Project Report

Attitudes Towards Emerging Mobility Options and Technologies – Phase 2: Pilot and Full Survey Deployment

Prepared for **Teaching Old Models New Tricks (TOMNET) Transportation Center**

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Disruptive transportation technologies such as autonomous vehicles and mobility-on-demand services are bringing transformative changes in the urban area. To enhance our understanding of various impacts of these new mobility options on travel behavior and relative consequences, people’s attitudes towards and perceptions of these technologies and services need to be measured and understood. This report summarizes the second phase of a large-scale survey-based research study to understand people’s preferences and choices when it comes to future mobility options and technologies in the four southern US metro areas. The T4 survey (TOMNET Transformative Transportation Technologies Survey) is intended to collect very detailed and in-depth data about people’s mobility patterns, as well as attitudes towards and perceptions of emerging transportation options such as ridehailing services and autonomous vehicles. TOMNET consortium members, Arizona State University, Georgia Institute of Technology, and the University of South Florida, as well as a sister University Transportation Center (called D-STOP) led by the University of Texas at Austin, are joining forces to collect the survey data from a sample of residents in the four metropolitan regions of Tampa, Austin, and Atlanta in addition to Phoenix metro area. This report explains the second phase of the project report including the pilot survey deployment in the Phoenix metro area and the full survey deployments in all four southern metro areas. The next phases of the project include data cleaning, weighting, analysis, and modeling to respond to the research questions compiled in the first phase of the study.</td></tr>
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EXECUTIVE SUMMARY

The Center for Teaching Old Models New Tricks (TOMNET), which is a Tier 1 University Transportation Center (UTC), aims to shed deep attitudinal and behavioral insights on the factors that affect a wide array of people's mobility choices in an era of new mobility options and technologies that will have a transformational impact on transportation. This report summarizes the second phase of a large-scale survey-based research study to understand people's preferences and choices when it comes to future mobility options and technologies. The T4 survey (TOMNET Transformative Transportation Technologies Survey) is intended to collect very detailed and in-depth data about people's mobility patterns, as well as attitudes towards and perceptions of emerging transportation options such as ridehailing services and autonomous vehicles.

TOMNET consortium members, Georgia Tech, and the University of South Florida, as well as a sister University Transportation Center (called D-STOP) led by the University of Texas at Austin, are joining forces with Arizona State University (ASU) to collect the same survey data from a sample of residents in the four metropolitan regions of Tampa, Austin, and Atlanta in addition to Phoenix metro area. Pilot data collection efforts yielded a respondent sample of 256 individuals from the Greater Phoenix metropolitan area collected through both online and paper platform during fall 2018. Full data collection efforts across Phoenix, Atlanta, and Tampa yielded a respondent sample of 2374 individuals collected through only online platform during late 2019. With the addition of the sample collected at UT-Austin, the total survey sample size will reach at 3740 completed responses across four southern metro areas. This report explains the second phase of the project including a pilot deployment with descriptive results in Phoenix in addition to full deployment administration in Phoenix, Atlanta, and Tampa. The results of the pilot survey are mainly illustrated in univariate or bi-variate graphs representing the distributions of the responses. The pilot survey questionnaire developed in the first phase of the study has been updated for the full deployment and the updated version is presented in Appendix I in this document.

The T4 survey explicitly collected detailed individual attitudes, both general and transport-related attitudes, socioeconomic characteristics, current commute and travel behavior, residential and vehicle ownership preferences in addition to perceptions and behaviors toward mobility-on-demand services and autonomous vehicles. The results of the pilot survey deployment show that half of the respondents are familiar with ridehailing services but not using them, while 12 percent stated using them monthly and 4 percent stated using them weekly in the Phoenix metro area. The ridehailing services usage rate significantly decreases for older people. While 37 percent of respondents 18-to-30 years old use the service at least monthly, only 15 percent of respondents 71+ years old use the service at the same rate.

Respondents generally agree that ridehailing services are good alternatives when away from home (76 percent), to avoid impaired driving (88 percent), when transit is not available (80 percent), to access transit (44 percent), when a personal vehicle is temporarily not available (73 percent), and to save time and money on parking (74 percent). The respondents also stated that they make 16 percent fewer transit trips, 10 percent fewer bike trips, and 12 percent fewer walk trips after starting using the ridehailing services. Only 29 percent of the respondents believe that the reduced cost worth choosing shared ridehailing modes to private ridehailing with longer travel time and the potential existence of strangers in the ride. Feeling uncomfortable sharing a ride with strangers is less among men (39 percent) compared to women (50 percent) and should be considered in any policymaking which is trying to promote sharing behavior.

With respect to autonomous vehicles, by average, 63 percent of the respondents are somewhat or very familiar with this technology. The familiarity with autonomous vehicles increases with the increase of the household annual income which reaches 77 percent for people with very high income ($150,000 or

more). With respect to using AVs, 27 percent of survey respondents stated that they never use an AV; 47 percent stated that they use it alone or with people they know, and only 20 percent stated that they are willing to share AVs with strangers. Moreover, 19 percent of the respondents are likely to make additional trips with the presence of AVs, and 23 percent are likely to make farther trips. Moreover, only 16 percent of respondents think that AVs are safer than human driver and 65 percent are concerned about the safety of pedestrians and bicycles on the streets.

Further work will go into an in-depth analysis of the survey results to respond to numerous research questions still unsolved about the usage pattern and perceptions around new transportation technologies. For further information on this project and accessing related project reports please visit the TOMNET UTC website at www.tomnet-utc.org or contact the project director at Sara.Khoeini@asu.edu.

INTRODUCTION

Emerging mobility options and technologies including autonomous vehicles and mobility-on-demand services are bringing transformative changes in the transportation landscape. To enhance transportation forecasting models considering the increasing penetration of disruptive forces, people's attitudes towards and perceptions of these technologies and services need to be measured and understood. Armed with such an understanding, it will be possible to specify and develop behavioral models that account for attitudes and perceptions, adoption cycles, and adaptation patterns. This project proposes the second phase of a large-scale survey-based study including two phases of respondents' recruitment for a sample of 2374 individuals across the Phoenix, Atlanta, and Tampa metro areas.

With the emergence of new transportation technologies and services, it is critical for transportation forecasting models to be enhanced to account for market dynamics that will result from increased penetration of disruptive forces in the transportation domain. It is envisioned that the enhanced models will help decision-makers better plan for the transportation infrastructure systems and design marketing and policy strategies that maximize the benefits of these disruptive technologies. Attitudes and perceptions are likely to vary by socioeconomic characteristics, existing travel patterns and mobility experiences, and land use and built environment attributes. The overall goal of this project is to collect a rich set of data that includes information about people's travel behavior and their attitudes towards and perceptions of advanced transportation technologies and mobility options with a view to inform the development of robust behavioral models of technology adoption capable of reflecting impacts of these disruptive forces on traveler behavior and values.

The objectives of this project include the development of a harmonized survey instrument, survey design and administration protocol, and sampling plan that other jurisdictions can adopt to conduct similar surveys in their areas. There is significant interest in understanding how people may adapt and respond to the introduction of transformative transportation technologies, but there is considerable uncertainty in how best to design a survey and set of questions that elicit the information needed to develop well-specified behavioral models. This project proposed a survey which is called T4 (Transformative Technologies in Transportation) Survey with the objective of providing a data collection protocol and methodology that can be widely adopted.

The first phase of this project started in August 2017 and lasted for a year. Phase 1 included the literature review, development of survey goals, objectives, detailed research questions, and survey questionnaire design (Attitudes towards Emerging Mobility Options and Technologies – Phase 1: Survey Design). During the second phase of the project, that this report is focusing on, data collection has happened in two phases: pilot and full deployment. The pilot phase of data collection is conducted during fall 2018 in the Pheonix metro area and the full deployment is conducted during summer 2019 across all four southern cities including Phoenix, Atlanta, Tampa, and Austin. It should be noted that the data collection in Austin is sponsored by the D-STOP University Transportation Center at the University of Texas at Austin and so the details about Austin data collection will not be explained here in the TOMNET UTC project report to avoid duplicate presentations. However, the final pooled dataset will include the Austin data for analysis and modeling.

The goals of the pilot T4 survey are to evaluate response rates across two survey methods, test the survey content, and evaluate the sampling plan. Based on the outcomes of pilot deployment, the survey instrument content and method have been revised. While the pilot phase of data collection is conducted only in the Phoenix metro area with a sample size of 262, the full deployment is conducted with the sample

size of 1071 residents in the Phoenix (AZ) metro area, 1021 residents in the Atlanta (GA) metro area, 281 residents in the Tampa (Fl) metro area, to understand how the market may perceive, adopt, and adapt to transformative transportation technologies mainly autonomous vehicles and mobility-on-demand services. The survey questionnaire for the full deployment has been revised from the pilot. Appendix I presents the revised survey deployment for the full deployment administration. Some ambiguities highlighted during pilot deployment were solved, and the AV section of the survey was expanded to include more in-depth questions about the potential impact of adopting AVs on users' travel behavior, residential choice, vehicle ownership, and policy preferences.

With the addition of the UT-Austin sample of 1367 completed responses collected through the online platform using random email recruitment and Facebook advertisement, the data collected across multiple jurisdictions will eventually be aggregated to produce a single dataset with a sample size of 3740 responses. This dataset will be unique in terms of large sample size, contents, and spatial expansion across multiple southern metro areas. During phase 3, the research team will compile and clean the data, deeply analyze it using advanced statistical methods, estimate econometric models, and produce the required reports and documentation. This project will provide a data collection protocol and methodology that can be widely adopted.

The remaining of this report will present a comprehensive description of all the steps taken to pilot survey deployment in Phoenix, AZ, and is organized in the following sections: data collection, sampling plan, survey administration, and results. The results section includes users' socioeconomic profile, attitudes and preferences, residential choice and vehicle ownership, current travel patterns, ridehailing services usage, and perceptions, autonomous vehicle perceptions, and stated preferences. Accordingly, the full survey administration details in Phoenix, Atlanta, and Tampa have been presented in this report. Same as all other surveys, the socioeconomic characteristic distributions of the respondents are not exactly equal to the population. Although weighting techniques can help to modify the results to be more representative of the entire population, this report is only presenting the pilot unweighted results due to the small sample size and relatively small differences between the sample and population attributes due to using different survey methods. The full deployment results will be presented in phase 3 annual report of this project with a fully weighted sample.

T4 SURVEY PILOT DEPLOYMENT – PHOENIX, AZ

Data Collection

The pilot phase of data collection is accomplished in October-December 2018 with a sample size of 262, in the Phoenix metropolitan area. The T4 survey full deployment launched in May 2019 and collected very similar data in four metropolitan areas: Phoenix, Atlanta, Tampa, and Austin, in partnership with peer universities. During the pilot data collection, paper survey questionnaires were mailed out to 2,500 randomly selected household addresses obtained from marketing companies. In the meantime, the link to an online version of the survey was sent out to 3,500 random email addresses. The following subsections will describe the pilot sampling plan and survey administration in more detail.

Sampling Plan

A random sample of the population from the Greater Phoenix Metropolitan area was desired. In order to gather a sample with such characteristics, ZIP codes from Maricopa County were specified to a marketing company, which would draw addresses randomly from those ZIP codes. The survey targeted individuals 18 years old and older. The total population of Maricopa County is estimated at 4,155,501 people, 3,261,770 of which is 18 years old and above. Information about the total population of Maricopa County is available from the ACS 2013-2017 estimates (www.census.gov).

Figure 1 shows the distribution of the drawn samples in comparison with the population distribution retrieved from census information. Overall, the distribution of households on the sample and on the region are similar. Particularly, the sample was drawn fewer households from Phoenix municipality (central area), and drawn more households from Scottsdale, Mesa, and Glendale, in comparison to Census distribution.

Survey Administration

The pilot deployment of the survey recruited respondents through two methods: 3,500 e-mail invitations, each with a personalized link, or 2,500 postal invitations, each with a unique access code, that allowed the respondents to choose between answering the survey online, or filling the enclosed booklet and mailing back using the business reply envelope provided. In the end, three inputs to the survey were possible: e-mail invitation, mail invitation with an online response, and mail invitation with a paper response.

The online survey was implemented on the Qualtrics platform, using logic flow rules, and skip patterns to facilitate the response. In order to access the survey, respondents had to provide their unique access code, which would serve as both login and password, to identify the respondent. The access codes were used to identify the source of the response. The first page of the booklet showed the invitation letter, also with unique access codes.

Once the addresses were gathered from the marketing company, mail addresses were presorted and posted using non-profit rates, significantly reducing recruitment costs. Mail invitations were sent to the post office on October 3, 2018. The packages included a printed booklet with all the survey questions and a business reply envelope. The first page of the booklet was the invitation letter.

Figure 2 shows the distribution of received responses over the month of October. Received responses were sparse through the months of November and December, therefore they were combined for better visualization. For the e-mail invitation (yellow bars), the responses have three peaks, corresponding respectively to the first invitation (October 4), first reminder (October 16), second reminder (October 26).

Given that only 10 additional responses were collected on the second reminder day, no further invitation message was sent. Online responses to mail invitations (green bars), began to appear on October 9, 6 days after packages were mailed out. Online responses from mail invitations were more evenly distributed at the beginning of the response window, with similar response input on the three first days (October 9, 10, and 11). Paper surveys (blue bars) did not begin to arrive at the TOMNET office until October 15 (12 days after mailing out). The largest batch of paper responses arrived on October 23, and while most of them were received by mid-November, booklets arrived up to December 2018.

A copy of the online version of the survey was created for data entry purposes. Logic requirements were removed, to capture the paper responses as they were provided by the respondents. Page breaks were also modified to facilitate the data entry process. An average of 13 minutes per booklet was required to enter the response. A total of approximately 28 hours of work were dedicated to the data entry process.

To create a final dataset, the responses collected from paper and online recruitment had to be combined. The raw dataset from this process had 269 responses: 130 paper responses from mail invitations, 50 online responses from mail invitations, and 89 online responses from e-mail invitations. After cleaning the dataset, and dropping ineligible responses and careless respondents, the final dataset had 262 records, 126 paper responses from mail invitation, 49 online responses from mail invitation, and 87 responses from e-mail invitation. Table 1 describes the final sample and the final response rates. 44 provided addresses were not valid and invitations were not sent, and two postal packages were returned to the sender (1.8 percent invalid). 167 e-mail invitations bounced (4.8 percent invalid).

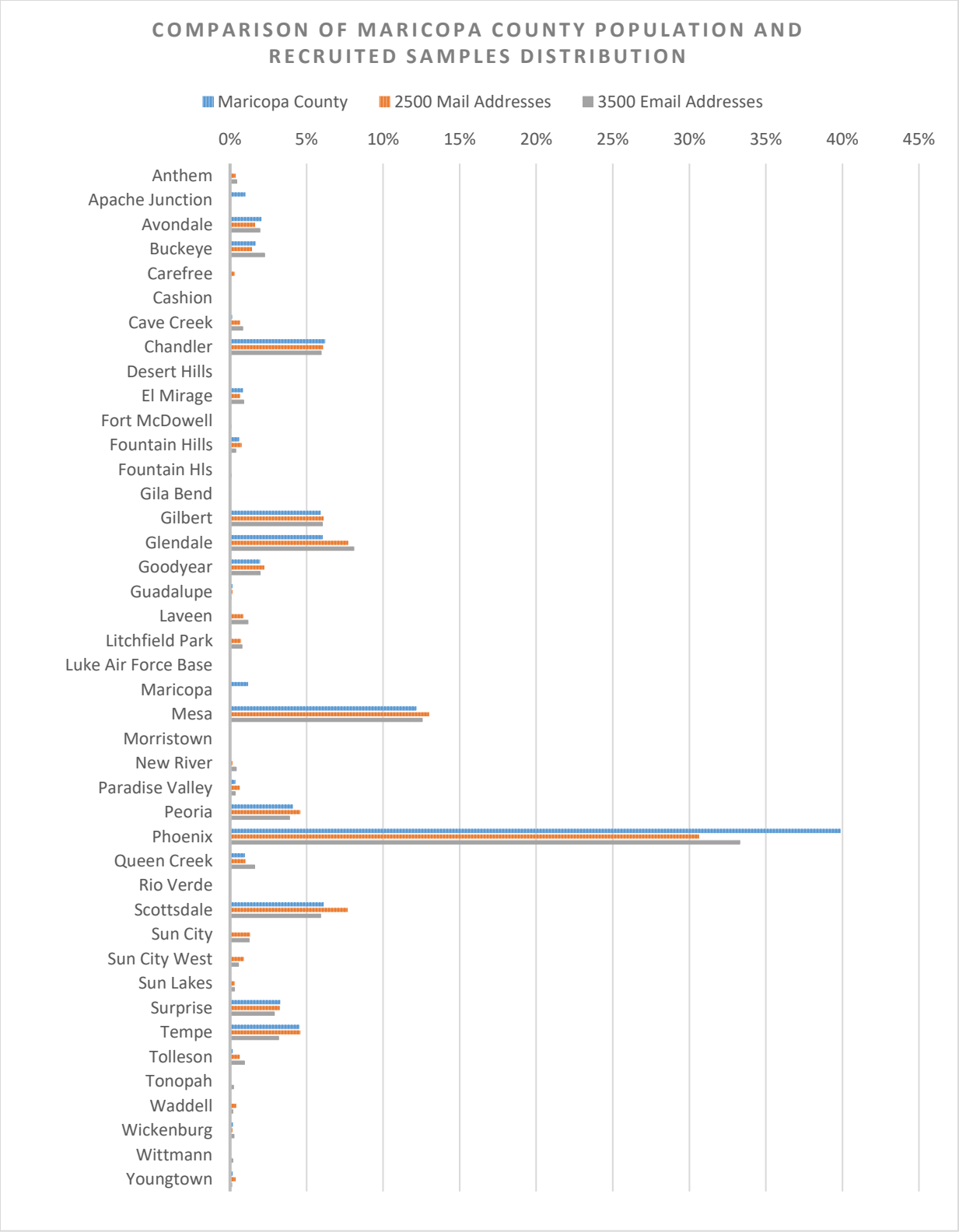

Figure 1 Distribution of purchased addresses per municipality in Maricopa County

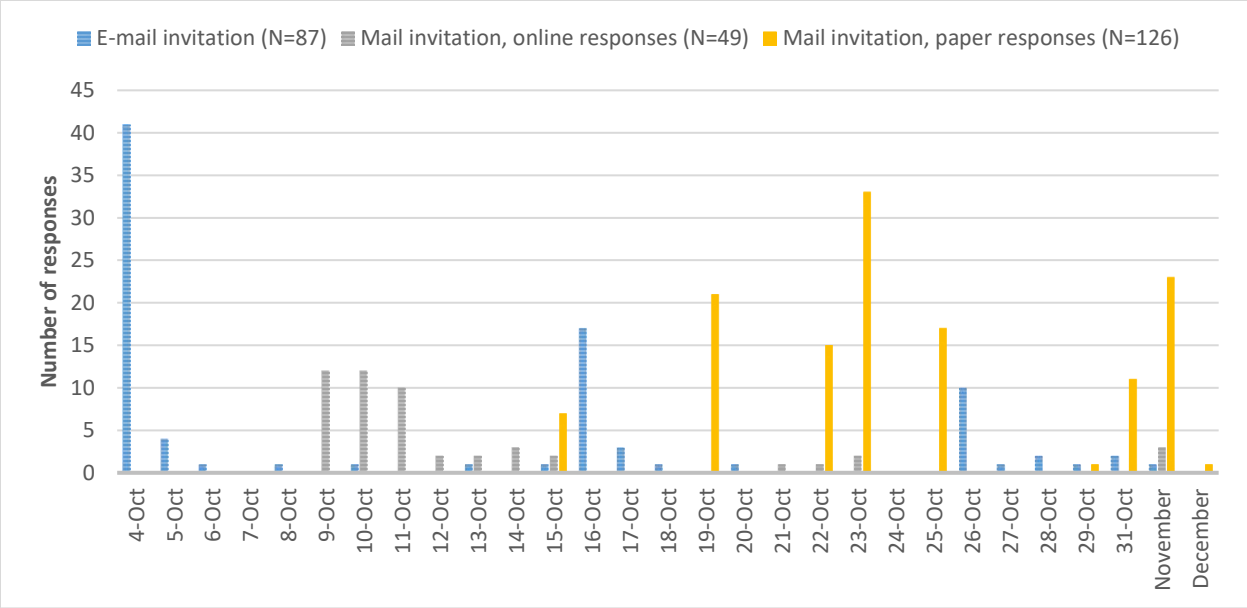

Figure 2 Time distribution of received responses, per recruitment method

Table 1 Description of the final sample and response rates

	Purchased	Invited	Completed	Response Rate		
Online responses Invited by email	3500	3333	87	2.6 percent	2.6 percent	Email Response Rate
Online responses Invited by mail	2500	2454	49	2.0 percent	7.1 percent	Mail Response Rate
Paper responses Invited by mail			126	5.1 percent		
Total responses	6000	5787	262	4.5 percent		

Results

Socioeconomic Profile

The respondents' basic socioeconomic attributes have been collected mostly in the last section of the survey. The collected socioeconomic attributes include age, gender, place of birth, Hispanic origin, ethnicity, driver's license status, occupation, home location, work location, traveling limitations, household size, household structure, and income. This information is useful for future modeling practices to predict the user's response to new transportation technologies as a function of socioeconomic attributes.

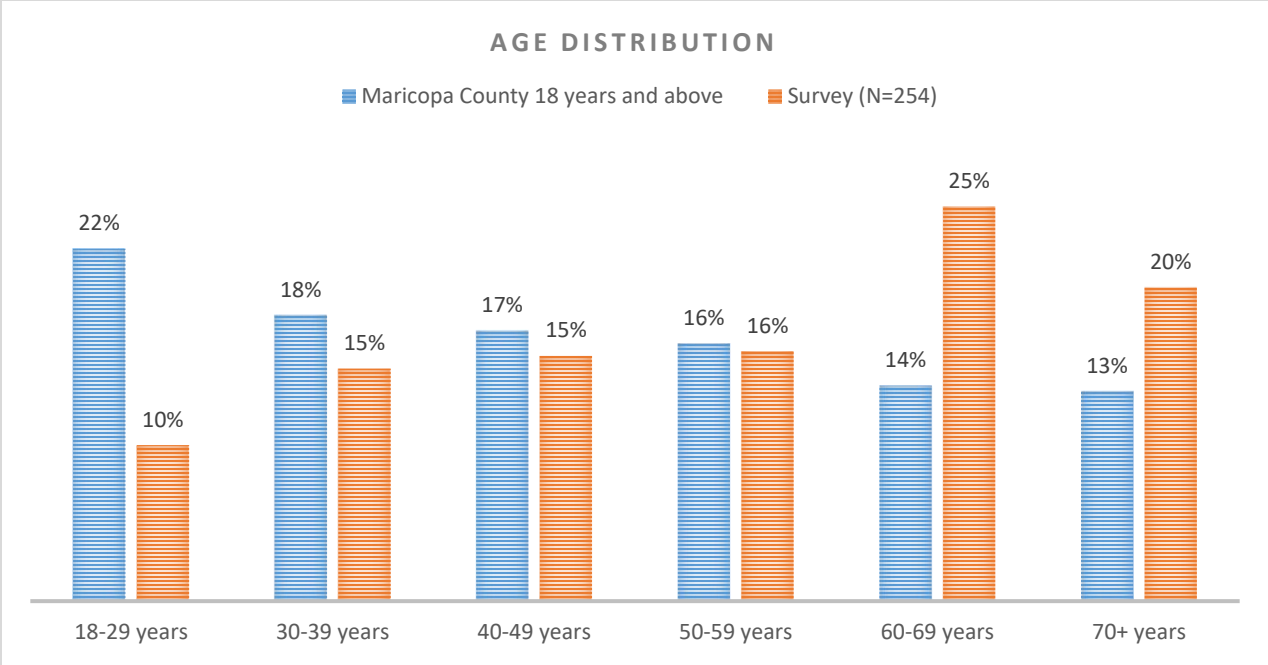

Figure 3 illustrates the distribution of age across the survey respondents. The respondents should be at least 18 years old to be eligible to participate in the survey. Similar to all surveys the respondents' age distribution skews toward the older population. While the T4 survey respondents have a larger portion of the older ages (60 and more years old), it has a significantly smaller portion of younger age group (29 years old or younger), comparing to the ACS 2013-2017 estimates of the general population of Maricopa County.

Figure 4 illustrates gender distribution in each age category. In total, 59 percent of the respondents are female. Females represent more than 65 percent of the respondents in the middle age categories (30-59 years old). In general, women are more willing to participate in surveys compared to men. However, in the youngest age category (18-29 years), 60 percent of the sample is male. In the older age categories (70 and more), the male and female percentages are closer with about 56 percent of the sample being female. According to ACS 2013-2017 estimates, 51 percent of Maricopa County who have 18 years of age and above are female.

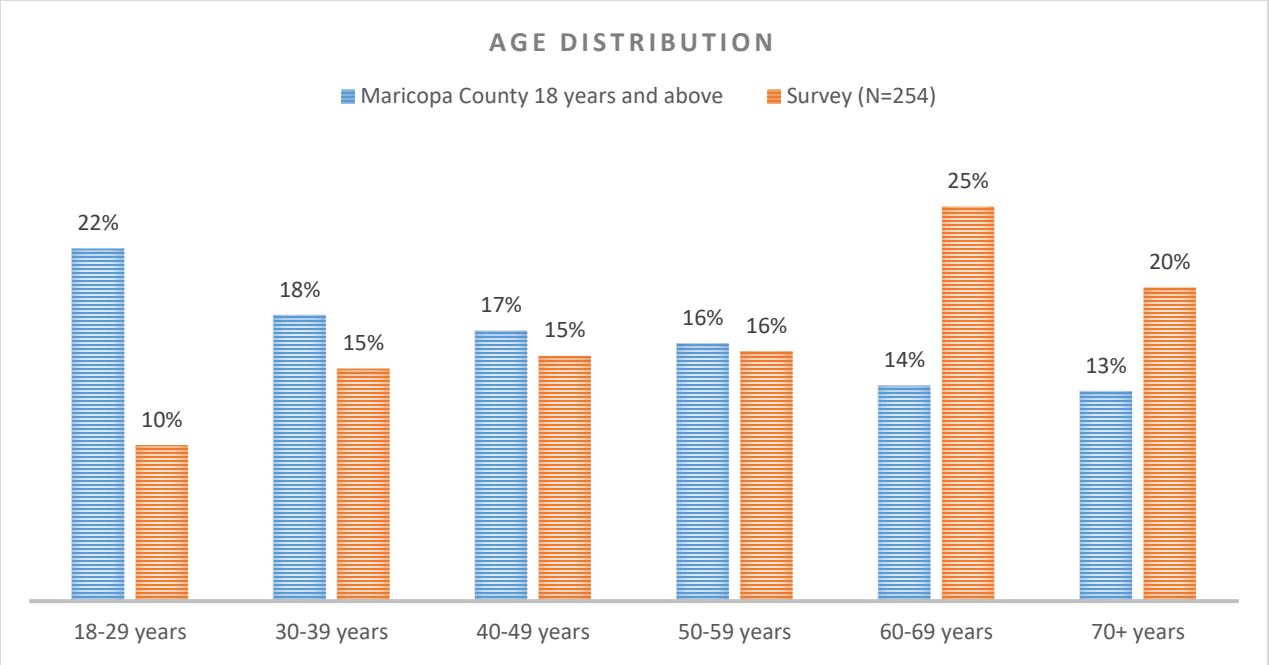

Figure 3 Age distribution

In terms of place of birth distribution, 88 percent of the respondents were born in the United States while 10 percent of the respondents were born in other countries (N=262). Based on ACS 2013-2017 data, in Maricopa County, about 15 percent of the population is foreign-born. This means that the T4 survey sample is very slightly skewed toward the US-born population. Only 2 percent of the respondents were not willing to answer the place of birth question.

With respect to Hispanic origin, about 14 percent of the sample indicated they have a Hispanic origin, considering 3 percent of the sample was not willing to respond to this question (N=262). Based on ACS 2013-2017 data, about 31 percent of the population in Maricopa County is Hispanic or Latino. Therefore, the T4 sample is over-representative of the non-Hispanic population. Similarly, 83 percent of the sample (N=262) associated themselves with White or Caucasian ethnic groups, while about 5 percent of the sample preferred not to answer this question. Similarly, ACS 2012-2017 data shows that 73 percent of the population is White, which means our collected sample during the pilot phase over-sample US-born, White, and non-Hispanic population. Additionally, 95 percent of the respondents have a driver's license (N=262).

With respect to occupation, 55 percent of the sample are workers; 31 percent of the sample is neither worker nor students; 4 percent of the sample are both workers and students; and, only 1 percent of the sample are students. According to the 2013-2017 estimates of the ACS data, 59 percent of the population over 16 years old in Maricopa County is employed, and 36 percent is not in the labor force, suggesting that the T4 sample provides a reasonable representation of occupation status in the county. The sample does not have responses from 9 percent of the respondents for occupation (N=262).

The education level distribution of the T4 pilot sample is presented in Figure 5. Most of the respondents (57 percent) reported having at least a bachelor's degree. Only 14 percent of respondents reported having a high school diploma or lower levels of education. Comparing to the 2013-2017 estimates of the ACS data, the collected T4 pilot sample under-represents residents with low levels of education.

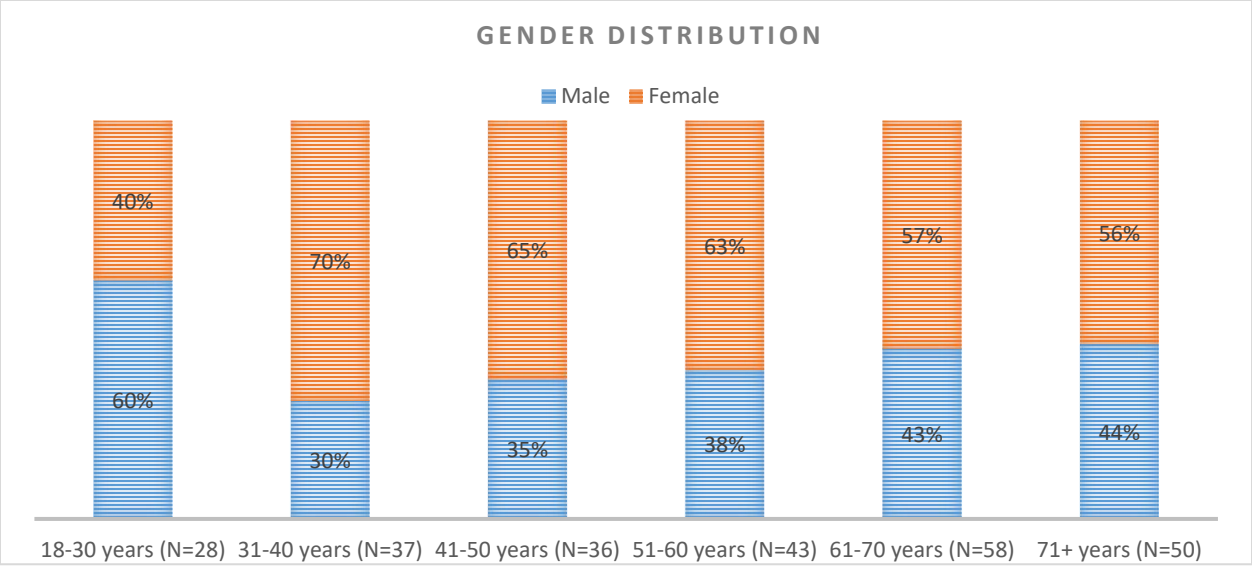

Figure 4 Gender distributions in each age category

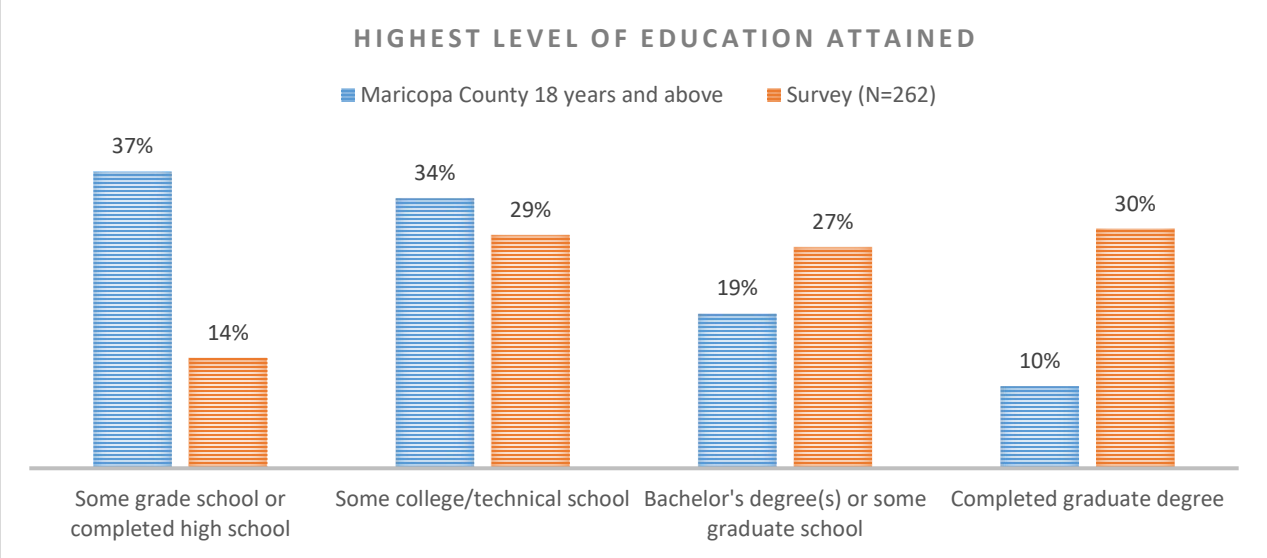

Figure 5 Highest level of education attained

Figure 6 shows the presence of limiting abilities to perform different types of traveling activities among the respondents. Biking, walking, and driving at night activities account for the largest percentages of activities that people at all or to some extent are limited to conduct (17 percent, 13 percent, and 11 percent respectively). The remaining activities can be performed by 90 percent or more of the sample. Moreover, for 9 percent of the respondents (N=234) indicated that there are adults (i.e., 18 years old or older) in their household (other than themselves) with conditions that either partially or fully limit their ability to drive.

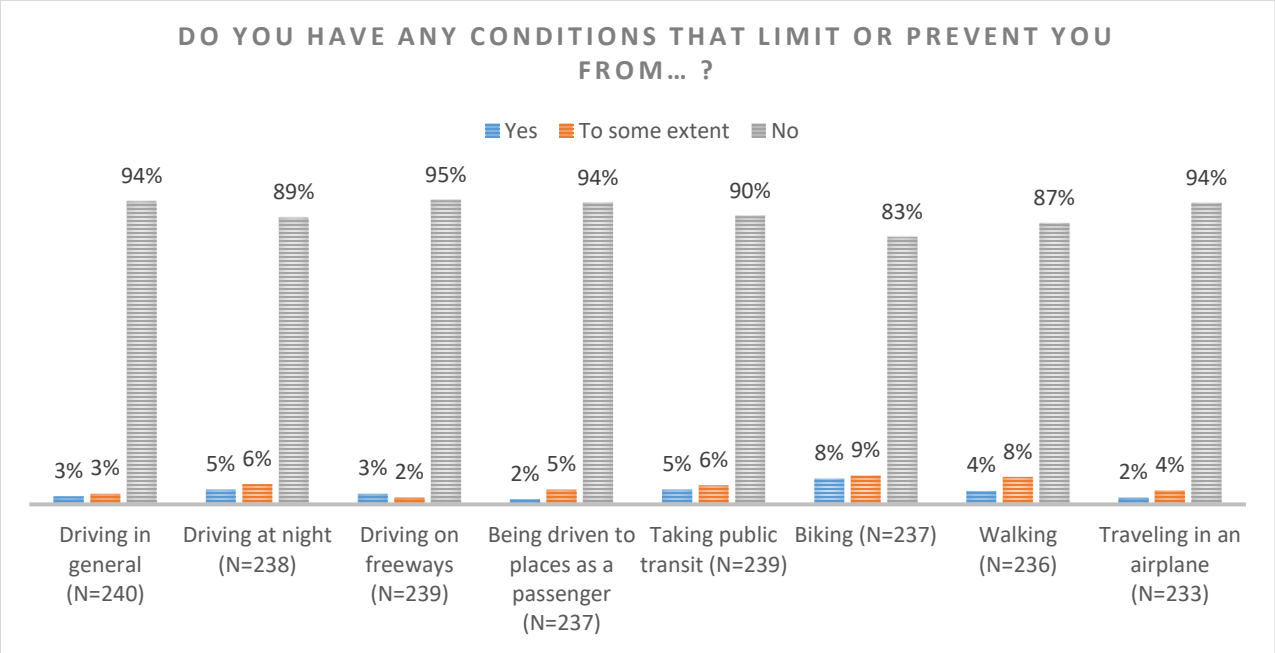

Figure 6 Medical conditions limiting travel activities

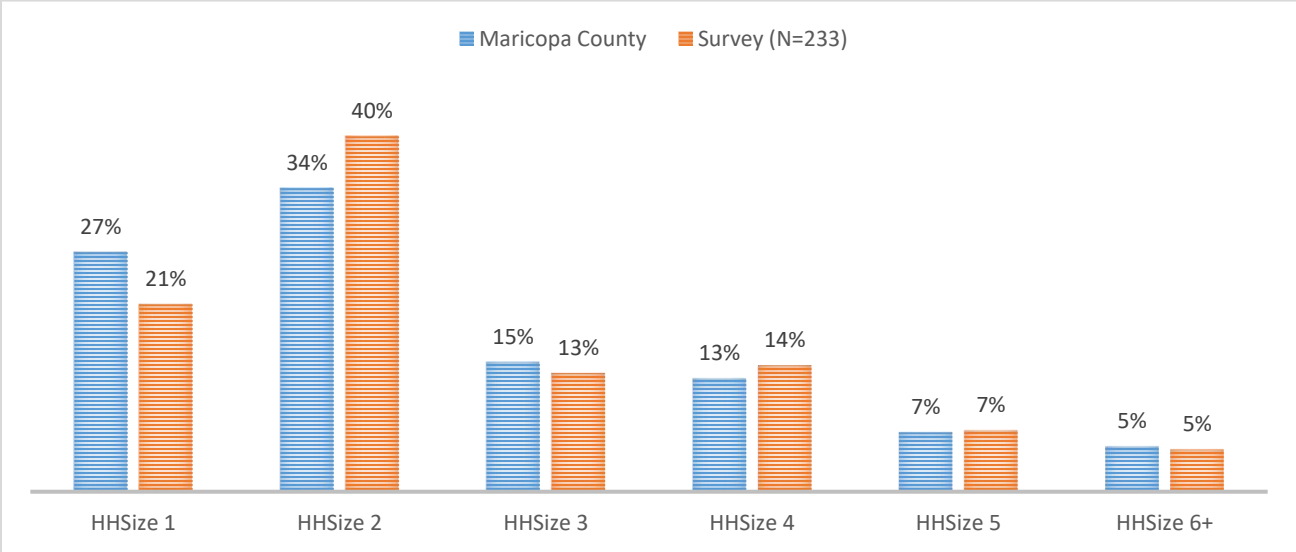

Figure 7 shows the distribution of the T4 pilot sample household size. Comparing the ACS data to the sample distribution, the collected sample is slightly under-representative of single households and over-represented in households with size 2. Household size was not reported by 11 percent of the survey respondents.

