dynamic ride-sharing and public transportation facilities. The respondents who traveled in other modes like bus or train also chose similar factors that would encourage their decision to probably use dynamic ride-sharing. On the contrary, about 70 percent and 51 percent of the SOV respondents indicated that they were unwilling to use dynamic ride-sharing for short trips and long trips, respectively. ‘Uncertain reliability/availability of a ride home or to next destination’ and ‘trip home or to next destination is time sensitive’ were the most common factors that would discourage the use of dynamic ride-sharing by single occupant vehicle respondents.

In the case of bike-sharing, the most common factors chosen by SOV respondents were ‘avoid parking fees’, ‘for fun’ and ‘bike-sharing makes transit more convenient’. The percentage of SOV riders, transit riders and those who drove others is significantly different in choosing the encouraging factor ‘avoiding/ reducing vehicle ownership’. In our survey, approximately 46 percent of respondents who drove alone were not likely to switch to bike-sharing from their traditional single occupant vehicles. Major factors that would discourage the use of bike-sharing were ‘bike-sharing would not work for the trips I take’, ‘I prefer driving my own car’ and other reasons that were not listed.

Main factors chosen by SOV respondents that would encourage the use of car-sharing were avoiding/reducing the cost of car ownership, being able to reserve vehicles with a smartphone and avoiding parking fees. More than 60 percent of respondents said that they would not prefer to use car-sharing for their short trips and long trips. Major factors chosen by them were ‘car-

sharing would not help on the trips I take', 'I preferred driving my own car' and 'Car-sharing stations were not located near my origin/destination'.

The percentage of SOV, transit riders and those who used all other modes based on their willingness to use shared modes is significantly different for dynamic ride-sharing and bike-sharing for short trips. On the other hand, the percentage of three above mentioned categories is significantly different for bike-sharing and car-sharing. This indicated the willingness of those who are using traditional modes to use dynamic ride-sharing, bike-sharing and car-sharing. With regard to the factors that would encourage the use of bike-sharing, the percentage of respondents in these three categories is significantly different in choosing 'avoiding/reducing the cost of car ownership'.

6.6.2. Commuters

This section analyzed the opinions of commuters on dynamic ride-sharing, car-sharing and bike-sharing. Thirty eight percent of long (greater than three miles) trips were commute trips while twenty one percent of short (less than three miles) trips were commute trips. Table 21 depicts the current travel behavior of commuting and non-commuting respondents.

Table 21. Mode of Travel & User Demographics Based on Commuting Characteristics (%)

Survey Question		Short Trips		Long Trips	
		Commuters (N = 103)	Non Commuters (N =404)	Commuters (N= 185)	Non Commuters (N = 322)
What was the mode of travel? Short Trip*	Vanpool	0%	0%	0%	0%
	Carpool	3%	1%	4%	3%
	Bus	8%	3%	8%	5%
	Motorcycle	3%	1%	1%	1%
	Car/Truck	43%	58%	74%	76%
	Train	4%	0%	3%	0%
	Walk	6%	13%	1%	0%
	Bike	33%	22%	11%	11%
	Taxi	1%	1%	0%	1%
	Other	0%	0%	1%	2%
Age Short Trip* Long Trip*	16 to 24	4%	6%	4%	6%
	25 to 34	48%	26%	34%	28%
	35 to 44	20%	21%	25%	18%
	45 to 54	14%	23%	22%	20%
	55 to 64	12%	17%	12%	18%
	65 and over	3%	9%	3%	10%
Gender	Male	51%	50%	52%	49%
	Female	50%	50%	48%	51%
Ethnicity	White/Caucasian	77%	76%	77%	76%
	Hispanic/Latino	12%	15%	15%	14%
	African American	2%	2%	2%	2%
	Asian American	3%	2%	3%	2%
	Native American	0%	1%	1%	1%
	Other	6%	4%	4%	5%
Number of people in the household	1	22%	19%	13%	24%
	2	54%	46%	49%	47%
	3	12%	13%	13%	13%
	4	9%	16%	18%	13%
	5	3%	4%	6%	3%
	6	1%	1%	2%	1%
	7	0%	0%	0%	0%

Table 21 Continued. Mode of Travel & User Demographics - Commuting (%)

Survey Question		Short Trips		Long Trips	
		Commuters	Non Commuters	Commuters	Non Commuters
Household type Short Trip*	Single Adult	9%	4%	2%	7%
	Unrelated adults(	22%	13%	15%	14%
	Married without child	37%	36%	37%	36%
	Married with child(ren)	24%	39%	39%	35%
	Single parent family	4%	2%	3%	2%
	Other	5%	6%	4%	6%
Occupation Short Trip* Long Trip*	Professional / Managerial	57%	51%	66%	44%
	Technical	8%	9%	12%	7%
	Sales	2%	2%	4%	1%
	Service (restaurants, retail, etc.)	3%	2%	1%	2%
	Administrative / Clerical	10%	5%	7%	5%
	Manufacturing / Construction	9%	3%	4%	4%
	Stay-at-home parent / homemaker	0%	3%	0%	3%
	Student	8%	9%	4%	11%
	Self employed	3%	6%	1%	8%
	Unemployed / Seeking work	0%	2%	0%	2%
	Retired	1%	9%	1%	12%
	Other	0%	0%	0%	0%
Education	Less than high school	0%	0%	0%	0%
	High school graduate	1%	2%	1%	2%
	Some college / Vocational	12%	14%	9%	16%
	College graduate	50%	47%	48%	47%
	Post graduate	38%	38%	42%	35%
Annual Income Long Trip*	Less than $10,000	2%	1%	0%	2%
	$10,000 to $14,999	1%	1%	0%	2%
	$15,000 to $24,999	3%	3%	3%	3%
	$25,000 to $34,999	7%	4%	2%	5%
	$35,000 to $49,999	9%	9%	9%	8%
	$50,000 to $74,999	24%	16%	15%	19%
	$75,000 to $99,999	9%	12%	15%	8%
	$100,000 to $149,999	17%	22%	25%	19%
	$150,000 to $199,999	6%	11%	14%	8%
	$200,000 or more	14%	8%	7%	11%
	Prefer not to answer	10%	14%	9%	15%
	It is easier to note wage/hr.	0%	1%	1%	0%

*symbol represents the corresponding demographic characteristic of commuters and non-commuters with respect to short trip and long trip are significantly different at a confidence level of 95%.

Table 22 depicts the willingness of commuters and non-commuters to use dynamic ride-sharing, bike-sharing and car-sharing.

Table 22. Willingness to Use Shared Modes Based On Commuting Characteristics (%)

Shared Mode	Options	Short Trip		Long Trip	
		Commuters	Non Commuters	Commuters	Non Commuters
Dynamic Ride-Sharing	I am not sure	2%	3%	2%	3%
	1 – Definitely Not	27%	36%	22%	23%
	2 – Probably Not	26%	31%	29%	21%
	3 – Maybe	21%	16%	29%	28%
	4 – Probably Yes	12%	8%	14%	14%
	5 – Definitely Yes	12%	6%	5%	11%
Bike-Sharing	I am not sure	1%	2%	1%	1%
	1 – Definitely Not	13%	23%	41%	42%
	2 – Probably Not	19%	19%	30%	27%
	3 – Maybe	25%	22%	17%	15%
	4 – Probably Yes	20%	18%	6%	8%
	5 – Definitely Yes	21%	16%	5%	7%
Car-Sharing Short Trip*	I am not sure	0%	2%	0%	3%
	1 – Definitely Not	27%	33%	21%	25%
	2 – Probably Not	25%	28%	24%	19%
	3 – Maybe	26%	19%	29%	27%
	4 – Probably Yes	7%	11%	17%	14%
	5 – Definitely Yes	15%	7%	9%	13%

*symbol represents the percentage of commuters and non-commuters in using shared mobility programs, with respect to short trip and long trip, are significantly different at a confidence level of 95%.

Table 23 and 24 show the most common factors that would encourage and discourage commuters and non-commuters to use dynamic ride-sharing, bike-sharing and car-sharing for short trips. The factors were represented on a scale of 1 to 5 and the options were: ‘1 - definitely not important’, ‘2 – probably not important’, ‘3 – may be’, ‘4 - probably not important’ and ‘5 - definitely not important’. Chi-squared tests were performed to find out whether there were any significance difference between the categories at a confidence level of 95% and results were shown in the tables.

