Stage 3/3 Project Report

Attitudes Towards Emerging Mobility Options and Technologies – Phase 3: Survey Data Compilation, and Analysis

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

By:

Sara Khoeini
Email: sara.khoeini@asu.edu

Ram M. Pendyala
Email: ram.pendyala@asu.edu

Denise Capasso da Silva
Email: denise.silva@asu.edu

Irfan Batur
Email: ibatur@asu.edu

Tassio Magassy
Email: tmagassy@asu.edu

Shivam Sharda
Email: ssharda@asu.edu

School of Sustainable Engineering and the Built Environment
Arizona State University
Tempe, AZ, 85281

February 2020

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. N/A	**2. Government Accession No.** N/A	**3. Recipient's Catalog No.** N/A	
4. Title and Subtitle Attitudes Towards Emerging Mobility Options and Technologies – Phase 3: Survey Data Compilation, and Analysis		**5. Report Date** February 2020 **6. Performing Organization Code** N/A	
7. Author(s) Sara Khoeini, https://orcid.org/0000-0001-5394-6287 Ram M. Pendyala, https://orcid.org/0000-0002-1552-9447 Denise Capasso da Silva, https://orcid.org/0000-0003-1414-8439 Irfan Batur, https://orcid.org/0000-0002-8058-2578 Tassio Magassy, https://orcid.org/0000-0003-1141-4607 Shivam Sharda, https://orcid.org/0000-0001-6531-0593		**8. Performing Organization Report No.** N/A	
9. Performing Organization Name and Address School of Sustainable Engineering and the Built Environment Arizona State University Tempe, AZ, 85281		**10. Work Unit No. (TRAIS)** N/A **11. Contract or Grant No.** 69A3551747116	
12. Sponsoring Agency Name and Address U.S. Department of Transportation, University Transportation Centers Program, 1200 New Jersey Ave, SE, Washington, DC 20590		**13. Type of Report and Period Covered** Research Report (October 2019 – February 2020) **14. Sponsoring Agency Code** USDOT OST-R	
15. Supplementary Notes N/A			
16. Abstract Emerging transportation technologies including electric and autonomous vehicles and emerging mobility services such as ride-hailing and vehicle sharing are bringing about transformative changes in the transportation landscape. With the emergence of new transportation technologies and services, it is critical that transportation forecasting models be enhanced to account for behavioral dynamics that will result from the increasing penetration of disruptive forces in the transportation marketplace. To enhance transportation forecasting models, people's attitudes towards and perceptions of emerging 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. It is envisioned that such models will help decision-makers better plan transportation infrastructure systems and design marketing and policy strategies that maximize the benefits of these disruptive technologies. With this background, the T4 survey (TOMNET Transformative Transportation Technologies Survey) has been designed and deployed in the previous stages of this large-scale survey based research projects. The survey 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. The third phase of this research project focuses on the compilation and analysis of survey data in order to better understand people's preferences and choices for future mobility options and technologies in the Greater Phoenix metropolitan area. A comprehensive description of all the steps taken to full deployment, data cleaning, and weighting is provided, in addition to a descriptive weighted univariate illustration of the findings from the Phoenix survey sample.			
17. Key Words Ridesharing, Ridehailing, Autonomous Vehicles, Driverless Vehicles		**18. Distribution Statement** No restrictions.	
19. Security Classif.(of this report) Unclassified	**20. Security Classif.(of this page)** Unclassified	**21. No. of Pages** 109	**22. Price** N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated in the interest of information exchange. The report is funded, partially or entirely, by a grant from the U.S. Department of Transportation's University Transportation Centers Program. However, the U.S. Government assumes no liability for the contents or use thereof.

ACKNOWLEDGMENTS

This study was funded by a grant from A USDOT Tier 1 University Transportation Center, supported by USDOT through the University Transportation Centers program. The authors would like to thank the TOMNET and USDOT for their support of university-based research in transportation, and especially for the funding provided in support of this project.

TABLE OF CONTENTS

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 preliminary descriptive results 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 Phoenix metropolitan area. 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, University of Washington, and 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. Data collection efforts yielded a respondent sample of 1025 individuals from the Greater Phoenix metropolitan area collected through an online platform. Similar respondent sample sizes are being obtained in the three other metro areas where consortium partners are engaged in data collection.