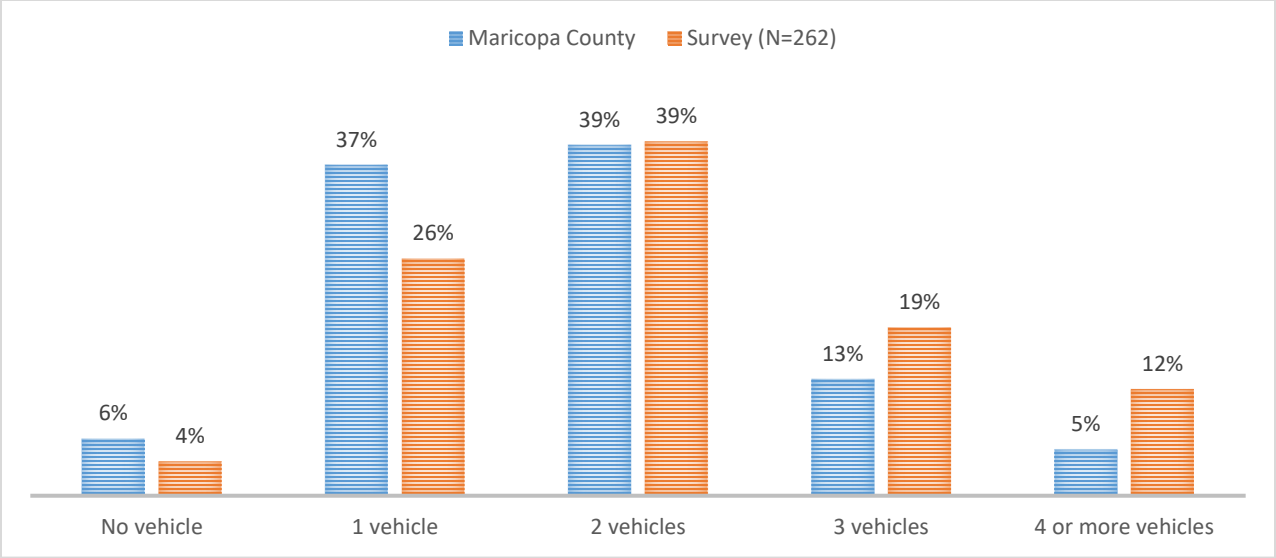

Figure 8 represents the household vehicle ownership distribution. About 39 percent of the households have two vehicles, and about 26 percent of the households have only one vehicle. The T4 sample is slightly skewed toward higher vehicle ownership. Households with two or more vehicles are overrepresented in the sample while households with zero and one vehicles are underrepresented.

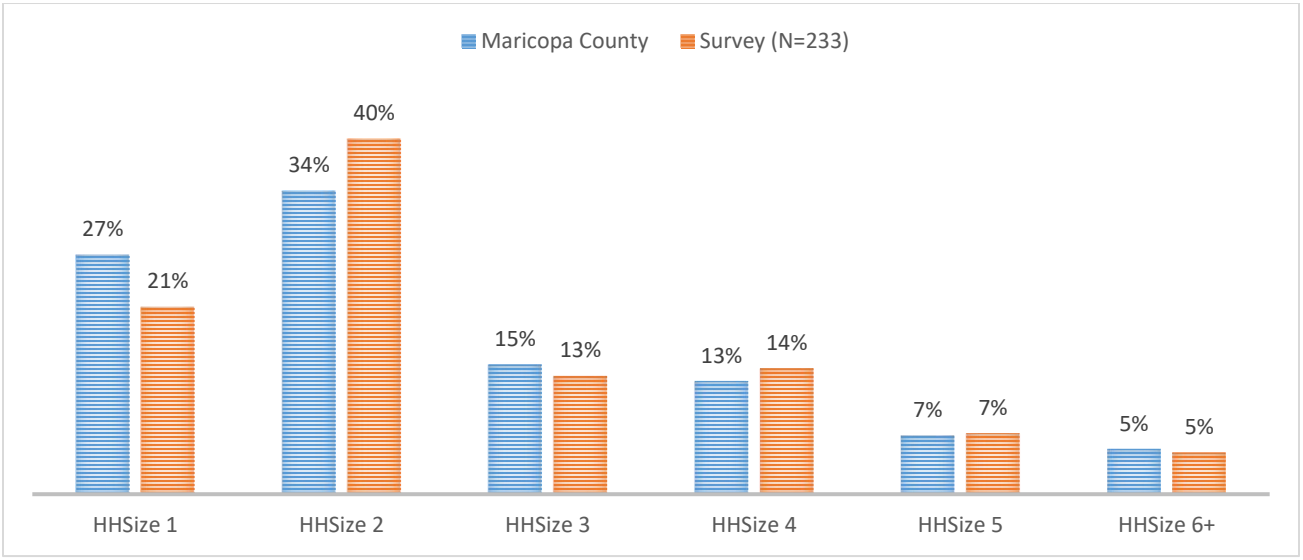

Figure 7 Household size distribution

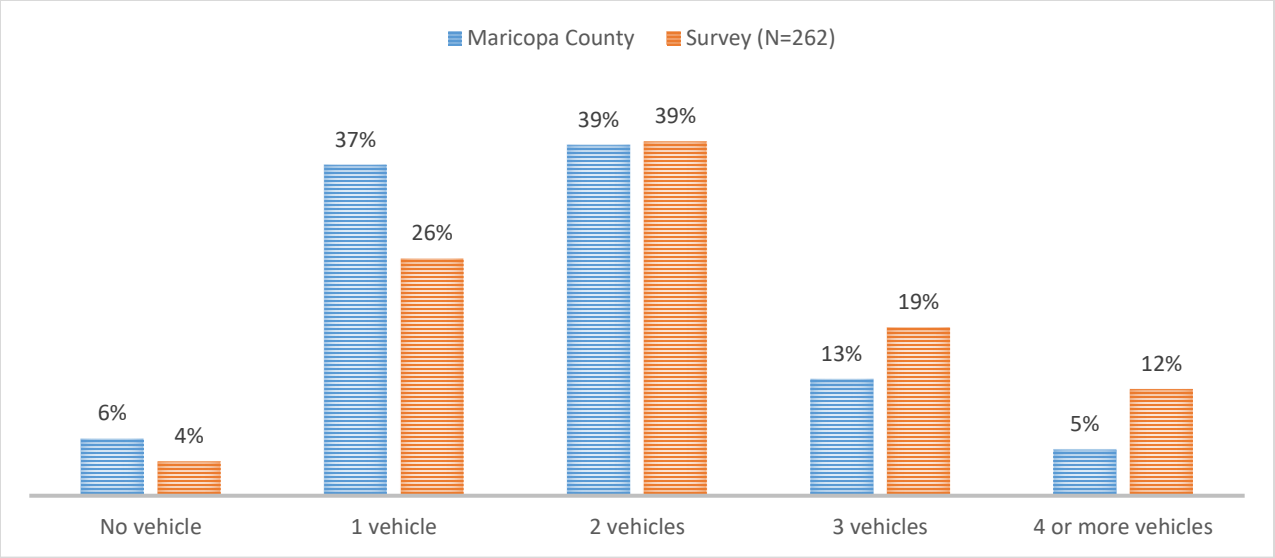

Figure 8 Household vehicle ownership

Figure 9 represents the household structure distribution of the sample. The largest category belongs to married couples with no children present at the household (about 30 percent of the sample). This category can potentially consist of both very young as well as very old couples.

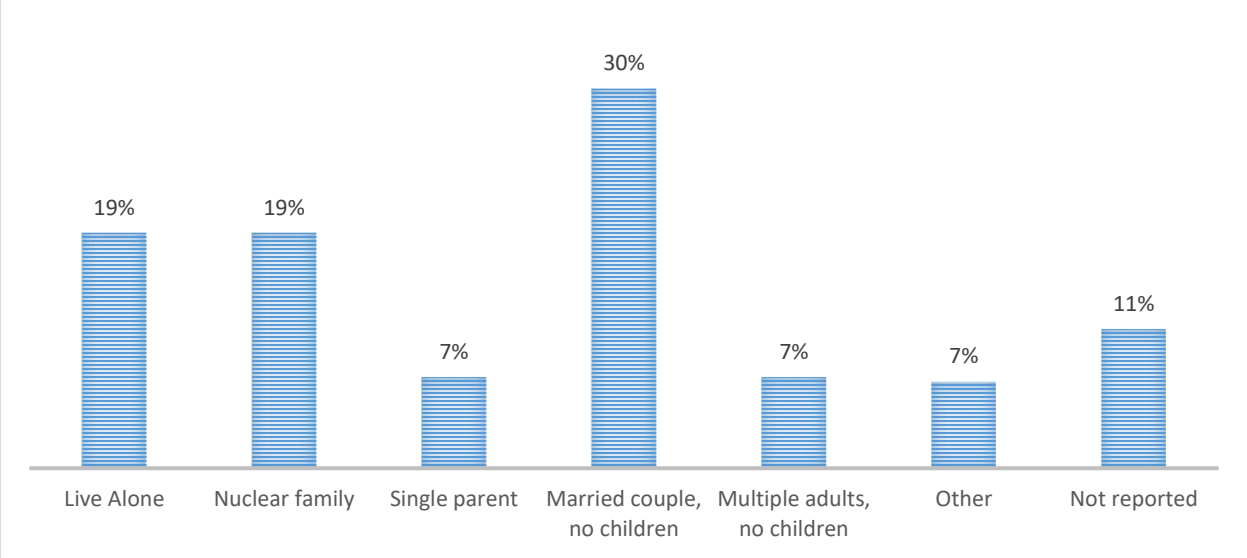

Figure 9 Distribution of household structure (N=262)

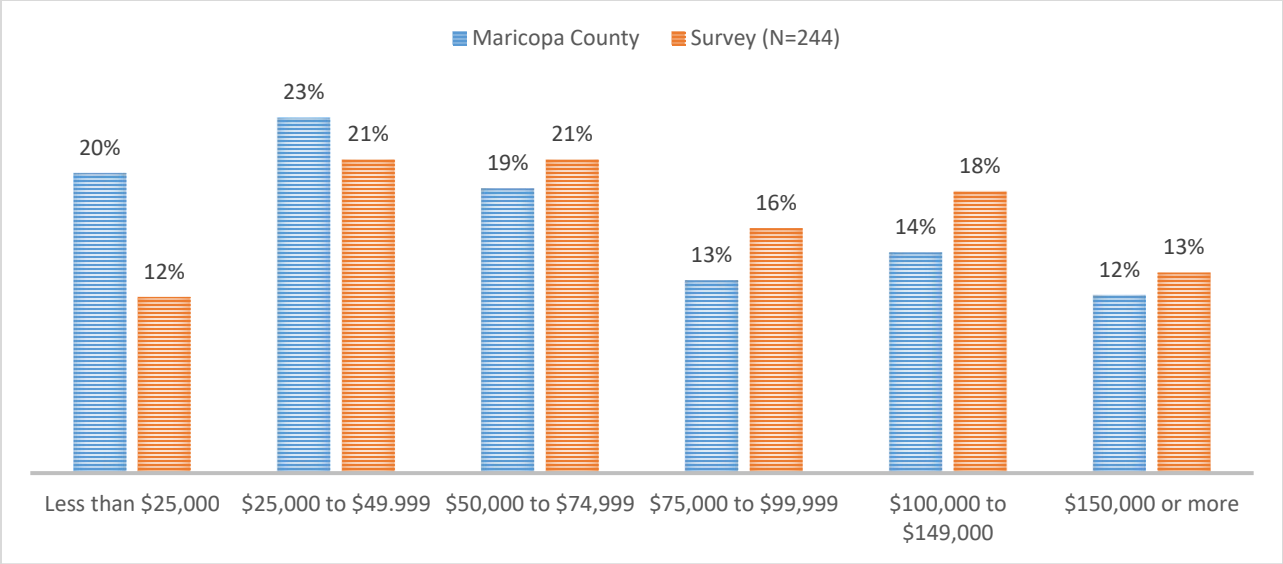

Figure 10 illustrates household income distribution in the sample. The sample household income is, to some extent, similar to the ACS 2017 household income distribution for the study region. The collected T4 pilot sample slightly under-represents low-income households (less than $50,000 annual income) and overrepresent the higher income groups (Annual income of $50,000 or above).

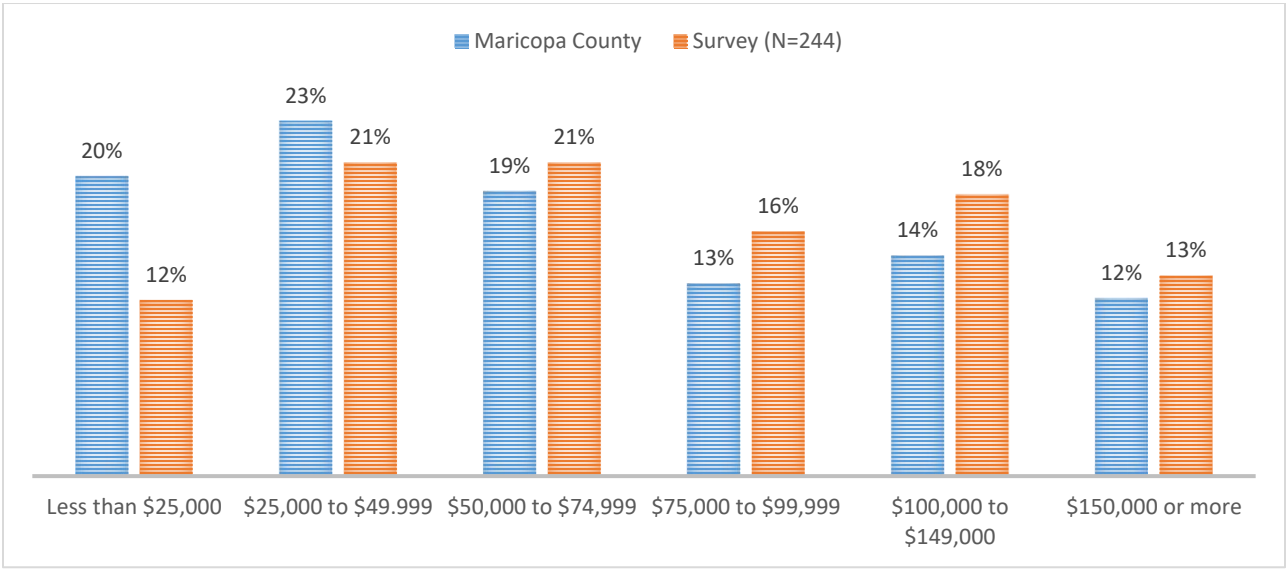

Figure 10 Household income distribution

Attitudes and Preferences

This section presents respondents' attitudes and opinions regarding different general aspects of life including privacy, willingness to share property and space, environmental friendliness, willingness to adopt new technologies, and time use, as well as transportation-related attributes such as residential preferences and mode use.

Figure 11 shows respondents' agreement levels with different statements with respect to privacy. As shown, 70 percent of people agree that sharing personal information or location from their devices

concerns them a lot. When asked about the possibility of renting out their private cars, the majority of respondents (89 percent) disagree. Lastly, only 24 percent of the T4 pilot sample agree that they feel uncomfortable around people they do not know.

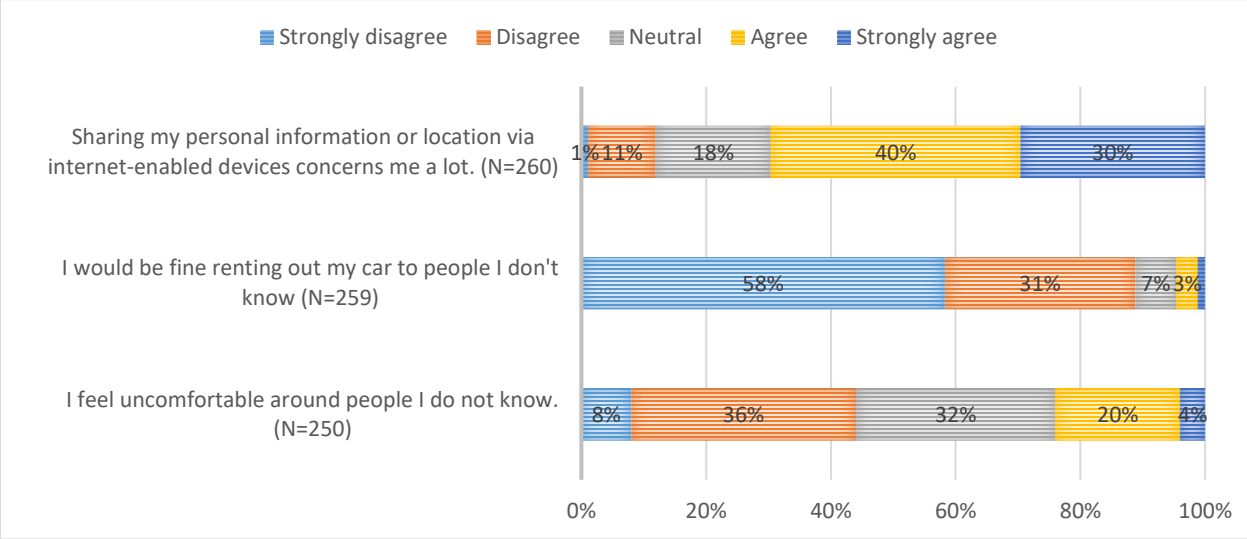

Figure 11 Level of agreement with privacy and sharing statements

Further exploring the level of agreement with privacy and sharing statements, Figure 12 shows the agreement with the statement "I feel uncomfortable around people I do not know" by age and gender. Those 71 years old and older reported the smallest level of discomfort among others. Men and women showed similar patterns, interestingly men reported to be neutral to this statement more than women did.

When asked about environmental friendliness, Figure 13 shows that 35 percent of respondents stated that they are committed to using less polluting transportation modes as much as they can. However, 75 percent of the respondents consider themselves as committed to an environmentally friendly lifestyle. Further investigation of this character in Figure 14 shows that people in 31 to 40 age range have the lowest commitment to an environmentally friendly lifestyle, in comparison to younger and older respondents. Females reported being slightly more committed than males with lifestyles that are friendly to the environment.

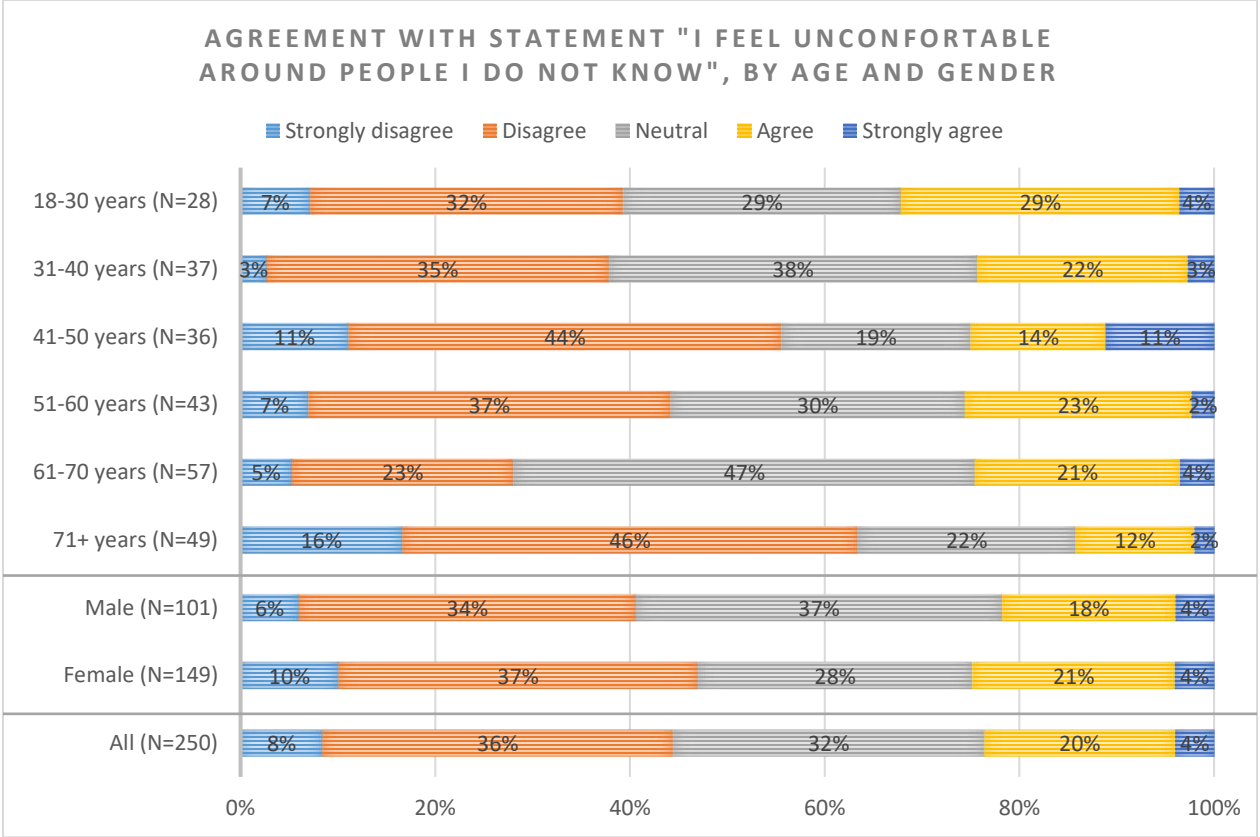

Figure 12 Agreement with the statement "I feel uncomfortable around people I do not know", by age and gender

Respondents' opinions related to technology are presented in

Figure 15. The process of learning how to use new technologies is often considered frustrating for 47 percent of respondents. 62 percent of the respondents rated internet connectivity everywhere they go important to them. 35 percent of respondents declared to like to be among the first people to have the latest technology. Moreover, half of the respondents prefer to shop in a store rather than online.

Figure 16 shows a trend that older people are more likely to agree that learning how to use new technologies is frequently associated with a frustrating experience. The younger the participants are, the less likely they are to agree with this opinion. This finding reinforces the concept that there is an extra challenge to promote the adoption of new and emerging technologies for people in older age groups.

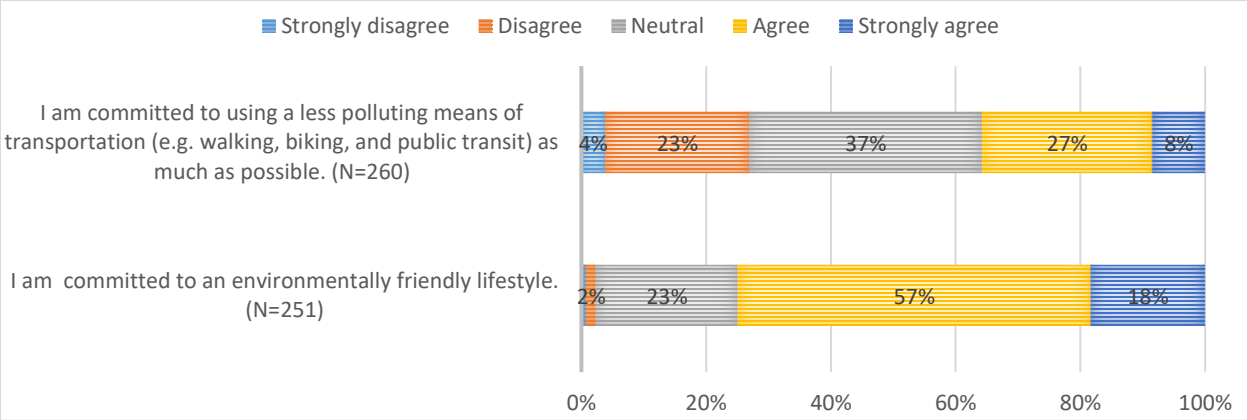

Figure 13 Level of agreement with environment-related statements

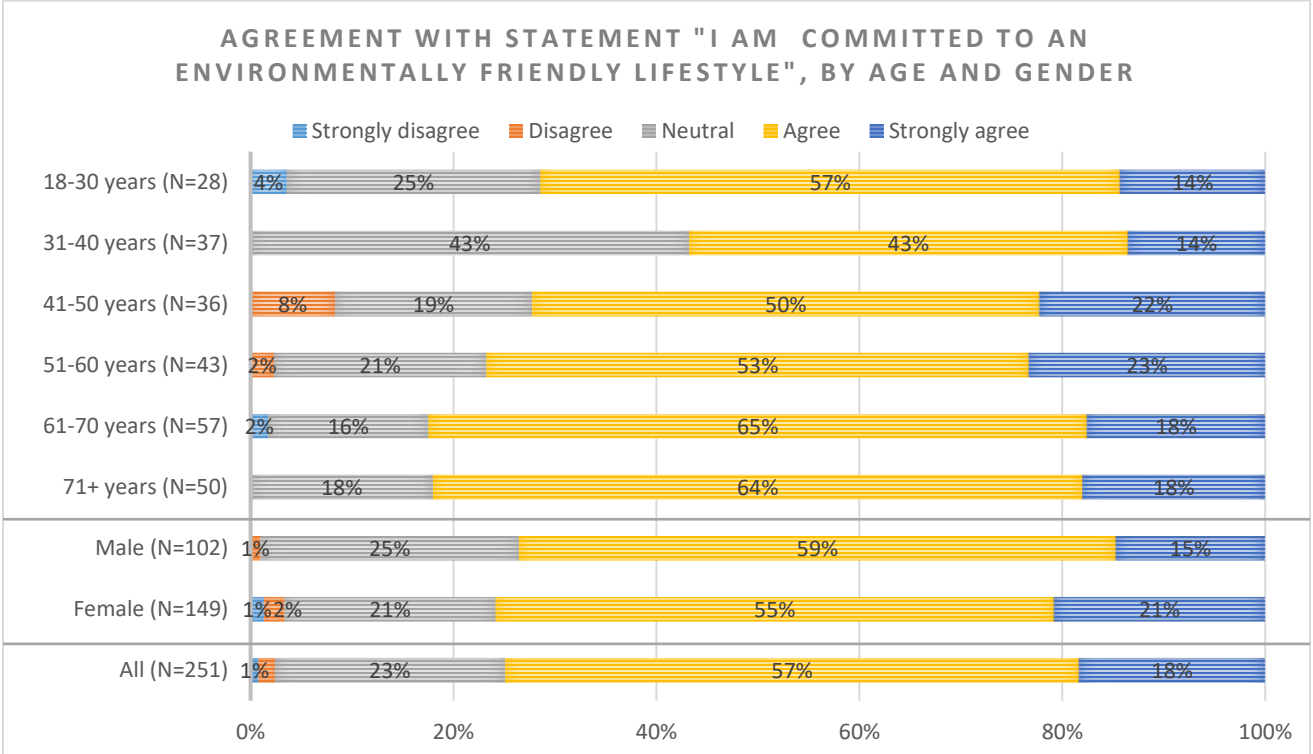

Figure 14 Agreement with the statement "I am committed to an environmentally friendly lifestyle", by age and gender

In order to understand people's behaviors and attitudes toward new mobility options, it is important to know how they use their personal time.

Figure 17 presents the stated preferences for different statements related to personal time usage. While almost half (49 percent) of participants stated that they believe the time spent going to places is a useful transition between activities, 79 percent of them agreed that they try to make good use of time when traveling. Moreover, 38 percent of the respondents indicated that they have busy lifestyles, and 39 percent of the respondents indicated that they prefer to do one thing at a time and avoid multi-tasking. The groups with the highest level of agreement with the anti-multitasking statement presented in Figure 18 are generation X groups (41 to 50 years and 51 to 60 years in 2018).

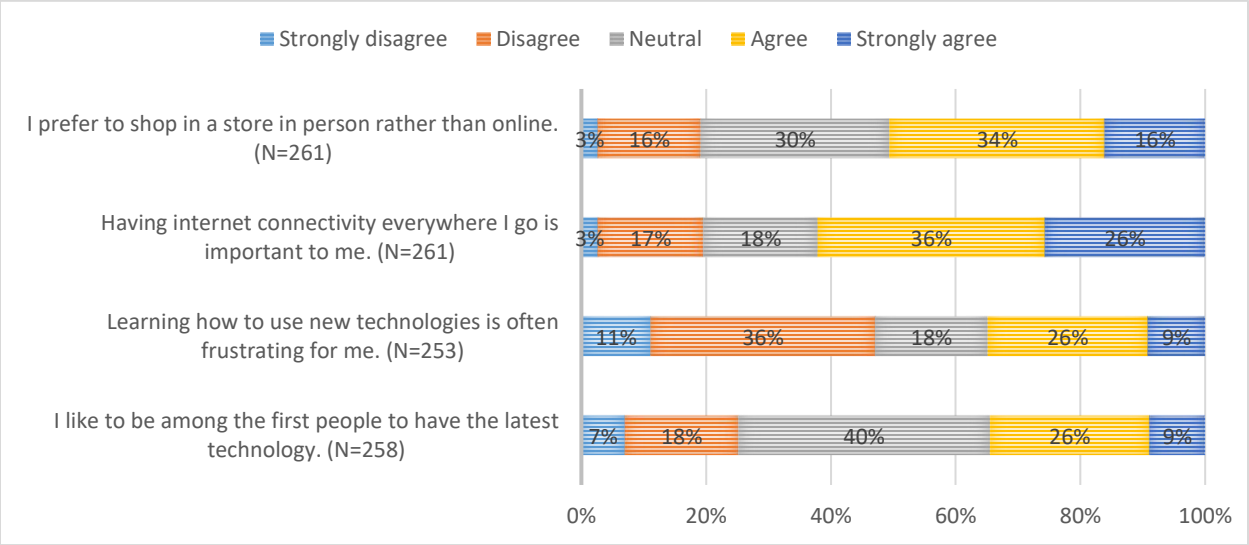

Figure 15 Level of agreement with technology-related statements

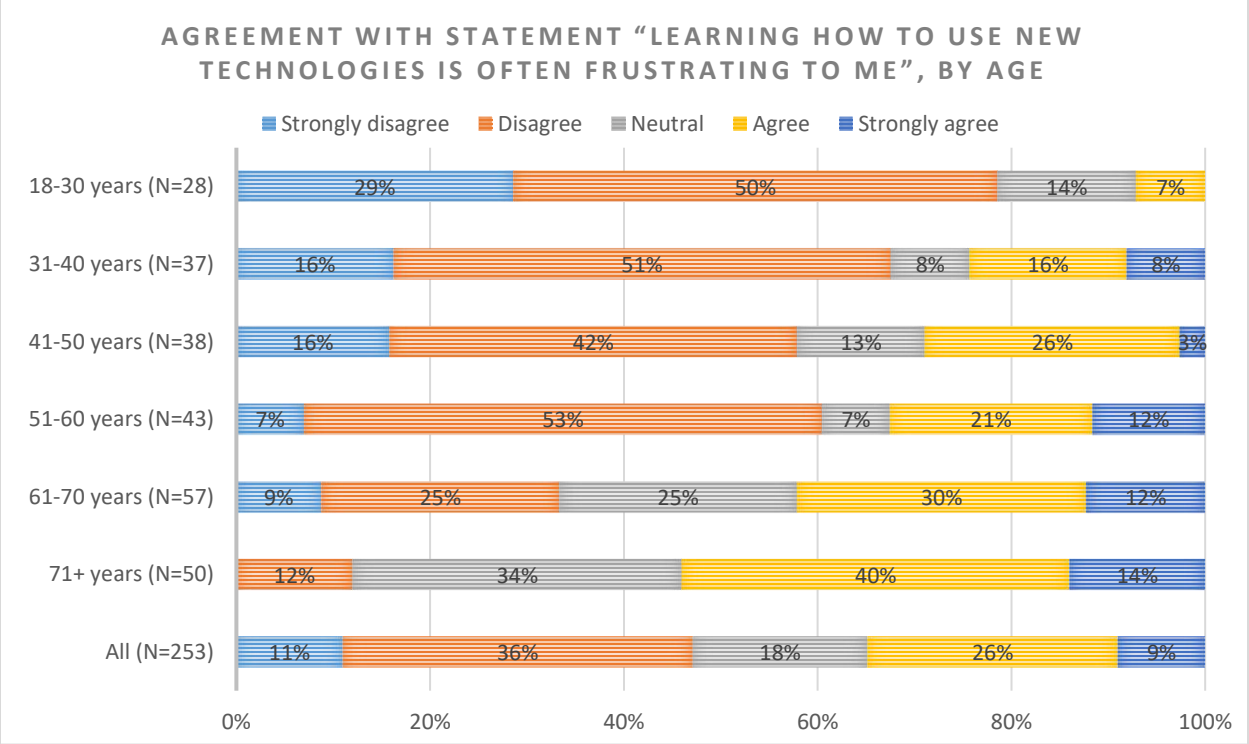

Figure 16 Agreement with the statement "Learning how to use new technologies is often frustrating to me", by age group

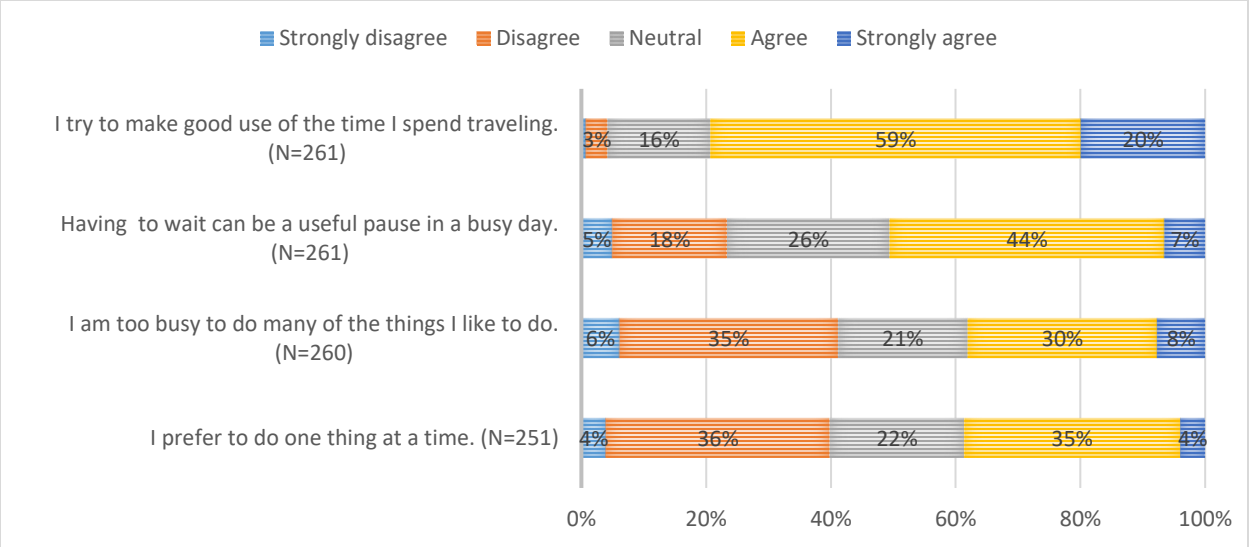

Figure 17 Level of agreement with personal time use statements

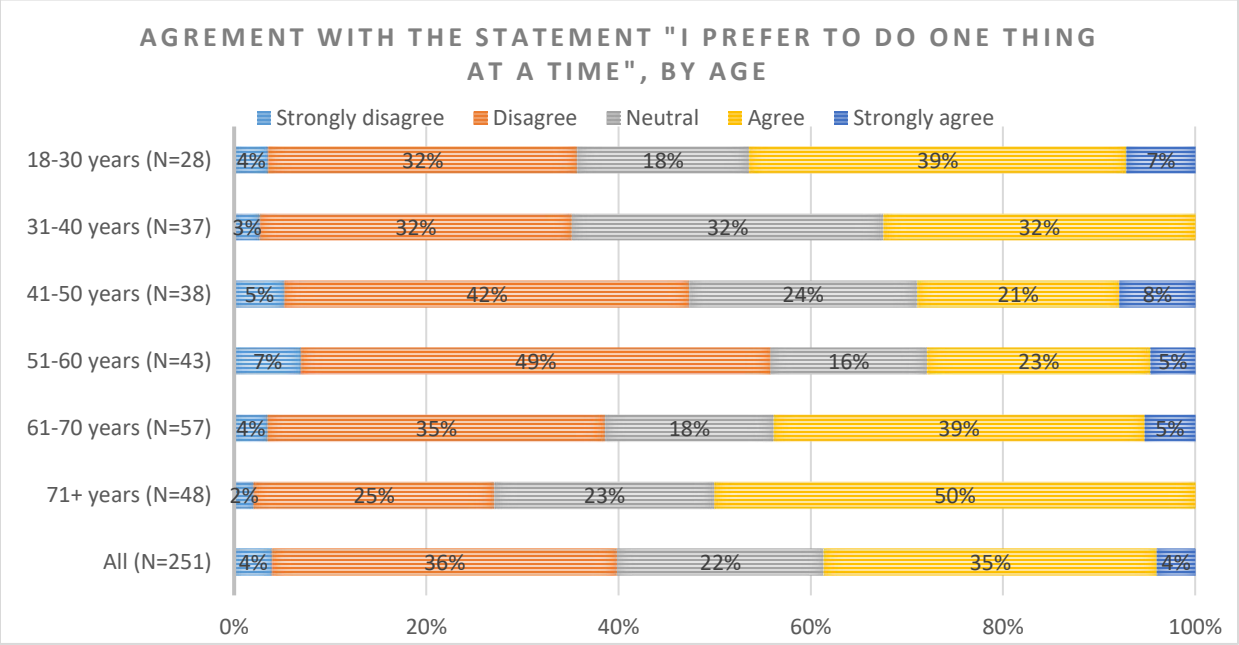

Figure 18 Agreement with the statement "I prefer to do one thing at a time", by age

Figure 19 illustrates the respondents' perceptions of transportation services. Despite the fact that today there are emerging and affordable modes of transportation that could potentially reduce car ownership, 92 percent of participants still like the idea of having their private cars. Likewise, only 17 percent of respondents agree that public transportation is a reliable means of transportation for their needs, while 67 percent disagree with the statement. Interestingly, 68 percent of people agreed that, for most of the time, they have no reasonable alternative to driving. In addition, for most of the survey respondents (82 percent), their current daily travel routine is considered satisfactory. On the other hand, congestion seems to bother more than half of the respondents. Regarding driving preferences, more than half of the respondents prefer to be a driver rather than a passenger when traveling in a vehicle. This finding suggests

that for a considerable amount of people driving itself is a positive act, which may not be willing to avoid in the autonomous world very easily.