Table 23. Reasons for Choosing Shared Modes- Current Commuting Characteristics – Short Trips (%)

		Percentage of Respondents who Indicated this Level of Importance for Each Factor									
Shared Mode	Factors	Commuters (%)					Non Commuters (%)				
		1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Avoiding/reducing the costs of car ownership	18	17	21	16	29	20	12	21	23	24
	Avoid parking fees	10	10	18	27	36	16	10	17	20	38
	No need to find parking for car (save time)	10	10	17	19	45	13	8	19	23	38
	Being able to schedule trips with my smartphone	5	6	21	29	40	13	8	21	25	33
	Lower trip fares than traditional taxi cabs	12	8	19	18	42	13	3	19	22	44
	Ride-sharing makes using transit more convenient	7	4	39	23	27	16	8	26	25	24
Bike-Sharing	Avoiding/reducing the costs of car ownership	21	20	12	30	18	29	10	15	32	14
	Bike-sharing allows me to reach more destinations than walking.	4	5	16	55	21	10	4	16	41	30
	Avoiding parking fees	17	5	14	47	18	21	5	12	42	20
	Getting exercise	3	5	22	42	29	7	4	16	49	25
	Bike-sharing makes transit more convenient.	5	3	22	39	32	11	6	20	37	26
	It's fun	5	5	13	48	30	10	4	14	43	29
Car-Sharing	Avoiding/reducing the cost of car ownership	12	8	19	21	40	19	8	22	18	33
	Being able to reserve vehicles with my smartphone	10	5	15	24	46	14	5	21	22	38
	Avoiding parking fees	10	8	15	22	45	19	7	15	22	37
	Car-sharing makes public transit more convenient	11	9	21	31	28	17	11	28	20	24

*symbol represents the corresponding encouraging factors of commuters and non-commuters based on their short trip are significantly different at a confidence level of 95%. However, there were no significant difference in choosing encouraging factors to use shared modes between commuters and non-commuters.

Table 24. Reasons for NOT Choosing Shared Modes-Current Commuting Characteristics – Short Trips (%)

		Percentage of Respondents who Indicated this Level of Importance for Each Factor									
Shared Mode	Factors	Commuters (%)					Non Commuters (%)				
		1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Personal safety concerns	37	8	22	11	22	24	14	17	15	30
	Financial safety concerns (must register credit card)	47	17	8	14	14	38	12	17	12	22
	Privacy concerns (GPS location)	49	14	19	13	5	41	14	17	9	20
	I like to drive*	57	19	15	5	5	37	11	20	13	20
	Uncertain reliability/availability of a ride home or to next destination*	18	9	21	24	27	17	5	14	17	47
Bike-Sharing	Bike-sharing would not work for the trips I take (Example: you take long trips that require a car)*	28	8	22	20	22	20	4	17	13	46
	I prefer driving my car*	61	15	8	8	8	39	9	16	11	26
	I do not like to bike*	87	8	3	2	0	64	9	11	5	12
Car Sharing	Privacy concerns (GPS location)*	70	7	15	6	2	53	16	10	5	16
	I prefer driving my own car*	38	13	18	2	30	28	8	18	14	33
	Car-share stations are not located near my origin/destination	30	4	11	18	38	13	3	14	13	56

*symbol represents the corresponding discouraging factors of commuters and non-commuters based on their short trip are significantly different at a confidence level of 95%.

Major insights were:

- Commuters were more likely to use shared mobility programs than non-commuters. In the case of dynamic ride-sharing, the percentage of commuters was higher than the percentage of all survey respondents who were willing to switch to shared modes. These observations confirm the findings about the potential of dynamic ride-sharing as a mode for commuting trips (JianLing et al., 2007; Deakin et al., 2010).
- Major factors that would encourage the use of dynamic ride-sharing for short trips were being able to reserve using smartphone, time savings, avoidance of parking costs and cheaper than traditional taxi cabs. A similar survey conducted in Berkeley, California found that the reasons for not using dynamic ride-sharing for commute trips were time-consumption and unreliability of trips (Deakin et al., 2010). However, Texan survey respondents did not mention the complexity of picking up fellow riders for a shared ride, similar to previous studies. In the case of bike-sharing, major encouraging factors were 'bike-sharing make public transit services more convenient', 'for fun' and 'ability to reach more destinations than walking'. The most common factors that would encourage the use of car-sharing for short commuting trips were being able to reserve easily using a smart phone, avoidance of parking fees and other reasons that were not listed.
- The percentage of commuters who would like to use shared mobility programs for long trips was less than those who would likely use these modes for short trips. However, in a similar survey conducted at the University of California in Berkeley, the results showed that commuters tend to use dynamic ride-sharing for long trips, as the time taken for picking up and dropping off the passengers might be higher for short trips compared to the total trip time (Deakin et al., 2010).

- The most common factors that would encourage the use of shared mobility programs for long commuting trips were similar to those factors for short commuting trips. The percentage of commuters (51.4 %) and non-commuters (67%) who chose 'No need to find parking for car (saves time)' that would encourage them to use dynamic ride-sharing, was significantly different. In the case of encouraging and discouraging factors for using car sharing, significantly higher percentage of non-commuters chose that 'I cannot rent a car at a regular rental place as I do not have car insurance' (commuters – 3.2%, non-commuters – 9.8%),and 'I prefer driving my own car' (commuters – 34.1%, non-commuters – 50%) respectively, for their long trips.

6.6.3. Gender

This section discusses the preference of travelers for car-sharing, bike-sharing and dynamic ride-sharing based on gender. There were 250 male respondents and 251 female respondents in the survey. Six respondents did not mention their gender. Table 25 lists the respondents' preference statistics based on their gender.

Table 25. Gender-wise Preference of Shared Mobility Programs (%)

Shared Mode	Options	Short Trip		Long Trip	
		Male	Female	Male	Female
Dynamic Ride-Sharing Long Trip*	I am not sure	1%	5%	1%	4%
	1 – Definitely Not	35%	34%	24%	22%
	2 – Probably Not	30%	30%	26%	22%
	3 – Maybe	19%	16%	28%	29%
	4 – Probably Yes	7%	9%	10%	18%
	5 – Definitely Yes	8%	6%	12%	6%
Bike-Sharing	I am not sure	2%	2%	2%	0%
	1 – Definitely Not	19%	22%	38%	45%
	2 – Probably Not	20%	18%	29%	28%
	3 – Maybe	21%	24%	18%	14%
	4 – Probably Yes	18%	18%	6%	7%
	5 – Definitely Yes	20%	15%	7%	5%
Car-Sharing	I am not sure	2%	2%	2%	1%
	1 – Definitely Not	33%	31%	24%	23%
	2 – Probably Not	26%	30%	19%	23%
	3 – Maybe	21%	20%	27%	28%
	4 – Probably Yes	11%	9%	17%	13%
	5 – Definitely Yes	9%	8%	11%	11%

*symbol represents the percentage of male and female respondents in using shared mobility programs, with respect to short trip and long trip, are significantly different at a confidence level of 95%.

Tables 26 and 27 depict major factors that encourage and discourage the use of shared mobility programs by gender. The respondents were asked to rate the factors on a scale of 1 to 5 and the options were: ‘1 - definitely not important’, ‘2 – probably not important’, ‘3 – may be’, ‘4 - probably not important’ and ‘5 - definitely not important’. The combined percentage of options ‘4 - probably not important’ and ‘5 - definitely not important’ were used to draw conclusions.

Table 26. Reasons for Choosing Shared Modes Based on Gender – Short Trips (%)

		Percentage of Respondents who Indicated this Level of Importance for Each Factor									
		Men					Women				
	Factors	1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Avoiding/reducing the costs of car ownership*	19.1	19.7	19.7	15.4	26.1	18.7	7.1	23.6	27.5	23.1
	Avoid parking fees*	18.5	6.9	20.1	26.5	28.0	10.4	11.5	14.3	15.4	48.4
	No need to find parking for car (save time)	12.8	9.0	18.6	22.3	37.2	11.5	7.1	18.1	20.9	42.3
	Being able to schedule trips with my smartphone*	12.6	4.2	23.2	28.9	31.1	9.3	11.0	18.1	23.6	37.9
	Not having to prearrange a carpool*	17.0	8.0	16.5	34.0	24.5	14.3	7.1	26.9	16.5	35.2
Bike-Sharing	Not worrying about getting bike to/from home as it is already where you need a bike*	12.0	6.0	21.3	36.1	24.6	11.0	2.5	16.0	51.5	19.0
	No need to find parking for car (save time)	10.9	6.5	17.4	41.8	23.4	11.0	2.5	10.4	52.1	23.9
	Avoiding parking fees*	23.0	5.5	14.2	33.9	23.5	15.4	4.3	11.1	54.3	14.8
	Getting exercise*	4.9	6.5	22.8	38.0	27.7	6.7	1.2	10.4	58.5	23.2
Car-Sharing	I enjoy driving a different vehicle than my own*	53.6	21.7	12.0	9.0	3.6	65.0	9.8	15.3	4.3	5.5
	Being able to reserve vehicles with my smartphone	12.6	5.4	21.6	21.6	38.9	14.0	4.1	18.1	24.0	39.8
	Avoiding parking fees	17.4	8.4	16.2	25.7	32.3	16.6	5.9	14.2	18.3	45.0
	Car-sharing makes public transit more convenient	16.2	14.4	25.7	24.0	19.8	16.4	6.1	26.1	21.8	29.7

*symbol represents the corresponding encouraging factors that male and female respondents chose based on their short trip are significantly different at a confidence level of 95%.