This report offers a descriptive weighted univariate illustration of the findings from the Greater Phoenix metropolitan area survey sample. 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. By collecting such a rich set of variables, the study offers a robust basis to construct scenarios critical to transportation demand forecasting and long-range planning.

Regarding usage and familiarity with new mobility services, a little over half of the respondents are familiar with the mobility-on-demand services including private and shared ridehailing services, carsharing, and micro-mobility services (bike and e-scooter sharing). However, a small percent of the participants is using these services frequently. The ridehailing users believe that their usage of these services decreased their walk, bike, e-scooter, and transit trips between 8 to 13 percent. Micro-mobility services have been used by one percent of the Phoenix metro area residents weekly with the majority of the trips happening during weekdays and are less than two miles.

With respect to automation technology in transportation, a little over half (54 percent) of the respondents stated to be very or somewhat familiar with AVs. With this high rate of familiarity, 22 percent stated that they will never ride in an AV and 42 percent stated that they are not willing to buy an AV. In general, safety and data security are among the top concerns for respondents rather than a benefit of AVs. In this respect, 79 percent want AVs to be allowed on the market only when they are at least as safe as human drivers. In addition to the stated concerns, close to half of the respondents believe that they can tolerate congestion better in AV and so the majority are willing to commute longer in AV. With respect to sharing perception, more than half of the respondents are uncomfortable sharing their ride with people they do not know and only 28 percent think that lower cost of shared ridehailing services worth the addition of travel time.

Overall it is important to consider that all the convenience and comfort that mobility-on-

demand services and autonomous vehicles provide for the users of transportation systems are in combination with the additional costs they may produce not just out of the users' pocket but from the entire people and the built and natural environment. These new mobility services and technologies could potentially decrease transit and green modes usage, increase the trip frequency and travel distance, change travel schedule and pattern, impact the home, work, and destination choices, exacerbate congestion, and increase energy consumption, emission production and induced demand for travel. Policymaking and planning practices with respect to smart pricing and sharing could maximize the positive impacts and minimize the negative impacts of these new revolutions to guide them wisely in the direction of sustainability, productivity, wellbeing, health, efficiency, accessibility, mobility, and socio-economic growth to serve human beings.

In this report, a comprehensive description of all the steps taken to full deployment, data cleaning, and weighting is explained. Moreover, a complete series of descriptive univariate graphs with explanations, which summarize the survey results, is presented in weighted mode. 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 design of a survey, two phases of respondents' recruitment, and data analysis for a sample of more than one thousand individuals across the Phoenix metro area.

Autonomous vehicles (AV) (also referred to as driverless cars or self-driving cars) are capable of navigating without human input using an array of technologies such as radar, LIDAR, GPS, odometry, and computer vision. Most industry experts suggest that autonomous vehicles will be on the road within a few years (www.driverless-future.com). The Secretary of Transportation in the US stated at the 2015 Frankfurt Auto show that he expects driverless cars to be in use all over the world by 2025 (Frankfurter Allgemeine Zeitung). The Institute of Electrical and Electronics Engineers (IEEE) predicts that up to 75 percent of all vehicles will be autonomous by 2040. Virtual ridehailing companies such as Uber and Lyft are beginning to change the transportation landscape in significant ways as they provide door-to-door mobility-on-demand with the use of mobile apps. In general, information technology is making rideshare and transit travel options more convenient using location-aware services and real-time data analytics.

Ridehailing services including cars (such as Uber, Lyft, Didi,…) and micro-mobility services (bike and e-scooter renting services such as Lime, Bird, and others) are becoming the new mode of transport in recent years. People use their cell-phone app to request a car ride which can be private or shared with other passengers matched by the companies. It is envisioned that ridehailing services will operate in AV mode in the future {REF}. Thus, the two renovations of the

transportation sector, automation and shared mobility, cannot be effectively evaluated separately.

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, 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 to inform the development of robust behavioral models of technology adoption capable of reflecting impacts of these disruptive forces on traveler behavior and values. It is envisioned that the findings of this project can help in shaping future policies and business models around new transportation technologies trying to prevent potential problems and promote the benefits that these new technologies are bringing.