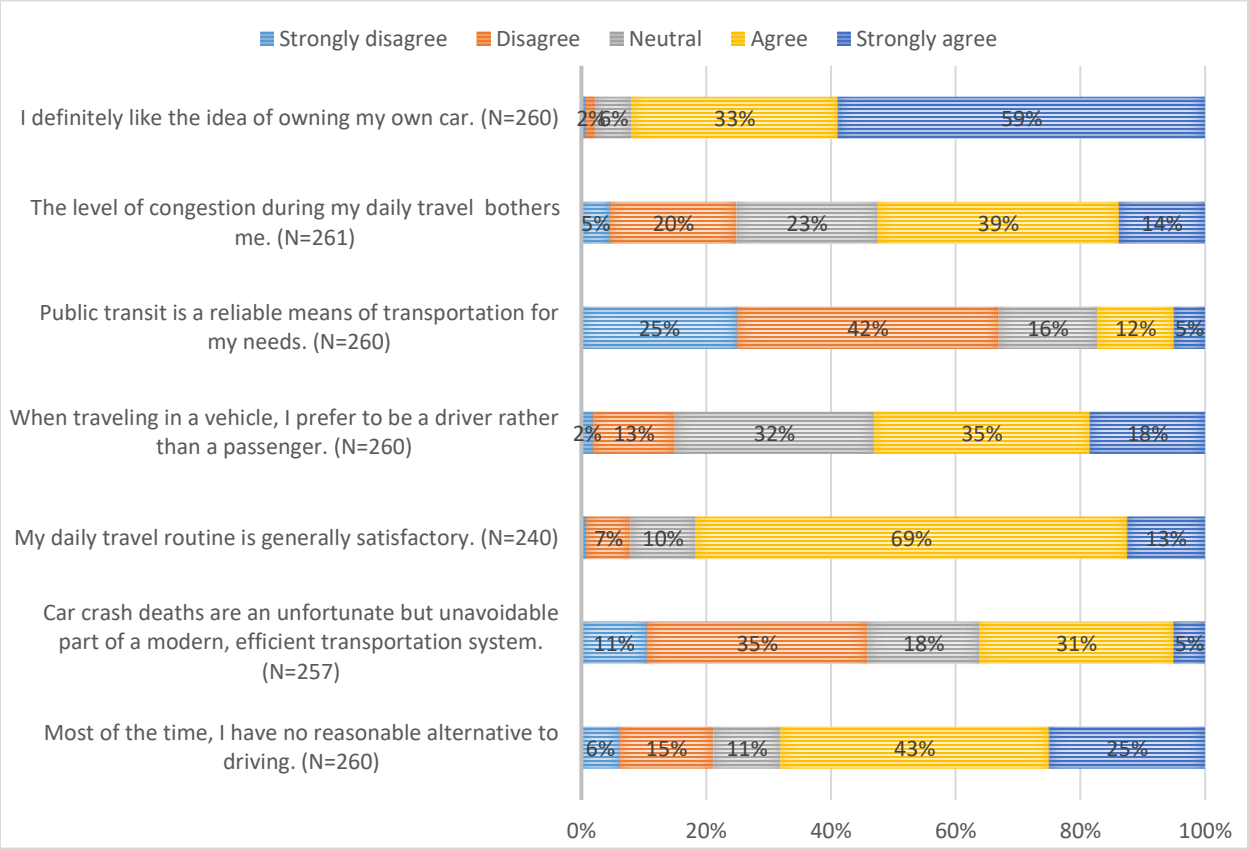

Figure 19 Level of agreement with transportation-related statements

Figure 20 takes a deeper look into the agreement with the statement "My daily travel routine is generally satisfactory", with respect to household income. The high-income category of $100,000 to $149,000 reported the highest levels of dissatisfaction with their daily travel routine. The lowest income class of less than $25,000 per year reported the lowest levels of satisfaction.

When asked about their residential location preferences, 68 percent of respondents agreed that they like the idea of having stores, restaurants, and offices around their neighborhood.

Figure 21 also shows that 61 percent of T4 survey participants disagree that they prefer to live close to transit, even if it means they will have a smaller home in a more crowded region; and, 43 percent of respondents agree to live in a spacious home, even if it is farther from public transportation or many places I go. Figure 22 shows the same agreement with different age groups and gender. Older individuals and females showed a smaller agreement with the preference to live in spacious homes.

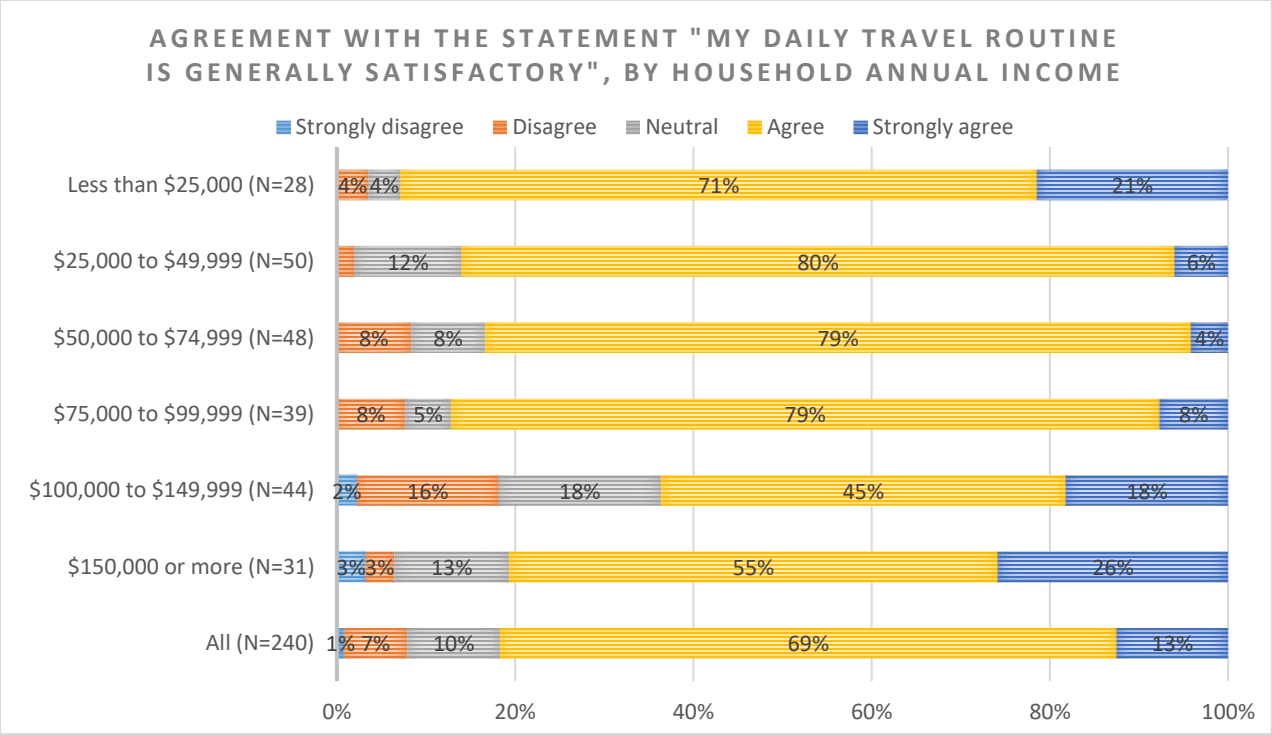

Figure 20 Agreement with the statement "My daily travel routine is generally satisfactory", by household annual income

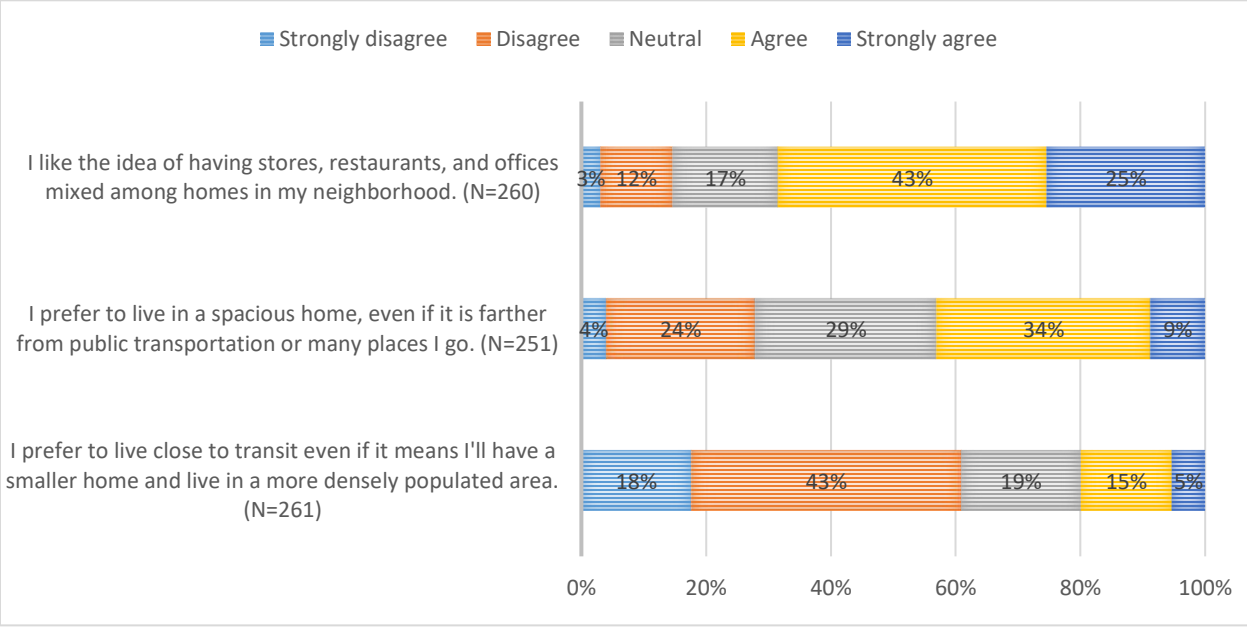

Figure 21 Level of agreement with residential location statements

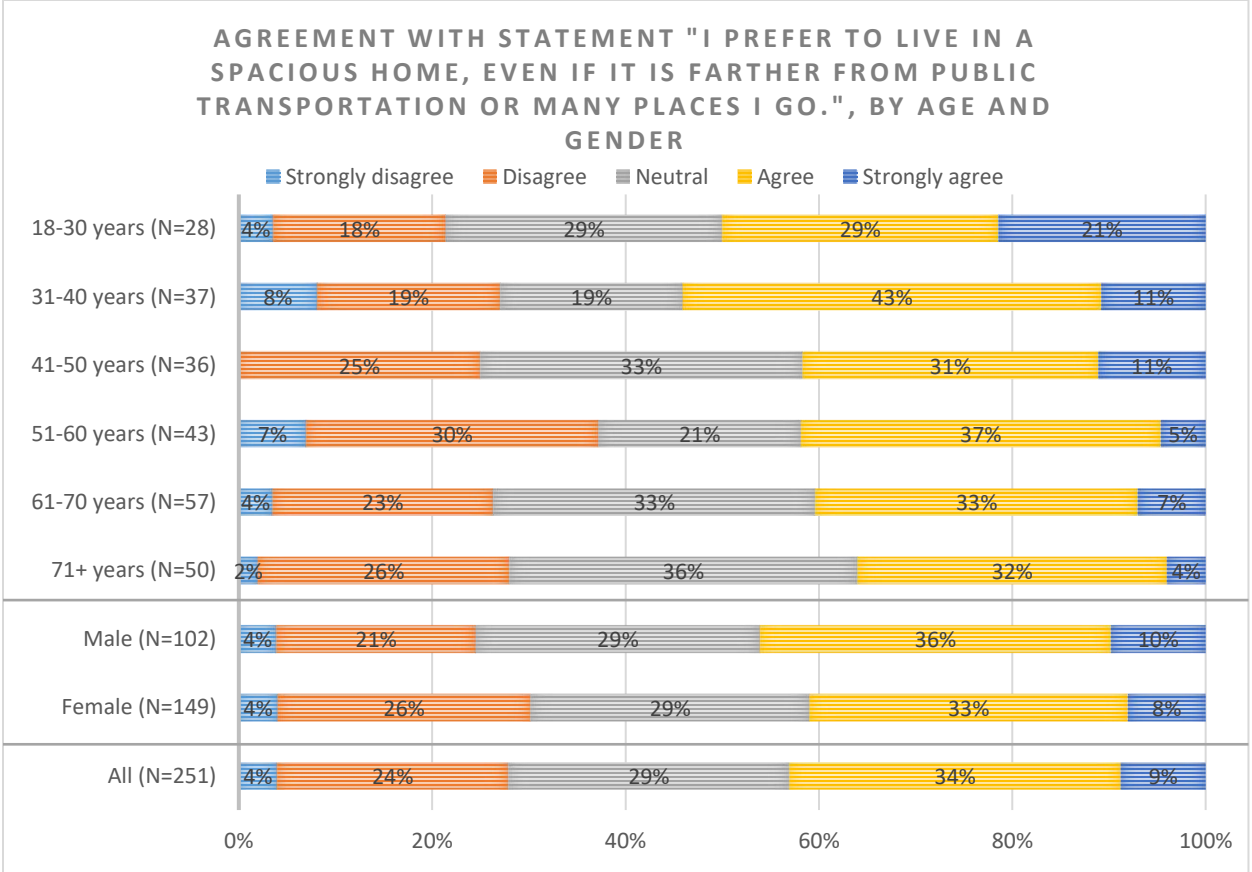

Figure 22 Agreement with the statement "I prefer to live in a spacious home, even if it is farther from public transportation or many places I go.", by age and gender

When asked about the gas tax, only 12 percent of respondents agree that the government should raise it, while 68 percent disagree with it. The survey also shows, for 86 percent of the respondents, the brand is not important compared to the functionality of the car (

Figure 23). One of the activities that some people do in a car when not driving is reading, however, 36 percent of respondents believe that this activity might cause sickness or discomfort when traveling in a car.

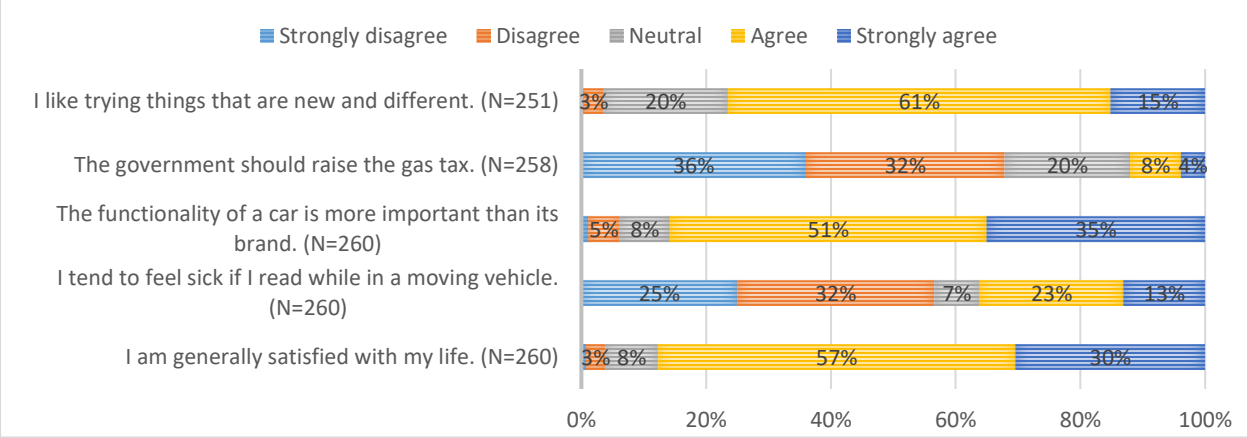

Figure 23 Level of agreement with other general attitudinal statements

When asked about their agreement with the statement “I like trying things that are new and different”, 76 percent of respondents agreed. Figure 24 shows the distribution of responses to the same statement by age and gender. The group that reported to enjoy trying new things the most was those between 41 and 60 years of age. Lastly, 87% of the respondents are generally satisfied with their lives.

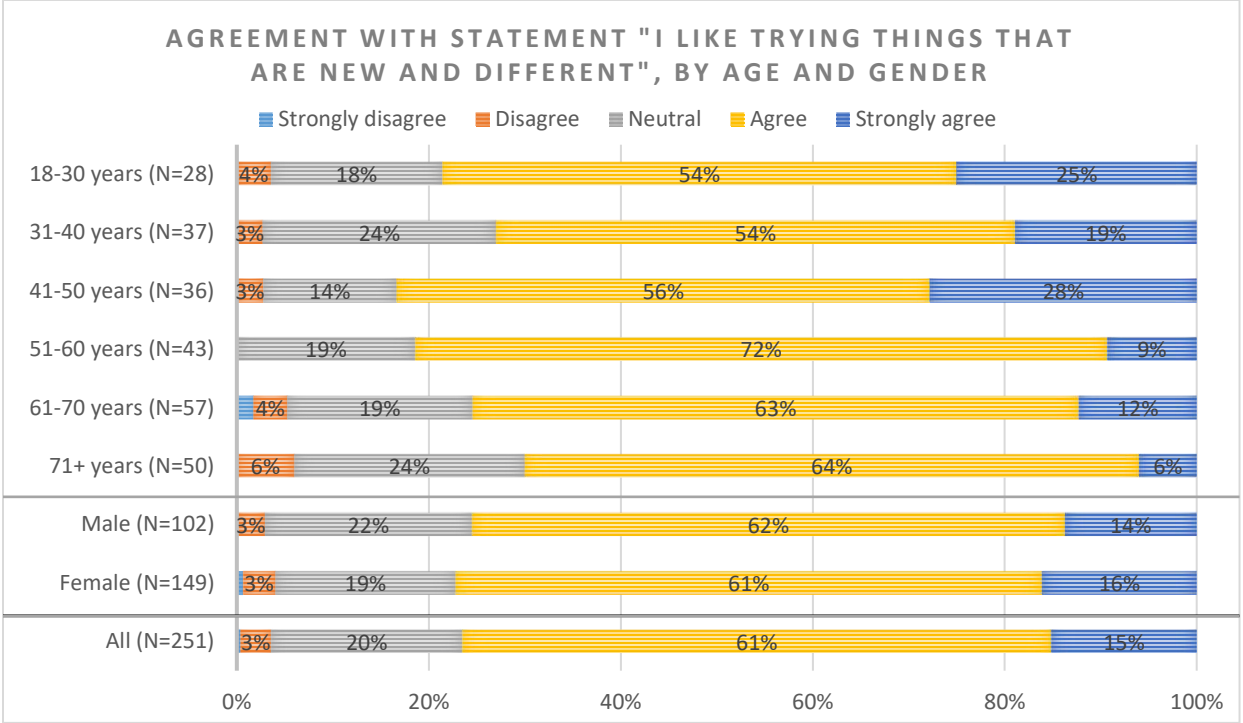

Figure 24 Agreement with the statement "I like trying things that are new and different", by age and gender

Vehicle Ownership

When asked about the vehicles they have, respondents provided responses for the vehicle they use the most (N=249) and all vehicles they own (N=543). One of the questions was about the vehicle make and models. For the vehicle they use the most, the top companies mentioned were Toyota (18 percent), Ford (15 percent), Honda (12 percent) and Chevrolet (8 percent). For all vehicles owned, Toyota again is leading the results (15 percent), followed by Ford (14 percent), Chevrolet (11 percent), and Honda (9 percent).

In addition to vehicle make and model, participants were asked about the model year for all vehicles they owned. In Figure 25, the distribution of vehicles is shown along the model year for all of their vehicles, and the vehicle used most often. Based on the results, it is observed that the vehicle people use the most tend to be newer, which is expected as users are likely to enjoy the new features present in newer cars. Interestingly, old car lovers could be captured in the survey. Although respondents rarely report older cars like the ones they use the most, the survey reveals that some users still own vehicles from the ‘60s and ‘70s.

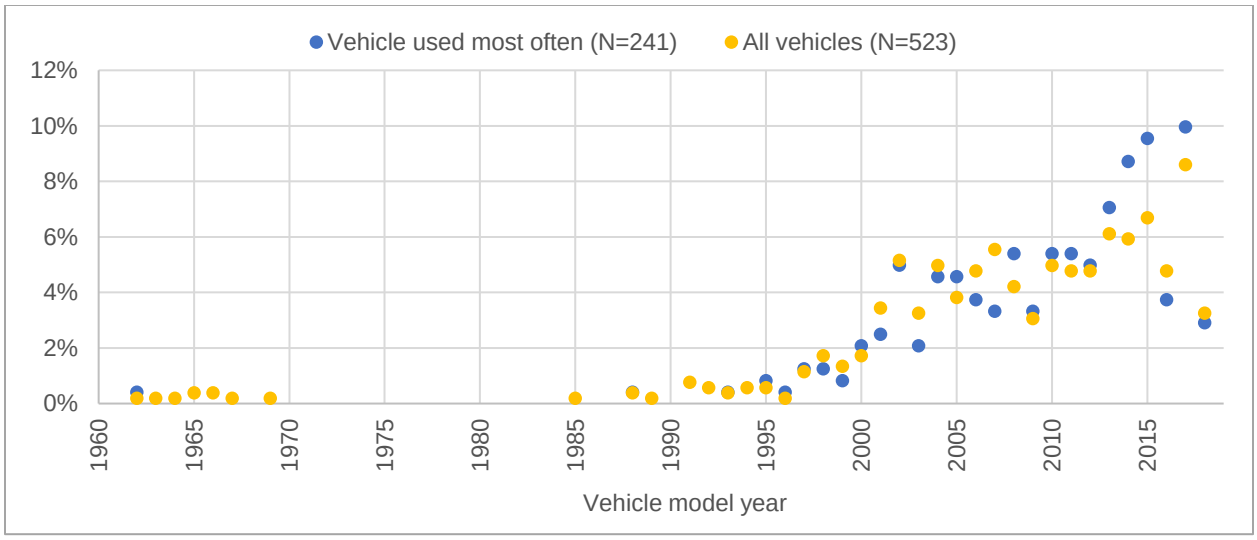

Figure 25 Vehicle model year distribution

As fuel types are important for the sustainability consideration of our transportation system, the survey asked about the fuel type present in the cars owned by respondents. For the vehicle used most often (N=227), 93 percent of them use gasoline, while 4 percent are hybrid, 1 percent are electric, and other fuel types were reported in 2 percent of the responses. For all vehicles owned (N=499), the results follow almost the same pattern.

Another important topic approached in the survey was the driving assistance features present in the cars that drivers use the most. Among the main features presented, Figure 26 shows that Automated Braking System (ABS), Adaptive Cruise Control (ACC), and Backup camera are the top three features reported by respondents, with 68 percent, 51 percent, and 45 percent, respectively. On the other hand, only 15 percent of participants said that there are no driving assistance features presented in the cars driven most often.

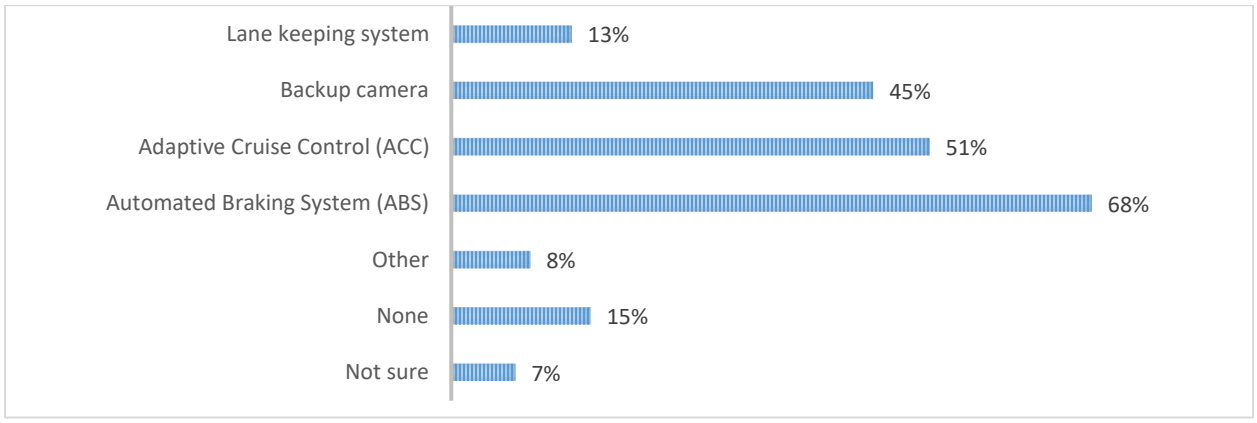

Figure 26 Driving assistance features present on the vehicle driven most often (N=249)

In order to understand people's travel patterns better, the annual miles driven by each participant is one important information. In the survey, respondents were asked about the annual miles driven by all the vehicles they owned. The responses are shown in Figure 27. About 51 percent of respondents reported more than 12,000 miles driven in the last year for the most used vehicle, and 15 percent had less than 6,000

miles driven. When all vehicles are considered, 43 percent of them have driven mileage of more than 12,000 miles, while 29 percent of them have driven mileage of fewer than 6,000 miles.

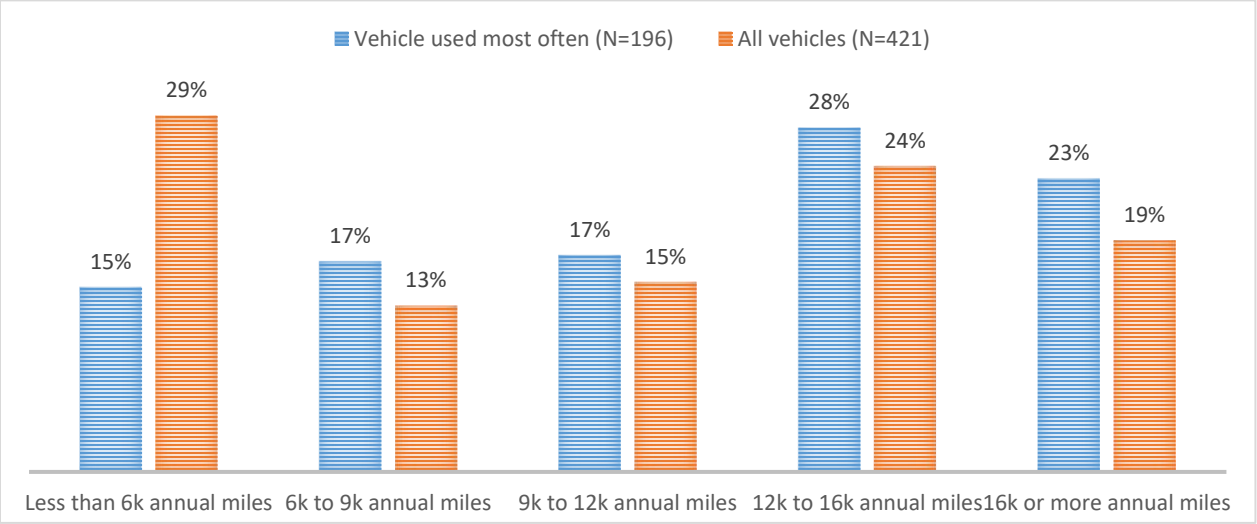

Figure 27 Annual miles driven

Residential Choice

As presented in the literature, residential patterns might be associated with people's attitudes and potential behaviors and might impact and get impacted by new mobility options and technologies. Therefore, the T4 survey also asked questions regarding respondents' residential choices and home characteristics.

Among the 261 respondents, 81 percent of them said they live in a stand-alone home, 10 percent live in a condo/apartment, 5 percent in a mobile home, and 1 percent declared other housing unit types. About the tenure status (N=262), 78 percent of participants stated that they own their homes, while 18 percent of them declared they rent the unit, and 4 percent said their home was provided by somebody else (e.g. relative, employer). According to ACS 2013-2017 estimates, 39 percent of households in Maricopa County are renter-occupied, suggesting that the survey sample over-represents homeowners.

When asked about the choice of home location, 93 percent of the people said they chose their home location, whereas 7 percent of them had their home location chosen by others (N=235). The survey also inquired what year they moved into their current home location. Despite few people moved into their current home from the '60s to the '90s, most of the respondents reported they got into their current place from 2008 to 2018, while fewer people said their last change in home location happened from 1990 to 2006 (N=259).

The importance of different house features for residential place selection was also collected. Figure 28 shows various features that were evaluated by the degree of importance. As expected, respondents are concerned about safety, as 97 percent of them said they want or must have a home in a low crime neighborhood. Interestingly, 57 percent of participants were neutral about having good access to public transit, while 34 percent of them reported they wanted or must have good access to it.

Preferences of home features are related to one another. Figure 29 shows the relationship between preference to live close to transit and preference to live close to shops and services. Those who declared the preference to live close to transit declared higher importance to live by shops and services as well. However, only three percent of respondents who would not prefer to live close to transit reported they do

not want to live close to shops and services as well. In general, 76 percent of the sample rated closeness to shops and services as a feature they "want" or "must-have".

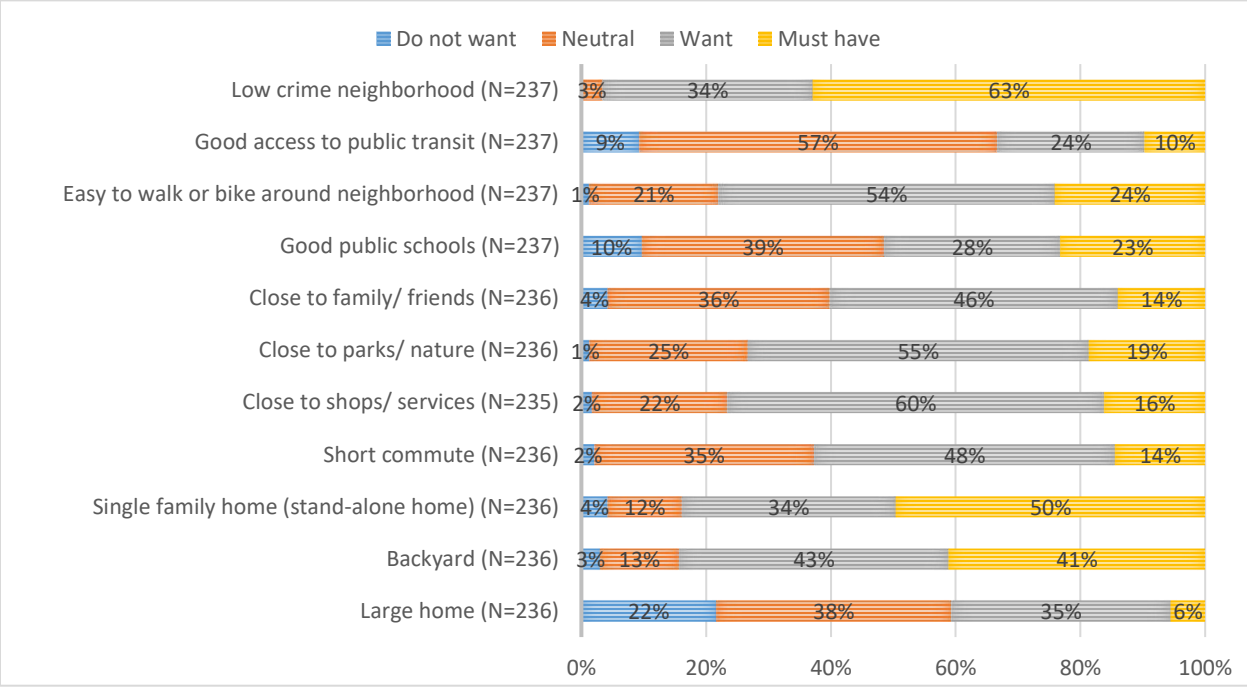

Figure 28 Rated importance of house features when considering a home relocation

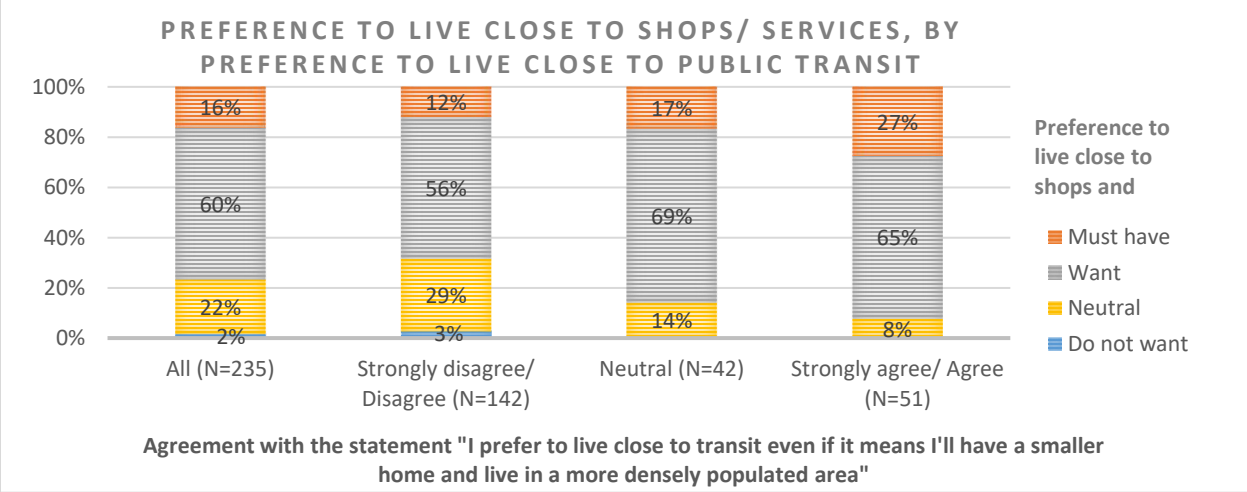

Figure 29 Preference to live close to shops and services by preference to live close to public transit

Current Travel Patterns

The third section of the survey focuses on the respondents' current travel patterns. It asks about general travel behavior, commute trips, and long-distance travel. Figure 30 shows that 74 percent of all respondents drive less than 150 miles a week. Among those who are committed to less polluting means of transportation, such as walking, biking, or public transit, 22 percent of respondents reported driving more than 150 miles a week, while 32 percent of those, who are not committed to less polluting means of transportation, drive

more than 150 miles a week. This graph suggests that people who are concerned with polluting means of transportation drive less on a weekly basis and highlight the value of collecting and incorporating attitudes in travel demand modeling and analysis.

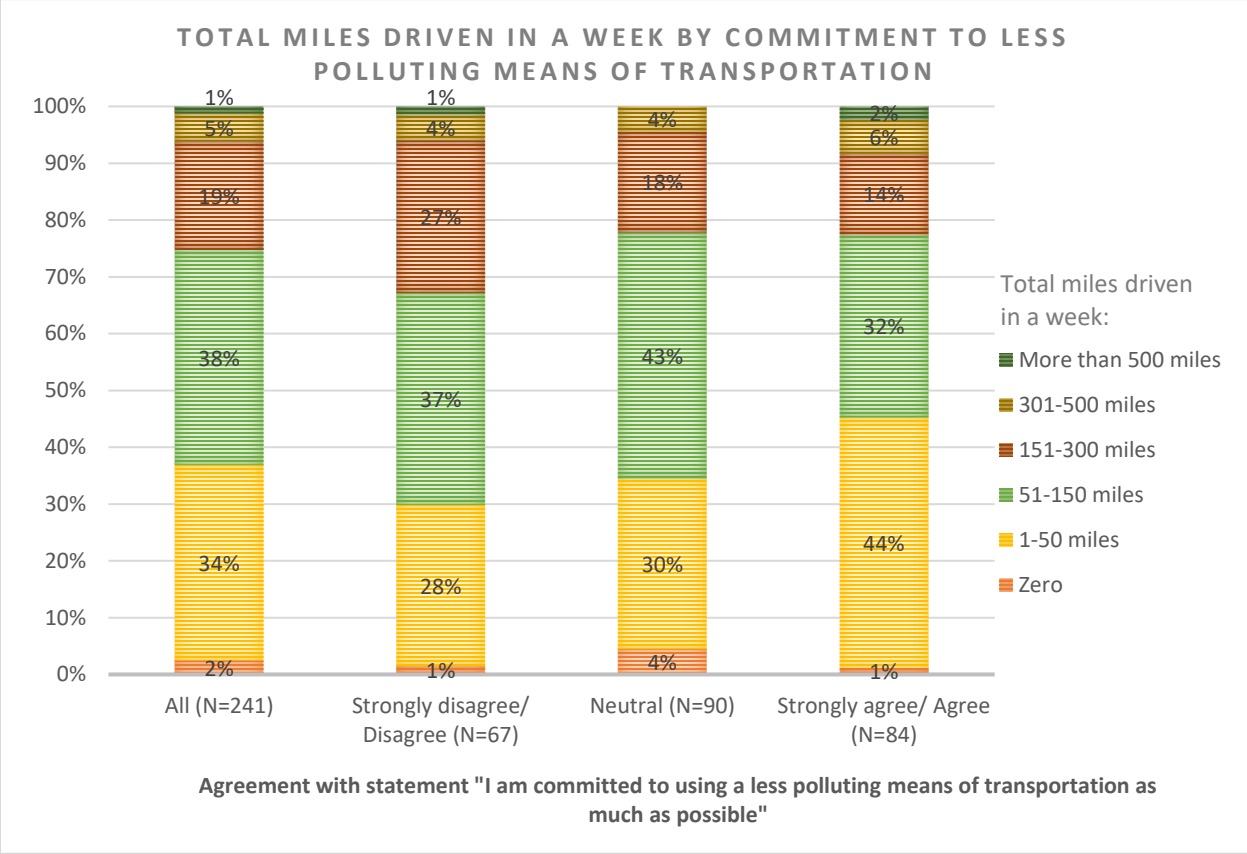

Figure 30 Average miles driven in a week, by commitment with less polluting means of transportation

Respondents were asked to indicate how often they use each means of transportation for non-commuting trips.

Figure 31 shows that for non-commute trips, 67 percent of respondents drive the private vehicle alone three or more times a week, while 34% of the respondents drive private vehicles with other passengers with the same frequency. 82 percent of respondents declared to never use public transit, 74 percent declared to never bike, and 43 percent declared to never walk for non-commute trips.

Commute Trips

The average reported distance from home to the workplace or school locations, which are the commute destinations, was 16.6 miles.

Figure 32 shows that 27 percent of commuters live less than 5 miles away from work or school locations, while 9 percent of commuters declared to live more than 30 miles away from their work/study place.

On average, respondents declare their typical commute to be 28.4 minutes long.

Figure 33 shows that 21 percent of respondents travel for less than 10 minutes to get to work or school. 56 percent of respondents declared their typical commute is between 10 and 30 minutes. Only 23 percent of respondents reported a commute longer than half an hour.