Table 27. Reasons for NOT Choosing Shared Modes Based on Gender – Short trips (%)

		Percentage of Respondents who Indicated this Level of Importance for Each Factor									
		Men					Women				
	Factors	1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Personal safety concerns*	35.1	17.5	16.2	16.2	14.9	17.7	7.9	20.1	13.4	40.9
	Privacy concerns*	51.9	10.9	17.9	6.4	12.8	32.9	17.1	17.1	12.8	20.1
	I like to drive*	36.9	14.0	14.6	16.6	17.8	44.4	11.3	22.5	6.9	15.0
	I do not have a smartphone*	77.6	3.8	3.2	3.2	12.2	82.4	1.9	8.2	0.0	7.5
	Uncertain reliability/availability of a ride home or to next destination*	22.2	7.0	18.4	17.1	35.4	13.1	4.8	13.7	18.5	50.0
	Trip home or to next destination is time sensitive*	17.9	9.6	28.8	14.7	28.8	16.6	4.3	17.2	16.6	45.4
Bike-Sharing	Financial security concerns	64.4	12.6	10.4	3.7	8.9	56.1	12.2	12.2	10.1	9.5
	Bike-sharing would not work for the trips I take	24.1	8.0	17.5	17.5	32.8	18.7	2.6	18.7	11.6	48.4
	It is too expensive	61.9	11.9	12.7	3.7	9.7	48.0	14.2	14.9	11.5	11.5
	I do not like to bike*	78.7	7.4	5.9	3.7	4.4	58.6	9.9	13.2	5.3	13.2
	I do not feel safe biking*	57.7	8.0	5.8	13.1	15.3	29.0	7.1	15.5	18.1	30.3
Car-Sharing	Financial security concerns*	66.4	10.3	8.2	2.7	12.3	47.6	12.6	14.0	11.2	14.7
	Privacy concerns	65.0	12.6	9.1	4.2	9.1	48.3	15.4	12.6	6.3	17.5
	Car-sharing would not help on the trips I take*	33.1	10.6	21.1	12.7	22.5	25.5	6.2	14.5	20.0	33.8
	It is too expensive	38.2	5.6	25.0	13.9	17.4	26.1	12.3	26.1	12.3	23.2

*symbol represents the corresponding discouraging factors that male and female respondents chose based on their short trip are significantly different at a confidence level of 95%.

Major insights included:

Dynamic-Ridesharing:

- The percentage of male respondents and female respondents who would likely use three shared modes are very similar. Major factors that encouraged a significantly higher percentage of female respondents than male respondents to use dynamic ridesharing were ‘avoiding/reducing the costs of car ownership’ and ‘avoid parking fees’. Conversely, male respondents indicated ‘not having to prearrange a carpool’ as an important factor to use dynamic ride sharing significantly more than females.
- Females were significantly more likely than males to choose ‘personal safety concerns’ and ‘privacy concerns’ as factors that would discourage their use of ride sharing. On the other hand, a significantly higher percentage of male respondents chose ‘I like to drive’ and ‘I do not have a smart phone’ as discouraging factors. Earlier studies found that women travelers prefer to travel with a women in a shared ride due of safety reasons (Deakin et al. 2010). The survey results support the finding that women respondents weigh safety more than males in using shared modes.

Bike Sharing:

- A significantly higher percentage of women than men chose ‘no need to find parking for car’ , ‘not worrying about getting bike to/from home as it is already when you need a bike’ and ‘getting exercise’ as reasons that would encourage them to bike-share. A significantly higher percentage of female respondents than male respondents chose ‘I do not feel safe biking’ and ‘I do not like to bike’, as factors that would discourage their use of bike-sharing.

Car Sharing:

- In the case of car-sharing, most men and women chose ‘being able to reserve easily using a smart phone’ and ‘avoid parking fees’ as encouraging factors. On the other hand, a significantly higher percentage of women than men chose ‘car-sharing stations would not work for the trips I take’ and ‘financial security concerns’ as factors discouraging car-sharing.

6.6.4. Drivers/Passengers

Respondents were asked whether they were drivers or passengers on their most recent trip. 57 drivers and 24 passengers responded about their most recent short trip. 91 drivers and 38 passengers responded about their recent long trip.

Table 28 depicts the preference of drivers and passengers in using dynamic ride-sharing, bike-sharing and car-sharing.

Table 28. Preference of Shared Modes: Drivers vs Passengers (%)

Willingness to use shared modes	Short Trip		Long Trip	
	Driver	Passenger	Driver	Passenger
Dynamic Ride-Sharing Short Trip*	17.6%	33.4%	23.3%	34.2%
Bike-Sharing	33.3%	20.8%	22%	32%
Car-Sharing Short Trip*	28.5%	12.5%	30%	29%

Key indications of the results were:

- A significantly higher percentage of passengers would like to use dynamic ride-sharing than drivers for their short trips. On the other hand, a significantly higher percent of drivers prefer to use car-sharing for their short trips. However, earlier studies stated that one of the important reasons for not taking dynamic ride-sharing was complexity in picking up and dropping of passengers (Deakin et al., 2010). The survey results indicated that passengers were more likely to use this service than drivers. Thus supporting the results from Deakin et al. that drivers would avoid the picking up and dropping off of passengers.

6.6.5. Respondents Who Heard About & Used Shared Modes Prior To Survey

As described earlier, the survey contained 3 sections for dynamic ride-sharing, car-sharing, and bike-sharing. A small description about the shared modes and examples of these modes existing in the location chosen by the traveler, in the beginning of the survey, was given in each survey section. The aim was to help the respondents to have a better understanding of shared modes of transportation.

The respondents were asked whether they had heard of /used dynamic ride-sharing, bike-sharing and car-sharing prior to the survey. Table 29 outlines the prior experience of respondents with car-sharing, bike-sharing and dynamic ride-sharing. More than 80 percent of respondents had heard about shared mobility programs prior to the survey. Further survey analysis was performed to examine whether they were willing to choose shared mobility programs or not, and the factors behind their decisions.

Table 29. Prior Experience on Shared Modes (%)

	Shared Program	(%)
Heard about shared mode prior to the survey	Ride-Sharing	89%
	Car-Sharing	83%
	Bike-Sharing	87%
Used shared mode prior to the survey	Ride-Sharing	32%
	Car-Sharing	72%
	Bike-Sharing	33%

Table 30 outlines how likely are the respondents who heard about shared modes prior to the survey to use dynamic ride-sharing, bike-sharing and car-sharing. Chi squared tests were performed to analyze whether there are any significant difference between these percentages of those who heard about dynamic ride-sharing and not heard prior to the survey.

Table 30. Preference of Those Who Already Heard About Shared Modes (%)

	Short Trip	Long Trip
Dynamic Ride-Sharing	15.40%	22.40%
Bike-Sharing	38.6%*	14.5%*
Car-Sharing	21.2%*	28.5%*

*symbol represents the percentage of those who heard/not heard about shared modes are significantly different at a confidence level of 95%.

Table 31 outlines the willingness of respondents who already used shared prior to the survey to continue using dynamic ride-sharing, bike-sharing and car-sharing. It is not surprising that the willingness percentage of respondents in this category is significantly higher than those who haven’t used these modes, in using dynamic ride-sharing, bike-sharing and car-sharing,

irrespective of trip length. Table 32 and 33 depicts major reasons for choosing/not choosing shared modes by those who have prior experience and not.

Table 31. Preference of Those Who Already Used Shared Modes (%)

	Short Trip	Long Trip
Dynamic Ride-Sharing	33.8%*	40.8%*
Bike-Sharing	65%*	26.5%*
Car-Sharing	41.1%*	49.2%*

*symbol represents the percentage of those who used shared modes and not used shared modes are significantly different at a confidence level of 95%.

Table 32. Reasons for Choosing Shared Modes Based on Prior Experience (%)

		Percentage of Respondents who Indicated this Level of Importance for Each Factor									
Shared Modes	Encouraging Factors	Respondents who have NOT used prior to the survey					Respondents who have used prior to the survey				
		1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	No need to find parking for car (save time)*	14%	8%	18%	24%	36%	5%	10%	18%	20%	47%
	Being able to schedule trips with my smartphone*	13%	9%	25%	26%	27%	6%	3%	13%	27%	50%
	Not having to exchange payment with driver*	13%	10%	31%	22%	24%	10%	6%	15%	27%	41%
	Not having to drive myself*	21%	9%	26%	17%	27%	14%	5%	16%	19%	46%
	Lower trip fares than traditional taxi cabs	14%	2%	19%	22%	42%	10%	5%	19%	21%	46%
	Avoid parking fees	16%	10%	20%	20%	34%	10%	9%	12%	25%	45%
Bike-Sharing	Avoiding/reducing the costs of car ownership*	33%	10%	16%	27%	14%	17%	14%	12%	38%	19%
	Bike-sharing allows me to reach more destinations in close range than walking*	10%	6%	17%	37%	31%	2%	4%	12%	55%	27%
	Bike-sharing makes transit more convenient*	11%	7%	24%	32%	26%	5%	3%	15%	45%	32%
	It's fun*	12%	7%	14%	38%	30%	2%	2%	6%	56%	34%
	Getting exercise	7%	4%	17%	44%	28%	4%	2%	17%	53%	23%
Car-Sharing	Being able to reserve vehicles with my smartphone*	14%	4%	24%	26%	32%	9%	3%	13%	17%	58%
	Avoiding parking fees*	19%	10%	19%	19%	33%	11%	3%	9%	26%	52%
	Car-sharing makes public transit more convenient	16%	9%	31%	23%	22%	14%	10%	18%	23%	35%

*symbol represents the corresponding encouraging factors that the respondents who had prior experience and who didn't have experience, chose are significantly different at a confidence level of 95%.