The objectives of this project include the development of a harmonized survey instrument, survey administration protocol, and sampling plan that other jurisdictions can adopt to conduct similar studies 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 (TOMNET D-stop Transformative Technologies in Transportation) Survey to provide 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 conducting a literature review, development of survey goals, objectives, detailed research questions, and survey questionnaire design. During the second phase of the project, data collection happened in two phases: pilot and full deployment. The pilot phase of data collection was conducted during fall 2018 and the full deployment conducted during summer and fall 2019.

The goals of the pilot T4 survey were 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 from both paper and online instruments, the full deployment was conducted in the Phoenix (AZ) metro area with a sample size of 1,071 using a fully only online format. A separate report details the data collection and results obtained from the 262 complete responses received on the pilot phase of the study. The survey questionnaire for the full deployment has been revised from the pilot. 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. During phase 2, the research team compiled and cleaned the data, and will deeply analyze it using advanced statistical methods, estimate econometric models, as well as produce the required reports and documentation. The complete survey questionnaire is attached to this report as Appendix for further exploration. The pilot survey questionnaire was also available as the attached Appendix to the previous report of this project for the pilot phase.

The same data collection effort with the same questionnaire has been conducted across

multiple jurisdictions. As part of a coordinated effort among TOMNET partners, Georgia Tech will collect the data for a similar sample size from Atlanta metro area, Georgia; and the University of South Florida will apply the survey in the Tampa metro area, Florida. Moreover, the University of Texas at Austin, who has been our close collaborator for many years, will also deploy the same data collection which is supported by the D-STOP University Transportation Center at the University of Texas at Austin. The data collected across multiple jurisdictions will soon be aggregated to produce a single dataset with a sample size of more than four thousand responses. This dataset will be unique in terms of sample size, contents, and spatial expansion across multiple southern metro areas.

The remaining of this section will present a comprehensive description of all the steps taken to design and deploy the full survey during Summer 2019.

Study Design

A comprehensive literature review concerning survey design and methodology was performed during phase 1 of this project. A comprehensive review of previous studies helped identify data needs and behavioral dimensions of interest to focus on this study. Previous studies showed that willingness to adopt autonomous vehicles (AVs) is higher among young men, living in dense urban areas (Becker and Axhausen, 2017). In terms of AV perceived benefits and concerns, safety was listed both as a concern and as a benefit of the AV technology (Becker and Axhausen, 2017). Providing mobility for those who can't drive was the most common benefit; while most common concerns were data security, privacy, reliability, and liability. Previous studies have shown that passion for driving and traffic conditions can influence the decision to adopt AVs (Schoettle and Sivak, 2014; Gurumurthy et al., 2018; Abraham et al., 2017; and Kyriakidis et al., 2015). Moreover, increased comfort and the opportunity to multitask could have substantial impacts on AV adaptation patterns (Becker and Axhausen, 2017).

Table 1 Comparison of similar surveys presented at the 97th Annual Meeting of TRB

Reference	Autonomous vehicle	AV perception	AV adoption	AV willingness to pay	AV Residential location	AV ridesharing	AV+Ride hailing services	Ridehailing	RH perception	RH shared rides	Attitudes/ Lifestyle	Stated preference	Changes in travel behavior	Car ownership	Value of time/ time use	Multi-tasking
Proposed Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Asgari et al., 2018	✓	✓	⚠	✓	✗	✓	✓	✓	⚠	✓	✓	✓	✓	✗	✗	✓
Alemi et al., 2018	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	⚠	✓	✗
Shabanpour et al., 2018	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	⚠	✗	✗	✗
Petrik et al., 2018	✗	✗	✗	✗	✗	✗	✗	⚠	⚠	✓	✓	✓	✗	✓	✓	✗
Hao et al., 2018	✓	✓	✗	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗
Bailey et al., 2018	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✓	✗	✗	✗	✓	✓
Lahkar et al., 2018	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	⚠	✗	⚠	✗	✗	✗

Wang et al., 2018	✓	⚠	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	⚠	✗	✗
Sener et al., 2018	✓	✓	✓	✗	✗	✗	⚠	✗	✗	✗	✓	✗	✓	✓	✗	✗
Nazari et al., 2018	✓	✓	✓	✗	⚠	✓	✓	✓	✗	✗	✓	✗	⚠	✓	✗	✗
Wadud et al., 2018	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
Noblet et al., 2018	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	⚠	✗	✗	✗
Harb et al., 2018	✓	✗	✗	✗	✗	⚠	✗	✗	✗	✗	✓	✗	✓	✗	✗	✗
NASEM, 2018	✗	✗	✗	✗	✗	✗	✗	✓	⚠	⚠	⚠	✗	✓	✗	✗	✗
Circella et al., 2018	✗	✗	✗	✗	✗	✗	✗	✓	✓	⚠	✓	✗	✓	⚠	✓	✓