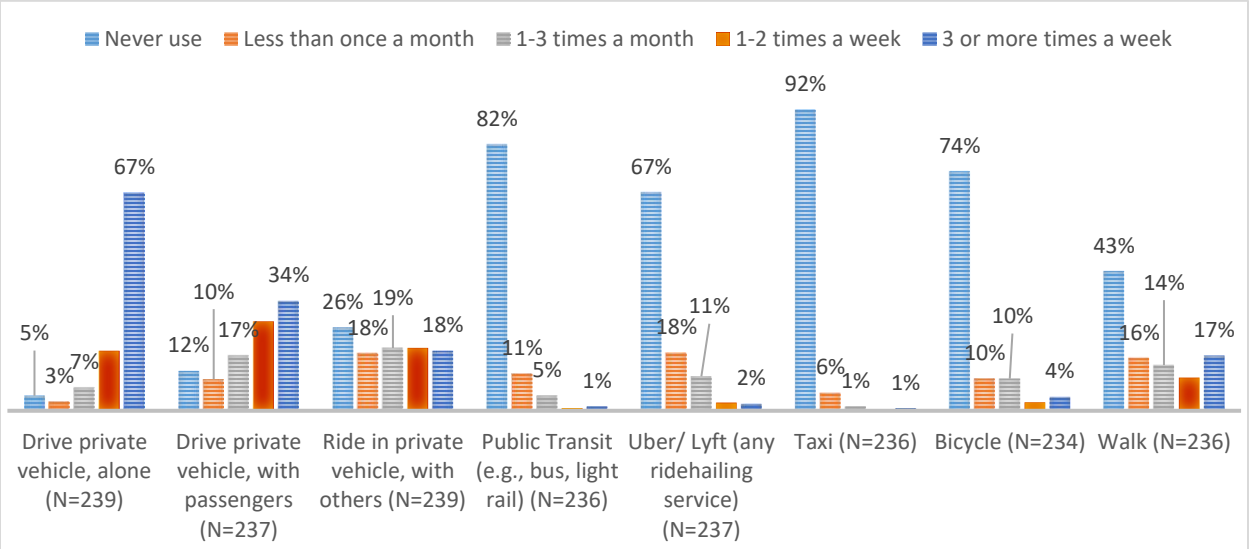

Figure 31 Frequency of mode use on errands/shopping/social/recreational/eat-out/medical trips

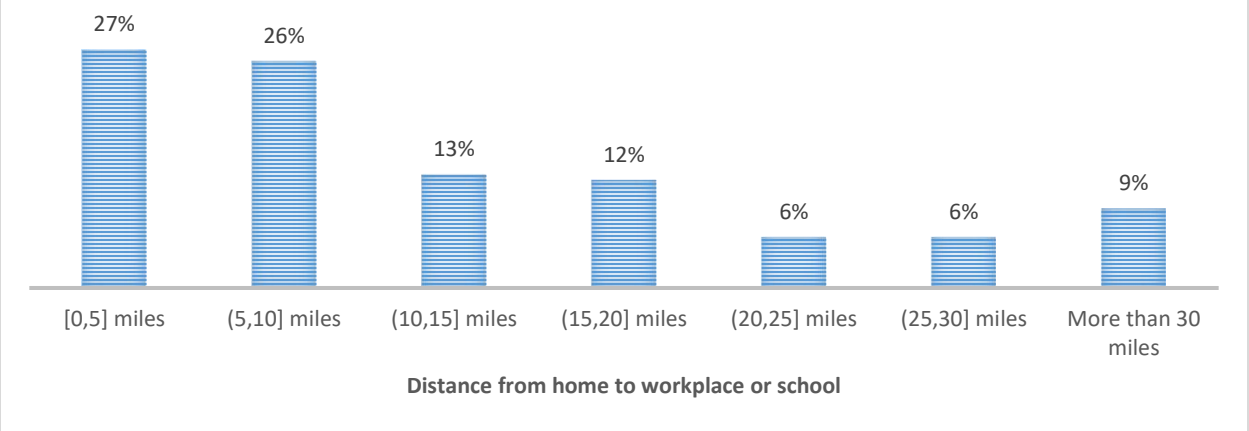

Figure 32 Distribution of reported distances from home to the workplace or school (N=155)

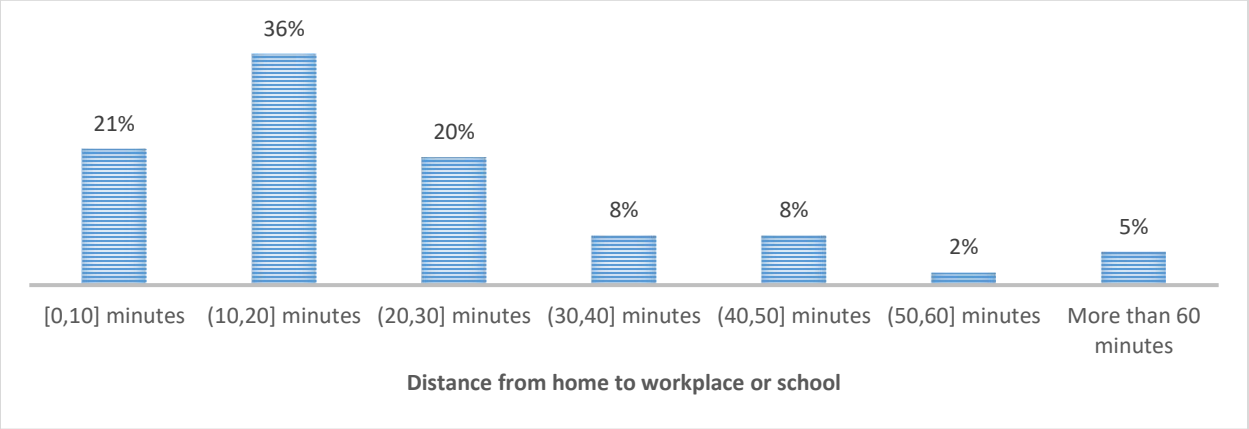

Figure 33 Distribution of reported time from home to the workplace or school (N=155)

When asked about parking at the school or work location, 91 percent declared to have free parking. Among those 9 percent who declared to pay for parking at the school or work location, 55 percent are paying for parking on daily basis, 9 percent are paying for parking weekly, 18 percent are paying for parking monthly, 9 percent are paying for parking annually, and 9 percent did not report the frequency of payment. The average price of parking per day was calculated to be $10.90.

Figure 34 shows the frequency of using each transportation mode on trips to and from the school or workplace (commute trips). In contrast to

Figure 31, which shows the same information for non-commute trips,

Figure 34 shows a larger proportion of respondents relying exclusively on driving a private vehicle alone. While 81 percent said to drive alone 3 or more days a week for commute purposes, only 4 percent declared to bike and 6 percent declared to walk with that same frequency. According to the ACS 2013-2017 estimates, 76 percent of commuters drive alone to work, 11 percent carpool to work, 2 percent use public transportation, and 1 percent walk to work. This fact suggests that our sample is similar to the population with respect to the commute mode distribution.

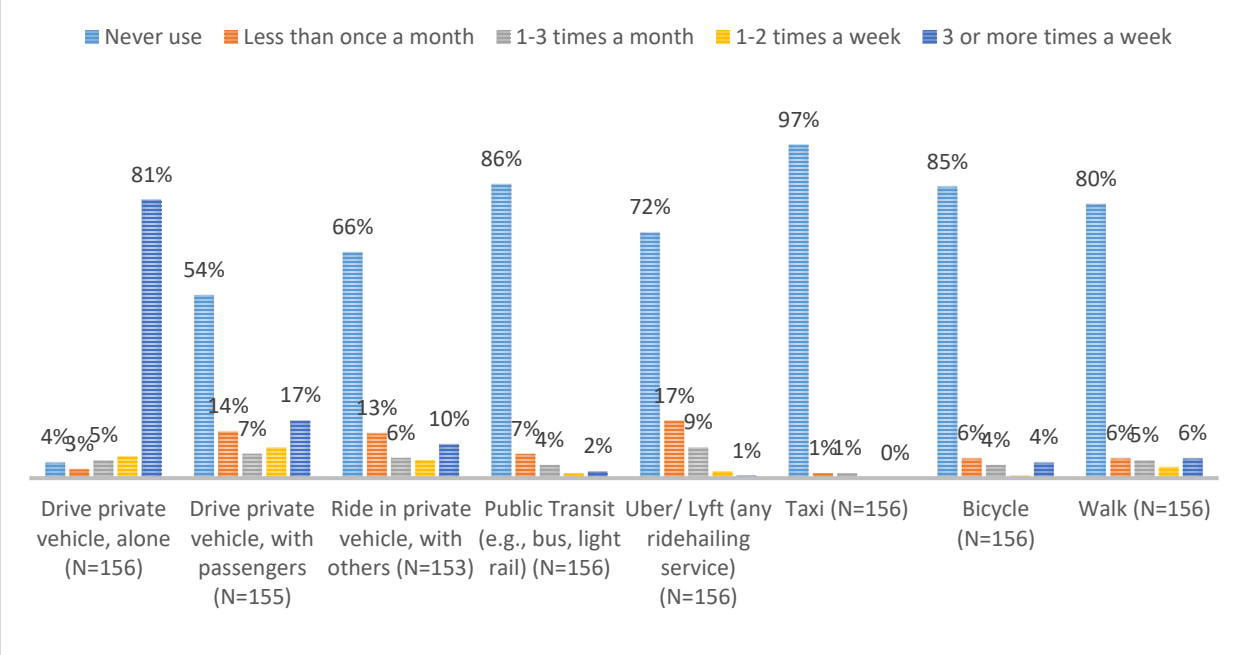

Figure 34 Frequency of mode use on commute trips

Long-distance Trips

This section shows how respondents answered the question regarding their long-distance travel. In this study, long-distance travel was defined as trips that were at least 75 miles long (one-way), not including commute trips. Journeys with multiple destinations were treated as one long-distance trip. Respondents reported an average of three long-distance trips in the past three months. Given that the pilot survey was

conducted around October, that period would be approximately from July to September.

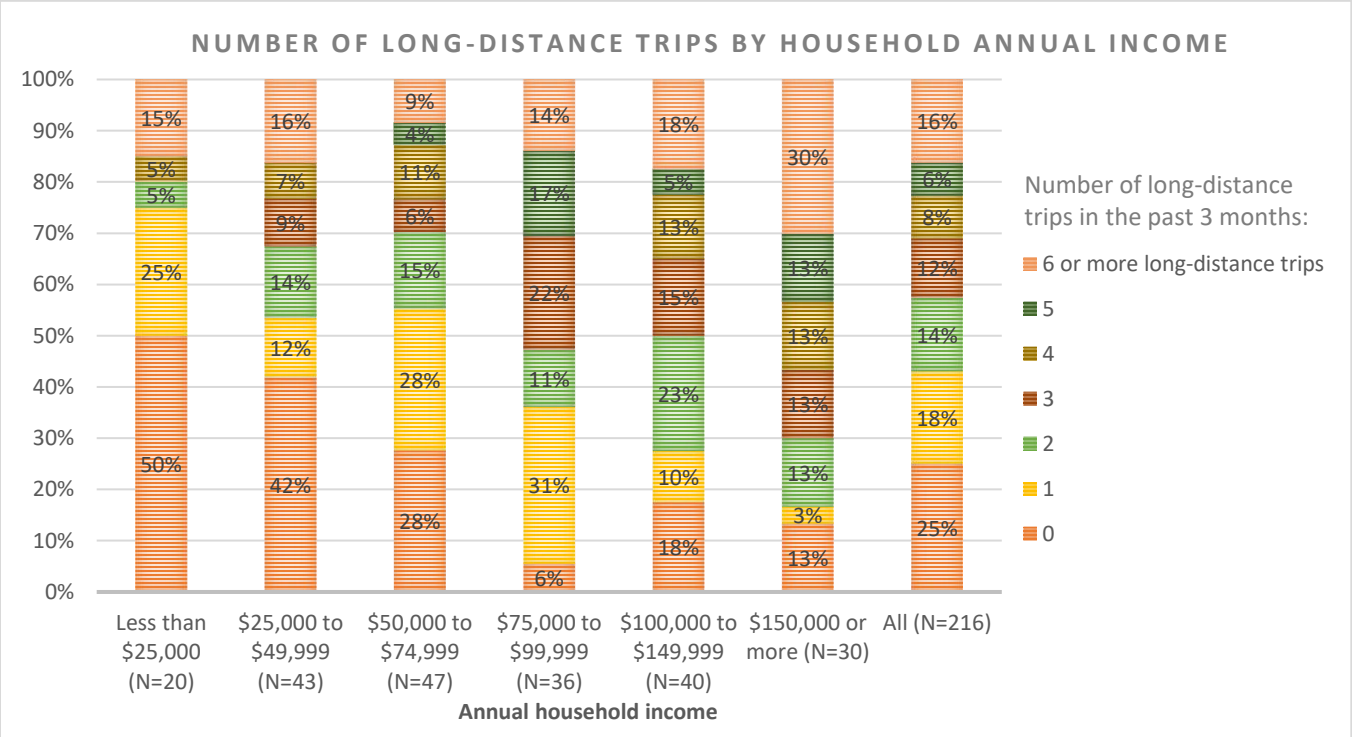

Figure 35 shows that 25 percent of all respondents declared to not have made any long-distance trip in the 3 months period prior to the completion of the survey. 16 percent of all respondents declared six or more trips in the same period. When contrasting that distribution with reported household income, 50 percent of those with income lower than $25,000 per year reported zero long-distance trips in the previous 3 months. 30 percent of those who reported income of $150,000 per year or above, declared to have made 6 or more long-distance trips.

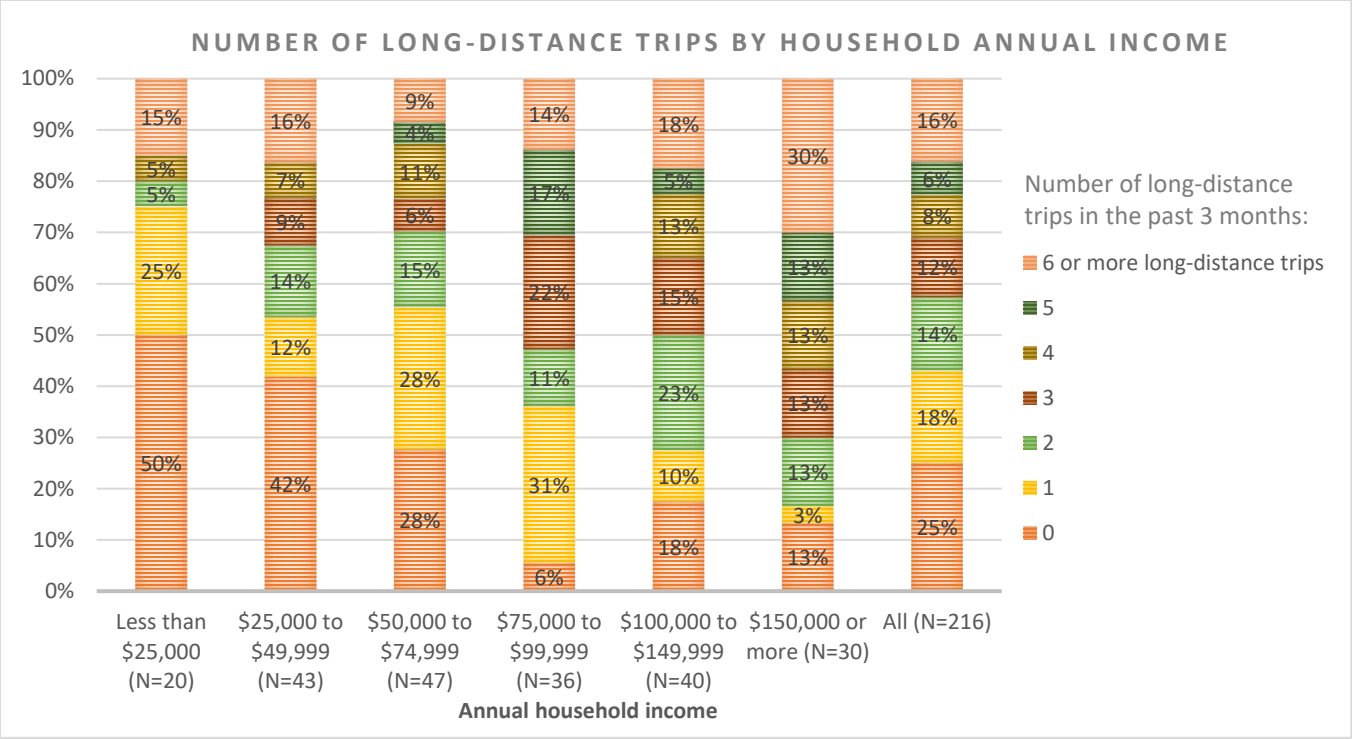

Figure 35 Estimate of the number of long-distance trips (over 75 miles) made over the past 3 months, by household annual income

In addition to the number of long-distance trips pursued in the previous 3 months, respondents were asked about the mode and destination location of the long-distance trips. Respondents reported an average of 2.99 total long-distance trips (over 75 miles) in the past 3 months. Among all respondents, an average of 2.23 long-distance trips by car was reported, as well as 2.52 trips within the U.S., and 0.95 trips by airplane. Only 5 percent of those who reported at least one long-distance travel did not make any trips within the country. Moreover, 47 percent of those who reported at least one long-distance travel did not use an airplane.

Ridehailing Services Usage and Perceptions

As ridehailing services (mobility-on-demand) have changed the way people move around in recent years, this survey is trying to understand more about people's behavior, attitudes, and main perceptions toward these new mobility options and their impact on travel behavior. In this study, an exclusive section was designed to ask the respondents about their familiarity, usage frequency, attitudes, and stated preference toward ridehailing services in both of the shared and single-passenger (private) versions of these services.

Familiarity and frequency of use of ridehailing services

Although for some people ridehailing services are part of their daily travel patterns, these services might not be familiar for others. In order to measure how much people are aware of these services and how much people use any shared mobility service, this survey asks about respondent's frequency of use of four distinct services: private ridehailing, shared ridehailing, carsharing, and bicycle/scooter sharing.

Figure 36 illustrates that at least half of the respondents are familiar, but not regular users of all the four shared mobility services provided. As expected, the most popular service, in terms of familiarity, is

the regular private ridehailing; only 12 percent of respondents are not familiar with it. On the other hand, carsharing is the least popular service, as almost half of the participants (48 percent) are not familiar with it. The shared version of ridehailing and bicycle/scooter sharing show similar public familiarity, with 35 percent and 34 percent of the respondents, respectively, having no familiarity with them. The most popular service, in terms of frequent usage (monthly/weekly), is the private ridehailing service with 4 percent of the respondents using it weekly, and 12 percent using it monthly. It should be noted that shared ridehailing services (Uberpool, and Lyftline) are not available in the Phoenix metro area at the time of this survey. Therefore, the low familiarity and the low usage of the shared ridehailing service is expected.

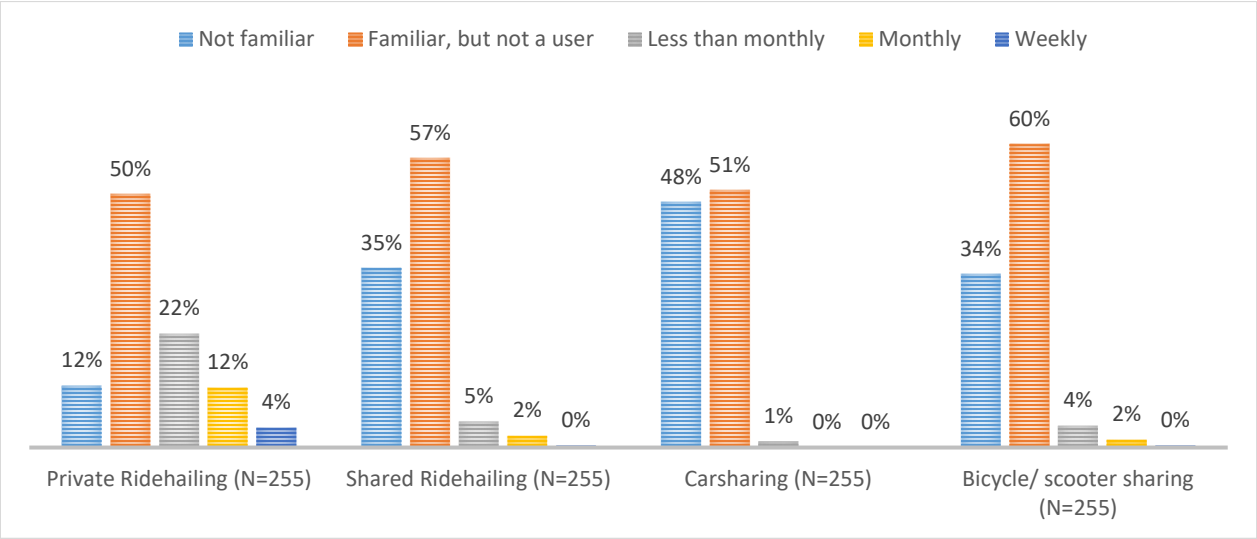

Figure 36 Familiarity with on-demand mobility services

When breaking down the private ridehailing users into different age groups, the distribution of public familiarity across different age groups is observed. Figure 37 shows that 39 percent of the sample are actual Uber or Lyft users with different frequencies. As expected, younger people use it more frequently than older people: 70 percent of respondents from 18 to 30 years old reported using the private ridehailing service with different frequencies, and this number decreases for older age groups, reaching only 15 percent for people aged 71 years and older. Interestingly, the percentage of people who are "familiar, but not user" is relatively similar for all age groups above 40 years old, varying from 53 percent to 60 percent, and around 25% for younger age groups.

When analyzing ridehailing familiarity by the agreement with the statement "I prefer to live close to transit even if it means I'll have a smaller home and live in a more densely populated area", it is shown that respondents that agree with that statement are more frequent users of ridehailing, as seen in Figure 38. Among those who prefer to live close to transit, 32 percent of respondents declared to use ridehailing monthly or weekly, while that share represents only 12 percent of whom do not prefer to live close to transit.

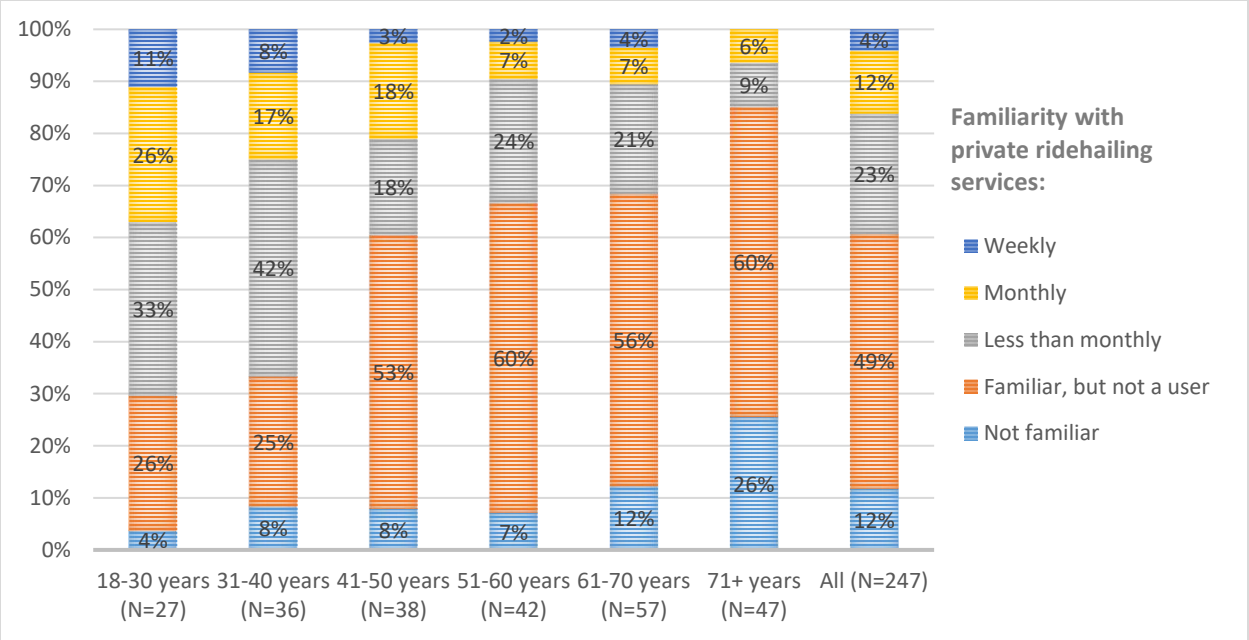

Figure 37 Familiarity with and frequency of using private ridehailing services, by age

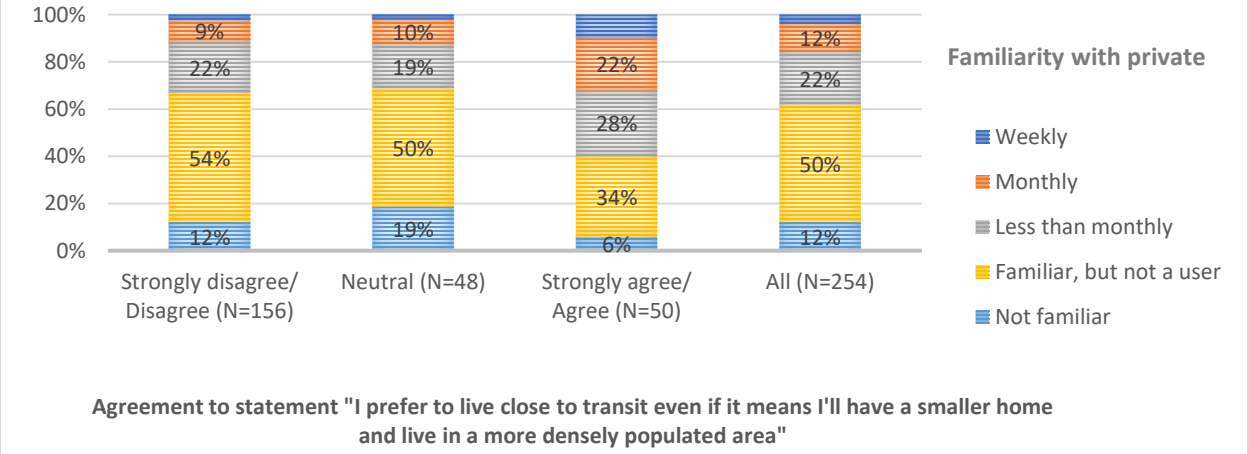

Figure 38 Familiarity with and frequency of using private ridehailing services, by preference to live close to transit

Attitudes towards Ridehailing Services

In addition to travel behavior and usage of ridehailing services, this survey also collects users' attitudes and perceptions of these relatively new mobility options. Understanding users' attitudes and perceptions will help to advance these new services to better serve the needs of the people and meet the goals of an urban area in all aspects of sustainability.

In Figure 39, responses to general questions about the ridehailing services are illustrated. Only 4 percent of participants agree that the ridehailing service availability influences where they choose to live and/or work or go to school, whereas 68 percent of people disagree with this statement. For 76 percent of respondents, ridehailing services are a good alternative mode when they are away from home. And 88 percent of respondents agreed that ridehailing services help avoid impaired driving. Ridehailing services

are perceived as reliable for 60 percent of the respondents. Regarding the service price, only 21 percent of the respondents believe that ridehailing services are expensive; and, 60 percent believe that they are reliable.

As ridehailing services are becoming increasingly part of people's travel patterns, some are still skeptical about them. In Figure 40, bivariate analysis of the agreement with the statement of "Ridehailing services are reliable" by age and gender, and it shows that younger groups of people agree with the statement more than older ones. In addition, when observing gender differences, women agree more than men that these services are reliable.

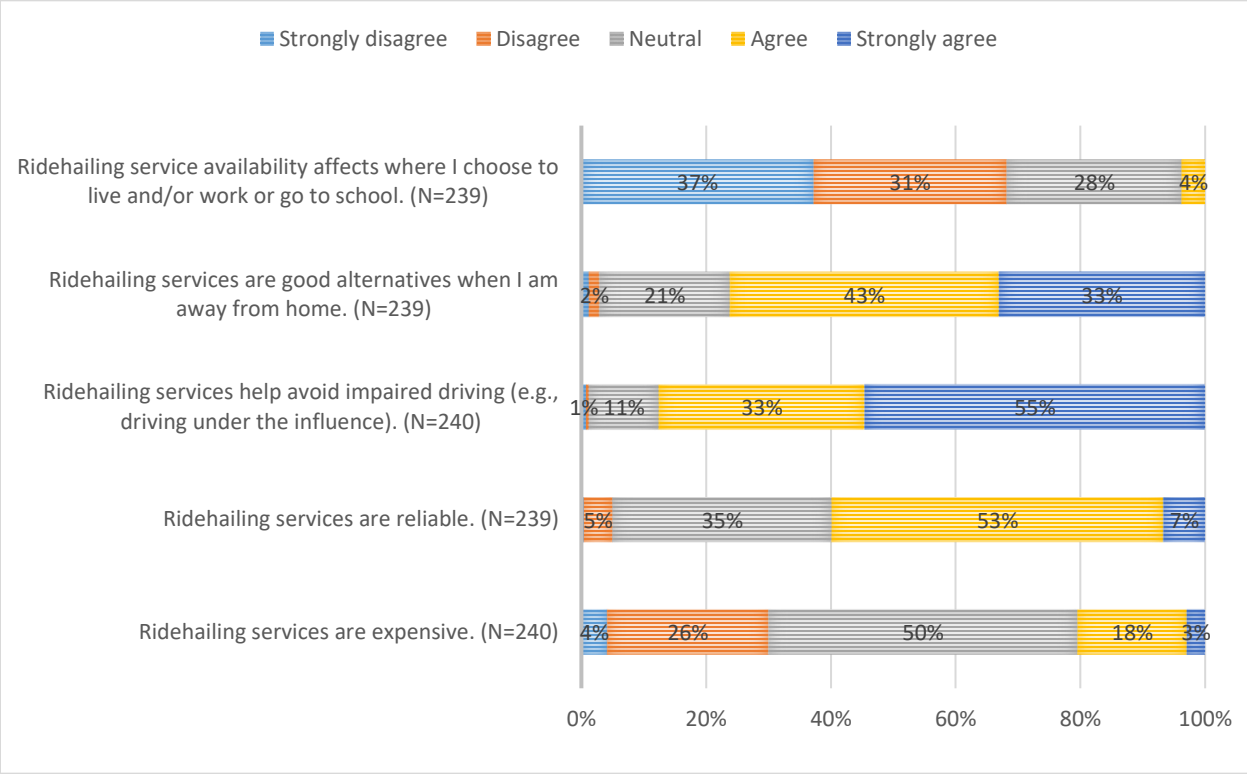

Figure 39 General attitudes towards ridehailing services

People's opinions were evaluated in comparison to other modes. As seen in Figure 41, ridehailing services are considered a good option, for 80 percent of respondents, where there is no public transit service available. When transit services are available, ridehailing services help 44 percent of the respondents to get to/from public transit facilities. 73 percent of them consider these services as good alternatives when their own cars are temporarily unavailable. One main advantage of ridehailing services is to help to save on parking costs. For 74 percent of the respondents, ridehailing services help save time and money on parking and only 1 percent of respondents disagree with the parking benefit.

One big concern that is seen in the literature is how these ridehailing services impact vehicle ownership (Clewlow and Mishra, 2017). As these services are increasingly accessible and affordable, having personal cars might not be necessary anymore. Figure 42 shows how people in different income groups agree to the statement that these services help them live with fewer or no cars. As a trend, it is noticeable that people in high-income categories are more likely to keep their cars regardless of the ridehailing services. While 43 percent of respondents that make less than $25,000 agree with the statement, only 16 percent of the ones who make $150,000 annually also agree with it.

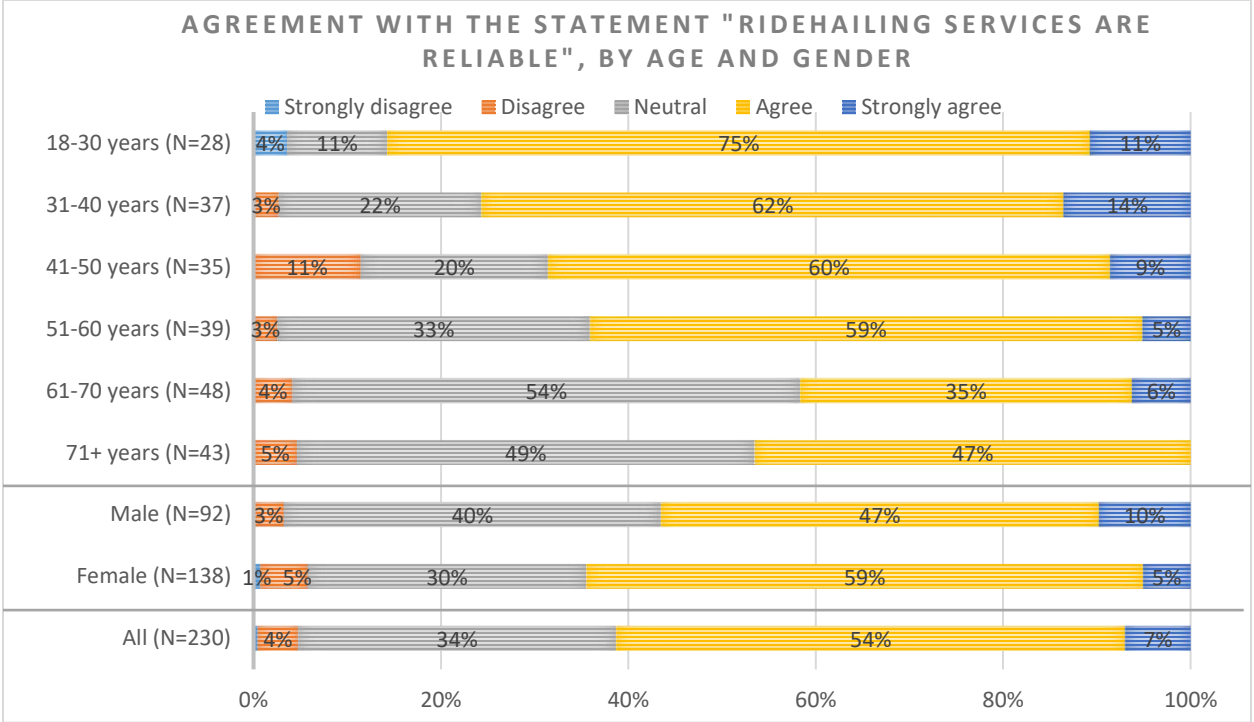

Figure 40 Agreement with the statement "Ridehailing services are reliable", by age and gender

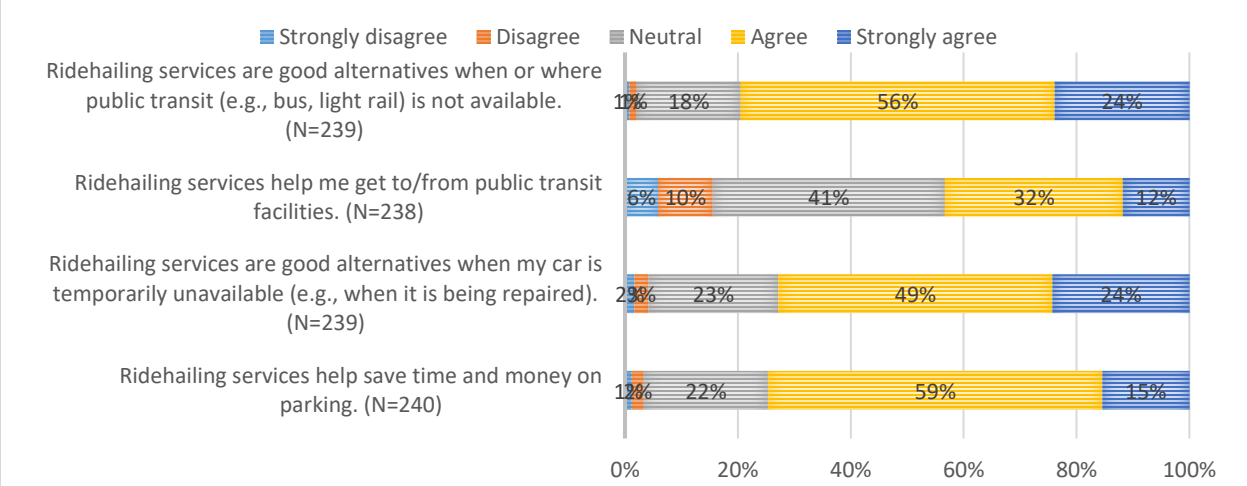

Figure 41 Attitudes towards ridehailing services, in comparison to other modes

Further analysis of the agreement with the statement "Ridehailing services help me get to/from public transit facilities" is presented in Figure 43. It is shown that people in higher-income categories tend to increasingly disagree with the statement perhaps because of their decline in the use of public transit services in the first place.

Nowadays, shared ridehailing services are also available as the private ones in some metro areas excluding the Phoenix metro area. These services are less expensive than the private ridehailing services but the travel time and waiting time might be higher depending on the number of passengers added to the ride. In this survey, some attitudes and opinions related to shared ridehailing services were also captured.

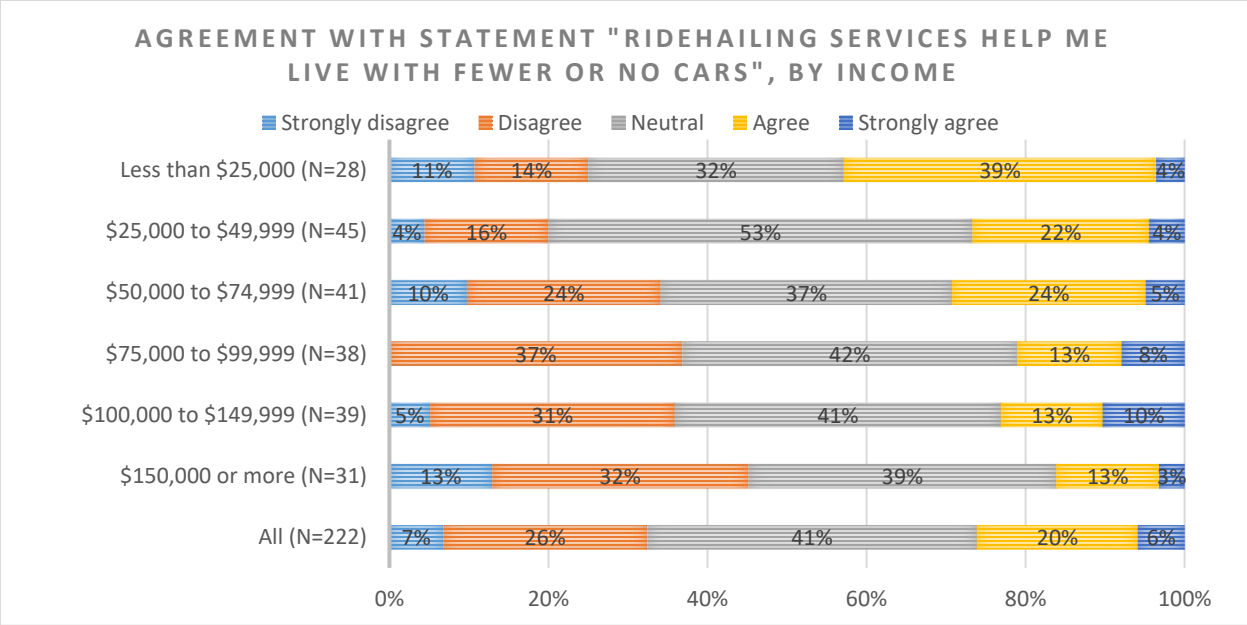

Figure 42 Agreement with the statement "Ridehailing services help me live with fewer or no cars", by income

Figure 44 shows that while 29 percent of respondents said that the lower cost is worth the additional time picking up and dropping off passengers, 30 percent of them disagree with this statement, and the majority of people (41 percent) are neutral about this statement. These results are intuitive as Figure 36 shows 57 percent of people know the shared service but are not users and 35 percent of them simply are not familiar with it at all. While the shared ridehailing services are attractive because of its cheaper price, the user still needs to make a tradeoff in order to decide how much longer he/she is willing to make the trip for that cheaper fare he is going to get. As different people might have different opinions about it, the bivariate analysis by age and gender was done for the statement "For shared ridehailing services, the lower cost is worth the additional time picking up and dropping off other passengers". As seen in Figure 44, despite some people believe that a pattern for different groups could exist, there is no noticeable difference in the way men and women react to the statement. Regarding age, middle-aged groups (41 to 60 years old) reported a higher level of agreement with the trade-off offering by shared ridehailing services.