Table 33. Reasons for NOT Choosing Shared Modes Based on Prior Experience (%)

		Percentage of Respondents who Indicated this Level of Importance for Each Factor									
Shared Modes	Discouraging Factors	Respondents who have NOT used prior to the survey					Respondents who have used prior to the survey				
		1	2	3	4	5	1	2	3	4	5
Dynamic Ride-Sharing	Personal safety concerns*	20%	13%	18%	17%	32%	47%	17%	13%	10%	13%
	Financial safety concerns (must register credit card)*	32%	13%	15%	16%	23%	59%	16%	14%	4%	7%
	Privacy concerns (GPS location)*	36%	15%	19%	11%	19%	66%	13%	9%	3%	10%
	Using an app to get a ride is too complicated*	57%	13%	16%	6%	8%	80%	13%	3%	3%	1%
	Uncertain reliability/availability of a ride home or to next destination*	12%	5%	14%	22%	48%	32%	11%	25%	13%	18%
	It is too expensive	20%	13%	19%	16%	31%	18%	13%	27%	13%	30%
	Ride-sharing would not work for the trips I take (Examples: you make frequent stops or you take short trips within walking distance)	18%	12%	23%	18%	29%	31%	13%	20%	10%	26%
Bike-Sharing	I prefer driving my car*	42%	10%	16%	13%	18%	67%	10%	14%	3%	5%
	I do not like to bike*	69%	8%	10%	5%	8%	88%	9%	4%	0%	0%
	It is too expensive	56%	11%	14%	7%	12%	58%	10%	12%	10%	10%
	I do not feel safe biking	44%	7%	10%	16%	23%	50%	7%	14%	12%	17%
Car-Sharing	Privacy concerns (GPS location)*	55%	15%	11%	5%	15%	82%	6%	8%	2%	2%
	Car-sharing would not help on the trips I take.(Example: you take short trips within walking distance)*	25%	8%	19%	17%	31%	49%	6%	16%	12%	16%
	I prefer driving my own car*	25%	10%	19%	15%	31%	63%	8%	10%	8%	10%
	Car-share stations are not located near my origin/destination*	12%	4%	11%	15%	57%	34%	2%	20%	16%	28%

*symbol represents the corresponding discouraging factors that the respondents who had prior experience and who didn't have experience, chose are significantly different at a confidence level of 95%.

The factors chosen by those who already used shared modes were further analyzed. For dynamic ride-sharing, the most common factors chosen by the respondents behind their decision to probably use dynamic ride-sharing were ‘being able to reserve with a smart phone’, ‘avoiding parking costs’ and ‘not having to exchange payment with driver’. Unlike the most common factors chosen in all other scenarios, factors like’ ‘being able not to exchange payment with the driver’ and ‘not having to drive myself’ were chosen by a higher percentage of respondents who had prior experience. The most commonly chosen discouraging factors are ‘expensive trips’, ‘it would not work for the trips I take’ and ‘uncertain reliability/availability of a ride home or to next destination’.

In this case, major encouraging factors behind their decisions were ‘for fun’ and ‘they allow to reach more destinations than walking’. 42 percent of respondents said bike-sharing was too expensive and 29 percent were concerned about safety. It was necessary to give due importance to these factors, as the respondents chose them based on their prior bike-sharing experiences.

In car-sharing, the most commonly chosen encouraging factors by majority of the respondents were ‘being able to reserve using a smartphone’ and ‘avoiding parking costs’. On the other hand, major factors for not using car-sharing were non–accessibility of car-sharing stations and ‘car-sharing would not help on the trips they take’. It is interesting to note that significantly lower percentage of respondents with prior experience chose ‘privacy concerns’ as a discouraging factor.

6.7. Impact of Bike-Sharing On Trips Taken

The respondents were asked to comment whether bike-sharing would impact the number of trips they make (see Table 32). Fishman et al. (2013) found that bike-sharing programs had a

significant impact on car-mode substitution and vehicle miles traveled. As the number of people who traveled by car increases, substitution rate increases (Fishman et al., 2013; Shaheen et al., 2010). 44 percent of respondents in the survey indicated that the use of bike-sharing services might reduce their number of car/bus/motorcycle trips. However, in order to optimize the impact of bike-sharing on car use, it is necessary to implement measures to encourage mode shifts from car to bike (Fishman et al., 2013).

Table 34. Impact of Bike-Sharing on Trips Taken (%)

If bike-sharing were available, how likely is bike-sharing to reduce the number of car/bus/motorcycle trips you take?	Percent of respondents
5 – Very Likely.	14%
4 – Likely/Probably	30%
3 – Maybe	17%
2– Unlikely/Probably Not	26%
1 – Very Unlikely	14%

6.8. Impact of Shared Modes on Vehicle Ownership

When asked to rate the factors behind their decisions to probably use dynamic ride-sharing, bike-sharing and car-sharing, many respondents (dynamic ride-sharing – 46.1%, bike-sharing – 46.1%, car-sharing 53.1%) mentioned one of the important factors as avoiding/reducing the cost of vehicle ownership. Furthermore, they were asked to comment whether dynamic ride-sharing, bike-sharing and car-sharing would impact the number of vehicles that they own. Table 33 demonstrates their responses for dynamic ride-sharing, bike-sharing and car-sharing.

However, only less than 10% respondents said that these new travel options would definitely reduce their vehicle ownership.

Compared to other shared modes, dynamic ride-sharing tend to impact the reduction of vehicle ownership the most. Unlike other shared modes, about 36 percent of respondents answered that dynamic ride-sharing definitely/probably would reduce the number of vehicles owned. Similarly, only 6 percent of respondents told that dynamic ride-sharing would definitely not reduce the number of vehicles owned. Levofsky and Greenswood (2001) stated that 'dynamic ridesharing allows households to limit their car ownership by providing opportunities to use an alternative form of transportation that does not sacrifice convenience'. Similarly, car-sharing is often advertised as an alternative to private vehicles. In the survey, 16 percent mentioned that that car-sharing might impact vehicle ownership, whereas 52 percent of respondents did not think car-sharing might impact vehicle ownership. This indicated that a section of the present survey respondents were also in agreement with the findings of Levofsky and Greenswood. About 80 percent of respondents mentioned that bike-sharing would not impact vehicle ownership.

Table 35. Impact of Shared Modes on Vehicle Ownership (%)

If shared mode is available do you think you would reduce the number of cars you or your family owns?	Ride-Sharing	Bike-Sharing	Car-Sharing
5 – Yes. I would reduce the number of vehicles owned.	3%	4%	8%
4– Probably Yes	33%	6%	8%
3 – Maybe	37%	10%	21%
2 – Probably Not	16%	35%	28%
1 – Definitely would not reduce the number of vehicles owned.	6%	45%	30%
Unsure	6%	1%	2%

6.9. Characteristics of Likely Users of Shared Mobility Programs

This section identifies likely user characteristics of those who were willing to switch to car-sharing, bike-sharing and dynamic ride-sharing. The user demographics of the respondents who answered they would definitely/ probably shift to shared programs for their short trip are tabulated for dynamic ride-sharing, bike-sharing and car-sharing in Table 36.

Table 36. Characteristics of Shared Mobility Program Likely Users for Short Trips

User Characteristics	Dynamic Ride-Sharing (256 responses)	Bike-Sharing (201 responses)	Car-Sharing (294 responses)
Age	25 to 34 (25%)	25 to 34 (24%)	25 to 34 (25%)
Gender	Men (50 %)	Women (51%)	Women (51%)
Ethnicity	White (Caucasian) (80%)	White (Caucasian) (79%)	White (Caucasian) (82%)
Education	College Graduate (47%)	College Graduate (41%)	College Graduate (45%)
Income Level	$100,000 to $149,999 (22%)	$100,000 to $149,999 (20%)	$100,000 to $149,999 (21%)
Profession	Professional (50%)	Professional (48%)	Professional (48%)
Household type	Married With Children (39%)	Married Without Children (42%) Married With Children (41%)	Married With Children (39%)
Vehicles Owned	2 (48%)	2 (45%)	2 (47%)
Number of people	2 (47%)	2 (46%)	2 (47%)

It was found that a major share of respondents would definitely/probably use dynamic ride-sharing, bike-sharing and car-sharing for long trips as well. When examining likely user characteristics of these respondents, the results showed that they exhibit similar characteristics

as those who would like to use dynamic ride-sharing, bike-sharing and car-sharing for short trips. These characteristics are similar to the most dominant demographic characteristics of survey respondents. The survey respondents' sample was biased and no weighting was performed for the data to make it more representative. Hence the above results are not giving us any interesting finding other than that of overall survey respondents.