Table 1 shows most of the recent survey-based studies related to AVs and ridehailing services that were presented in TRB 2018 (this portion of the study was conducted before the TRB 2019 and 2020), with the addition of other relevant publications. The complete list of references used in Table 1 is presented at the end of this report. The table columns are survey data elements that have been covered in each one of the reviewed studies, while each row represents one study. This review helped us identify data gaps that needed to be addressed. Our designed and ready to implement T4 survey includes all the stated data elements. Many of the previous surveys were missing data elements such as AV willingness to pay, AV residential location choice, AV ridehailing services, and inclusion of AV and ridehailing services. Moreover, the sample size of the proposed study will be significantly larger than previous studies, and this study will cover multiple metro areas across the United States.

A complete list of survey goals, objectives and detailed research questions was compiled. The goal of the T4 survey is to understand people's perceptions towards new transportation technologies, as well as to measure how general attitudes (e.g., technology savviness, environment friendliness, etc.) influence attitudes towards new transportation technologies. Furthermore, the study aims at understanding the role of current travel behavior and current use of mobility-on-demand services on perceptions of automated mobility, and willingness to adopt autonomous vehicles. The questionnaire was designed to identify how people's travel patterns, residential choices, vehicle ownership, and mode choice decisions will change in response to transformative changes in transportation. The goal is to obtain a database able to enlighten the study of long-term impacts on people's lifestyle and well-being, as well as the general impacts on energy consumption, emissions, congestion, and urban planning, and thus revise future demand models and activities forecasting models accounting for adaptation of these new transportation technologies.

The questionnaire and wording of the questions were carefully designed by a team with members from all four institutes where the T4 survey is deployed: Arizona State University, University of South Florida, the University of Texas at Austin, and Georgia Tech. With the collaboration of all, the survey was developed in five sections:

- *Section A – Attitudes and Preferences*: a set of attitudinal statements regarding privacy and willingness to share; environment-friendly lifestyle; technology-savviness; personal time use; general transportation perceptions; and residential location preferences. The goal of this section is to understand respondents' general attitudes to control for its effects on the analysis of travel behavior and the expected use of autonomous vehicles.
- *Section B – Household Vehicles and Residential Preferences*: description of vehicles available to the household, licensure status, tenure status, housing unit type, and detailed residential location preferences.
- Section C – Current Travel Patterns: details about commute trips, mode frequency for

commute and non-mandatory trips, average driven miles, and details about long-distance trips, as well as the frequency of online shopping and items delivered to the home.

- *Section D – Mobility-on-demand*: frequency and familiarity with mobility-on-demand services, detailed information on the last trip using bike-sharing or e-scooter sharing, as well as detailed information on the last trip using ridehailing services. This section includes a stated preference question where respondents were asked to choose between private a ridehailing trip or a shared ridehailing trip, given a specific (random) scenario.
- *Section E – Autonomous Vehicles*: familiarity with AVs, willingness to adopt, attitudinal statements, expected changes in travel behavior and vehicle ownership, as well as stated preference question regarding which form of adoption would be more desirable to the respondent. A stated preference ranking question was designed to understand respondents' mode choice in a scenario where autonomous vehicles are available through ridehailing services.
- *Section F – Background Information*: additional sociodemographic information, such as age, gender, race, place of birth, education attained, household location, size, and income. The goal of this survey section was to assess respondents' socioeconomic profile to better understand their travel-related decisions

Data Collection

Sampling Plan, Deployment, and Rewards Strategy

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.

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.

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 1. 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.