In addition to that, the concept of sharing a ride with a stranger is seen as a possible uncomfortable experience for a significant amount of people. For 46 percent of respondents, traveling with other unknown passengers makes them feel uncomfortable (Figure 45). Figure 45 shows that differences in age do not show a clear pattern with respect to the discomfort of sharing the ride, but it is seen that women tend to agree with the statement (50 percent) more than men (39 percent).

Ridehailing companies face several limitations as well. When asked about accessibility, 8 percent of respondents agreed that the lack of equipment to accommodate disabilities prevents them from using the services. The regulations that require drivers to use specific seats for children also affect the significant number of users (IIHS, 2019). While 46 percent of participants disagree that the lack of child safety seat prevents them from using ridehailing services, still 20 percent of people agree with it and are affected by the absence of the safety seat.

Another concern regarding ridehailing services can be captured through the statement “Traveling with a driver I don’t know concerns me a lot”. As seen in Figure 47, differences in age are perceptible.

Older people agree slightly more with the statement in comparison to younger age groups. Considering gender, women tend to agree with the statement more than men (45 percent against 36 percent).

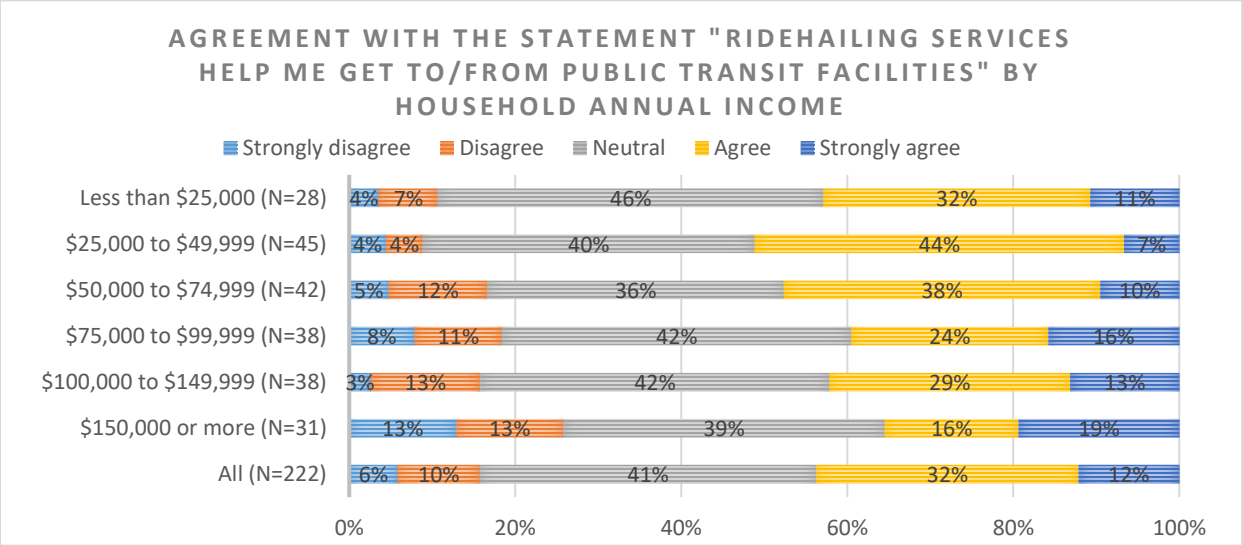

Figure 43 Agreement with the statement "Ridehailing services help me get to/from public transit facilities" by household annual income

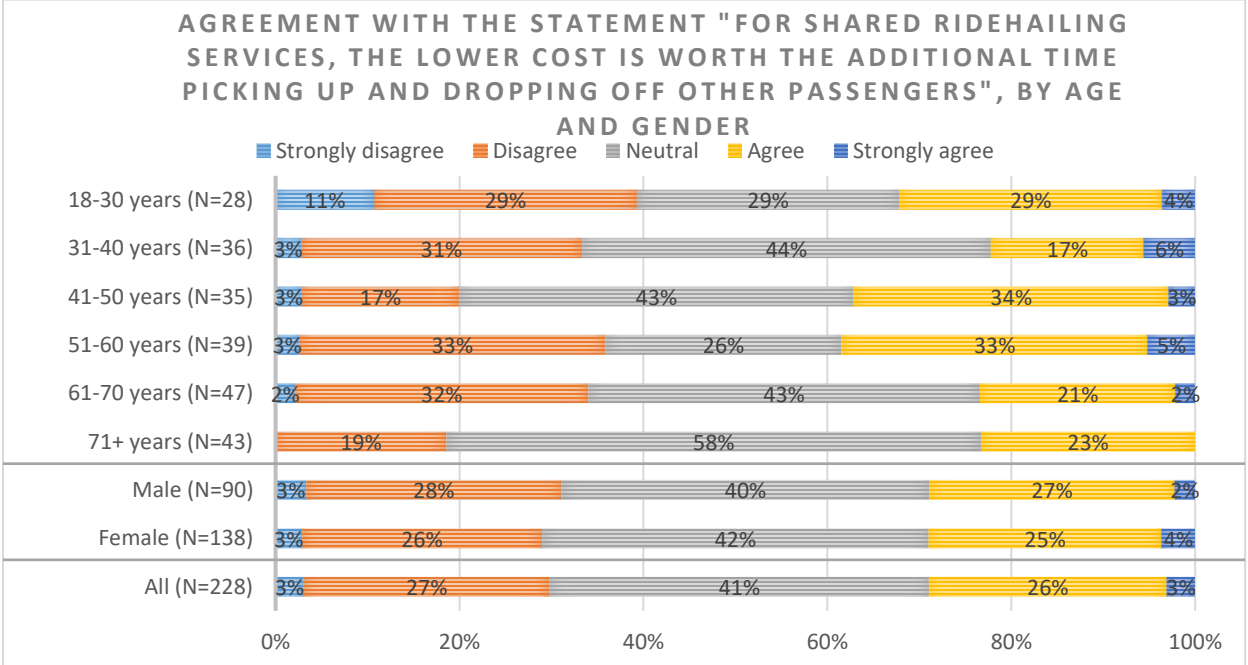

Figure 44 Agreement with the statement "For shared ridehailing services, the lower cost is worth the additional time picking up and dropping off other passengers", by age and gender

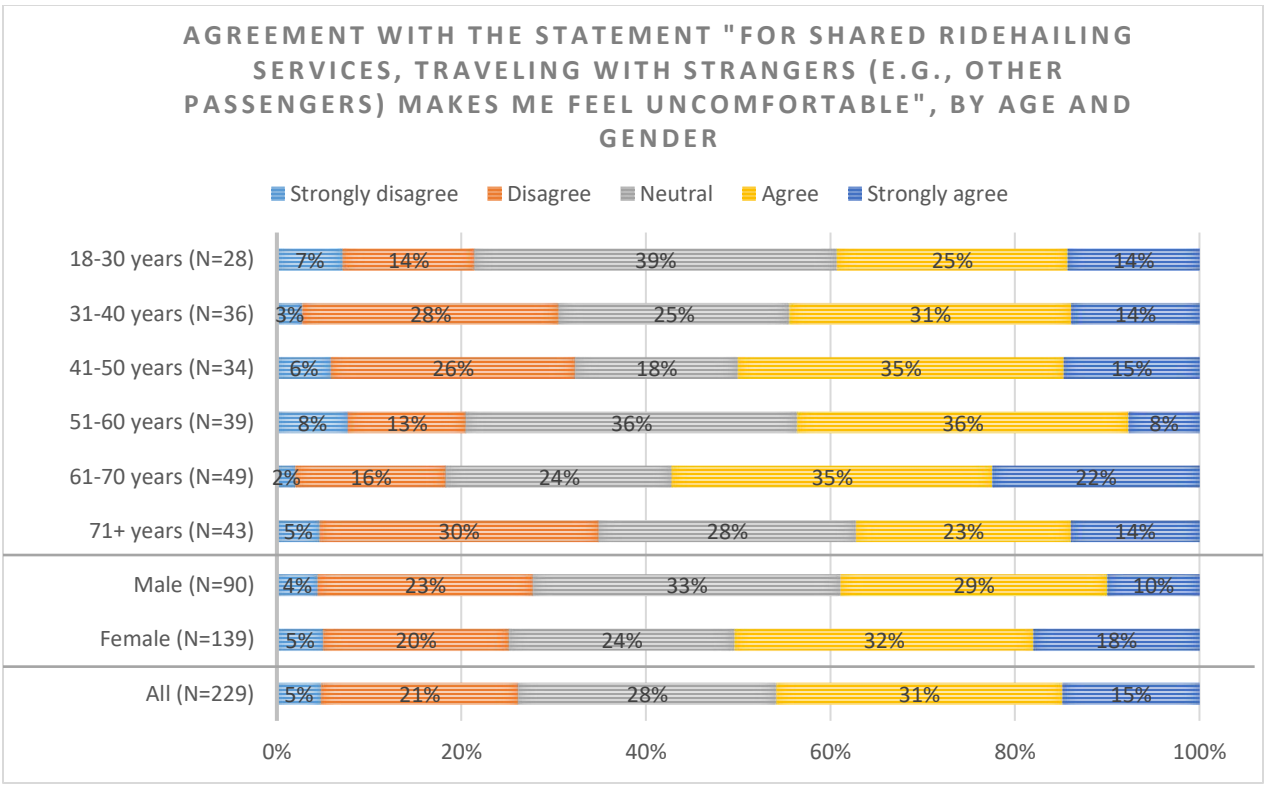

Figure 45 Agreement with the statement "For shared ridehailing services, traveling with strangers (e.g., other passengers) makes me feel uncomfortable", by age and gender

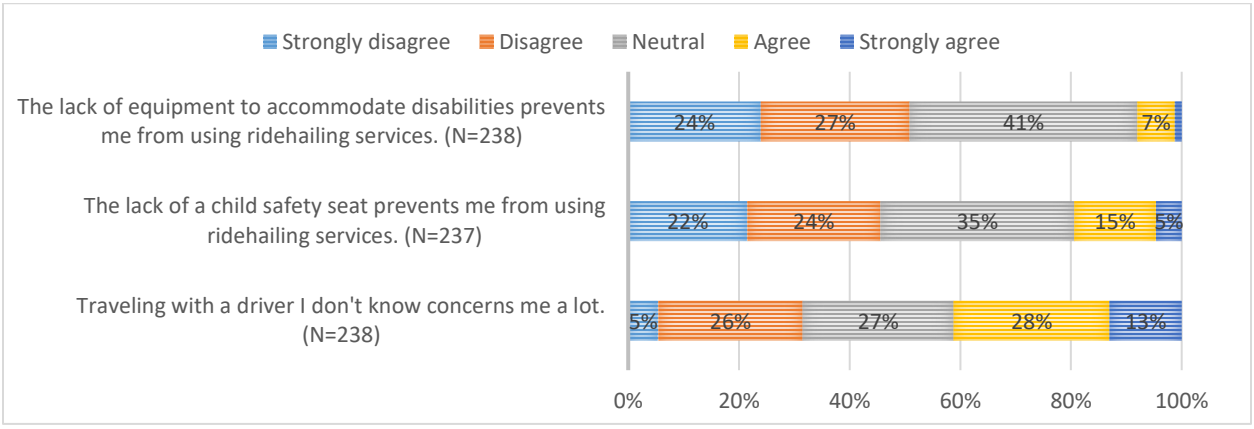

Figure 46 Concerns and barriers to adoption of ridehailing services

Questions Asked Only to Ridehailing Users

The actual ridehailing trip characteristics are also important information to understand the benefits and limitations of these services which is beneficial to provide better services to the users, in addition, to enhance travel demand modeling practices with inclusion of these travel modes under current and future conditions.

Figure 48 shows the purpose (based on the destination) of the last trip users made using ridehailing services and the alternative mode they would use if the service were not available. Interestingly, going to the airport represented almost a quarter (24 percent) of responses; following by social/recreational trips

corresponding to 23 percent of the trips reported. Considering the scenario in which the service was not available, 28 percent of the participants said they would carpool; 26 percent would use the regular taxis; 16 percent would drive alone; and, 7 percent would not make the trip at all.

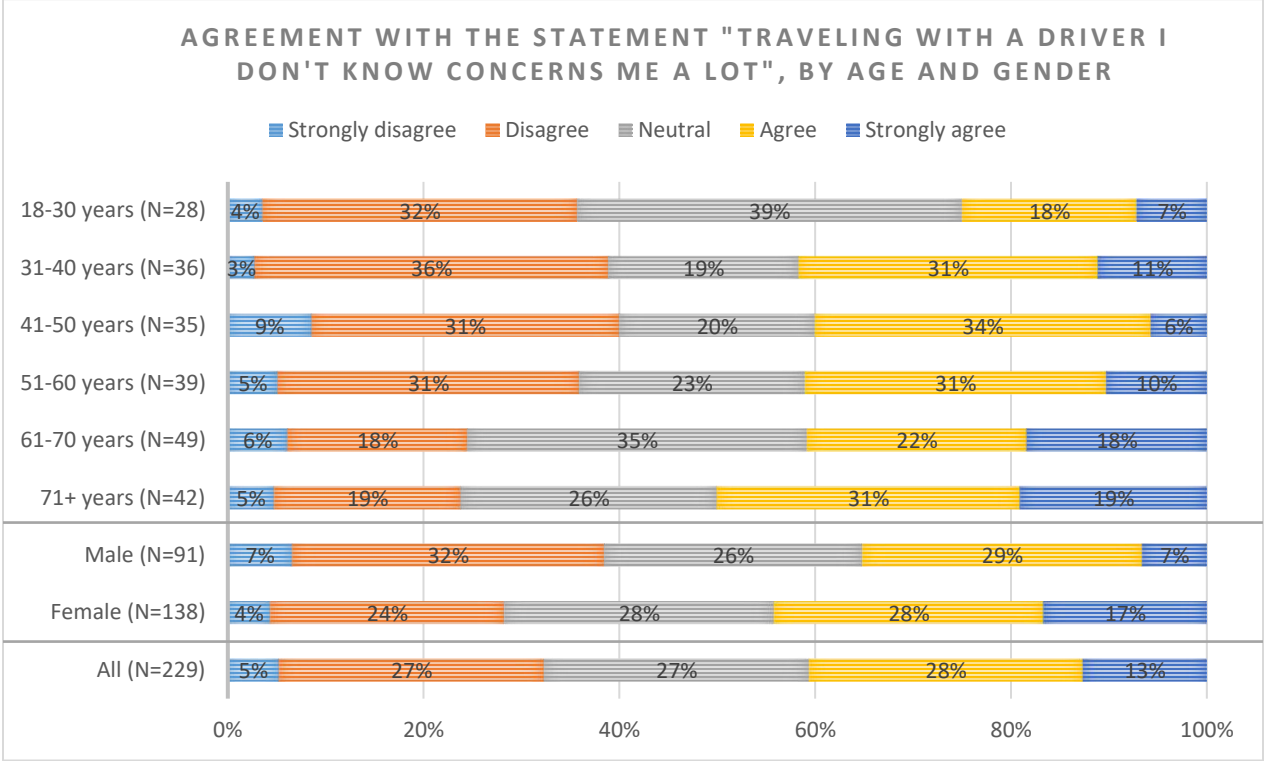

Figure 47 Agreement with the statement "Traveling with a driver I don't know concerns me a lot", by age and gender

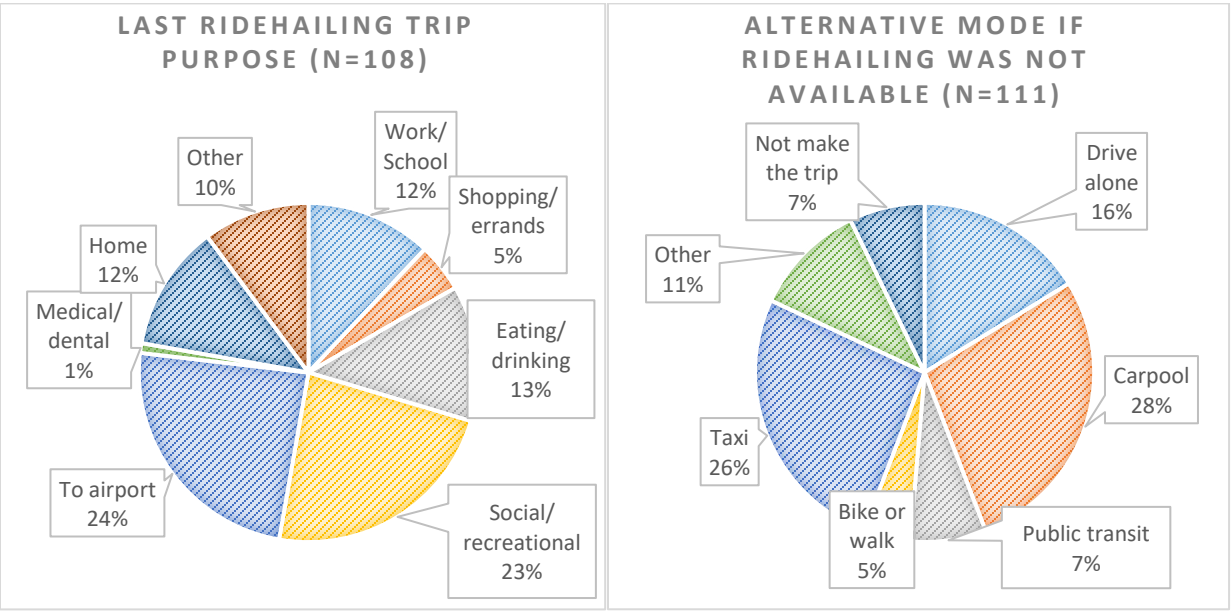

Figure 48 Characteristics of respondents' last ridehailing trip

After ridehailing services were introduced to the public, some people might have changed the way they used other transportation modes. These changes were also captured in this survey when participants were asked the change in frequency of using each mode after ridehailing services became available (Figure 49). The most affected mode by ridehailing services was the taxi, 24 percent of respondents reported that they use the mode less often. Public transit, taxi, bike, and walk had 26 percent-28 percent of change but not as a result of introducing these services. In addition, many people reported that they did not change the frequency they use some modes.

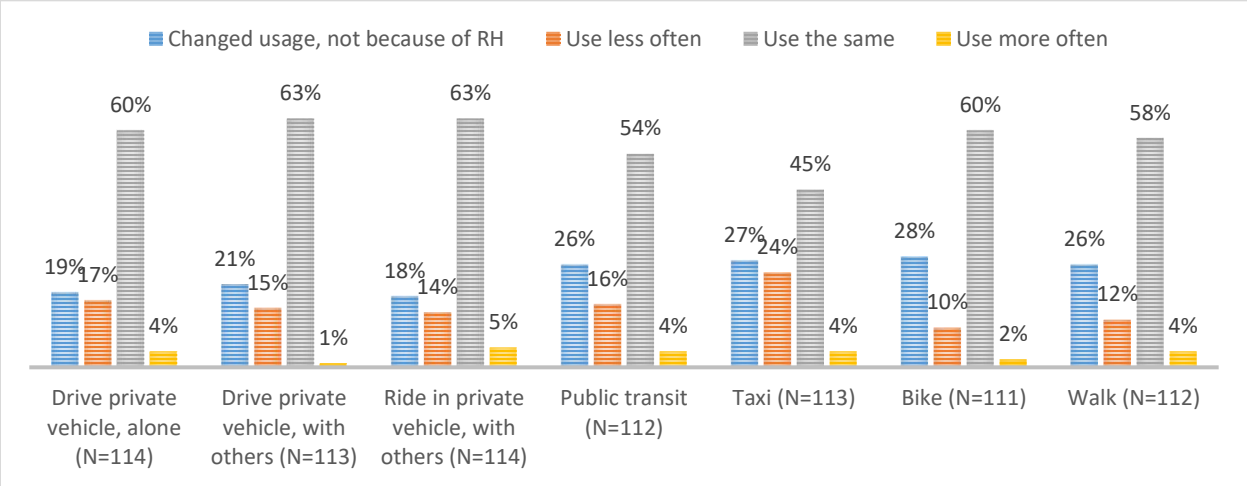

Figure 49 Change in other mode usage, due to ridehailing

Stated preference: Shared versus Private Ridehailing

As explained before, there are tradeoffs between using shared vs. single user ridehailing services in terms of the associated time and cost. Trying to capture the dynamics under users' decision-making using stated preference questions is a good way to approach these tradeoffs, which could enhance future planning and policymaking with respect to these services. The survey exposes participants to different scenarios varying trip purposes, price, and time of the ride, and the number of additional passengers (Figure 50). Most people still prefer the single ridehailing version, varying from 57 percent to 65 percent, while the shared ridehailing under the different proposed scenarios is chosen by 24 percent to 32 percent of respondents in different trip purposes. The cost, waiting time, and the number of passengers will change for different people in the full deployment survey to facilitate the modeling of the state-preference responses.

While gender is believed to play a significant role in these preferences, gender differences influencing the survey responses could be slightly noticed only in shopping trips. Figure 51 shows that women are choosing single passenger ridehailing services for shopping trips slightly more than men do.

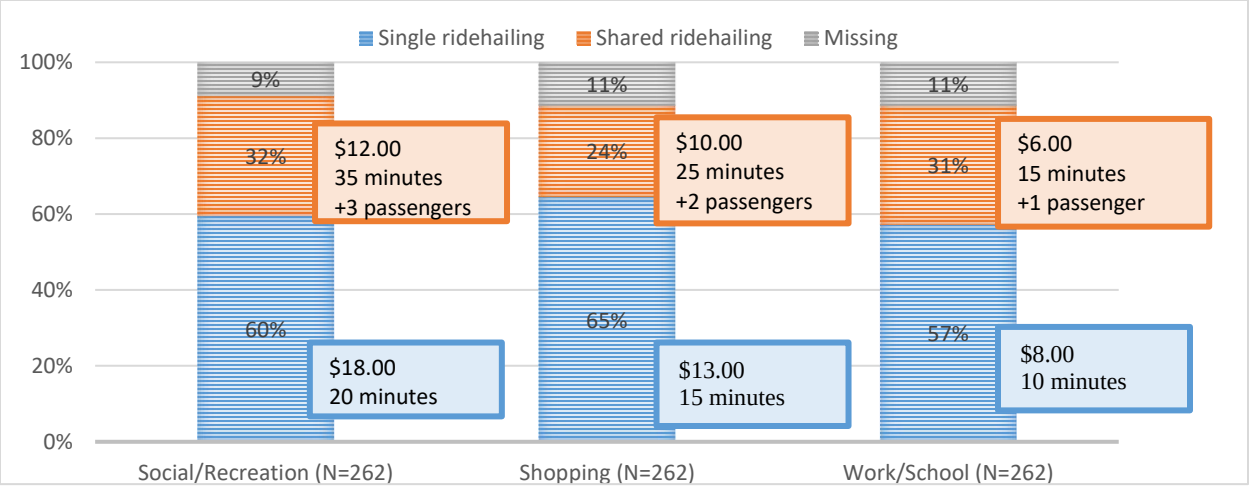

Figure 50 Stated preference: private ridehailing versus shared ridehailing

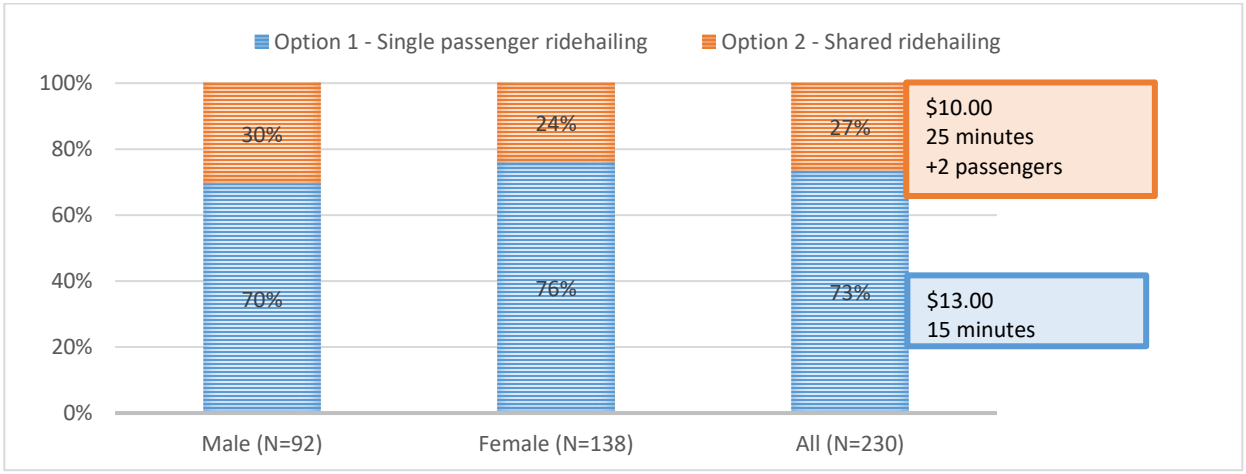

Figure 51 Stated preference of shopping trips by gender

Autonomous Vehicles Perceptions and Stated Preferences

The fifth section of the survey focused entirely on respondents' perceptions and intentions to use autonomous vehicles. As an introduction to the questions, the following paragraph was presented to the respondents:

"An autonomous vehicle (AV) is a vehicle that drives itself without human supervision or involvement. It picks up and drops off passengers including those who do not drive (e.g., children, elderly), goes and parks itself after dropping off passengers, and picks up and delivers goods and services. When AVs become available, ridehailing companies are likely to use them to provide rides without a human driver in the vehicle. When answering the questions in this section, please assume a future in which AV technologies are widely adopted, but human-driven vehicles are still present."

Familiarity and willingness to adopt autonomous vehicles technology

Figure 52 shows familiarity with autonomous vehicles, by income. Respondents with greater income reported more often to be somewhat familiar and very familiar with autonomous vehicle technology. In general, 7 percent of respondents declared to never had heard about autonomous vehicles prior to the survey,

30 percent of respondents had heard about AVs but were not familiar with them, 50 percent of respondents were somewhat familiar, 13 percent were very familiar with AVs, and 1 percent of respondents declared they have taken a ride in an AV.

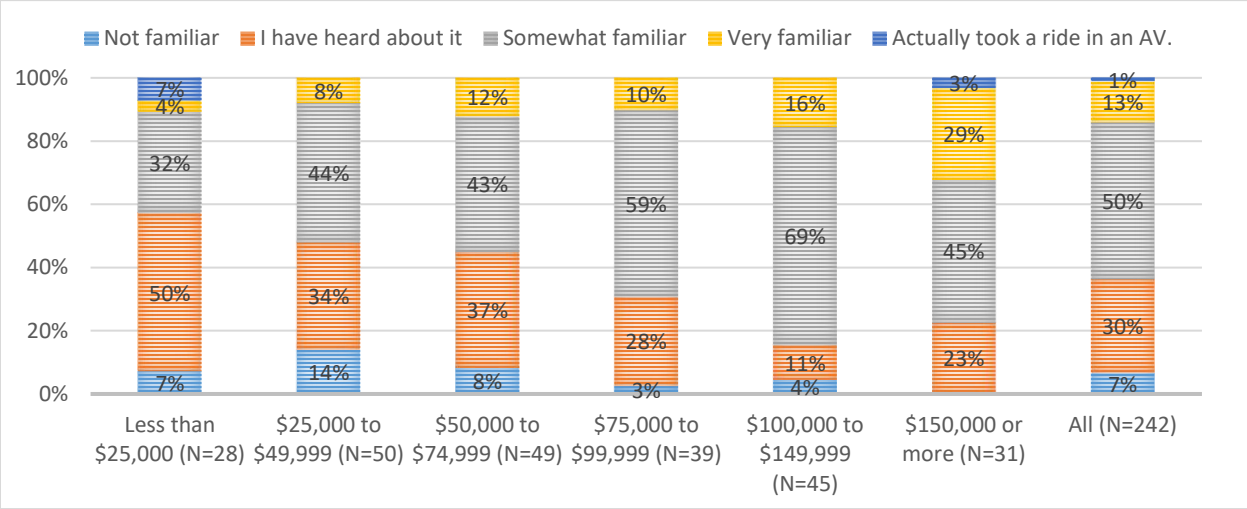

Figure 52 Familiarity with autonomous vehicles, by household income

It is important to mention that in the Phoenix metro area, Uber conducted tests with autonomous vehicles until March 2018 (www.theverge.com); Waymo has a large AV fleet operating their Waymo One program (www.waymo.com), along with other companies testing AV technology in Arizona (www.hbr.org). The usage of Arizona roads as a testbed for autonomous vehicles technology influences respondents' familiarity with AVs to some extent.

Figure 53 shows the level of agreement with sentences that reflect the willingness to adopt autonomous vehicles. While 47 percent of respondents declared they would use an AV alone, or with others they know, only 20 percent of respondents agree that they would use an AV ridehailing service with passengers that are unfamiliar to them. 27 percent of respondents declared they would never use an autonomous vehicle, and only 6 percent of respondents declared intention of being one of the first people to purchase an AV.

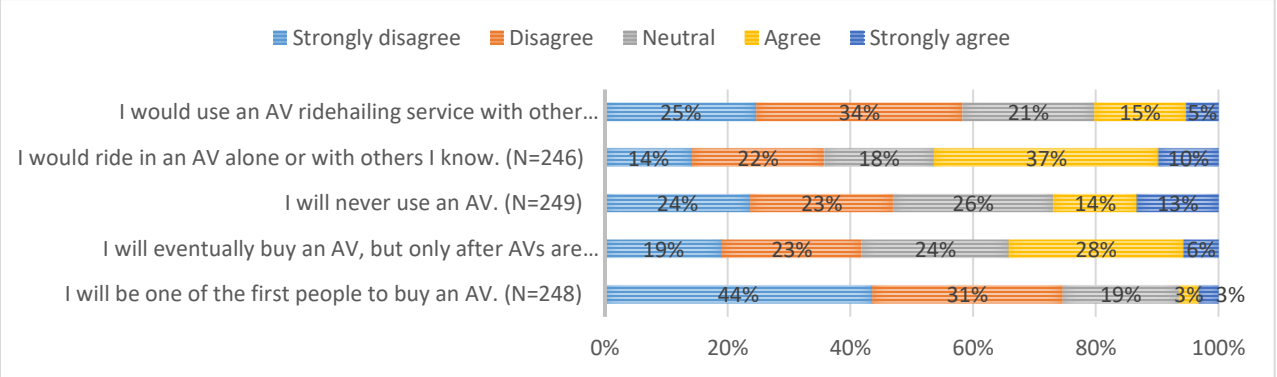

Figure 53 Willingness to use and purchase an autonomous vehicle

In order to observe how different groups of people adopt AV, based on age and gender, some bivariate analyses are conducted and presented in the following. When observing the agreement with the

statement "I would use an AV ridehailing service with other passengers who are strangers to me", older people tend to disagree to a higher degree compared to younger group ages (Figure 54). Women also showed a higher disagreement with the same statement, in comparison to men (64 percent against 48 percent).

A similar investigation is conducted for the statement “I would never use an AV” (Figure 55). The higher levels of disagreement with the statement “I would never use an AV” was seen from the youngest age groups. It is also clear that men disagree significantly more than women; while only 40 percent of the female respondents disagree with it, 59 percent of the male respondents disagree with the statement.

Trying to understand how people in households with different vehicle availability would potentially use AVs, a bivariate analysis is done. Figure 56 shows that people that don’t have cars agree more with the statement "I would ride in an AV alone or with others I know", than people with at least one vehicle in the household. Figure 57 explores the agreement with the same sentence for different age groups and genders. As previously mentioned, 47 percent of respondents agreed with that sentence. However, that share is smaller among older groups, and larger among young groups.

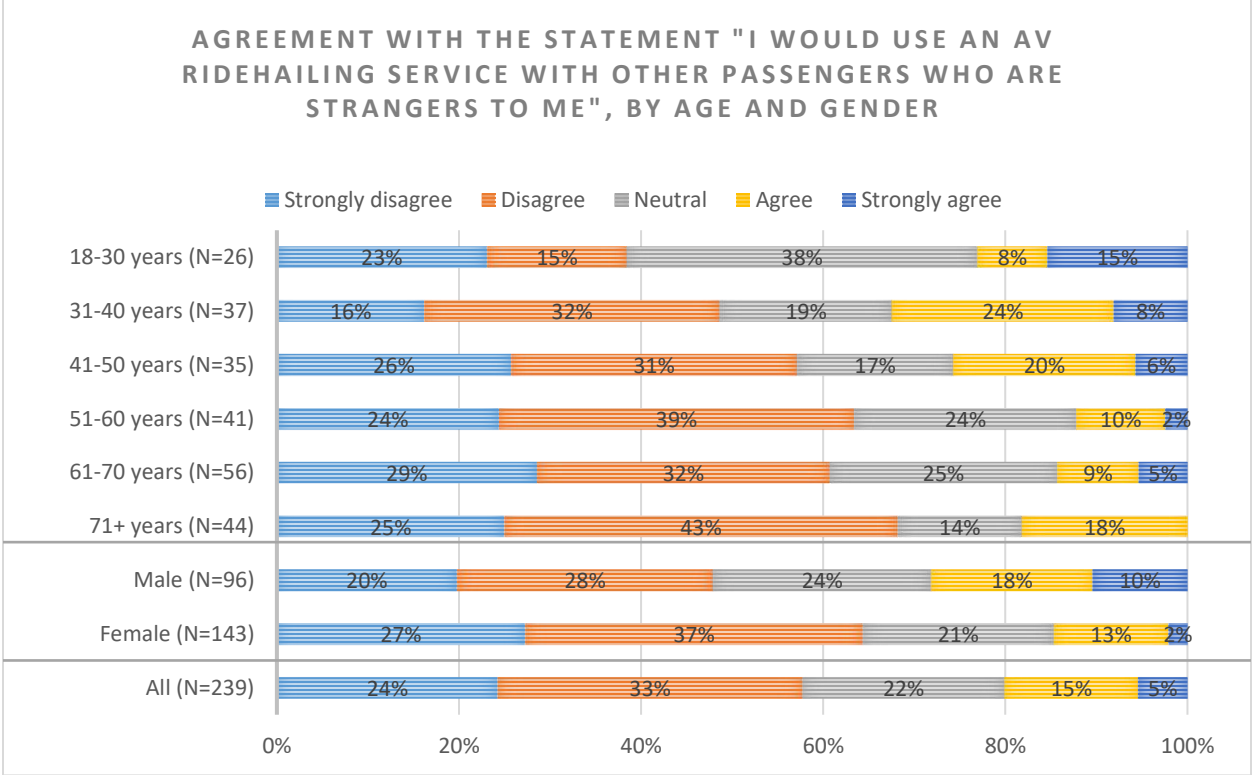

Figure 54 Agreement with the statement "I would use an AV ridehailing service with other passengers who are strangers to me", by age and gender

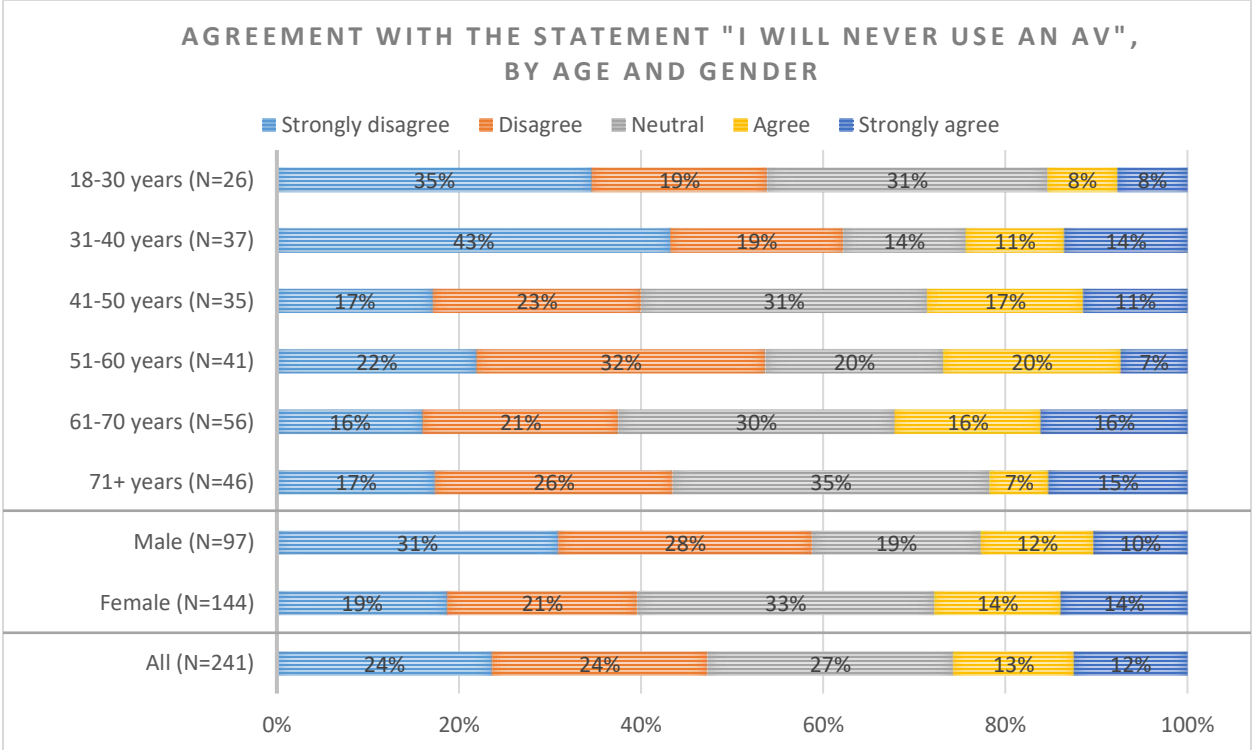

Figure 55 Agreement with the statement "I will never use an AV", by age and gender

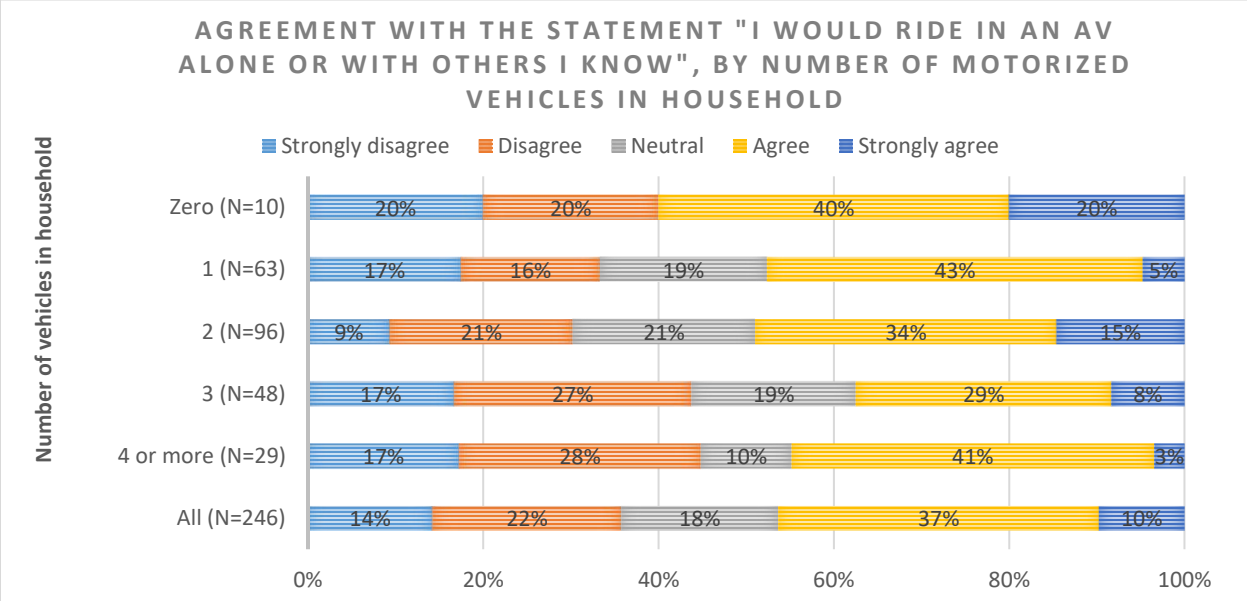

Figure 56 Agreement with the statement "I would ride in an AV alone or with others I know", by number of motorized vehicles in household

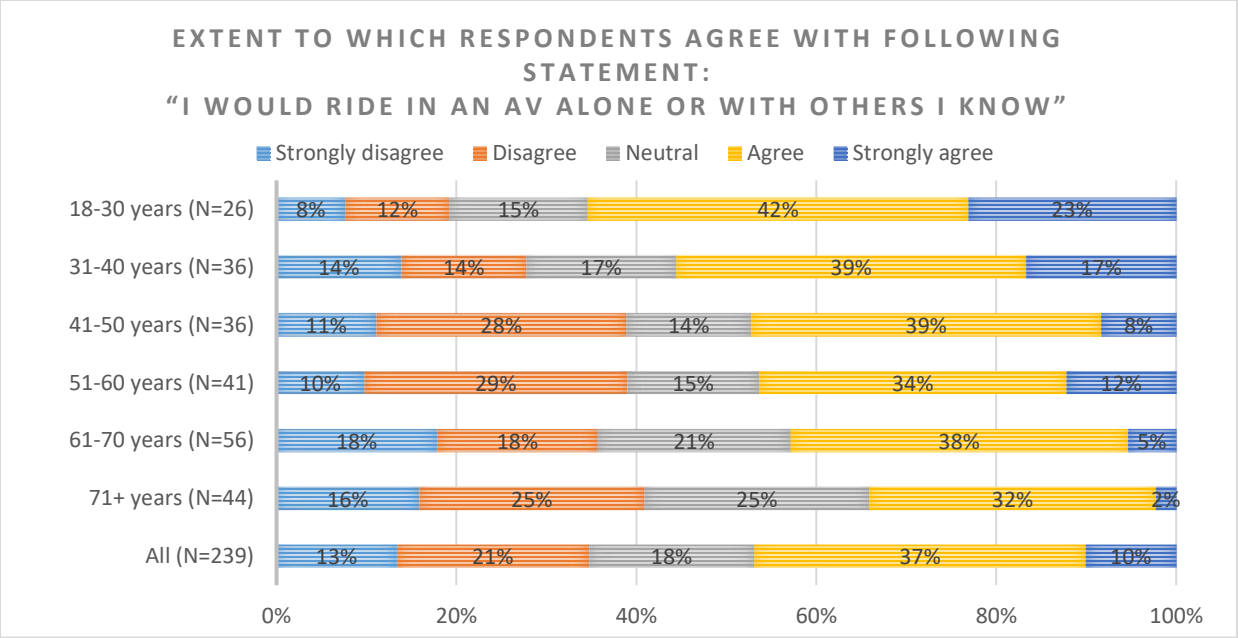

Figure 57 Extent to which respondents agree with the statement "I would ride in an AV alone, or with others I know", by age

Attitudes towards Autonomous Vehicles

This section explores attitudes, perceptions, and potential behavior towards autonomous vehicles. Figure 58 shows to what extent respondents agree with the sentences that reflect different intentions to use autonomous vehicles. While 35 percent of respondents are willing to send their AV to serve family members and friends without them, 42 percent disagree with that. A similar pattern is seen regarding willingness to use autonomous vehicles to pick up items by itself. While 19 percent of respondents expect to make additional trips when AV technology becomes available, 23 percent of respondents expect to travel longer distances when AV is available. 56 percent of respondents reported they would not be comfortable leasing their autonomous vehicles to ridehailing companies while they are not using it.