Earlier studies found that car-sharing users tend to be in their mid-30s and mid-40s (Brook, 2004; Lane, 2005). According to the survey results, the likely users of shared modes in Texas tend to be younger than literature findings. However, several studies across the globe also found that the users of car-sharing and bike-sharing tend to be younger (Efthymiou et al., 2012; Millar-Ball, 2006). Morency (2007) defined ride-sharing as a preferred transportation mode for young travelers. The survey results tend to refute some findings on education and income of car-sharing users. Shaheen et al. (2004) found that car-sharing was an inexpensive choice for students and low-income households. Similarly, Zhou Bin et al. (2011) found that higher income adults who own a car did not wish to use shared mobility programs in Austin and education level of individuals doesn't impact the usage of these programs. On the other hand, the survey tends to support the likely user characteristics of 'Ca-Bi' bike-sharing members, found by Shaheen and Cohen. These findings indicated that they were younger than 34 years age, white and had a bachelor's degree or higher (Shaheen and Cohen, 2012).

6.10. User Comments

The respondents were asked to provide general comments at the end of survey to improve shared mobility programs. 229 respondents provided their comments on dynamic ride-sharing, bike-sharing and car-sharing. Most of the respondents requested improvements to biking infrastructure facilities for increasing the ridership of bike-sharing programs, confirming the

findings of Fishman et al. (2013). They also mentioned the difficulty of those who lived in sub-urban areas to use shared mobility programs and non-accessibility of car-sharing programs. Some respondents preferred point-to-point car-sharing services rather than round trip services in which they had to return the vehicle to the origin. Several researches had been conducted to examine one-way car-sharing systems, which allow users to take vehicles from one location and drop off in a different location, and their performance over round trip services (Jorge and Correia, 2013). Many of them indicated the need for improved public transportation facilities so that they could use shared mobility programs along with public transit as a multi modal travel option.

The respondents were also asked to mention changes to be made so that they could use car-sharing, bike-sharing and dynamic ride-sharing for their future trips. Many respondents requested to improve background security checks of drivers and ensure the safety of the riders for dynamic ride-sharing. They also described lowering the trip fares further to increase the ridership of dynamic ride-sharing modes. Some respondents who already own enough motor vehicles for themselves were not willing to switch to shared rides. Respondents suggested to improve biking infrastructure facilities and place more bike-sharing stations. Those who already own bicycles were not as willing to use shared programs. Some respondents considered bike-sharing too expensive for short term trips. In the case of car-sharing, the changes suggested by the respondents to increase the uses of car-sharing include accessibility to more car-sharing stations in more locations, need for larger vehicles, free registration, economic incentives for users and safety security checks.

7. CONCLUSIONS

This research focused on shared mobility programs, their characteristics, and their potential use by Texas travelers. A web-based survey was conducted in six Texas cities to better understand Texas travelers' thoughts on car-sharing, bike-sharing and dynamic ride-sharing. The survey responses were analyzed and provided insight on the potential use, and impact, of these alternate mobility programs. The author analyzed the characteristics of travelers who would like to use car-sharing, dynamic ride-sharing and bike-sharing for their short trips or long trips and the important factors for choosing or not choosing these modes as an alternate mode of transport. The impact of shared mobility programs on the current travel behavior of individuals was evaluated, including the number of trips made and the number of vehicles owned. This research provided insight on likely user characteristics of these relatively new modes.

7.1. Conclusions

The first part of the New Travel Options Survey documented the current travel behavior of respondents, focusing on attributes of short trips (less than three miles) and long trips (greater than three miles). Car/trucks, biking and walking were often used for short trips and the automobile mode dominated for long trips. Most short trips were shopping and personal errands, while most long trips were commute trips.

Based on the survey results, the respondents indicated interest in using dynamic ride-sharing, bike-sharing and car-sharing. The most frequently chosen factors encouraging the use of dynamic ride-sharing were the ability to schedule trips with a smartphone, no need to find parking and lower trip fares than traditional taxi cabs. On the other hand, the prominent reasons

for not using this mode were the uncertainty regarding their return trip, time sensitivity and personal safety reasons. In the case of car-sharing, the most common reasons encouraging the use of car-sharing were being able to reserve using a smart phone, avoid parking fees and avoid/reduce the cost of car ownership. The most commonly chosen reason for not using car-sharing were the car-sharing locations were not close to their origin or destination, car-sharing would not work for the trips they take and they prefer driving their own car. Similarly, the most frequently chosen reasons to use bike-sharing were getting exercise, the ability to reach more destinations than walking and for fun. On the other side, the most common reasons for not choosing bike-sharing were it would not work for the trips they take, safety concerns in riding bike and they prefer driving their own car.

It was surprising to see that the likely users of three shared mobility programs were very similar. The likely user characteristics of respondents' pool who would like to use dynamic ride-sharing, bike-sharing and car-sharing were: 25 to 34 years old, white (Caucasian) ethnicity, college graduates, having an income level between $100,000 to $149,999, working in professional sector and married with children. This might have been due, at least in part, to our choice-based sampling technique.

Based on the survey results, shared mobility programs tend to impact the travel behavior of various categories of travelers differently. The major findings were:

- Single Occupant Vehicle respondents were more likely to use bike-sharing for their short trips than those who used other shared modes to replace their short SOV trips.
- The factors most commonly chosen by SOV respondents were 'ride-sharing makes transit more convenient', 'lower fare than traditional taxi cabs' and 'avoiding parking fees'. These

factors indicated their interest to switch to dynamic ride-sharing and public transportation facilities.

- Commuters were more likely to use shared mobility programs than non-commuters.
- Major reasons for using dynamic ride-sharing for short commuting trips were being able to reserve using smartphone, time savings, avoidance of parking costs and cheaper than traditional taxi cabs, confirming the findings of similar survey conducted in Berkeley, California.
- The percentage of male respondents and female respondents who would likely use three shared modes are very similar.
- Females were significantly more likely than males to choose 'personal safety concerns' and 'privacy concerns' as factors that would discourage their use of ride sharing.
- Similarly for bike-sharing, significantly higher percentage of female respondents than male respondents chose 'I do not feel safe biking' and 'I do not like to bike', as discouraging factors.
- The survey results indicated that passengers were more likely to use this service than drivers. Thus supporting the results from Deakin et al. that drivers would avoid the picking up and dropping off of passengers.
- Encouraging factors like' 'being able not to exchange payment with the driver' and 'not having to drive myself' were chosen by significantly higher percentage of respondents who had prior experience than those who didn't have any experience.
- Significantly lower percentage of respondents with prior experience chose 'privacy concerns' as a discouraging factor to use car-sharing

- Shared modes tend to impact vehicle ownership and number of trips taken by the respondents.

7.2. Research Benefits

The results of this project can be used as an aid to incorporate car-sharing, bike-sharing and dynamic-ride-sharing into the traditional mobility planning activities at regional and local government agencies. The survey provides insight into the perspectives and limitations that influence the success of these mobility programs in a given region. It provides inputs on the aspects need to be focused for incorporating shared mobility programs in multimodal transportation planning.

7.3. Next Steps

The results of this research could be used as a starting point to better understand potential users of shared mobility programs. Discrete choice models could be used to predict the usage of car-sharing, bike-sharing and dynamic ride-sharing by designing utility functions. Utility function parameters can have positive coefficients for terms indicating the factors chosen by majority of respondents to encourage the use of shared modes, whereas the parameters can have negative coefficients for terms indicating the factors chosen by majority of respondents for not choosing shared mode. It may also contain parameters or ASC parameters indicating likely user characteristics of shared modes. Logistic regression models or any other logit models can be used to understand more about how alternate viability programs influence travel decisions of Texans.