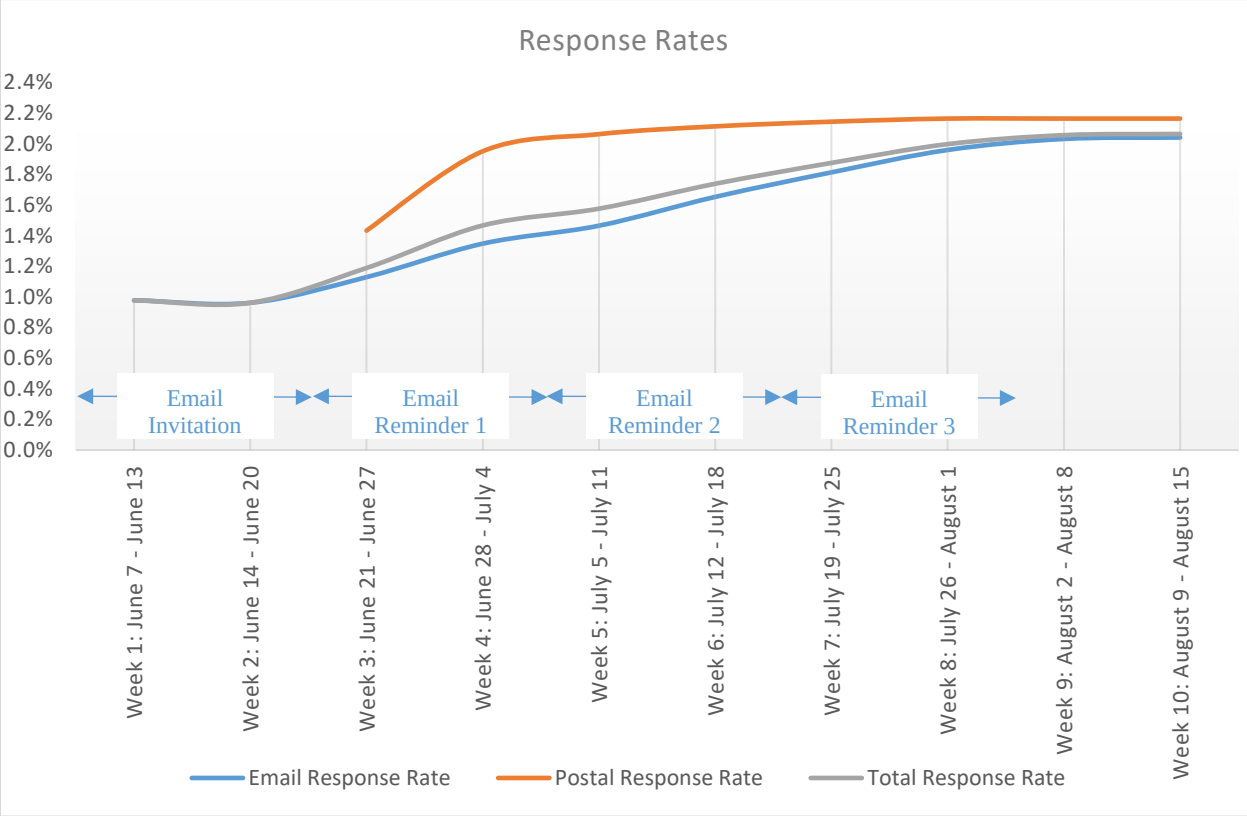


Figure 1 Evolution of Response Rates, by Recruitment Method

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 2 details the response rates for each invitation method, based on the final data set. The number of addresses invited was explained in the previous section. 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. The characteristics of the survey sample and their weighted responses to different survey questions will be explained in detail in the forthcoming sections of this report.

Table 2 Sample Size and Response Rates

	Addresses Invited	Not Valid/ Bounced	Invitations Sent	Recorded Valid Responses	Response Rate
Total Online	53,305	10,250 (19.2%)	43,055	861	2.00%
Postal invitation	10,000	163 (1.6%)	9,837	**210**	2.13%
Total	63,304	10,413 (16.4%)	52,891	1,071	2.02%