With AVs being available and accessible, their impacts on the number of trips people make can increase travel demand and exacerbate the congestion. In order to deeply evaluate people's opinions in this matter, an analysis based on vehicle ownership is conducted. From the results shown in Figure 59, people in vehicle sufficient households show less interest in making additional trips, in comparison to those in vehicle deficient households. A vehicle sufficient household was defined as a household who have the same or more number of vehicles as people with driver's license; while a vehicle deficient household is defined as a household with more people with driver's license than vehicles available.

As the activity of driving will not be as burdensome as before with the advent of AVs, it is hypothesized that people will travel longer distances when AVs become available. The level of agreement with the statement of "I would travel farther (longer distances) when AVs are available" based on familiarity/usage of ridehailing services is presented in Figure 60. It is seen that people who are more frequent users of ridehailing agree more with traveling farther; 55 percent of weekly users agree with farther trips, against only 17 percent of agreement level by respondents that are not familiar with AVs.

Figure 61 shows attitudes towards autonomous vehicles' safety and policies. 23 percent of respondents believe that in an AV crash, the vehicle owner and his/her insurance should be held responsible. 60 percent of respondents would support laws and regulations limiting the speed of autonomous vehicles in order to guarantee safety on the roads. 16 percent of respondents agree or strongly agree that AVs should prioritize the safety of its own passengers over that of pedestrians, bicyclists, and other vehicles on the road. 65 percent of respondents reported they would be concerned with the safety of pedestrians and cyclists in an AV future. Only 16 percent of respondents agreed with the statement “Autonomous vehicles are significantly safer than human-driven vehicles”.

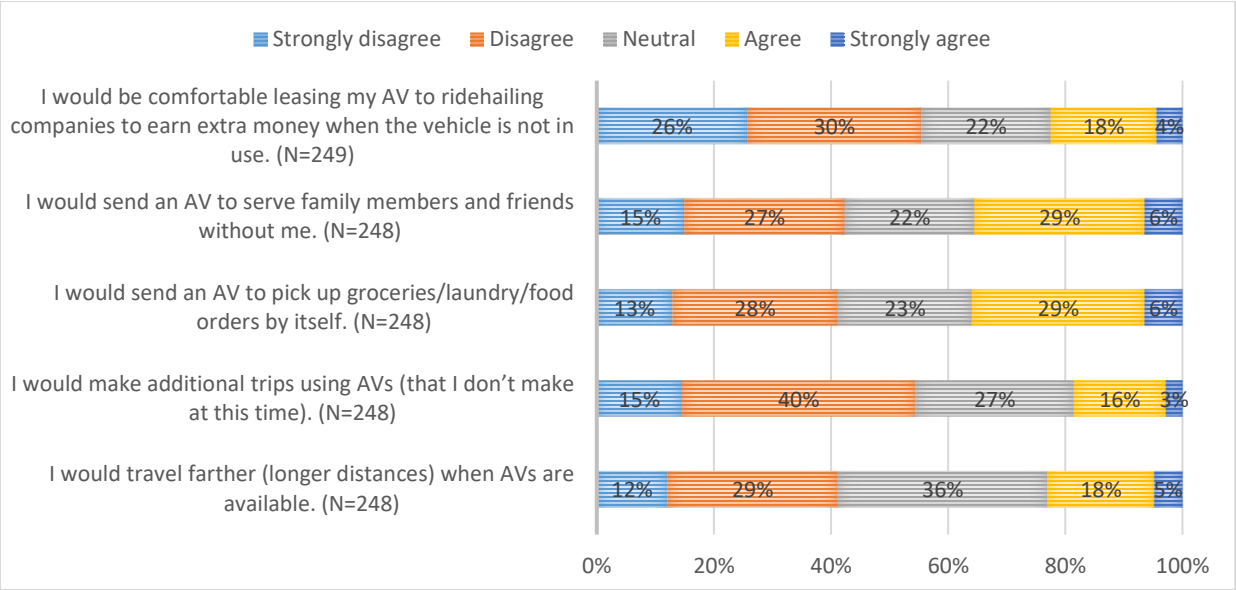

Figure 58 Intended use of autonomous vehicles

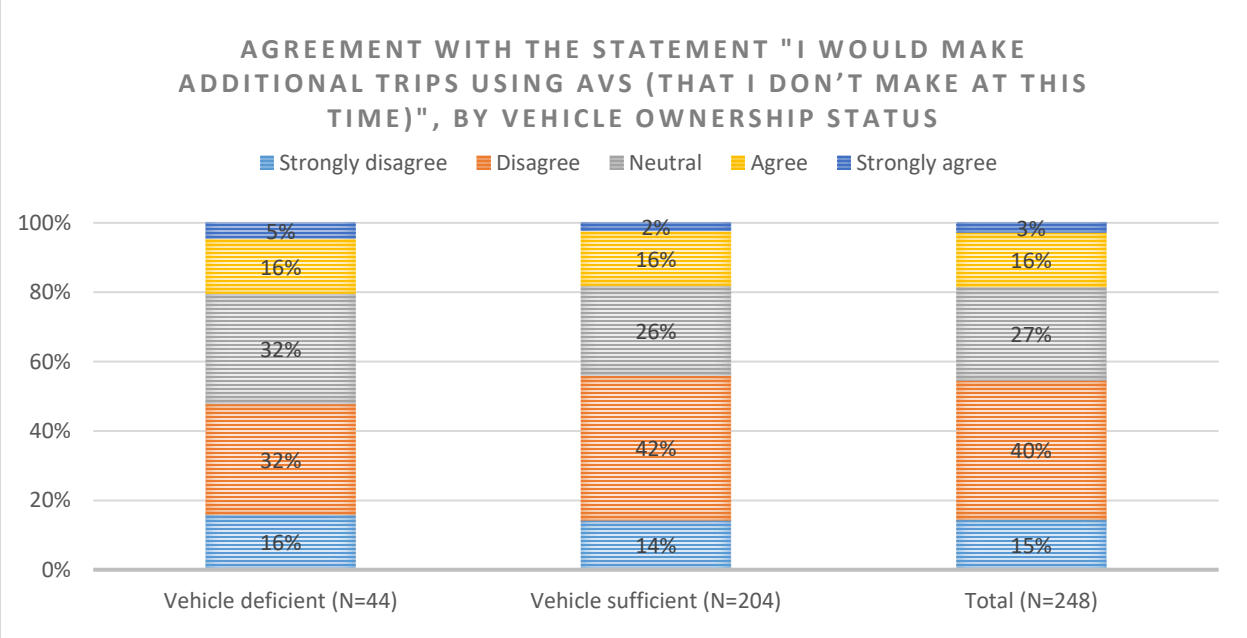

Figure 59 Agreement with the statement "I would make additional trips using AVs (that I don’t make at this time)", by vehicle ownership status

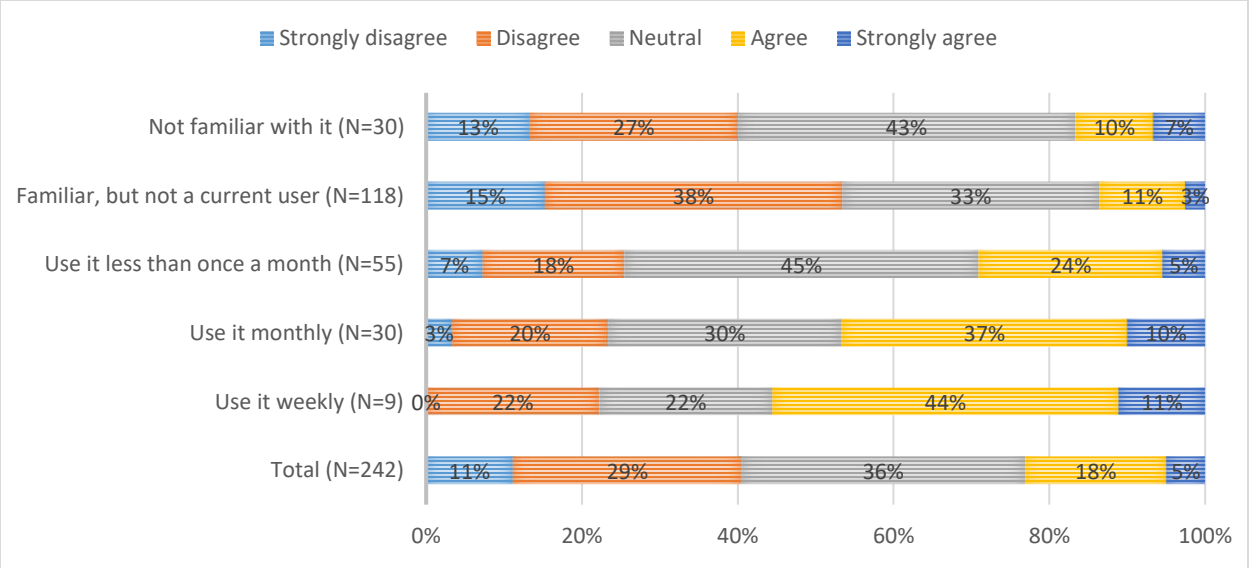

Figure 60 Agreement with the statement "I would travel farther (longer distances) when AVs are available", by ridehailing familiarity

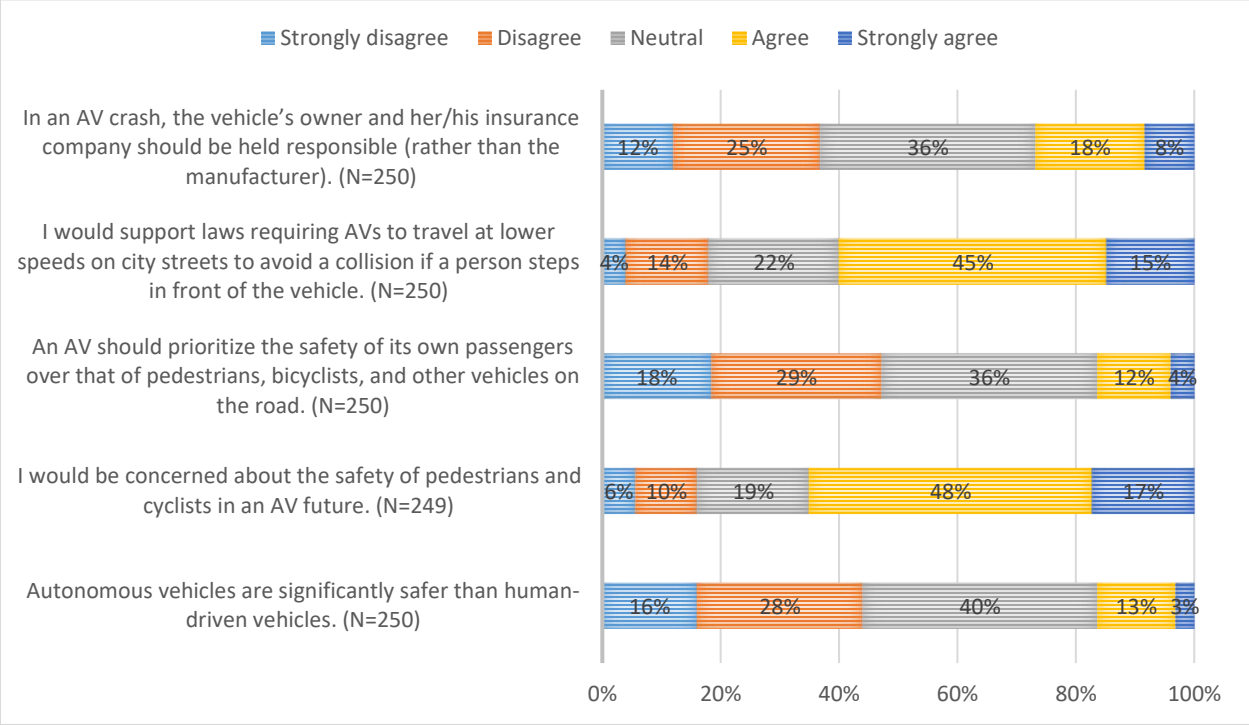

Figure 61 Attitudes towards autonomous vehicles safety and policies

Safety is seen as one of the main advantages in autonomous vehicles, however, the general public still does not believe in how safe they will eventually be (NHTSA, 2019). Breaking down people's safety perceptions into different age groups and genders, Figure 62 shows that older people show more disagreement with the statement compared to younger respondents. In addition, men agree with the statement more than women (23 percent of men compared to 13 percent of women).

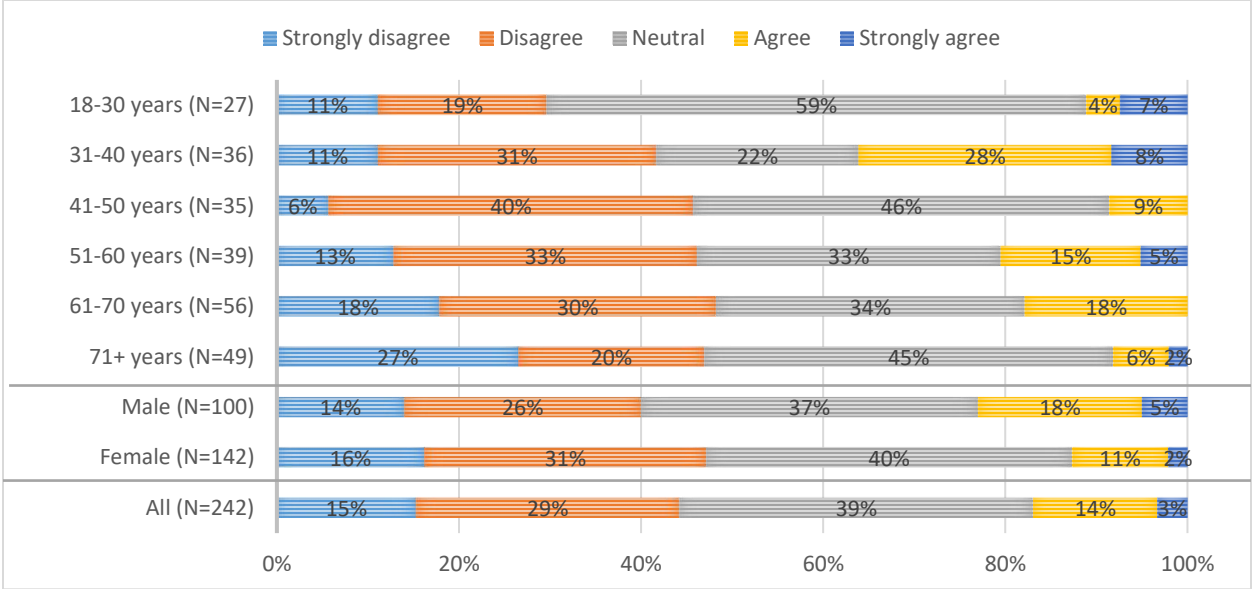

Figure 62 Agreement with the statement "Autonomous vehicles are significantly safer than human-driven vehicles", by age and gender

Figure 63 shows respondents' attitudes towards other aspects of autonomous vehicles, such as willingness to pay for a backup driver, and personal time use in an AV. 44 percent of respondents declared to be willing to pay to have a human driver inside their autonomous vehicle during a ridehailing ride. Only 11 percent of respondents declared they would be comfortable having an AV pick up or drop off children without adult supervision. Only, 49 percent of respondents believe autonomous vehicles will allow them to use their travel time for other activities.

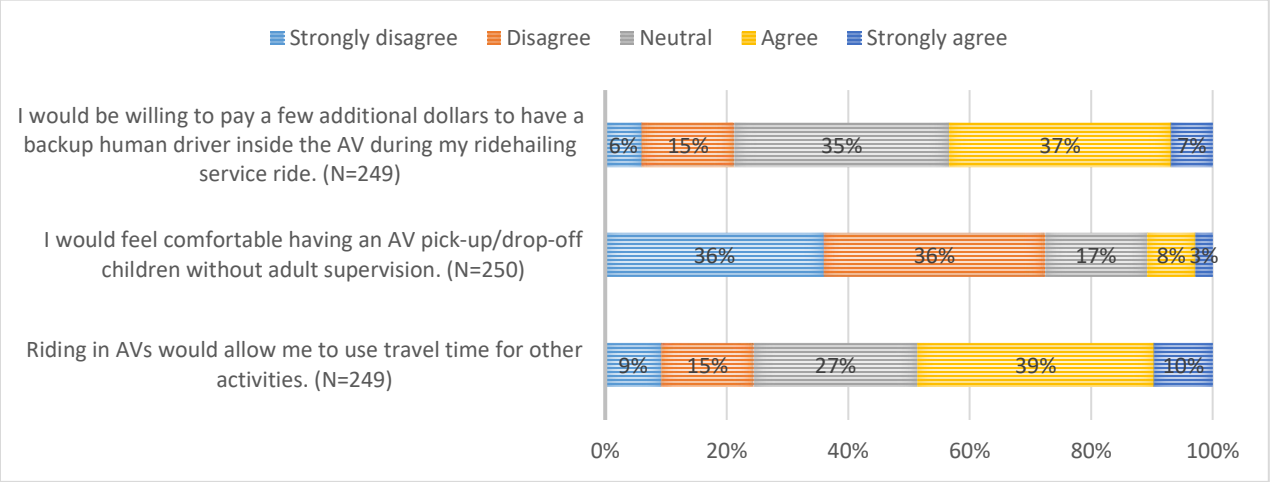

Figure 63 Attitudes towards other aspects of autonomous vehicles

One advantage of autonomous vehicles is allowing drivers to use their times for activities other than driving. Figure 64 shows that people in higher-income categories increasingly tend to agree with the statement "Riding in AVs would allow me to use travel time for other activities". Interestingly, people in the household annual income group of $75,000 to $99,999 showed the greatest level of agreement (74 percent), even greater than people who make $150,000 or more annually.

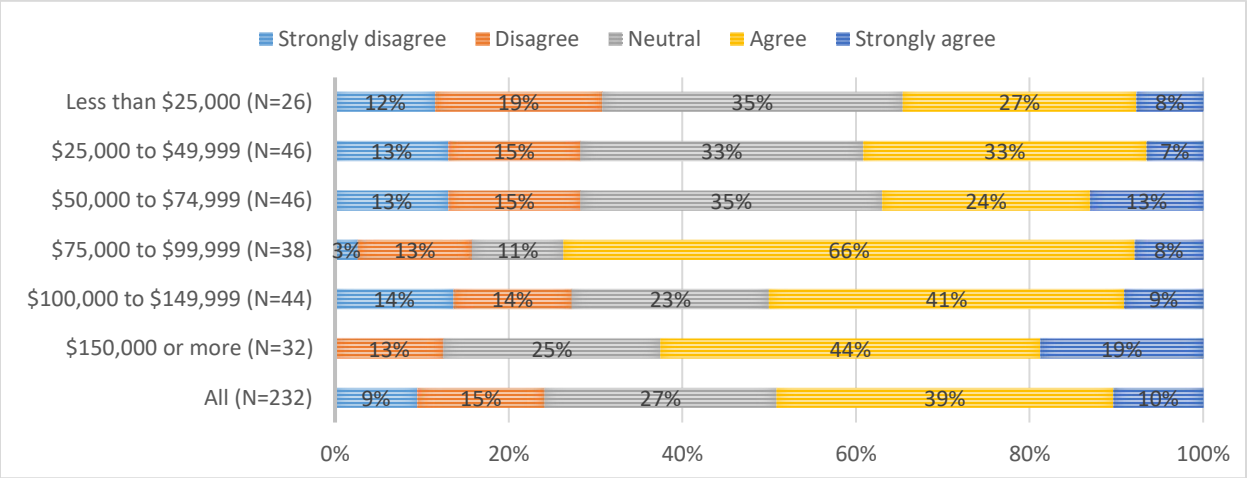

Figure 64 Agreement with the statement "Riding in AVs would allow me to use travel time for other activities", by household annual income

Other Aspects of Autonomous Vehicles

In addition to familiarity with autonomous vehicles, and perceptions towards the technology, the survey also inquired about other general aspects concerning a future with automated mobility.

Figure 65 shows the willingness to increase commute time given AV technology. In general, 40 percent of respondents declared they would not make any increase in their commute time due to autonomous vehicle technology; with older generations being less willing to tolerate longer commutes due to AV technology.

When asked about willingness to change their home location in a future with automated mobility, 94 percent of respondents declared they would not change where they live, while 3 percent declared they would move closer to work, and 3 percent declared they would move farther from work.

When asked about the willingness to change the number of vehicles their household owns in a future with AV availability, 69 percent of respondents do not foresee any change in the number of vehicles available in their household due to automated mobility. On the other hand, 5 percent of respondents expect to own more cars than today, and 26 percent of respondents expect to own fewer cars than today. Respondents were asked if they would be willing to upgrade a rental car to an autonomous vehicle for a long-distance trip, given the opportunity. 52 percent of respondents reported they would not upgrade their regular vehicle to AV regardless of the price; 27 percent would accept an AV if that would not imply in additional costs; and, 21 percent declared to be willing to pay for the upgrade to an autonomous vehicle.

Figure 66 shows that while 7 percent of respondents believe AVs will make up more than half of the vehicle fleet available in 5 years or less, 7 percent of respondents believe autonomous vehicles will never represent 50 percent of all vehicles. That distribution shows that public perception is still divided regarding potential market penetration of automated mobility.

Ranking Stated Preference: Next Vehicle Purchase

The last question of the autonomous vehicles section of the survey asked respondents to imagine their next car purchase decision making, given that AVs are available for purchase, lease/rent, or to use via ridehailing services. **Error! Reference source not found.** shows the responses for a scenario where 25 percent of v ehicles are AVs, and **Error! Reference source not found.** shows the responses for a scenario where 75

percent of vehicles are AVs. Beyond the penetration rates, fixed and variable costs of each alternative varied for each scenario and are presented in the graph. Each respondent was asked to rank the following three choices in each scenario: buying AV, buying a regular vehicle, and rely only on ridehailing services.

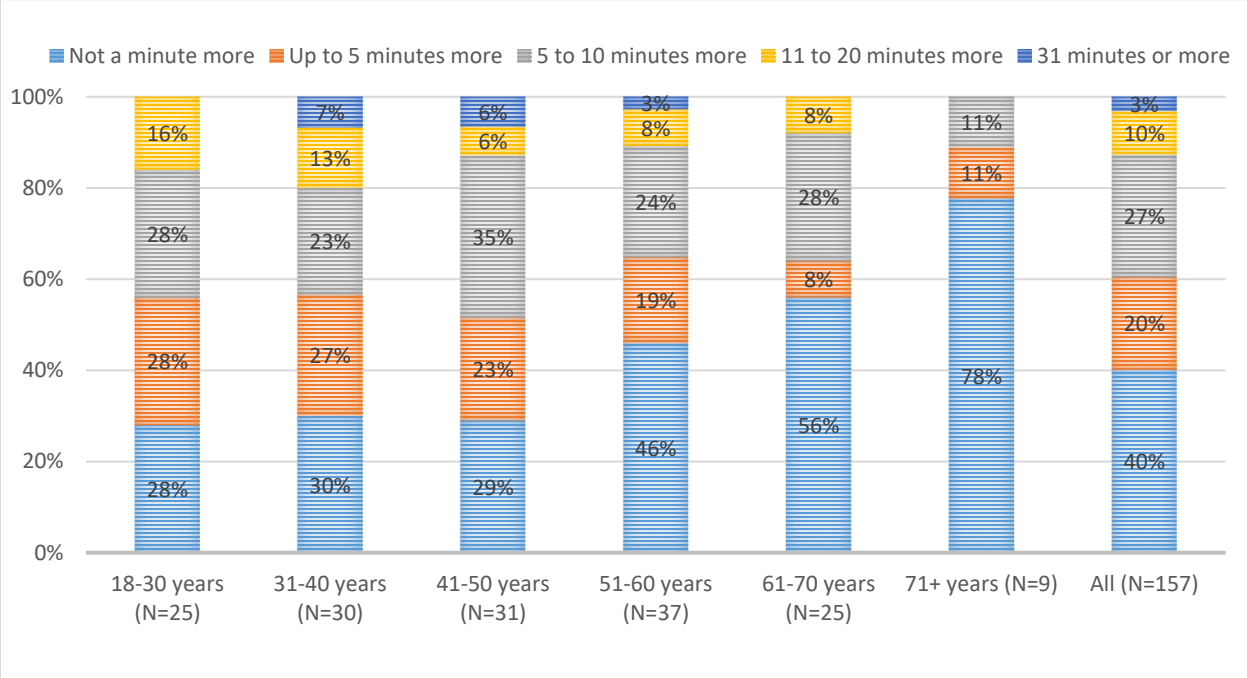

Figure 65 Additional time accepted on a one-way commute, by age

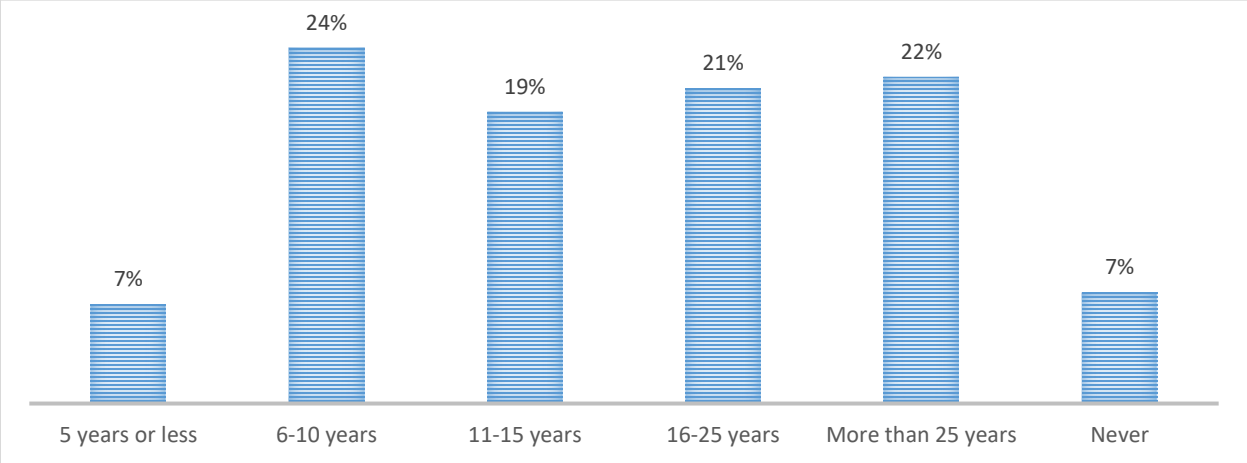

Figure 66 Expected time until AVs would make up more than half of the vehicles available (N=257)

Error! Reference source not found. shows that 63 percent of respondents declared the regular h uman-driven vehicle as being their most preferred alternative, and only 6 percent of the respondents chose AV as their most preferred alternative. Respondents who like ridehailing as their preferred exclusive mode corresponds to only 5 percent of the sample. It should be noted that 22% of the sample only selected one option and 4% didn't respond.

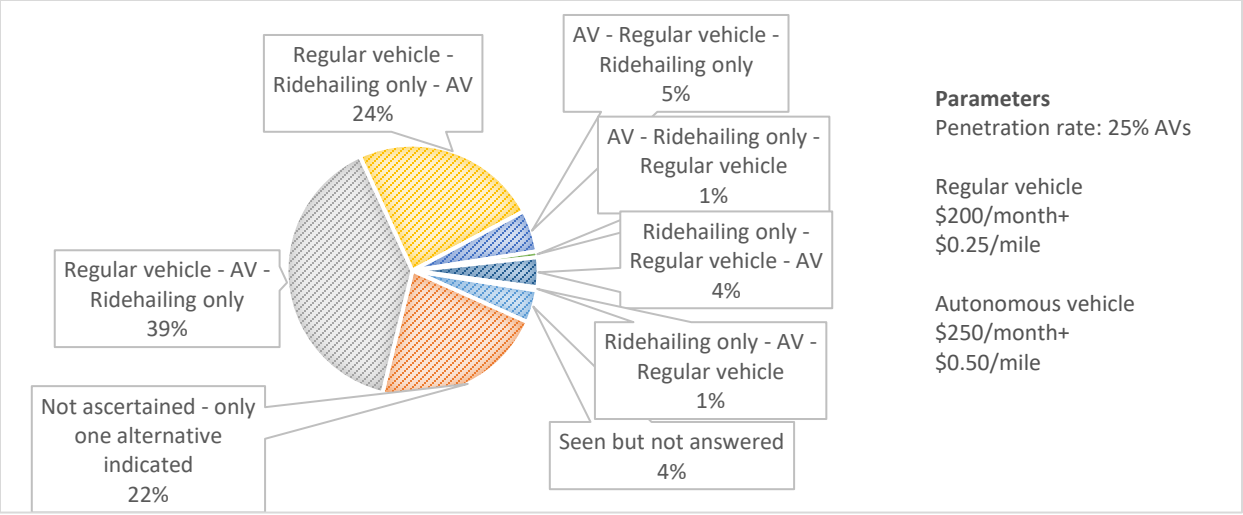

Figure 67 Stated preference on vehicle purchase (Scenario 1), given that 25 percent of vehicles are AVs (N=262)

Figure 68 shows a more divided opinion when the assumption is that 75 percent of the vehicles around you are AVs. In this scenario, 29 percent of respondents declared the regular human-driven vehicle as being their most preferred alternative, and 34 percent of the respondents chose AV as their most preferred alternative. The expected increase in AV preference after the increase in the penetration rate is very significant (from 6 percent to 34 percent) and noticeable. Respondents who like ridehailing as their preferred exclusive mode also increased to 11 percent of the sample. It should be noted that 22% of the sample only selected one option and 4% didn't respond similarly to the previous scenario.

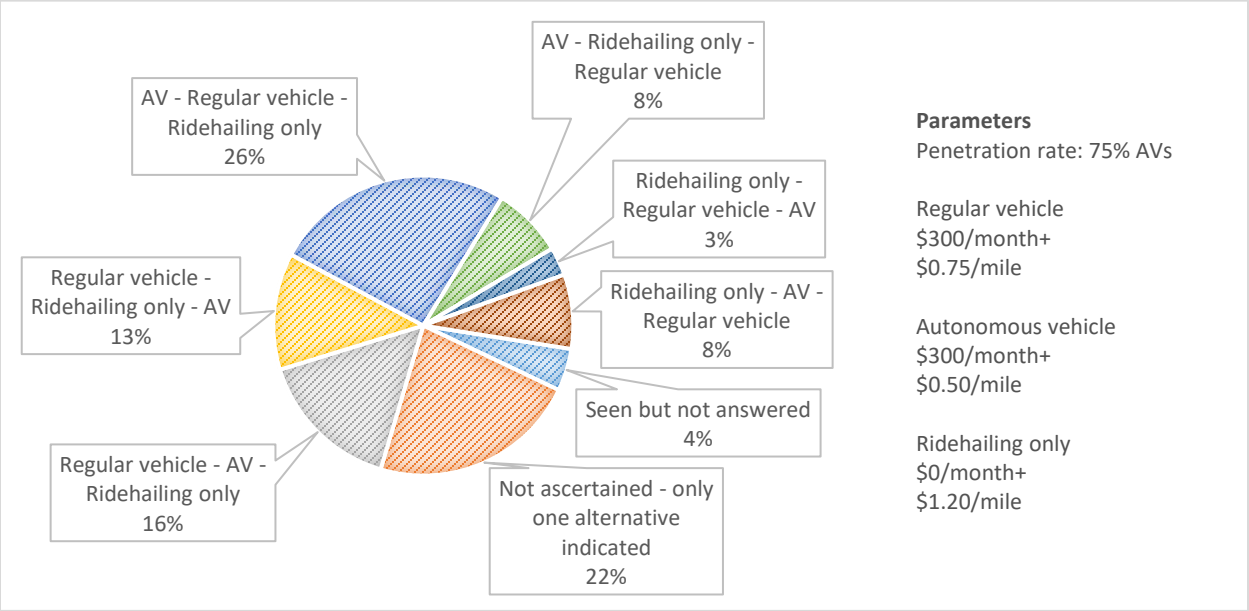

Figure 68 Stated preference on vehicle purchase (Scenario 2), given that 75 percent of vehicles are AVs (N=262)

Lessons Learned

One important benefit of the pilot survey was the existence of both online and paper survey recruitment methods in one data collection. Even the people who received the paper booklet had the option to fill out the survey online. Having multiple survey methods in one data collection increases the variety of the respondents and therefore minimizes the potential bias that each survey method may introduce to the survey results. Therefore, the demographic distributions of the total respondents were not hugely different from the actual population. Another advantage is the possibility to compare costs, response rates, and actual responses across different survey methods. TOMNET researchers are writing a paper to further investigate the comparison across different survey methods (De Silva et al., 2020).

Comparing online to the paper survey instrument, each has its advantages and disadvantages. The advantages of the online web instrument included ease of data retrieval, better accessibility for those with impaired vision, more flexibility on the survey design, support for random scenario testing on stated preference questions, and ability to build in validation mechanisms and skip patterns on the questionnaire. The disadvantages of the online web questionnaire included low response rates and no measurement of population groups without internet access. The advantages of the paper instrument included allowing people with limited or no internet access to participate in the study, lower recruitment costs, higher response rates, and convenience of filling the questions on the paper. Disadvantages of the paper instrument included time-consuming data entry once the booklets are returned, longer time between sending the invitation, and having the data available to use and constrained survey design to the limitations of the paper questionnaire (no complex logic patterns, no random stated preference questions).

When it comes to choosing the best survey method for the full deployment, one important factor is the survey cost especially that our full deployment across four universities would be about 16 times larger in size compared to the pilot data collection in Pheonix metro area. Table 2 illustrates all the statistics of the pilot survey with detailed amounts of costs. The total unit cost of the pilot survey was $32.34 (including incentives) per each completed response. Survey booklets and envelopes printing, mailing in, and mailing back account for a significant portion of this cost. While the complete online responses invited by email cost $17.21, the online responses invited by mail cost $36.49 and the paper responses invited by mail are the most expensive method and it cost $41.16 per completed response. In the Phoenix metro area, considering all the attributes of this survey, the cost of a complete response with mail invitations is two times larger than the cost of a complete response with email invitation. Therefore, the research team decided to collect the data mainly with email invitations directed to an online platform. To consider the potential bias that email survey invitation may produce by eliminating people with limited email/internet access, some postcard invitations have also been decided to be sent out to a random mail-based sample of Pheonix area residents. More detailed information about the full deployment recruitment method will be presented in the next section of this report. Depending on previous experiences in three other metro areas, researchers in charge of conducting the survey in those cities may have chosen slightly different methods. However, they mainly used an online survey platform for their recruitment methods. Details of the full deployment in Atlanta and Tampa will also be explained in this report following the Phoenix metro area deployment.

Another important lesson that we learned by accomplishing the pilot survey was the quality of the responses to different questions. We found that people may have not understood a few questions as we were expecting and so we revised the survey questionnaire in response to that. Moreover, the online-only survey platform provides the option to smartly use logic and enhance the survey presentation. For example, people who mentioned that they are physically commutating were entered into the section with extra questions

about commute trips, and that section was automatically skipped for the rest of the respondents. This removes the extra burden from the respondents and increases the quality of the responses.

In addition to the explained changes, the AV section of the full survey questionnaire has been significantly upgraded and advanced compared to the pilot phase. The new AV section has all the sections in the pilot phase including the familiarity, expected use, and attitudes toward AVs and new sections with respect to potential impacts of AV on travel behavior, vehicle ownership, residential choice, and willingness to pay. Appendix I presents the updated survey questionnaire for full deployment. The previous version of the survey questionnaire implemented for the pilot can be found at the end of the project report for the previous phase of this project (Attitudes towards Emerging Mobility Options and Technologies – Phase 1: Survey Design).