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APPENDIX A:

SURVEY AS ONLINE

NEW TRAVEL OPTIONS SURVEY

Dear Traveler,

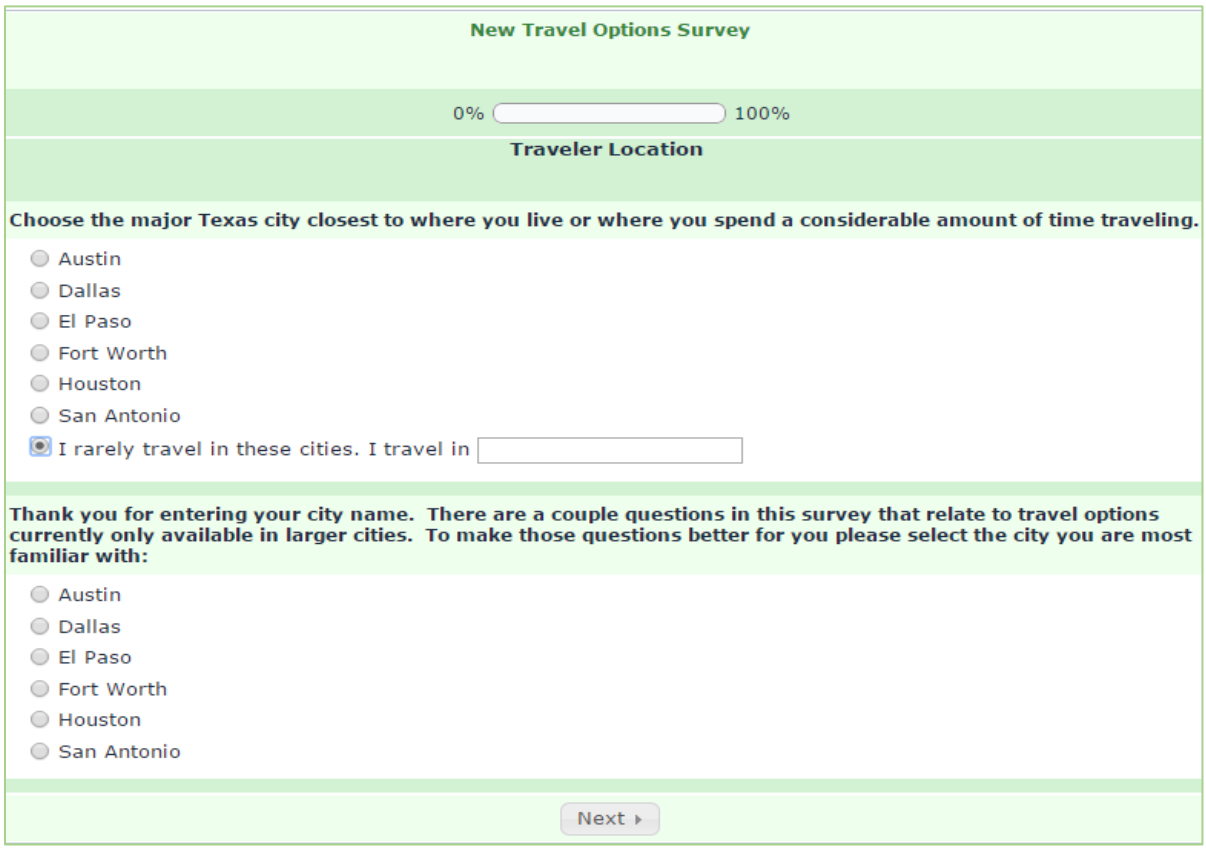
The Texas Department of Transportation is studying the use of new travel options and would like to hear your opinions. Please help us improve travel conditions in Texas by responding to the following transportation related questions. The survey takes about 20 minutes to complete. You are not required to participate in this study however your responses are extremely valuable in our effort to improve travel across Texas. Your survey responses are confidential and will not be used to identify you in any way.

Sincerely,

Mark Burris
mburris@tamu.edu.

This research has been reviewed by the Institutional Review Board at Texas A&M University.
TAMU IRB # 2014-751M-I
Approved 12/02/2014
For research related questions, please contact their office at irb@tamu.edu.

Figure A-1. New Travel Options Survey: Welcome Message



New Travel Options Survey

0% 100%

Traveler Location

Choose the major Texas city closest to where you live or where you spend a considerable amount of time traveling.

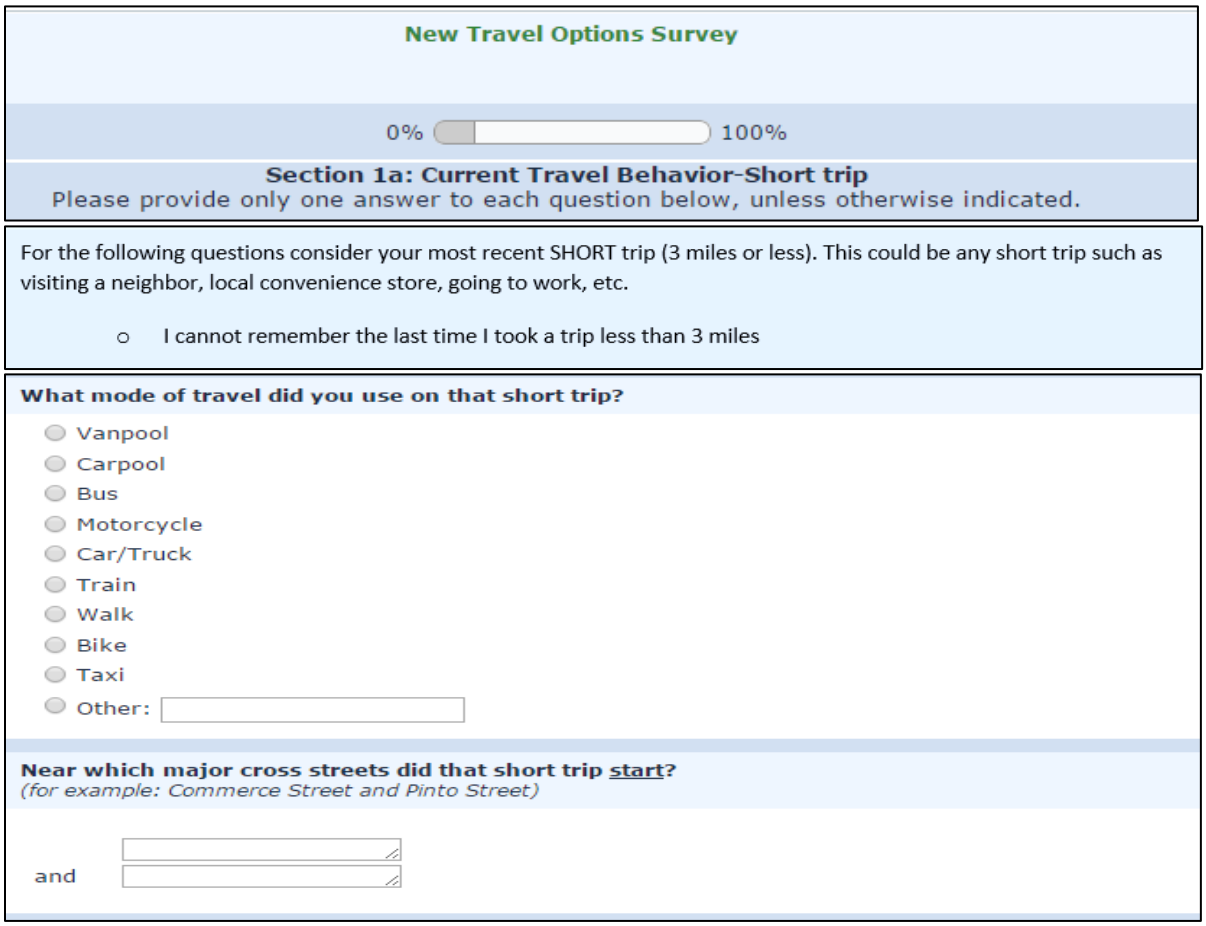
- Austin
- Dallas
- El Paso
- Fort Worth
- Houston
- San Antonio
- I rarely travel in these cities. I travel in

Thank you for entering your city name. There are a couple questions in this survey that relate to travel options currently only available in larger cities. To make those questions better for you please select the city you are most familiar with:

- Austin
- Dallas
- El Paso
- Fort Worth
- Houston
- San Antonio

Next

Figure A-2. New Travel Options Survey: Traveler Location



New Travel Options Survey

0% 100%

Section 1a: Current Travel Behavior-Short trip

Please provide only one answer to each question below, unless otherwise indicated.

For the following questions consider your most recent SHORT trip (3 miles or less). This could be any short trip such as visiting a neighbor, local convenience store, going to work, etc.

- I cannot remember the last time I took a trip less than 3 miles

What mode of travel did you use on that short trip?

- Vanpool
- Carpool
- Bus
- Motorcycle
- Car/Truck
- Train
- Walk
- Bike
- Taxi
- Other:

Near which major cross streets did that short trip start?
(for example: Commerce Street and Pinto Street)

and

Figure A-3. New Travel Options Survey: Current Travel Behavior (Short trips) -1

Near which major cross streets did that short trip end?
(for example: Highway 6 and Clay Road)

and

What was the purpose of that short trip?

- Commuting to or from my place of work (going between home and work)
- Recreational/Social/Entertainment
- Shopping/Personal errand
- Work related (other than to or from home to work)
- To attend class at school or an educational institute
- Other(Type other reason here):

What time of day did that short trip start? (Example: 12:30 PM)

Please choose...