Report Format

The remainder of this report will show distributions of the data collected on all questions of the survey. Section 0.1 describes the unweighted socioeconomic profile of respondents. Section 2.2 describes how the data were weighted, and the resulting weighted distributions for socioeconomic characteristics. Similarly, to other surveys, the socioeconomic characteristic distributions of the respondents are not exactly equal to the population. Weighting techniques have been applied to adjust the results to be more representative of the entire population; therefore, this report is presenting the weighted results in addition to explaining the applied weighting methodology. Thus, the results presented in all the following sections are weighted to better represent the population of Maricopa County, Arizona. Section 3 presents the weighted data collected on the attitudes and preferences section of the survey. Section 4 of the report details vehicles owned by the household, and respondents' residential preferences (weighted). Section 5 details respondents weighted current travel patterns, including commuting characteristics, long-distance travel behavior, and online shopping usage. Section 6 of the report shows the weighted results obtained on the mobility-on-demand section of the survey. Section 7 of the report details the weighted results regarding perceptions and expected use of autonomous vehicles. Lastly, section 8**Error! Reference source not found.** provides the final considerations of the results presented in the report. Appendix I shows the survey instrument with details about the survey logic implemented.

DATA

Unweighted Socioeconomic Profile

The respondents' basic socioeconomic attributes have been collected 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.

When analyzing respondents' age and gender, 49 percent of the sample is female, 49 percent is male, 2 percent preferred not to answer the gender question. Figure 2 shows that the survey has covered a significant portion of people above 50 years old, resulting in an underrepresentation of younger individuals when compared to the age distribution of ACS (American Community Survey) data for Maricopa County. Although we obtained the same proportion of males and females, males were more representative in the age categories over 60 years old, and women more representative in the younger age categories.

Regarding nationality and Hispanic/Latin origin, Figure 3shows that 91 percent of respondents were born in the U.S., which is proportionally higher than the county's population born in the US (85 percent). As expected, the percentage of Hispanic/Latinos was also observed to

be lower in our survey than in Maricopa County. In Figure 4the race distribution of participants in the survey is illustrated; 81 percent of respondents identified themselves as white, only 2 percent as black, and 8 percent preferred not to answer the question.

Figure 5 explores the educational background of the survey participants. With significantly higher proportions of highly educated people when compared to the population in Maricopa County, most of the respondents (37 percent) hold a bachelor's degree or some graduate school. As the proportion of respondents with a higher level of education are greater than the ones observed in the county, the sample appears to be over-representative of the individuals with higher education. One possible explanation could be the internet accessibility requirement to fill the survey, as people with lower educational backgrounds tend to have lower income and less internet usage.

To capture more details about respondents' activity patterns, they were asked about their employment status. Figure 6 shows that most of them (52 percent) are part-time or full-time workers, 4 percent are both worker and student, 2 percent part-time or full-time students, and 42 percent are neither a worker nor a student. In Maricopa County, 60 percent of the population 18 years and above is employed.