Table 2 Pilot Survey Stats

Cost for Purchasing Mail and Email Addresses	$1,425
Cost for Booklets and Envelopes	$4,149
Mailing-out Cost	$1,113
Mailing-back Cost	$248
Total Recruitment Cost	$6,935
Total Emails Sent	3333
Total Mails Sent	2454
Response Rate	4.53%
Data Entry Cost	$338
Total Incentives	$1,200
Total Cost	$8,473
Final Sample	262
Total Responses by Email Recruitment-Online Response	87
Total Unit Cost for Email Recruitment-Online Response	$17.21
Total Responses by Mail Recruitment-Online Response	49
Total Unit Cost for Mail Recruitment-Online Response	$36.49
Total Responses by Mail Recruitment-Paper Response	126
Total Unit Cost for Mail Recruitment-Paper Response	$41.16
Total Unit Cost per Complete Response	$32.34

T4 SURVEY FULL DEPLOYMENT – PHOENIX, AZ

Data Collection

Based on the pilot deployment results that used both a paper survey instrument sent by mail and an online survey invited by email, the project leadership team decided to implement the full deployment only in the online form using the Qualtrics software. In addition to the savings in cost, the online survey method provided a higher quality of the responses with a smaller number of incomplete responses and the platform allows the implementation of logic conditions that increase the efficiency and provide a respondent-specific design of the survey. To overcome the potential bias that an email-only invitation may produce toward respondents with regular access to email, survey invitations were also mailed out to physical addresses providing the participants with the online survey link. On the mail-out postcards, it was mentioned that we can mail out the actual paper questionnaire if the respondents are willing to complete the survey exclusively on the paper, for which we didn't get any requests in the Arizona deployment.

Sampling Plan

A random sample of the population from the Greater Phoenix Metropolitan area was desired. To gather a sample with such characteristics, a random address-based sample of Maricopa County residents was purchased from a marketing company, with addresses randomly selected from the specified boundary. The survey targeted individuals 18 years old and older. The total population of Maricopa County is estimated at 4,155,501 people, 3,124,636 of which is 18 years old and above. Information about the total population of Maricopa County is available from the ACS 2013-2017 estimates (US Census, 2017).

In May 2019 two independent samples were acquired from the marketing vendor: a sample of 50,000 emails and a sample of 10,000 mail addresses (for which emails were not available). The email list was purchased for sending the online survey link via email while the physical addresses were purchased to send the online survey link using the postcard invitations. These numbers of email and mail addresses were selected informedly based on the results of the pilot survey. Response rates, as well as the cost of deployment, were considered in finalizing the sampling plan for the full deployment. From the pilot phase, 3,301 respondents did not complete the survey and were invited again on the full deployment phase, thus increasing the invitation list to 53,301 addresses.

Survey Administration

Due to limitations on the survey platform, and to decrease the likelihood of the invitation message being qualified as a "bulk message" by email providers and sent directly to spam folders, the invitation list was broken down into batches of 5 thousand email addresses for the reminders following on a suggestion from the marketing company. The first round of invitations was sent to 24,900 email addresses on June 7, and the second round of invitations was sent to an additional 24,900 addresses on June 14, 2019. Following that first invitations, reminders were sent in batches of 5 thousand emails, not exceeding 25 thousand emails on any given rolling week (platform limitation).

To improve response rates, the Email Marketing Calendar provided by World Data (2019) was used, and poor performing dates were avoided. The time when the message was sent was based on the recommendations from the marketing company that provided the email addresses. Preferred times for the reminder distributions were Mondays 7 pm, Tuesday 5 pm, Wednesday 2 pm, Thursday 7 pm, Friday 5 pm, or Weekends 2 pm (observing expected performance given by the World Data Email Marketing Calendar). The first round of reminders was sent from June 22 to July 8. The second round of reminders was sent from

July 9 to July 21. The third and final round of email reminders was sent from July 22 to August 2. The remaining 200 email addresses on the list acquired in June 2019 were invited on June 27. The 3,301 email addresses from the pilot deployment were invited on July 11, 2019. Responses were accepted until August 25, 2019.

The mail invitation was sent out to 9,387 households on June 21, 2019. The postal piece was a 4x9 inches flyer, printed on a postcard material, inserted on a number 10 commercial white envelope with ASU's logo. Respondents were invited to go online and fill their surveys using a unique access code. The first response completed through a mail invitation was submitted on June 24, 2019. No postal reminder was sent. The evolution of the cumulative response rate through the data collection period is illustrated in Figure 69. The email response rate started at around 1 percent on the first week after the invitation and increased at a somewhat steady pace of 0.2 percent per week during the reminder deployment. The mail response rate started at 1.4 percent on the week of the invitation and stabilized at 2.0 percent three weeks after.

The invitation letters for mail invitees and email invitees (June 7 and June 14) informed that the first 250 respondents to submit completed surveys would receive a $10 Amazon E-gift card, and the remaining respondents would enter a drawing to win additional 100 $10 Amazon E-gift cards. Online invitations sent after June 14 offered only eligibility to participate on the raffle as a reward. After the data collection was finalized on August 25, respondents who submitted a complete and unique answer, reported to live in the state of Arizona and provided an email address on the rewards section, were considered eligible for the rewards. From the total sample (1,071), 879 responses were eligible for rewards. Most of the ineligible responses for the rewards (124, 64.5 percent of ineligible cases) were not considered for the gift card because the respondent did not provide their email for the reward selection.

Based on the survey end date on the eligible responses, the first 101 respondents from June 7 invitation, the first 99 respondents from June 14 invitation, and the first 50 respondents from the postal invitation were selected for the gift card. For those who were eligible for the rewards but did not receive one of the first 250 gift cards, drawing numbers were assigned based on the survey end date, for those who were invited online and for those who were invited by mail separately. From all the online invitations, 488 responses were eligible for the drawing. Among the 488 online responses eligible for the drawing, 80 cases were randomly selected. Among the 190 responses eligible for the drawing from the postal invitation, 20 cases were randomly selected. In this way, 350 $10 Amazon E-gift cards were selected and dispersed on September 9, 2019, via the provided email addresses to send out the rewards.

Final Dataset

The final data set considered uniquely submitted responses, with the home location in Arizona. Responses with inconsistencies, such as the number of drivers in the household larger than household size, or respondents who marked the same answer on a large set of attitudinal questions were flagged as problematic on these particular questions but kept in the dataset to be used for other measured aspects. Table 3 details the Arizona full deployment statistics for each invitation method, based on the final data set. For the online invitation, about 19.2 percent of the address list purchased from a market vendor bounced, meaning the email was invalid, or the email provided refused the invitation message. Considering only the delivered messages, the response rate for the online invitations was 2.0 percent and for the mail invitation 2.1 percent. Responses from the online invitations represent 80.4 percent of the final dataset, and the responses through the postal invitation are responsible for the remaining 19.6 percent. The online and postcard survey invitations ended up with 1,071 responses collected from the Phoenix metro area with a total response rate of 2.01 percent. The unit price per completed response is $12.83 which is significantly lower than the cost

of the pilot survey administration which included paper survey booklets. The characteristics of the survey sample and their weighted responses to different survey questions will be explained in the forthcoming report for the third phase of the project.

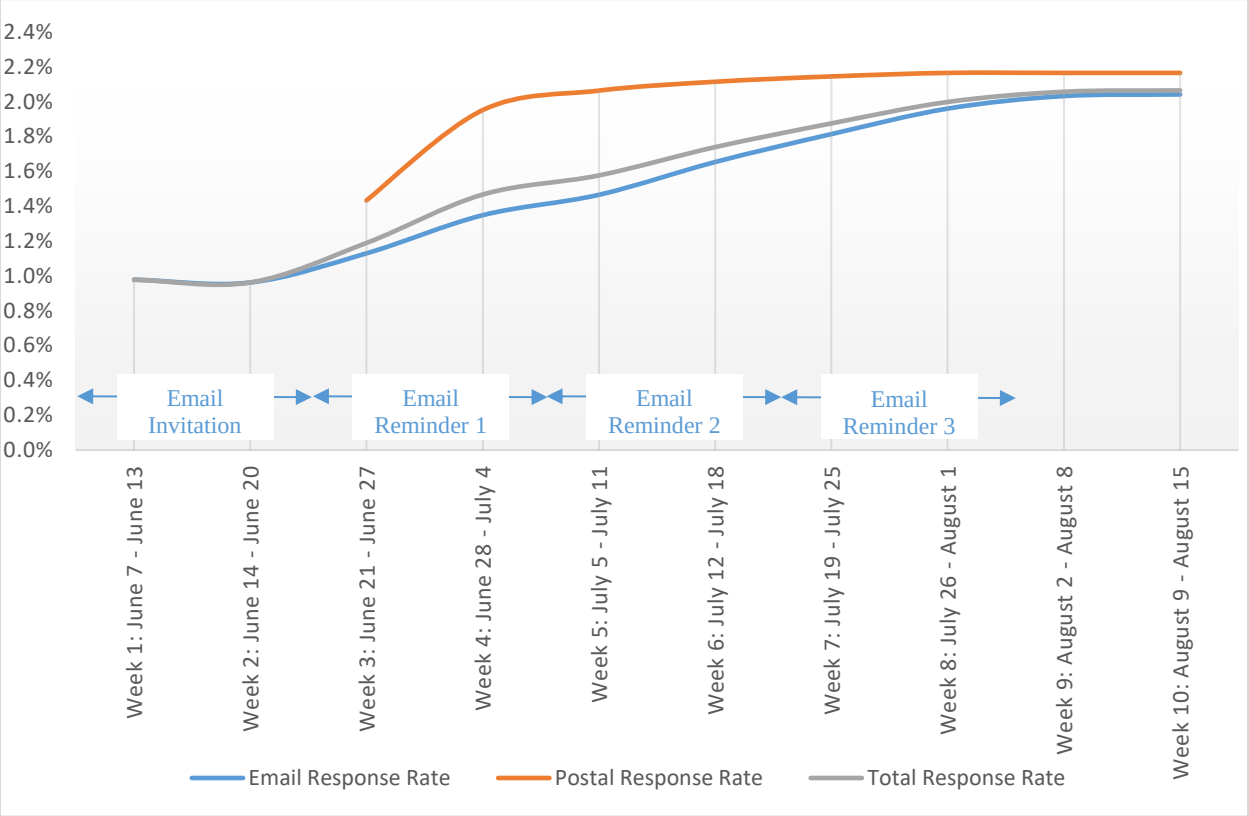

Figure 69 Evolution of Response Rates, by Recruitment Method

Table 3 Sample Size and Response Rates

Cost for Purchasing Mail and Email Addresses	$1,325
Cost for Postcards and Envelopes	$2,921
Mailing Cost	$6,000
Total Recruitment Costs	$10,246
Total Emails Sent	53,305
Not Valid/ Bounced Emails	10,250 (19.2%)
Recorded Valid Online Responses invited by email	861
Online Invitation Response Rate	2.00%
Total Postcards Sent	10,000
Not Valid/ Bounced Mails	163 (1.6%)
Recorded Valid Online Responses invited by Mail	210
Mail Invitation Response Rate	2.13%
Total Response Rate	2.01%
Total Incentives	3,500
Total Costs	13,746
Final Sample	1,071
Total Unit Cost per Complete Response	$12.83

T4 SURVEY FULL DEPLOYMENT – ATLANTA, GA

Data Collection

With the agreement with the other TOMNET institutions at ASU and USF (and collaborating researchers at UT Austin), we employed two methods for recruitment, via mailing and emailing invitation letters. We chose to do so for two main reasons. First, the conventional administration method – *the mail-out mail-back survey* – is not the most efficient approach in terms of time and monetary costs. For example, the administration of paper surveys requires the printing and mailing of survey questionnaires and reminders and the data entry of returned responses to an online system (i.e., digitization of hand-written responses). In the university setting, data entry is usually conducted manually by undergraduate or graduate students as a part of their training, and for quality control, the same survey is entered into the system twice by two different students and their entries are cross-checked for the identification and correction of any mistakes. In addition, the data entry process cannot be expedited more than a certain level. After all, there is a limit in the number of students that one research supervisor can handle at the same time. Second, we were also interested in conducting a systematic investigation of survey responses collected via multiple methods. Potential topics for such an investigation will include, but not be limited to, response rates, non-response bias, and quality of responses across various types of questions, which may differ by survey methods. Surprisingly, the survey method literature provides limited empirical evidence and guidance on these topics, while new methods have been introduced, widely adopted, and supported for their merits over conventional methods. In this context, transportation researchers need to be informed of evidence-based tradeoffs across survey methods when choosing one method over others. After all, unobserved biases, which may be introduced to survey responses in ways that different survey methods lead to different types/amounts of biases, cannot be more critical for the understanding of travel behavior and forecasting of travel demand, especially under the considerable uncertainty created by emerging transportation technologies.

As for the method for survey taking, our initial invitation asked interested individuals to visit a webpage and take an online survey on the Qualtrics platform, a survey administration tool. The platform supports a wide set of digital devices including smartphones and tablets, and it informs researchers of the type of devices that individuals use to take the survey. The information about chosen devices helps determine the reliability of survey responses later in the data cleaning stage. In addition, we allowed interested individuals to request a paper version of the same survey if they would prefer taking the survey on paper or have difficulties with taking online surveys (e.g., lack of stable internet connection at home).

Sampling Plan

As for sampling, we first identified the target population in the Atlanta region (i.e., a sampling frame), and then determined the size of a sample from that population for recruitment via two channels. The 2010 US Decennial Census defines the Atlanta-Sandy Springs-Marietta Metropolitan Statistical Area (i.e., Atlanta MSA) as a set of 28 contiguous counties including and around Fulton County, where the city of Atlanta is located. However, we find not all of these counties are dense enough to support convenient access to new mobility services (e.g., ridehailing and micromobility). Thus, we first computed the share of the residents in individual counties, who live within the Atlanta Urban Area (UA), which are defined in the 2010 US Decennial Census and considered relatively denser areas within the Atlanta MSA. By doing so, we identified 15 counties as core counties in the Atlanta MSA because all of them have higher than 50% of residents living within the Atlanta UA (refer to Table 4). Our approach leads to the sampling frame as those who live in these 15 counties at the time of survey administration.

Table 4 The Sample Size of Individual Counties for Two Recruitment Channels

(A)	(B)	(C)	(D)	(E)	(F)	(G)
County	Total households (ACS 2018)	% living in the Atlanta UA	Mail recruitment		Email recruitment	
			Initial target (1.62%)	Valid Invitations	Initial target (1.62%)	Valid invitations
Fulton	400,016	98.9 %	6,458	6,508	6,458	6,448
Gwinnett	288,724	99.5 %	4,679	4,744	4,679	4,675
DeKalb	277,757	99.7 %	4,543	4,606	4,543	4,539
Cobb	277,222	99.8 %	4,561	4,604	4,561	4,557
Clayton	92,845	99.1 %	1,512	1,577	1,512	1,511
Cherokee	85,825	82.0 %	1,348	1,408	1,348	1,345
Henry	73,826	86.1 %	1,191	1,255	1,191	1,191
Forsyth	73,675	87.9 %	1,115	1,181	1,115	1,114
Paulding	52,389	77.5 %	839	905	839	838
Coweta	51,308	65.1 %	829	895	829	828
Douglas	48,968	84.3 %	797	863	797	793
Fayette	39,753	82.2 %	653	719	653	651
Newton	36,626	68.8 %	588	654	588	586
Rockdale	30,521	85.1 %	502	568	502	502
Spalding	24,137	59.2 %	384	450	384	384
Sum	1,853,592		30,000	30,937	30,000	29,962

1) The number of households (2018) in individual counties are from the US Census American Community Survey 5-year estimate 2014-2018, the latest release at the time of writing this report.
2) Valid invitations in Columns E and G indicate only eligible cases after the exclusion of incorrect or outdated contacts from the original address lists of InfoGroup, our chosen address vendor.

Based on our expectation of the final sample size for analysis, we decided to invite 60,000 households to take part in the survey via two recruitment channels, 30,000 households for each of the two channels. Our previous experience in the administration of similar transportation-themed surveys over years suggests that the response rate of mail-out and mail-in paper surveys falls in the range of three to five percent, although the rate has fallen over time. For this survey, we expected a lower response rate because we would ask interested individuals to take an online survey, which older adults may have difficulties with. (While young adults feel comfortable with online surveys, they are less responsive to invitations to surveys than older adults.) Thus, we chose 2.5 percent as an optimistic, upper-bound response rate. In addition, we aimed to collect about 1,500 completed cases for statistical analysis. These numbers lead to 60,000 households for recruitment (1,500*100/2.5 = 60,000). With the region-wide sampling rate of about 3.2 percent, our next task was to determine whether to differentiate the sampling rate by county or any demographic characteristics (i.e., quota sampling). This approach helps recruit and collect more cases from areas/demographic groups that are less accessible or known for low response rates. However, we found the core counties were more or less similar in sociodemographic and economic characteristics, so we decided to apply the same sampling rate to all 15 counties.

We chose InfoGroup as the "list vendor" from which we purchased contact information of 60,000 randomly selected individuals from the study area. InfoGroup maintains a high reputation in the marketing industry with attractive cost estimates and responsive customer services, and we have good experience working with them in the past for similar transportation survey projects. We purchased two sets of contact

information, 30,000 cases with postal addresses only (for mailing recruitment), and another 30,000 cases with both postal and email addresses (for emailing recruitment). The datasets InfoGroup delivered to us also included basic individual and household level characteristics such as name, sex, age, educational attainment, marital status, annual income, housing tenure, and length of living at the current address (many of them are imputed). Later in the data cleaning stage, these characteristics help determine the reliability of individual cases through the comparison of these against reported characteristics on the survey.

Survey Administration

This subsection explains the process of sending out the initial invitation and (recurring) reminder(s) to the mailing and emailing samples. Note that the initial due date for the survey was set on August 31st, 2019 (Saturday), which would allow interested individuals about two months to complete the survey for the mailing sample, and one month to do so for the emailing sample. With the reprographics unit, we finalized proofreading of the invitation letter and the envelope on June 27, 2019 (Thursday), and the first case came in on July 5th, 2019 (Friday), eight days later from the start of the printing and mailing process (more details follow below). In addition, to boost the response rate, we sent out a postcard reminder in mid-August, with its proofreading finalized on August 16th, 2019 (Friday). The postcards were sent only to those who did not take part in the survey yet (n=30,443), and this time, the survey due date was postponed for a month from the end of August to the end of September. The reprographics unit informed us that it would take one to two weeks (depending on the location in the study area) from the day on which final proofs were made and respondents would receive letters or postcards. As a result, we observed two hikes in the daily count of completed responses by the mailing sample (refer to Figure 1), the first in early July, and the second from late August to early September.

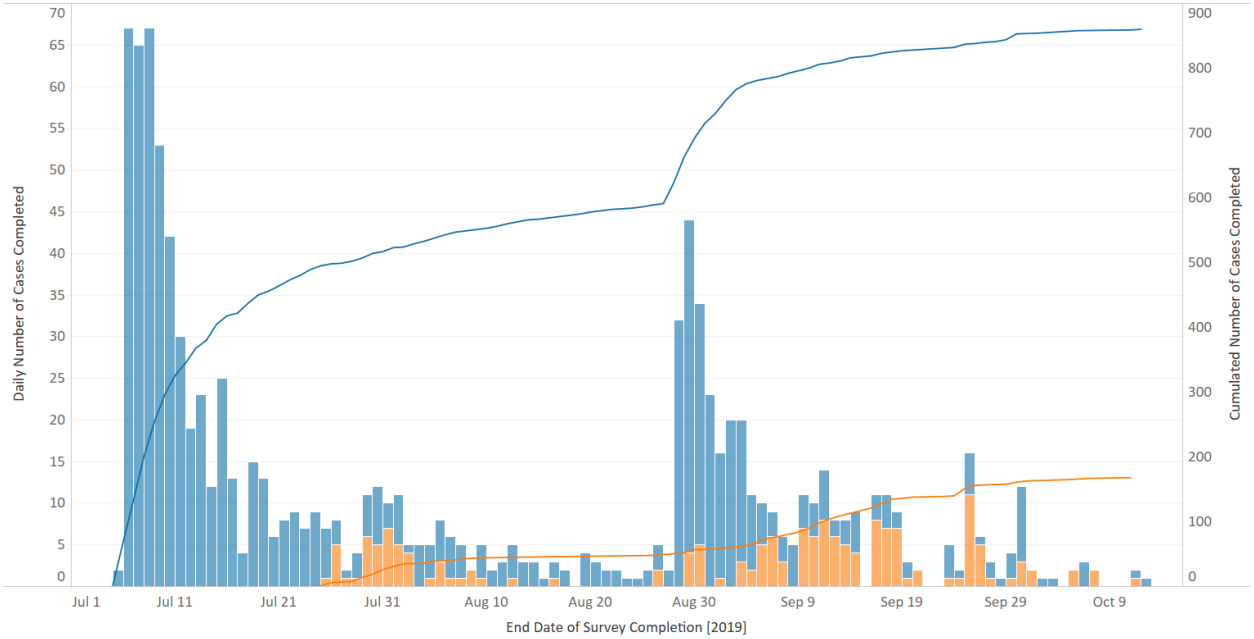

Figure 70 The Daily Count of Completed Responses

1) Blue indicates those from the mailing sample and orange from the emailing sample

2) The left axis indicates the daily count of completed cases on each day, and the right axis the cumulative count of completed cases until that day.

As for emailing recruitment, we sent out the invitation emails to the 30,000 accounts with a set of 2,500 emails each time, which was determined based on Qualtrics' weekly limit (i.e., 25,000 emails per

seven consecutive days). By referring to a recommendation on good and bad days for marketing emails (Schwedelson, n.d.), we decided to send out the invitation emails only on regular working days, which led us to send out up to 5,000 emails per weekday. In addition, we chose two times a day, at 9:15 AM around the usual morning commutes, and at 5:30 PM around the usual afternoon commutes, to see if response rates differ by the sent-out time. Table 5 presents the time periods for the first invitation and three reminder emails. Note that we had about a month interval between mailing and emailing recruitment because of the change in the fiscal year and state-wide migration to a new integrated administration system across all 26 public universities and colleges in the state of Georgia. These changes prevented from purchasing email addresses, so we had to wait for about a month to resume the purchasing process. For this reason, from the first invitation, we specified as the due date September 30th, 2019 (Wednesday), which would allow interested individuals to complete the survey for about two months.

Table 5 Dates on which the initial invitation and reminder emails were sent out

Time period	Action	Time interval from the previous sent-out
July 25 – August 8, 2019	First invitation	
August 29 – September 9, 2019	First reminder	About a month
September 10 – September 18, 2019	Second reminder	2 weeks
September 20 – September 30, 2019	Third reminder	1.5 weeks (i.e., 10 days)

From the emailing sample, we have two types of *invalid* email addresses. First, we found about 11.47% of the initially sent-out emails (3,442 out of the initial 30,000 emails from InfoGroup) were immediately bounced back, suggesting that certain email service providers (e.g., Yahoo) did not allow our invitation to be delivered to their email users. Oddly, those at other TOMNET institutions did not have issues with these providers, although they also had similar bounced-back rates. We reported this issue to InfoGroup, and received replacements for those undelivered emails, which were not associated with the service providers. We still had 28 emails bounced back out of the new 3,442 emails, which lead to 29,972 as the (intermediate) sample size for email recruitment. Second, we had returned emails from individuals indicating they do not belong to the sampling frame (i.e., those who lived in the 15 core counties in the Atlanta region at the time of the survey administration). Common cases include (1) corporate email accounts whose users were no longer with their companies (for whom we cannot determine eligibility for this survey), (2) email accounts whose users reported they had long used their accounts, but identified themselves not the same individuals as those specified by InfoGroup, and (3) automatic replies saying that the email account would be no longer in use. We found ten such cases from the remaining 29,972, which left us 29,962 as the final sample size.

Final Dataset

Table 6 presents total costs and costs per completed case, separately computed for mail and email samples. Note that, by taking the survey, respondents will enter a drawing for two types of rewards: a $100 Amazon gift card for 10 respondents, and a $10 Amazon gift card for 200 respondents. Once we finish data cleaning of key variables, we will randomly select who will receive these rewards, and deliver them either email or mail. As for eligibility for the drawing, Georgia Tech IRB requested us to include any interested individuals in the recruitment sample, regardless of their participation in the survey. We received two requests by individuals who were interested in the rewards but did not want to take the survey.

Table 6 Total and Per Case Costs for Mailing and Emailing Samples

Items	Mailing	Emailing	Sum
purchase of addresses	$1,500.00	$6,000.00	$7,500.00
printing/mailing of the invitation letters[1)]	$3,213.57	NA	$3,213.57
printing/mailing of the reminder postcards[2)]	$6,454.22	NA	$6,454.22
mail-out/mail-back of paper surveys[3)]	$82.50	NA	$82.50
manual data entry to the Qualtrics platform[4)]	$80.00	NA	$80.00
Rewards[5)]	$2,529.87	$470.13	$3,000.00
total costs	$13,860.17	$6,470.13	$20,330.29
completed cases after an initial cleaning[6)]	861	160	1,021
costs per case	$16.10	$40.44	$19.91

1) Black and white on 8.5 by 11-inch letters, with a non-profit bulk rate
2) Black and white on 6 by 4.25-inch postcards
3) $5.50 for each, and 15 cases in total
4) 20 minutes for the data entry of each case, multiplied by 12 cases and $20/hour (hourly rate)
5) Since we did not yet select who would receive rewards yet, $3,000 (total amount) is split based on the number of completed responses from mailing and emailing samples.
6) We have 1,040 completed cases in total; however, five cases lived out of the study area, and eight cases did not report any information about residential addresses. In addition, six cases are found not from the two recruitment samples. Thus, these 19 cases are removed from the table above.

Table 7 presents the number of completed cases and response rates for individual counties, computed separately by the recruitment methods. We could collect a sizeable number of completed responses (N=1,021 from the two recruitment samples, plus an additional six cases), which allow us to estimate complex models for travel behaviors and various underlying factors. In contrast, response rates do not look impressive. 2.78 percent of those who were invited via mails took the survey, either online or on the paper questionnaire (12 cases) and only 0.53 percent of those who were asked via emails participated in the survey (only one respondent in the email sample requested the paper questionnaire). On average, the response rate is 1.68 percent in the selected 15 core counties in the Atlanta region, which is somewhat disappointing and lower than initially expected.

Among potential factors accounting for these low response rates, our choice on data collection method, recruitment method, and survey period appears to be the most important. In general, paper surveys are handy, and especially for older adults, who are on average less familiar with information and communication technology, paper surveys are more convenient. In addition, with the same recruitment size, our invitation to postal addresses generated many more responses (n=861) than our invitation to email addresses (n=160) with the ratio of five to one. This stark difference in response rates is related to the way these invitations are perceived and handled by receivers. While sending an initial invitation and reminders *via email* does not incur any additional costs (once the email list is purchased), these emails may receive only minimum attention from users if any because they are likely to receive a large volume of marketing emails every day. Lastly but most importantly, our chosen survey period from July to September appears not to be the best months of a year for data collection. For example, travel patterns reported for the past 30 days may differ from their typical behaviors because of the school break and vacations (e.g., trip rates for social and recreational purposes). Also, residents may be less available for taking surveys because of more frequent travel schedules, especially long-distance trips. In part because of these unique characteristics of our chosen survey period, for the mailing sample, the second peak took place around the end of August,

when personal vacations are over and schools resume, and for the email sample, respondents completed more surveys in September in response to reminders, than they did to the initial invitation.

Table 7 Response Rates for Mailing and Emailing Samples

Name	Mail recruitment			Email recruitment			Combined		
	valid invitations	completed responses	response rate	valid invitations	completed responses	response rate	valid invitations	completed responses	response rate
Fulton	6,508	203	3.12%	6,448	28	0.43%	12,956	231	1.78%
Gwinnett	4,744	131	2.76%	4,675	35	0.75%	9,419	166	1.76%
DeKalb	4,606	173	3.76%	4,539	28	0.62%	9,145	201	2.20%
Cobb	4,604	131	2.85%	4,557	22	0.48%	9,161	153	1.67%
Clayton	1,577	19	1.20%	1,511	5	0.33%	3,088	24	0.78%
Cherokee	1,408	45	3.20%	1,345	11	0.82%	2,753	56	2.03%
Henry	1,255	23	1.83%	1,191	0	0.00%	2,446	23	0.94%
Forsyth	1,181	27	2.29%	1,114	9	0.81%	2,295	36	1.57%
Paulding	905	18	1.99%	838	2	0.24%	1,743	20	1.15%
Coweta	895	17	1.90%	828	3	0.36%	1,723	20	1.16%
Douglas	863	14	1.62%	793	2	0.25%	1,656	16	0.97%
Fayette	719	25	3.48%	651	6	0.92%	1,370	31	2.26%
Newton	654	14	2.14%	586	2	0.34%	1,240	16	1.29%
Rockdale	568	10	1.76%	502	4	0.80%	1,070	14	1.31%
Spalding	450	11	2.44%	384	3	0.78%	834	14	1.68%
sum	30,937	861	2.78%	29,962	160	0.53%	60,899	1,021	1.68%

1) The final sample contains additional six cases (N=1,027) (three cases from undeliverable addresses, possibly completed by new residents, and three cases by those who voluntarily contacted the research team and requested single-use access codes)

T4 SURVEY FULL DEPLOYMENT – TAMPA, FL

Data Collection

Based on the pilot deployment results that explained earlier, the research team decided to implement the full deployment via the email recruitment channel. This was pursued to induce savings in mailing costs that would be supplemented by providing guaranteed incentives for each respondent. All participants were compensated with a $10 Amazon gift card (after January 1st, incentives were increased to $20). No additional incentive or randomized prize was advertised.

Sampling Plan

A random sample of the Tampa-St. Petersburg-Clearwater metropolitan statistical area was desired. Additionally, since the Tampa Bay Area Regional Transportation Authority also includes Citrus county in their analysis area, the research team included Citrus county residences in the sampling frame. The five-county area includes Hillsborough, Pinellas, Pasco, Hernando, and Citrus counties. This five-county area is home to 3,214,767 residents.

A random address-based sample was acquired from the marketing vendor for these five counties. InfoGroup was chosen as the source of address information for the Tampa Bay study. Fifty thousand (50,000) households in the sampling frame were invited to take part in the survey via the email recruitment channel. This number of email addresses (with accompanying mail addresses) were selected based on email response rate results of the pilot survey. The research team decided to recruit across the three largest counties at approximately a proportional rate to their actual population sizes. The smallest county (Citrus) was over-sampled and the largest county (Hillsborough) was under-sampled. This was done to account for Citrus county being more rural and tending to have an older population and less broadband internet access.

Survey Administration

Upon completion of the proofreading of the modified survey for the Tampa Bay region, and the supplemental invitation letter, the first wave of emails was sent out on Tuesday, the 29th of October 2019. The first set of responses started trickling in by the same date and the subsequent days of that week. During the initial few weeks of survey dissemination, we were only able to send 1000 emails per weekday (as there was a Qualtrics restriction of 5,000 emails per week). This was rectified after consultations with Qualtrics and the subsequent waves were sent at a rate of 10,000 emails per week. Out of the 50,000 total email invitations sent, 1,306 bounced back due to invalid addresses or other reasons. Emails were sent on specific days, based on a recommendation of good and bad days for marketing emails (Schwedelson, n.d). Figure 71 illustrates the daily number of responses received in addition to the cumulative numbers on the secondary axis.

Emails were typically sent on predefined time intervals – 9 AM and 4 pm on weekdays, and 1 PM on weekends. The two major hikes in respondent feedbacks were observed on December 11, 2019 (Wednesday), and the other on February 11, 2020 (Tuesday). After the first invitations of email distributions, first, and second email reminders were initiated for selected subsamples of survey respondents keeping a 10-14-day time interval from the previous sent-out email. As the Tampa Bay surveys were staggered over multiple months, respondents received reminders based on their corresponding invitation email dates. Table 8 describes the time periods for email invitations and subsequent reminders.

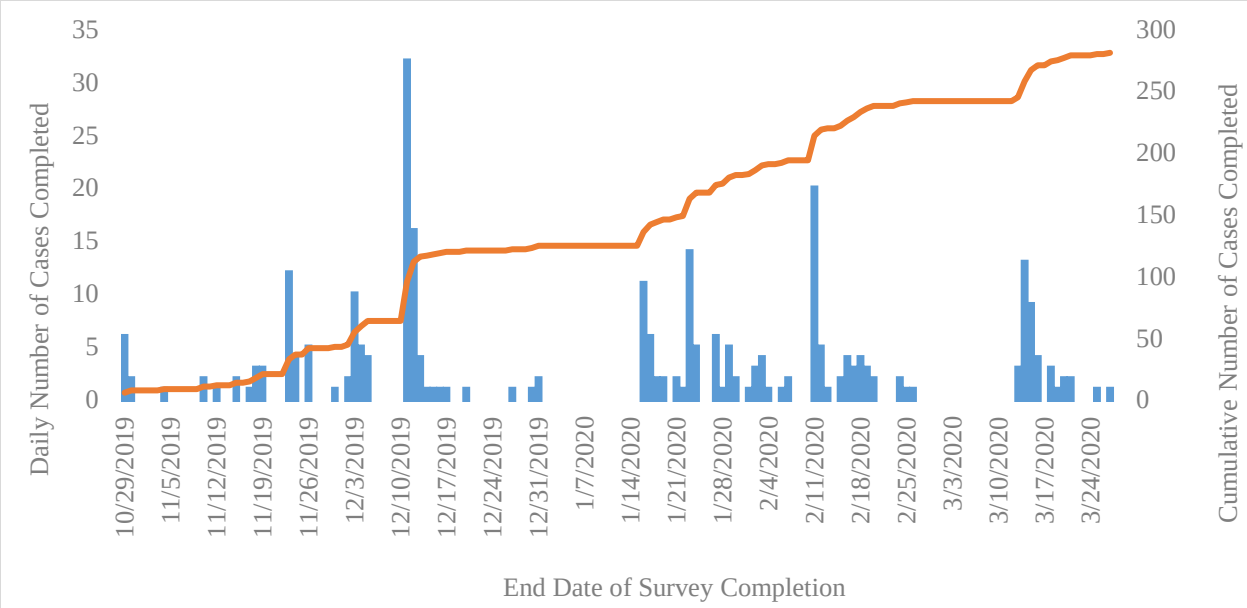

Figure 71 The Daily Count of Completed Responses from Tampa Bay Sample

Table 8 Dates on which the initial invitation and reminder emails were sent out for Tampa Bay Sample

Time period	Action	Time interval from the previous sent-out
October 29 – February 1, 2019	First invitation	
November 15 – February 11, 2020	First reminder	10-14 days
January 23 – February 18, 2020	Second reminder	7-10 days
March 13 – March 15, 2020	Third reminder	3 weeks

Invitations were staggered and delayed primarily due to the three following reasons:

1. The University of South Florida has a limited number of email invitations available per month for researchers to use due to its contract with Qualtrics. A request for increasing that limit for the research group took approximately two weeks to be approved by USF IT.
2. The University of South Florida Office of the President sent out a survey to all students and staff at USF during the month of October. Because this used up the university's allotment of email invitations, the research team was notified that it would have to wait to be allocated email invitations until the end of October or possibly November.
3. The holiday season limited the sending of reminders as the research team attempted to avoid the weeks of Thanksgiving, Christmas, and New Years' to avoid contacting people during times of travel.

All respondents who completed the survey before March 13, 2020, were provided with a $10 Amazon gift card. Between the second and third reminders, discussions were held with Qualtrics to further increase the capacity of emails and we received approvals for 50,000 emails a week. The third reminders were sent with the intention of increasing the number of responses completed by including an increased incentive of a $20 Amazon gift card. Surprisingly, this did not increase response rates (with only 39 responses from all the third reminders that were sent).

Final Dataset

In total, 281 completed responses were received from the 50,000 email invitations which resulted in a 0.5% response rate (Table 9). While this response rate is lower than Arizona, it matches closely with the

experience of Georgia Tech who similarly had a 0.5% response rate via email invitations. Response rates were greatest in the three largest counties in the metro area with Hillsborough County exhibiting a 0.70% response rate. Citrus and Hernando counties (the most rural counties in the MSA) had below-average response rates. This may indicate that responses may have been impacted by varying levels of internet penetration throughout the region. Other factors that may have impacted response rates include the timing of the survey around the Thanksgiving and Christmas holiday seasons. The survey's length is also a possible concern as respondents averaged 30-40 minutes per survey and the research team had 244 incomplete questionnaires. Additionally, the survey team received some complaints about mistrust in how their data would be used which could be a localized effect.

Table 9 Sample Sizes and Response Rates by County for Tampa Bay Sample

County	Total households (ACS 2018)	Email recruitment		
		Initial target	Completed Responses	Response Rate
Citrus	72,104	2,500	4	0.16%
Hernando	190,865	3,000	10	0.33%
Hillsborough	1,436,888	21,500	150	0.70%
Pasco	539,630	8,000	39	0.49%
Pinellas	975,280	15,000	78	0.52%
Total	**3,214,767**	**50,000**	**281**	**0.56%**

The survey administration costs are summarized in Table 10. The cost of the survey per case came to $51.03. Although this is higher than the cost for other areas, it is comparable to the online costs for the Atlanta metro sample of about $40 per case since a guaranteed reward per case was given.

Table 10 Survey Administration Cost for Tampa Bay Sample

Purchase of email addresses	$10,000.00
Rewards	$4,340.00
Total costs	$14,340.00
Completed cases after an initial cleaning	281
Costs per case	$51.03

Attempts to expand the Tampa Bay-based sample will be pursued in the third phase of the project. Current plans involve using targeted internet advertising to find new respondents and to filter their location characteristics at the beginning of the survey to ensure the sample frame is still properly represented. The targeted advertising will help to control the costs of the new recruitment. The currently collected sample can be used to assist in properly weighting this next non-random-based sample to account for self-selection. The newly acquired sample will be added to the existing pooled dataset during the third phase of the project and used thereafter for further modeling and analysis.

CONCLUSIONS AND POLICY IMPLICATIONS

Disruptive transportation technologies such as autonomous vehicles and mobility-on-demand services are bringing transformative changes in the urban area. To enhance our understanding of various impacts of these new mobility options on travel behavior and relative consequences, people's attitudes towards and perceptions of these technologies and services need to be measured and understood. This project goal is to collect such information in multiple jurisdictions through a comprehensive attitudinal and behavioral survey. This report particularly covers the pilot phase of data collection in the Phoenix metro area and the coordinated full survey deployment in Phoenix, Atlanta, and Tamps metropolitan areas. The previous phase of the project included a literature review, development of survey goals, objectives, and detailed research questions, and survey questionnaire design.

The pilot phase of data collection is conducted during fall 2018 and the full deployment is conducted during summer and fall 2019. The goals of the pilot T4 survey is to evaluate response rates across two survey methods (online and paper questionnaires), test the survey content, and evaluate the sampling plan. After evaluating the response rates across different survey methods with relative benefits and costs, the study team decided to do the full deployment using an online questionnaire with both mail-based postcards and email invitations to a random address-based sample in Phoenix metro area.