What time of day did that short trip end? (Example: 12:30 PM)

Please choose...

How many people, including you, were there in the vehicle on that short trip?

1 2 3 4 5+

Did you have to pay a toll or fare on that short trip?

- No
- Yes
- I do not know/I forgot

Did you have to pay to park at your destination?

- No
- Yes
- I do not know/I forgot

How many of these types of short trips do you make during a full week (Monday to Sunday)? *(Count each direction of travel as one trip. For example, traveling to work and returning home counts as 2 trips.)*

Trips

These questions refer to the short trip (less than 3 miles) that you just described.
You carpooled/vanpooled with others.

How much extra time does it take you to pick up and drop off all passenger(s)?

Minutes

Who do you generally carpool/vanpool with? (Check all that apply)

- Co-worker / person in the same or a nearby office building
- Neighbor
- Adult family member
- Child
- Other(Type the relationship of the person you travelled with:

Next

Figure A-4. New Travel Options Survey: Current Travel Behavior (Short trips) -2

Section 1b: Current Travel Behavior- Long Trip

For the following questions consider your most recent LONG trip (more than 3 miles). This could be any short trip such as visiting a neighbor, local convenience store, going to work, etc.

- ○ I cannot remember the last time I took a trip more than 3 miles

What mode of travel did you use on that long trip?

- Vanpool
- Carpool
- Bus
- Motorcycle
- Car/Truck
- Train
- Walk
- Bike
- Taxi
- Other: _____

Near which major cross streets did that long trip start?
(for example: Highway 6 and Clay Road)

_____
and _____

Near which major cross streets did that long trip end?
(for example: Highway 6 and Clay Road)

_____
and _____

Figure A-5. New Travel Options Survey: Current Travel Behavior (Long trips) -1

What was the purpose of that long trip?

- Commuting to or from my place of work (going between home and work)
- Recreational/Social/Entertainment
- Shopping/Personal errand
- Work related (other than to or from home to work)
- To attend class at school or an educational institute
- Other(Type other reason here): _____

What time of day did that long trip start? (Example: 12:30 PM)

Please choose...

What time of day did that long trip end? (Example: 12:30 PM)

Please choose...

How many people, including you, were there in the vehicle on that long trip?

1 2 3 4 5+

Did you have to pay a toll or fare on that long trip?

- No
- Yes
- I do not know/I forgot

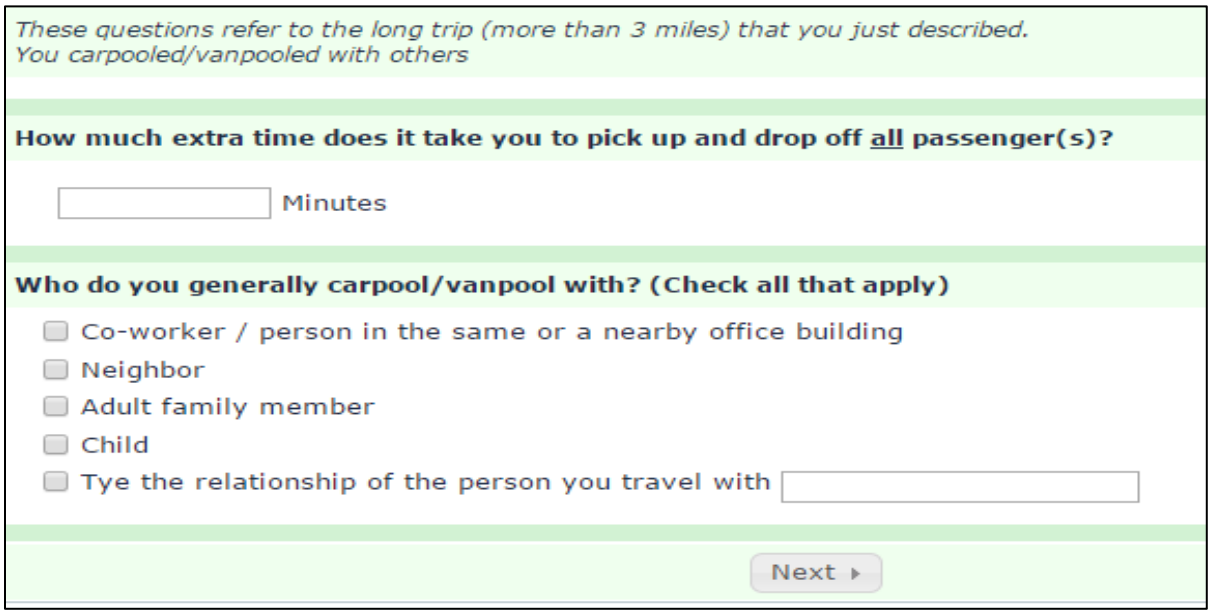
Did you have to pay to park at your destination?

- No
- Yes
- I do not know/I forgot

How many of this type of long trip do you make during a full week (Monday to Sunday)? *(Count each direction of travel as one trip. For example, traveling to work and returning home counts as 2 trips)*

_____ Trips

Figure A-6. New Travel Options Survey: Current Travel Behavior (Long trips) -2



These questions refer to the long trip (more than 3 miles) that you just described.
You carpooled/vanpooled with others

How much extra time does it take you to pick up and drop off all passenger(s)?

Minutes

Who do you generally carpool/vanpool with? (Check all that apply)

- Co-worker / person in the same or a nearby office building
- Neighbor
- Adult family member
- Child
- Tye the relationship of the person you travel with

Next

Figure A-7. New Travel Options Survey: Current Travel Behavior (Long trips) -3

Section 2a. Introduction to New Travel Option - Dynamic Ride-sharing

Dynamic ride-sharing is a one-time shared trip with another traveler on very short notice. Ride-sharing companies (such as Uber or Lyft) match contracted drivers with passengers through their smartphone applications and GPS navigation. Passengers are required to register credit cards, allowing all payment to be handled electronically through the smartphone application rather than with the driver at the end of a trip. Drivers and passengers are able to rate each other at the end of each ride and may view the rating of each other prior to scheduling the ride. Many ride-sharing companies and their users report lower trip fares than traditional taxicab companies.

Have you ever heard of dynamic ride-sharing (such as Uber or Lyft) prior to this survey?

- (●) Yes
- ( ) No

Have you ever used a dynamic ride-sharing company (such as Uber or Lyft)?

- ( ) Yes
- ( ) No

If available, how likely would you be to use ride-sharing for the SHORT trip (less than 3 miles) you previously described?

- ( ) 5 – Definitely Yes
- ( ) 4 – Probably Yes
- ( ) 3 – Maybe
- ( ) 2 – Probably Not
- ( ) 1 – Definitely Not
- ( ) I am not sure

If available, how likely would you be to use ride-sharing for the LONG trip (more than 3 miles) you previously described?

- ( ) 5 – Definitely Yes
- ( ) 4 – Probably Yes
- ( ) 3 – Maybe
- ( ) 2 – Probably Not
- ( ) 1 – Definitely Not
- ( ) I am not sure

Figure A-8. New Travel Options Survey: Dynamic Ride-Sharing – Preference

If you indicated you would choose dynamic ride sharing, then C5) How important are the factors below in your decision to possibly use dynamic ride-sharing?

Scale of Importance:	1	2	3	4	5
Factors:	**Not Important**		**Somewhat Important**		**Very Important**
Avoiding/reducing the costs of car ownership					
Avoid parking fees					
No need to find parking for car (save time).					
Being able to schedule trips with my smartphone.					
Not having to exchange payment with driver.					
Not having to ride in a taxi cab.					
Lower trip fares than traditional taxi cabs.					
Ride-sharing makes using transit more convenient.					
Meeting new people.					
Not having to drive myself					
Not having to prearrange a carpool					
Other					

What are the other factor(s) ?

Figure A-9. New Travel Options Survey: Dynamic Ride-Sharing - Encouraging Factors

If you indicated you would probably not choose dynamic ride sharing, then, how important are the factors below in your decision to possibly not use dynamic ride-sharing?

Scale of Importance:	1	2	3	4	5
Factors:	**Not Important**		**Somewhat Important**		**Very Important**
Personal safety concerns					
Financial safety concerns (must register credit card)					
Privacy concerns (GPS location)					
Ride-sharing would not work for the trips I take. *(Examples: you make frequent stops or you take short trips within walking distance)*					
It is too expensive.					
Using smartphones is too complicated.					
I like to drive.					
I do not have a smartphone.					
I do not have a credit card					
Other					

What are the other factor(s) ?

What changes to dynamic ride-sharing would make you more likely to use it? (Explain below)

If dynamic ride-sharing were available do you think you would reduce the number of cars you or your family owns?