While the pilot phase of data collection is conducted only in Phoenix metro area with a sample size of 262, the full deployment is conducted in four southern metro areas (Phoenix, Atlanta, Tampa, and Austin) to understand how the market may perceive, adopt, and adapt to transformative transportation technologies mainly autonomous vehicles and mobility-on-demand services. The full deployment in the Phoenix metro area yielded a sample size of 1071 completed responses collected through an online platform and recruited through both email and mailed postcard invitations. Similar data collection in Atlanta yielded a sample size of 1021 completed responses through an online platform recruited via both mail and email invitations. In Tampa, the sample size collected over this report coverage period is 281 completed responses collected using an online platform and recruited via only email addresses. Moreover, the University of Texas at Austin, who has been our close collaborator for many years, also conducted the same data collection which yielded an additional sample of 1367 completed responses collected using an online platform and recruited with random email and Facebook advertisements (supported by the D-STOP University Transportation Center). The four full deployments across the four southern metro areas produced a dataset consisting of 3740 completed responses collected over summer and fall 2019. This project will provide a data collection protocol and methodology that can be widely adopted. The collected dataset will be unique in terms of large sample size, contents, and spatial expansion across multiple southern metro areas.

Similar to all other surveys, the socioeconomic characteristic distributions of the respondents to the pilot survey are not exactly equal to the population of Maricopa County which represents the Phoenix metro area. The survey respondents are by average older, more educated, have higher income, and consist of proportionally more women than men. Although weighting techniques can help to modify the results to be more representative of the entire population, this report is only presenting the unweighted results due to the small sample size. The pilot survey collected detailed socioeconomic attributes, full-spectrum of general and transportation-related attitudes, vehicle ownership status, residential preferences, and current commute pattern as background information. Additionally, it collected data on mobility-on-demand and autonomous vehicle perceptions, attitudes, and stated usage behavior. The results of the pilot survey deployment show that half of the respondents are familiar with ridehailing services but not using them, while 12 percent stated using them monthly and 4 percent stated using them weekly in the Phoenix metro area. The ridehailing

services usage rate significantly decreases for older people. While 37 percent of 18-to-30 years olds use the service at least monthly, only 15 percent of 71+ years old use the service at the same rate.

Respondents generally agree that ridehailing services are good alternatives when away from home (76 percent), to avoid impaired driving (88 percent), when transit is not available (80 percent), to access transit (44 percent), when a personal vehicle is temporarily not available (73 percent), and to save time and money on parking (74 percent). However, it is important to consider the potential negative impacts of these services on sustainability if they replace transit or green transportation modes or induce extra travel demand. The respondents stated that they make 16 percent fewer transit trips, 10 percent fewer bike trips, and 12 percent fewer walk trips after starting using the ridehailing services.

Promoting the shared-usage of ridehailing services could compensate for the sustainability considerations of these modes of transportation. However, respondents are not showing a strong desire for sharing. Only 29 percent of the respondents believe that the reduced cost worth choosing shared ridehailing modes to private ridehailing with longer travel time and the potential existence of strangers in the ride. Feeling uncomfortable sharing a ride with strangers is less among men (39 percent) compared to women (50 percent) and should be considered in any policymaking which is trying to promote sharing behavior.

With respect to autonomous vehicles, by average, 63 percent of the respondents are somewhat or very familiar with this technology. The familiarity with autonomous vehicles increases with the increase of the household annual income which reaches 77 percent for people with very high income ($150,000 or more). With respect to using AVs, 27 percent of survey respondents stated that they never use an AV; 47 percent stated that they use it alone or with people they know, and only 20 percent stated that they are willing to share AVs with strangers.

Two important featured goals of automated technology are to increase safety by eliminating the stress and hassle of driving and enabling people to perform other tasks or rest during the ride. AVs can also work as a personal chauffeur and run errands. However, all of this convenience that AVs could offer to the transportation system may come at a cost of increasing the frequency and length of the trips. The pilot survey results show that 19 percent of the respondents are likely to make additional trips with the presence of AVs and 23 percent are likely to make farther trips. Moreover, only 16 percent of respondents think that AVs are safer than human driver and 65 percent are concerned about the safety of pedestrians and bicycles on the streets.

In this report, a comprehensive description of all the steps taken to pilot survey deployment is presented. Moreover, a complete series of descriptive univariate and multivariate graphs, which summarize the survey results, are presented with related descriptions. The full deployment administration in four southern metro areas has also been presented in this report. The results for the full deployment across four southern metro areas will be presented in the next phase of this project's report with a fully weighted sample and more in-depth questions about the potential impacts of autonomous vehicles with four times larger sample size that the pilot survey. Further work will go into an in-depth analysis of the survey results to respond to numerous research questions still unsolved about the usage pattern and perceptions around new transportation technologies. For further information on this project and accessing related project reports please visit the TOMNET UTC website at www.tomnet-utc.org or contact the project director at Sara.Khoeini@asu.edu.

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APPENDIX I - FULL DEPLOYMENT SURVEY INSTRUMENT

Section A: Attitudes and Preferences

To begin, we would like to learn about your attitudes and opinions on transportation and life in general. For each of the following statements, please choose the response that most closely matches your feelings. We want your honest opinion on each topic (or your *best guess*, for topics you are not very familiar with) – *remember, there are no "right" or "wrong" answers!*

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*
I like to be among the first to have the latest technology.	○	○	○	○	○
The government should raise the gas tax to help reduce the negative impacts of transportation on the environment.	○	○	○	○	○
I feel uncomfortable around people I do not know.	○	○	○	○	○
I prefer to do one thing at a time.	○	○	○	○	○
Most of the time, I have no reasonable alternatives to driving.	○	○	○	○	○
I am too busy to do many of the things I like to do.	○	○	○	○	○
Car crash deaths are an unfortunate but unavoidable part of a modern, efficient transportation system.	○	○	○	○	○
I am committed to an environmentally-friendly lifestyle.	○	○	○	○	○
Having to wait can be a useful pause in a busy day.	○	○	○	○	○
I prefer to shop in a store rather than online.	○	○	○	○	○
Learning how to use new technologies is often frustrating for me.	○	○	○	○	○
I would be fine with renting out my car to people I do not know.	○	○	○	○	○
Having internet connectivity everywhere I go is important to me.	○	○	○	○	○
I prefer to live close to transit, even if it means I'll have a smaller home and live in a more densely populated area.	○	○	○	○	○
Sharing my personal information or location via internet-enabled devices concerns me a lot.	○	○	○	○	○
My daily travel routine is generally satisfactory.	○	○	○	○	○
When traveling in a vehicle, I prefer to be a driver rather than a passenger.	○	○	○	○	○
I prefer to live in a spacious home, even if it is farther from public transportation or many places I go.	○	○	○	○	○
I am committed to using a less polluting means of transportation (*e.g.*, walking, biking, and public transit) as much as possible.	○	○	○	○	○

Public transit is a reliable means of transportation for my daily travel needs.	○	○	○	○	○
I tend to feel sick if I read while in a moving vehicle.	○	○	○	○	○
I like trying things that are new and different.	○	○	○	○	○
I try to make good use of the time I spend traveling.	○	○	○	○	○
The level of congestion during my daily travel bothers me.	○	○	○	○	○
I definitely like the idea of owning my own car.	○	○	○	○	○
The time spent traveling to places provides a useful transition between activities.	○	○	○	○	○
The reliability and quality of a car are more important than its brand.	○	○	○	○	○
I like the idea of having stores, restaurants, and offices mixed among the homes in my neighborhood.	○	○	○	○	○

Section B: Household Vehicles and Residential Preferences

Learning about your household vehicles and residential preferences will help us better understand your transportation and lifestyle choices.

1. Do you have a driver's license? ○ No ○ Yes

2. How many people in your household have a driver's license (including you)? _____
   By "household" we mean "people who live together and share at least some financial resources". Unrelated housemates/roommates are usually ***not*** *considered members of the same household even if they live in the same housing unit.*

3. How many *motorized* vehicles (including four-wheelers and two-wheelers) are available in your household? _____
   If you have ***zero motorized vehicles*** *in your household, please enter "0" and proceed to Question 6.*

4. Please provide details of all motorized vehicles (including four-wheelers and two-wheelers) available to your household. If your household has more than four vehicles, consider the four vehicles used the most. **Please report the vehicle you use most often as Vehicle 1.**

Vehicle	*Make*	*Model*	*Model Year*	*Year Acquired*	*Fuel Type*	*Annual Miles Driven (Estimate)*
Example	*Toyota*	*Camry*	*2004*	*2008*	●Gasoline ○Electric ○Hybrid ○Other	○*Less than 5,000 miles* ○*5,000 to 9,999 miles* ●*10,000 to 14,999 miles* ○*15,000 to 19,999 miles* ○*20,000 to 24,999 miles* ○*25,000 to 29,999 miles* ○*30,000 to 39,999 miles* ○*40,000 and above*
1	_____	_____	_____	_____	○Gasoline ○Electric ○Hybrid ○Other	○*Less than 5,000 miles* ○*5,000 to 9,999 miles* ○*10,000 to 14,999 miles* ○*15,000 to 19,999 miles* ○*20,000 to 24,999 miles* ○*25,000 to 29,999 miles* ○*30,000 to 39,999 miles* ○*40,000 and above*
2	_____	_____	_____	_____	○Gasoline ○Electric ○Hybrid ○Other	○*Less than 5,000 miles* ○*5,000 to 9,999 miles* ○*10,000 to 14,999 miles* ○*15,000 to 19,999 miles* ○*20,000 to 24,999 miles* ○*25,000 to 29,999 miles* ○*30,000 to 39,999 miles* ○*40,000 and above*

3	_____	_____	_____	_____	○ Gasoline ○ Electric ○ Hybrid ○ Other	○ *Less than 5,000 miles* ○ *5,000 to 9,999 miles* ○ *10,000 to 14,999 miles* ○ *15,000 to 19,999 miles* ○ *20,000 to 24,999 miles* ○ *25,000 to 29,999 miles* ○ *30,000 to 39,999 miles* ○ *40,000 and above*
4	_____	_____	_____	_____	○ Gasoline ○ Electric ○ Hybrid ○ Other	○ *Less than 5,000 miles* ○ *5,000 to 9,999 miles* ○ *10,000 to 14,999 miles* ○ *15,000 to 19,999 miles* ○ *20,000 to 24,999 miles* ○ *25,000 to 29,999 miles* ○ *30,000 to 39,999 miles* ○ *40,000 and above*

5. Which of the following driving assistance features does **Vehicle 1** have? *Please check all that apply.*

☐ Lane keeping system
☐ Backup camera
☐ Adaptive Cruise Control (ACC)
☐ Automated braking system
☐ Blind spot monitoring
☐ Other (please specify): _____
☐ None
☐ Not sure

In the following questions, we are interested in the location where you currently live most of the time. For example, if you are a college student, please consider your local address when answering all questions, not your parents' home address.

6. What best describes the home you **currently** live in?

○ Stand-alone home
○ Attached home/townhome
○ Condo/apartment
○ Mobile home
○ Other (please specify): _____

7. Do you rent or own your home?

○ Rent
○ Own
○ Provided by somebody else (*e.g.*, relative, employer)
○ Other (please specify): _____

8. What year did you move to your current address (*e.g.*, 2010)? _____

9. Did you choose your current home **location**?

○ No, my home location was chosen by others (*e.g.*, spouse/partner)
○ Yes, I chose or helped choose my current home location

10. This question focuses on your preferences about homes and neighborhoods. If you participated in choosing your current home, please tell us what features led you to choose your current residence. If not, imagine that you are planning a move now: which of the following features would you seek for your future home?

	Do not want	*Do not care*	*Want*	*Must have*
Large home	○	○	○	○
Backyard	○	○	○	○
Single family home (stand-alone home)	○	○	○	○
Close to work/school location (for one or more household members)	○	○	○	○
Close to shops/services	○	○	○	○
Close to parks/nature	○	○	○	○
Close to family/friends	○	○	○	○
Good public schools	○	○	○	○
Easy to walk or bike around neighborhood	○	○	○	○
Good access to public transit	○	○	○	○
Low crime neighborhood	○	○	○	○

Section C: Current Travel Patterns

1. At this time, you are:

   ○ Both a worker and a student
   ○ A worker (part-time or full-time)
   ○ A student (part-time or full-time)
   ○ Neither a worker nor a student: *Please go to Question 6.*

2. On average, how many **days per week** do you…

   a. Travel to work: _____
   b. Travel to school: _____
   c. Telecommute for work: _____

   "Telecommute" refers to working from home or a location close to home, without the need to travel to the regular workplace at all.
   If you do not commute to work or school, please go to Question 6.

3. How far do you live from your main work/school location? _____ miles (estimate one-way trip distance)

4. On a typical day, how long does it take you to get from home to your main work/school location (one-way) by the **means of transportation you use most often**?

   My trip typically takes _____ minutes by:

   Please choose the means of transportation used most often:
   ○ private vehicle, driving alone.
   ○ private vehicle, driving with passengers.
   ○ private vehicle, riding with others.
   ○ carsharing services (*e.g.*, Zipcar).
   ○ bus.
   ○ light rail.
   ○ Uber/Lyft/other ridehailing services.
   ○ taxi.
   ○ bicycle (including bikesharing).
   ○ e-scooter sharing service (*e.g.*, Bird, Lime).
   ○ walk.
   ○ other mode not listed above.

5. Considering only your **travel to work/school**, please indicate how often you typically use ***each*** of the following means of transportation.

			I use it…			
	Not available	*Available but I never use it*	*Less than one day a month*	*1-3 days a month*	*1-2 days a week*	*3 or more days a week*
Drive private vehicle, alone	○	○	○	○	○	○
Drive private vehicle, with passengers	○	○	○	○	○	○
Ride in private vehicle, with others	○	○	○	○	○	○
Carsharing services (*e.g.*, Zipcar)	○	○	○	○	○	○
Public transit: bus	○	○	○	○	○	○
Public transit: light rail	○	○	○	○	○	○
Uber/Lyft/other ridehailing service	○	○	○	○	○	○
Taxi	○	○	○	○	○	○
Bicycle (including bikesharing)	○	○	○	○	○	○
E-scooter (*e.g.*, Bird, Lime)	○	○	○	○	○	○
Walk	○	○	○	○	○	○
Other (please, specify): _____	○	○	○	○	○	○

If you do not commute to work or school, please resume here.

6. Considering only your **errands/shopping/social/recreational** trips, please indicate how often you typically use ***each*** of the following means of transportation.
Note: The last question was about travel to work/school, while this question is about other trip purposes.

			I use it…			
	Not available	*Available but I never use it*	*Less than one day a month*	*1-3 days a month*	*1-2 days a week*	*3 or more days a week*
Drive private vehicle, alone	○	○	○	○	○	○
Drive private vehicle, with passengers	○	○	○	○	○	○
Ride in private vehicle, with others	○	○	○	○	○	○
Carsharing services (*e.g.*, Zipcar)	○	○	○	○	○	○
Public transit: bus	○	○	○	○	○	○
Public transit: light rail	○	○	○	○	○	○
Uber/Lyft/other ridehailing service	○	○	○	○	○	○
Taxi	○	○	○	○	○	○
Bicycle (including bikesharing)	○	○	○	○	○	○
E-scooter (*e.g.*, Bird, Lime)	○	○	○	○	○	○
Walk	○	○	○	○	○	○
Other (please, specify): _____	○	○	○	○	○	○

7. Do you have any conditions that prevent or limit you from …

	No	*To some extent*	*Yes*

Driving in general	○	○	○
Driving at night	○	○	○
Taking public transit	○	○	○
Bicycling	○	○	○
Walking	○	○	○

8. Are there any adults (*i.e.*, 18 years old or older) in your household, other than yourself, with conditions that either partially or fully limit their ability to drive? ○ No ○ Yes

9. On average, how many miles **do you drive** in a week? *Please **do not include** miles you drive while "on the clock" for your job (e.g., bus driver, Uber/Lyft driver).*

○ Zero

○ 1-25 miles	○ 26-50 miles	○ 51-75 miles	○ 76-100 miles
○ 101-200 miles	○ 201-300 miles	○ 301-500 miles	○ More than 500 miles

10. In the past 30 days, about how many times did you have each of the following delivered to your home?

	Zero	*1*	*2-3*	*4-6*	*7-10*	*More than 10*
a. Items purchased online	○	○	○	○	○	○
b. Prepared meals	○	○	○	○	○	○
c. Groceries	○	○	○	○	○	○

We would now like to obtain some information about your **long-distance travel** (for vacation, business, visiting friends/relatives, etc.).

11. About how many long-distance trips (at least 75 miles one-way) did you make **since the beginning of the year?** Do **not** include trips to and from work/school. Please count each complete **round-trip** as ONE trip, and classify it based on the primary destination, the main trip purpose, and the means of transportation that was used for the longest portion of the journey. *If you made no long distance trips for a specific category, then please enter 0.*

    a. Number of long-distance trips for **<u>leisure/personal</u>** purposes since the beginning of the year:
    _____Trips by car _____Trips by airplane _____Trips by other means

    b. Number of long-distance trips for **<u>business</u>** purposes since the beginning of the year:
    _____Trips by car _____Trips by airplane _____Trips by other means

12. Have you been to the Phoenix Sky Harbor or Mesa Gateway airports since the beginning of the year to either travel yourself or to pick-up/drop-off someone else who was traveling? ○ No ○ Yes

Section D: Mobility-on-demand

This section asks questions about the use of mobility-on-demand (also called **ridehailing or ridesharing)** such as Uber and Lyft, which provide door-to-door transportation via a smartphone app, as well as other new mobility services such as carsharing and bike/scooter sharing. Ridehailing can be either **private** (involving only you and your own travel companions) or **shared** (involving pick-up/drop-off of other people you don't know). Even if you have never used these services, please answer all questions to the best of your ability.

1. How often do you generally use the following transportation services?

	I am not familiar with it	*I am familiar but never used the service*	*I use it rarely (e.g., less than once a month)*	*I use it monthly*	*I use it weekly*
Private ridehailing (*e.g.*, Uber, Lyft)	○	○	○	○	○
Shared ridehailing[a] (*e.g.*, uberPOOL, Lyft Share)	○	○	○	○	○
Carsharing (*e.g.*, Zipcar, Share Now)	○	○	○	○	○
Bikesharing (*e.g.*, Jump, Grid)	○	○	○	○	○
E-scooter sharing (*e.g.*, Lime, Bird)	○	○	○	○	○

[a] Shared ridehailing is an Uber/Lyft ride which you are sharing with other passengers not in your party.

If you have never used bikesharing or e-scooter sharing, please go to Question 3 on page 9.

2. Considering the **last trip** you made using **bikesharing** or **e-scooter sharing**, please answer the following questions:

   a. What type of service did you use for this trip?

      ○ Bikesharing
      ○ E-scooter sharing

   b. When did you use it?

      ○ Weekday daytime
      ○ Weeknight (**excluding** Friday night)
      ○ Weekend daytime
      ○ Weekend night time (**including** Friday night)

   c. What was the length of the trip?

      ○ Less than a mile
      ○ 1 – 2 miles
      ○ 3 – 4 miles
      ○ 5 miles or more

   d. What was the primary purpose of the trip? *Please check the **best answer.***

      ○ Work/school
      ○ Shopping/errands
      ○ Eating/drinking
      ○ Social/recreational
      ○ To access airport
      ○ To access public transit
      ○ Medical/dental

○ Going/returning home from another location
○ Just to enjoy the ride/try the new service
○ Other (please, specify): _____

e. Why did you use this service for the trip? *Please check ALL that apply.*

☐ No need to park/parking was expensive or scarce
☐ For more physical exercise
☐ To save time
☐ To save money
☐ Public transit was not available
☐ Public transit was not convenient
☐ Private vehicle was not available
☐ Just to enjoy the ride/try the new service
☐ Other (please, specify): _____

f. How would you have made this trip if the shared bikes or e-scooters were not available? *Choose the most likely option.*

○ **Drive** private vehicle, alone
○ **Drive** private vehicle, with passengers
○ **Ride** in private vehicle, with others
○ Ride the bus
○ Ride the light rail
○ Use taxi
○ Use Uber/Lyft
○ Use my own bike or scooter
○ Walk
○ I would not have made this trip
○ Other (please, specify): _____

If you have never used ridehailing services, please go to Question 6 on page 10.

3. Considering the **last trip** you recall using ridehailing services, please answer the following questions. If you don't remember all of the information precisely, your best guess is fine. You can also refer to your app to see trip details.

What type of ridehailing service did you use?	○ Private ridehailing (*e.g.*, Uber, Lyft) ○ Shared ridehailing (*e.g.*, UberPOOL, Lyft Share)
Where did you travel using this service? *Provide address or major cross-streets and city name*.	From: _____ To: _____
When did you use it?	○ Weekday daytime ○ Weeknight (**excluding** Friday night) ○ Weekend daytime ○ Weekend night time (**including** Friday night)
About how long was the **wait time** for this trip?	_____ minutes
About how long was the **travel time** in the vehicle?	_____ minutes
About how much did the **trip cost**?	$_____ *OR* ☐ I don't know because someone else called the ride.
What was the primary **purpose** of the trip? *Please check the **best answer.***	○ Work/school ○ Shopping/errands ○ Eating/drinking ○ Social/recreational ○ To access airport ○ To access public transit ○ Medical/dental ○ Going/returning home from another location ○ Other (please, specify): _____
How many other passengers traveled with you?	○ I was the only passenger *OR* ___ Family members, friends or colleagues ___ Other passengers matched via the app (for shared ridehailing)
What would you have done if this service were **not** available? *Choose the most likely option.*	○ **Drive** private vehicle, alone ○ **Drive** private vehicle, with passengers ○ **Ride** in private vehicle, with others ○ Ride the bus ○ Ride the light rail ○ Use taxi ○ Use a bikesharing or e-scooter sharing service ○ Walk ○ Ride my personal bicycle or scooter ○ I would not have made this trip ○ Other (please, specify): _____
Assume that **shared ridehailing** (*e.g.*, uberPOOL or Lyft Share) was available for this trip, allowing for cheaper fares but longer travel times to reach your destination. What is the maximum **additional** travel time you would have accepted if you had received a 50% discount?	○ I already made this trip using shared ridehailing ○ I would not have used shared ridehailing for the trip ○ 1-5 more minutes ○ 6-10 more minutes ○ 11-15 more minutes ○ 16 or more minutes

4. In the **last month**, about how much did you spend on ridehailing (such as Uber/Lyft) services?

○ $0
○ $1 - $9

○ $10 – $29
○ $30 - $ 49
○ $50 - $74
○ $75 - $100
○ More than $100

5. After beginning to use ridehailing services, how has your use of each of the following means of transportation changed?

	*I have changed usage, but **not** because of ridehailing*	*I use it less often*	*I use it about the same*	*I use it more often*
Drive private vehicle, alone	○	○	○	○
Drive private vehicle, with passengers	○	○	○	○
Ride in private vehicle, with others	○	○	○	○
Public transit: bus	○	○	○	○
Public transit: light rail	○	○	○	○
Taxi	○	○	○	○
Bicycle or e-scooter	○	○	○	○
Walk	○	○	○	○

If you have never used ridehailing services, please resume here.

6. Please rate your level of agreement with each of the following statements about ridehailing services (e.g., Uber/ Lyft). Even if you do not currently use these services, your opinions about them are important to us.

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*
Ridehailing services are too expensive to use on a frequent (*e.g.*, daily or weekly) basis.	○	○	○	○	○
I would use ridehailing services more often if the service was more reliable.	○	○	○	○	○
Ridehailing services help me save time and money on parking.	○	○	○	○	○
Ridehailing services help me avoid impaired driving (*e.g.*, driving under the influence).	○	○	○	○	○
Ridehailing services are good alternatives when my car is temporarily unavailable (*e.g.*, when it is being repaired).	○	○	○	○	○
Ridehailing services are good travel options for me when I am away from home.	○	○	○	○	○
Ridehailing services help me get to/from public transit stops.	○	○	○	○	○
Ridehailing services are good options for me when or where public transit is not available.	○	○	○	○	○
Ridehailing services allow me to live with fewer or no cars.	○	○	○	○	○
Traveling with a driver I don't know makes me feel uncomfortable.	○	○	○	○	○
For shared ridehailing (*e.g.*, uberPOOL, Lyft Share), traveling with unfamiliar passengers makes me uncomfortable.	○	○	○	○	○
The lower cost of shared ridehailing (*e.g.*, uberPOOL, Lyft Share) is worth the additional time picking up and dropping off other passengers.	○	○	○	○	○
The lack of a child safety seat prevents me from using ridehailing services.	○	○	○	○	○
The lack of equipment to accommodate disabilities prevents me from using ridehailing services.	○	○	○	○	○
Ridehailing service availability affects where I choose to live, work, and/or go to school.	○	○	○	○	○

7. Imagine that you call a ride through a smartphone app. For each of **the trip purposes** below, check whether you would choose the **private** (Option 1) or **shared** (Option 2) ridehailing options based on the trip features presented (trip cost, travel time, and the presence of additional passengers). *Select only one option **in each row**. Note that the travel times for shared ridehailing include both your waiting time and the extra time picking up/dropping off other passengers.*

	Option 1: **Private ridehailing** (*e.g.*, Uber and Lyft)	**Option 2:** **Shared ridehailing** (*e.g.*, uberPOOL and Lyft Share)
Social/Leisure	○ $ 18.00/ 20 minutes	○ $ 16.25/ 25 minutes/ 1 additional passengers
Shopping	○ $ 13.00/ 10 minutes	○ $ 9.75/ 13 minutes/ 2 additional passengers
Work/School	○ $ 8.00/ 20 minutes	○ $ 6.00/ 25 minutes/ 3 additional passenger

Section E: Your Thoughts on Autonomous Vehicles

PLEASE READ THIS DESCRIPTION CAREFULLY:

An **Autonomous Vehicle (AV)** is a vehicle that drives itself without human supervision or control. It picks up and drops off passengers including those who do not drive (*e.g.*, children, elderly), goes and parks itself, and picks up and delivers laundry, groceries, or food orders on its own. When AVs become available, ridehailing companies (*e.g.*, Uber and Lyft) will use them to provide rides without a human driver in the vehicle. When answering the questions in this section, please assume a future in which **autonomous vehicles (AVs) are widely adopted, but human-driven vehicles are still present.**

1. Which of the following statements best describes your **familiarity with AVs**?

- ○ I had never heard of AVs before taking this survey.
- ○ I have heard of AVs, but don't know much about them.
- ○ I am somewhat familiar with AVs.
- ○ I am very familiar with AVs.
- ○ I have actually taken a ride in an AV.

2. Please rate your level of agreement with each of the following statements about AVs. We want your opinion even if you are not familiar with AVs.

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*
AVs would help me avoid impaired driving (*e.g.*, under the effects of medication or alcohol).	○	○	○	○	○
AVs will eliminate my joy of driving.	○	○	○	○	○
AVs would make me feel safer on the street as a pedestrian or as a cyclist.	○	○	○	○	○
I would feel comfortable having an AV pick-up/drop-off children without adult supervision.	○	○	○	○	○
I am concerned about the potential failure of AV sensors, equipment, technology, or programs.	○	○	○	○	○
AVs would make traveling by car less stressful for me.	○	○	○	○	○
I would feel comfortable sleeping while traveling in an AV.	○	○	○	○	○
I would make more long-distance trips when AVs are available because I wouldn't have to drive.	○	○	○	○	○
I am concerned that my travel logs and personal information stored in AVs could be leaked.	○	○	○	○	○
I would send an AV to pick-up groceries/laundry/food orders by itself.	○	○	○	○	○
I will never ride in an AV.	○	○	○	○	○
I want the ability to take control of the AV at any time during the ride.	○	○	○	○	○

AVs would make it easy to share vehicles within my household because they can pick-up/drop-off household members on their own.	○	○	○	○	○
AVs would save me time and money for parking by dropping me off and parking themselves.	○	○	○	○	○

If you do not commute to work or school, please go to question 4.

3. Imagine a future when you have regular access to an AV (by owning, leasing, or using automated ridehailing services) and you can do other activities while riding in an AV. How much longer would you be willing to commute in an AV (compared to your current commute)?

○ Up to 5 additional minutes (one way)
○ Between 5 and 15 additional minutes (one way)
○ Between 15 and 30 additional minutes (one way)
○ More than 30 additional minutes (one way)
○ I would not accept a longer commute even when I have access to an AV

4. Imagine a future when you **can access an AV** (by owning, leasing, or using automated ridehailing services). How likely would you change in each of the following ways?

	Very unlikely	*Somewhat Unlikely*	*Neutral*	*Somewhat likely*	*Very likely*
Make additional trips that I do not make now	○	○	○	○	○
Travel farther to go shopping or eat out	○	○	○	○	○
Travel farther to go to social/recreational activities	○	○	○	○	○
Travel and do more activities after dark	○	○	○	○	○
Make more long-distance road trips	○	○	○	○	○
Travel more in peak hours (because I can do other activities while traveling in an AV)	○	○	○	○	○
Move to a better location or home	○	○	○	○	○
Change my workplace to a location with better/more jobs	○	○	○	○	○
Tolerate congestion better because I don't have to drive	○	○	○	○	○

5. When do you expect to buy an AV?

○ I will be one of the first people to buy an AV.
○ I will eventually buy an AV, but only after these vehicles are in common use.
○ I will never buy an AV. *Please go to question 7, on this page.*

6. Suppose you were looking to purchase a new vehicle. The regular human-driven model of the vehicle you wish to purchase costs $25,000. How much more would you be willing to pay for a fully autonomous version of the vehicle?

- ○ Up to $1,000 more
- ○ Between $1,000 and $3,000 more
- ○ Between $3,000 and $5,000 more
- ○ Between $5,000 and $8,000 more
- ○ Greater than $8,000 more
- ○ I would NOT be willing to pay any additional amount for the autonomous version of the vehicle

7. Suppose ridehailing companies (*e.g.*, Uber and Lyft) will start using AVs to serve trip requests. Please rate your level of agreement with the following statements.

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*
I will use AV ridehailing services alone or with coworkers, friends, or family.	○	○	○	○	○
I will use AV ridehailing services with other passengers I don't know.	○	○	○	○	○
I would be willing to pay extra for having a backup human driver inside the AV during my ride.	○	○	○	○	○
I would feel comfortable leasing my personal AV to ridehailing companies so that I can earn money when I am not using it.	○	○	○	○	○

8. Considering **the number of cars** your household currently owns, how might that **change when AVs are available for purchase or use as a ridehailing service**?

- ○ Likely own **fewer** cars than today
- ○ Likely own **the same** number of cars as today
- ○ Likely own **more** cars than today

9. Suppose you have regular access to an AV (by owning, leasing, or using automated ridehailing services). How would your use of different modes of transportation change in such a future? *Please choose one answer in each row.*

	Use Less	*Use the Same*	*Use More*
Human-driven personal vehicle	○	○	○
Human-driven ridehailing service	○	○	○
Public transit: bus	○	○	○
Public transit: light rail	○	○	○
Walk	○	○	○
Bicycle or scooter	○	○	○
Airplane	○	○	○

10. To what extent do you agree with the following statements for AVs?

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*
AVs should be allowed on the market only when they prove to be at least as safe as human drivers.	○	○	○	○	○
AVs should prioritize the safety of pedestrians and bicyclists over that of passengers in the vehicle.	○	○	○	○	○
AV owners should be able to program how their AVs prioritize safety of different groups in the event of a crash (*e.g.*, pedestrians, bicyclists, other vehicles, or AV passengers).	○	○	○	○	○
Laws should be passed to require AVs to travel at 25 mph or less on city streets.	○	○	○	○	○
In an AV crash, vehicle manufacturers and their insurance companies should be held responsible (instead of the AV owner, passenger, or operator).	○	○	○	○	○
The government should establish dedicated AV-only lanes/areas.	○	○	○	○	○

11. Suppose AVs are now available for purchase, lease/rent, or to use via automated ridehailing services, and **half of the vehicles on the streets are AVs**. What would you do when **faced with your next car purchase decision** in each of the following scenarios? Please rank the alternatives **based on your preference (1=most preferred; 3=least preferred).** *Please do not give the same rank to multiple alternatives.*

Scenario 1

Options	**Option A:** Buy a regular vehicle	**Option B:** Buy an AV	**Option C:** Don't buy a vehicle and use AV ridehailing/rental services
Costs	$ 500/month + $ 0.75/mile Average wait time: 0 minutes	$ 500/month + $ 0.75/mile Average wait time: 0 minutes	$ 0/month + $ 2.25/mile Average wait time: 6 minutes
Rank	_____	_____	_____

Scenario 2

Options	**Option A:** Buy a regular vehicle	**Option B:** Buy an AV	**Option C:** Don't buy a vehicle and use AV ridehailing/rental services
Costs	$ 500/month + $ 0.25/mile Average wait time: 0 minutes	$ 625/month + $ 0.50/mile Average wait time: 0 minutes	$ 0/month + $ 1.50/mile Average wait time: 6 minutes
Rank	_____	_____	_____

12. Suppose you are traveling with family members to a neighborhood park in an AV. Which of the following would you do in the vehicle during your trip? *Select **up to three** activities.*

☐ Work, or study
☐ Talk on the phone/ send or read text messages/ teleconference
☐ Read
☐ Sleep
☐ Watch movies/ TV/ other entertainment
☐ Play games
☐ Eat and drink
☐ Interact with other passengers
☐ Enjoy the scenery
☐ Watch the road, even though I would not be driving
☐ I would not ride in an AV
☐ Other (please, specify): _____

13. Suppose you are going out to spend some time with your friends (*e.g.*, going to their house or to a bar). You have the following seven options for your transportation. Rank the alternatives listed from most preferred (Rank 1) to least preferred (Rank 7). *Please do not give the same rank to multiple alternatives.*

Rank	***Alternative***	***Wait time***	***In-vehicle travel time***	***Cost for entire trip***
	Private vehicle: Use your own private vehicle (human-driven or AV)	No wait	24 minutes	$1.00
	Bicycle	No wait	48 minutes	$0.00
	Public transit: Use bus or rail	10 minutes	48 minutes	$1.25
	Private ridehailing: Get a ride with a human-driven ridehailing service (*e.g.*, Uber, Lyft)	6 minutes	24 minutes	$30.00
	Shared ridehailing: Get a human-driven ride in a vehicle in which other passengers may be added.	7 minutes	34 minutes	$15.00
	AV private ridehailing: Same as ridehailing, except that the vehicle will be autonomous.	6 minutes	24 minutes	$30.00
	AV shared ridehailing: Same as shared ridehailing, except that the vehicle will be autonomous.	7 minutes	34 minutes	$15.00

Section F: Background Information

We have reached the last section of this survey! To help us generalize the response from this small sample to the population as a whole, we would like to ask you a few background questions. Your privacy is guaranteed.

1. In what year were you born? _____

2. What is your gender?

   ○ Male
   ○ Female
   ○ Other
   ○ Prefer not to answer

3. Where were you born?

   ○ United States or U.S. territory
   ○ Other country
   ○ Prefer not to answer

4. Are you Hispanic or Latino?

   ○ No
   ○ Yes
   ○ Prefer not to answer

5. Which of the following categories do you identify with? Please check **no more than two categories**.

   ☐ White/Caucasian
   ☐ Black/African American
   ☐ Native American
   ☐ Asian or Pacific Islander
   ☐ Other (please specify): _____
   ☐ Prefer not to answer

6. What is your educational background? *Check the highest level of education you have attained.*

   ○ Some grade/high school
   ○ Completed high school or GED
   ○ Some college or technical school
   ○ Bachelor's degree(s) or some graduate school
   ○ Completed graduate degree(s)

7. **Including yourself**, how many people live in your household? _____
   *By "household" we mean "people who live together and share at least some financial resources." Unrelated housemates/roommates are usually **not** considered members of the same household even if they live in the same housing unit.*
   If you live alone, please go to question 9.

8. Please describe the people who live with you.

	Relationship to you	*Age category*	*Gender*	*Occupation*
Person 2	○ My partner/spouse ○ My or my partner's child or grandchild ○ My or my partner's parent or grandparent ○ Other	○ 0 to 4 years old ○ 5 to 12 years old ○ 13 to 17 years old ○ 18 to 24 years old ○ 25 to 44 years old ○ 45 to 64 years old ○ 65 or more years old	○ Male ○ Female	○ Part-time worker ○ Full-time worker ○ Part-time student ○ Full-time student ○ Both student and worker ○ Neither worker nor student
Person 3	○ My partner/spouse ○ My or my partner's child or grandchild ○ My or my partner's parent or grandparent ○ Other	○ 0 to 4 years old ○ 5 to 12 years old ○ 13 to 17 years old ○ 18 to 24 years old ○ 25 to 44 years old ○ 45 to 64 years old ○ 65 or more years old	○ Male ○ Female	○ Part-time worker ○ Full-time worker ○ Part-time student ○ Full-time student ○ Both student and worker ○ Neither worker nor student
Person 4	○ My partner/spouse ○ My or my partner's child or grandchild ○ My or my partner's parent or grandparent ○ Other	○ 0 to 4 years old ○ 5 to 12 years old ○ 13 to 17 years old ○ 18 to 24 years old ○ 25 to 44 years old ○ 45 to 64 years old ○ 65 or more years old	○ Male ○ Female	○ Part-time worker ○ Full-time worker ○ Part-time student ○ Full-time student ○ Both student and worker ○ Neither worker nor student
Person 5	○ My partner/spouse ○ My or my partner's child or grandchild ○ My or my partner's parent or grandparent ○ Other	○ 0 to 4 years old ○ 5 to 12 years old ○ 13 to 17 years old ○ 18 to 24 years old ○ 25 to 44 years old ○ 45 to 64 years old ○ 65 or more years old	○ Male ○ Female	○ Part-time worker ○ Full-time worker ○ Part-time student ○ Full-time student ○ Both student and worker ○ Neither worker nor student
Person 6	○ My partner/spouse ○ My or my partner's child or grandchild ○ My or my partner's parent or grandparent ○ Other	○ 0 to 4 years old ○ 5 to 12 years old ○ 13 to 17 years old ○ 18 to 24 years old ○ 25 to 44 years old ○ 45 to 64 years old ○ 65 or more years old	○ Male ○ Female	○ Part-time worker ○ Full-time worker ○ Part-time student ○ Full-time student ○ Both student and worker ○ Neither worker nor student

9. Knowing more about your **home location** will help us put your travel choices and opinions in context. Please provide your address or, if you prefer, major cross streets near your home.

_____

City: _____ State: _____ Zip code: _____

10. Please check the appropriate category for your annual *household* income before taxes.

- ○ Less than $25,000
- ○ $25,000 to $49,999
- ○ $50,000 to $74,999
- ○ $75,000 to $99,000
- ○ $100,000 to $149,999
- ○ $150,000 to $249,999
- ○ $250,000 or more

If you do not commute to work or school, please skip question 11.

11. Knowing more about your work/school location will help us understand the transportation options available to you. Please give the address or, if you prefer, major cross streets close to your main workplace/school location. *If you travel to more than one location on a regular basis, enter the location to which you travel most often.*

_____

City: _____ State: _____ Zip code: _____

REWARDS! Thank you for completing this survey. If you are interested in being considered for a **$10 Amazon e-gift card**, please provide your email address in the line below. Your email will only be used for the purpose of sending the reward.

_____

If you have any additional comments about your current travel, and the new transportation, you are welcome to share them in the space below.

Thank you for your valuable participation in this study!

All your responses have been successfully recorded.