- 5 – Yes. I would reduce the number of vehicles owned.
- 4 – Probably Yes
- 3 – Maybe
- 2 – Probably Not
- 1 – Definitely would not reduce the number of vehicles owned.
- Unsure

Figure A-10. New Travel Options Survey: Dynamic Ride-Sharing - Discouraging Factors and Impacts

Section 2b. Introduction to New Travel Option – Bike-Sharing

Bike-sharing services offer an alternative to long walking trips and short vehicle trips by making bicycles available for short-term rental. Bicycles may picked-up at rental stations scattered throughout an urban area, and dropped-off at any rental station. Typically, the first hour of rental is very inexpensive to encourage short trips (such as, going to lunch, running errands or travelling to and from transit stations).

***Source: https://houston.bcycle.com/pricing.aspx

Have you ever heard of bike-sharing programs (such as B-cycle)prior to this survey?

- (●) Yes
- ( ) No

Have you ever used a bike-sharing program (such as B-cycle)?

- ( ) Yes
- ( ) No

If available, how likely would you be to use bike-sharing for the SHORT trip (less than 3 miles) you previously described?

- ( ) 5 – Definitely Yes
- ( ) 4 – Probably Yes
- ( ) 3 – Maybe
- ( ) 2 – Probably Not
- ( ) 1 – Definitely Not
- ( ) I am not sure

If available, how likely would you be to use bike-sharing for the LONG trip (more than 3 miles) you previously described?

- ( ) 5 – Definitely Yes
- ( ) 4 – Probably Yes
- ( ) 3 – Maybe
- ( ) 2 – Probably Not
- ( ) 1 – Definitely Not
- ( ) I am not sure

Figure A-11. New Travel Options Survey: Bike-Sharing - Preference

If you indicated you would probably choose bike-sharing, then, how important are the factors below in your decision to possibly use bike-sharing?

Scale of Importance:	**1**	**2**	**3**	**4**	**5**
Factors:	**Not Important**		**Somewhat Important**		**Very Important**
Avoiding/reducing the costs of car ownership					
Avoiding/reducing the costs of bike ownership					
Not worrying about getting bike to/from home as it is already where you need a bike					
No need to find parking for car (save time).					
Bike-sharing allows me to reach more destinations in close range than walking.					
Avoiding parking fees					
Getting exercise					
Bike-sharing makes transit more convenient.					
Other					

What are the other factor(s) ?

Figure A-12. New Travel Options Survey: Bike-Sharing- Factors

If you indicated you would probably not choose bike-sharing, then, how important are the factors below in your decision to possibly not use bike-sharing?

Scale of Importance:	1	2	3	4	5
Factors:	**Not Important**		**Somewhat Important**		**Very Important**
Financial security concerns (must register credit card)					
Bike-sharing would not work for the trips I take. *(Example: you take long trips that require a car)*					
It is too expensive.					
I prefer driving my car.					
I prefer walking.					
I do not like to bike.					
I do not have a credit card.					
Other					

What are the other factor(s) ?

What changes to bike-sharing would make you more likely to use it? (Explain below)

Figure A-13. New Travel Options Survey: Bike-Sharing- Factors

If bike-sharing were available, how likely is bike-sharing to reduce the number of car/bus/motorcycle trips you take?

- 5 – Very Likely.
- 4 – Likely/Probably
- 3 – Maybe
- 2 – Unlikely/Probably Not
- 1 – Very Unlikely

If bike-sharing were available do you think you would reduce the number of cars you or your family owns?

- 5 – Yes. I would reduce the number of vehicles owned.
- 4 – Probably Yes
- 3 – Maybe
- 2 – Probably Not
- 1 – Definitely would not reduce the number of vehicles owned.
- Unsure

Next

Figure A-14. New Travel Options Survey: Bike-Sharing Impacts

Section 2c. Introduction to New Travel Option – Car-Sharing

Similar to bike-sharing programs, car-sharing services provide vehicle rentals for short time periods, often by the hour or minute. Car-sharing services are most often found in downtown areas, where travelers often commute by public transit, the cost of parking is high and most trips are short distance. In downtown settings, car-sharing (like bike-sharing) allows travelers to avoid long walking trips and avoid the cost of parking.

Car-sharing companies (such as Car-2-Go or Zip Car) allow travelers to view the location of available vehicles on a street map and reserve them using their smartphone. There are parking spaces designated for car-sharing vehicles throughout a geographic area, however vehicles may be parked anywhere at no additional fee. Car-2-Go users must pay a one-time registration fee of $35. Users can rent vehicles by the minute ($0.41 per minute), by the hour ($14.99 per hour) or by the day ($84.99 per day). To encourage shorter trips, a fee of $0.45 per mile is charged when trips go over 150 miles.

Have you ever heard of car-sharing prior to this survey?

- (●) Yes
- ( ) No

Have you ever used car-sharing (such as Car-2-Go or Zip Car)?

- ( ) Yes
- ( ) No

If available, how likely would you be to use car-sharing for the SHORT trip (less than 3 miles) you previously described?

- ( ) 5 – Definitely Yes
- ( ) 4 – Probably Yes
- ( ) 3 – Maybe
- ( ) 2 – Probably Not
- ( ) 1 – Definitely Not
- ( ) I am not sure

If available, how likely would you be to use car-sharing for the LONG trip (more than 3 miles) you previously described?

- ( ) 5 – Definitely Yes
- ( ) 4 – Probably Yes
- ( ) 3 – Maybe
- ( ) 2 – Probably Not
- ( ) 1 – Definitely Not
- ( ) I am not sure

Figure A-15. New Travel Options Survey: Car-Sharing - Preference

If you indicated you would probably choose car-sharing, then, how important are the factors below in your decision to possibly use car-sharing?

Scale of Importance:	1	2	3	4	5
Factors:	**Not Important**		**Somewhat Important**		**Very Important**
Avoiding/reducing the cost of car ownership					
I enjoy driving a different vehicle than my own.					
Being able to reserve vehicles with my smartphone.					
Avoiding parking fees					
Car-sharing makes public transit more convenient					
I cannot rent a car at a regular car rental place because I am less than 25 years old.					
I cannot rent a car at a regular car rental place because I do not have car insurance.					
Other					

What are the other factor(s) ?

Figure A-16. New Travel Options Survey: Car-Sharing - Encouraging Factors

If you indicated you would probably not choose car-sharing, then, how important are the factors below in your decision to possibly not use car-sharing?

Scale of Importance:	1	2	3	4	5
Factors:	**Not Important**		**Somewhat Important**		**Very Important**
Financial security concerns (must register credit card)					
Privacy concerns (GPS location)					
Car-sharing would not work for the trips I take. *(Example: you take short trips within walking distance)*					
It is too expensive.					
Using smartphones is too complicated.					
I prefer driving my own car.					
I do not have a credit card					
Other					

What are the other factor(s) ?

What changes to car-sharing would make you more likely to use it? (Explain below)

If car sharing were available, do you think you would reduce the number of cars for you/your family?

- 5 – Yes. I would reduce the number of vehicles owned.
- 4 – Probably Yes
- 3 – Maybe
- 2 – Probably Not
- 1 – Definitely would not reduce the number of vehicles owned.
- Unsure

Figure A-17. New Travel Options Survey: Car-Sharing - Discouraging Factors & Impacts

SECTION 3: TRAVELER INFORMATION

The following questions will be used for statistical purposes only and answers will remain confidential. All of your answers are very important to us and in no way will they be used to identify you.

What is your age?

- 16 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 and over

What is your gender?

- Male
- Female

What is your ethinicity?

- White/Caucasian
- Hispanic/Latino
- African American
- Asian American
- Native American
- Other: [ ]

Including you , how many people live in your household?

[ ] people

Figure A-18. New Travel Options Survey: User Demographics -1

Please describe your household type.

- Single Adult
- Unrelated adults(e.g. room-mates)
- Married without child
- Married with child(ren)
- Single parent family
- Other: _____

Altogether, how many motor vehicles (including cars, vans, trucks, and motorcycles) are available for use by members of your household?

_____ vehicles

What category best describes your occupation?

- Professional / Managerial
- Technical
- Sales
- Service Industry (restaurants, retail, etc.)
- Administrative / Clerical
- Manufacturing / Construction
- Stay-at-home parent / homemaker
- Student
- Self employed
- Unemployed / Seeking work
- Retired
- Other: _____

What is the last year of school you have completed?

- Less than high school
- High school graduate
- Some college / Vocational
- College graduate
- Postgraduate degree

Figure A-19. New Travel Options Survey: User Demographics -2

What was your annual household income ?

- Less than $10,000
- $10,000 to $14,999
- $15,000 to $24,999
- $25,000 to $34,999
- $35,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $149,999
- $150,000 to $199,999
- $200,000 or more
- Prefer not to answer
- It is easier to note wages per hour ($/hr)

Please list any comments or suggestions you have regarding your travel needs and these new travel options

That concludes the survey. Thanks again for your participation

Submit

Figure A-20. New Travel Options Survey: User Demographics -3