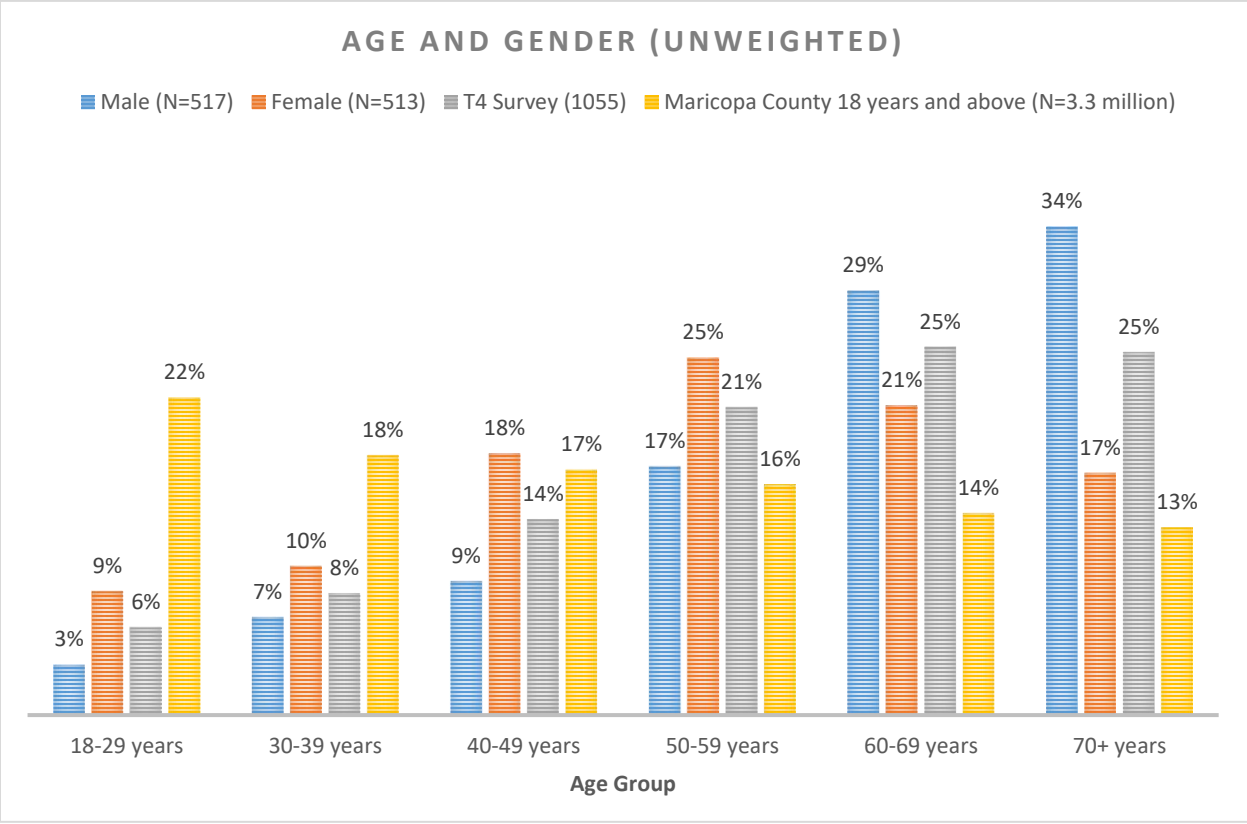


Figure 2 Age and Gender Distributions (Unweighted)

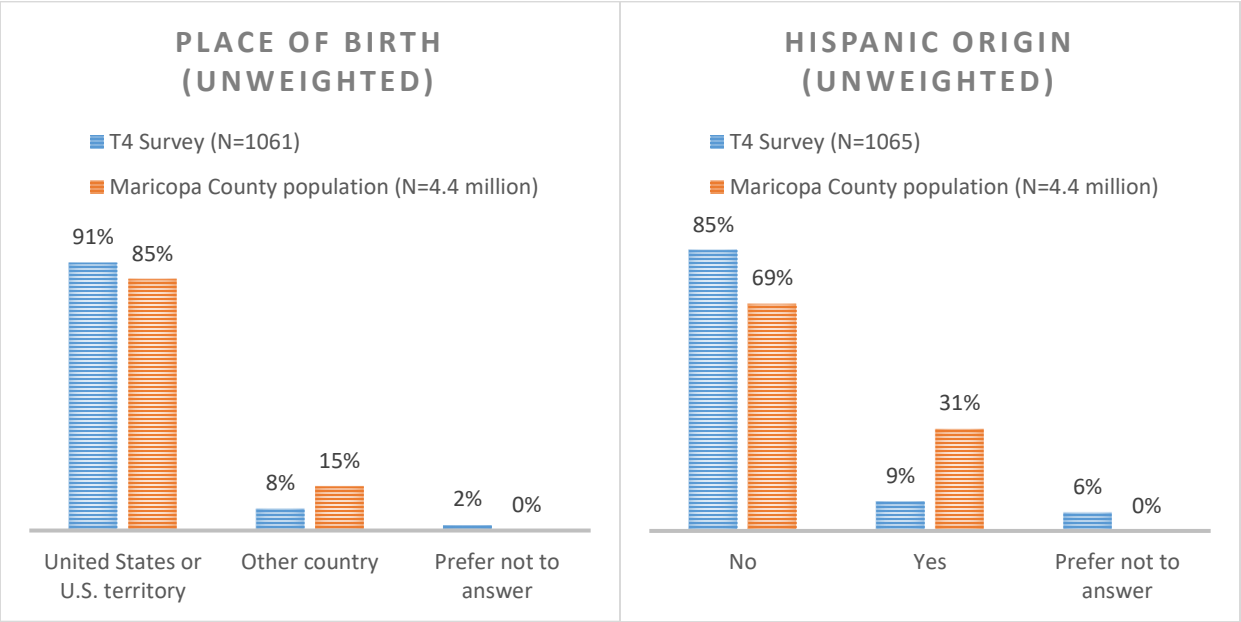


Figure 3 Place of Birth and Hispanic/Latin Origin Distributions, Unweighted

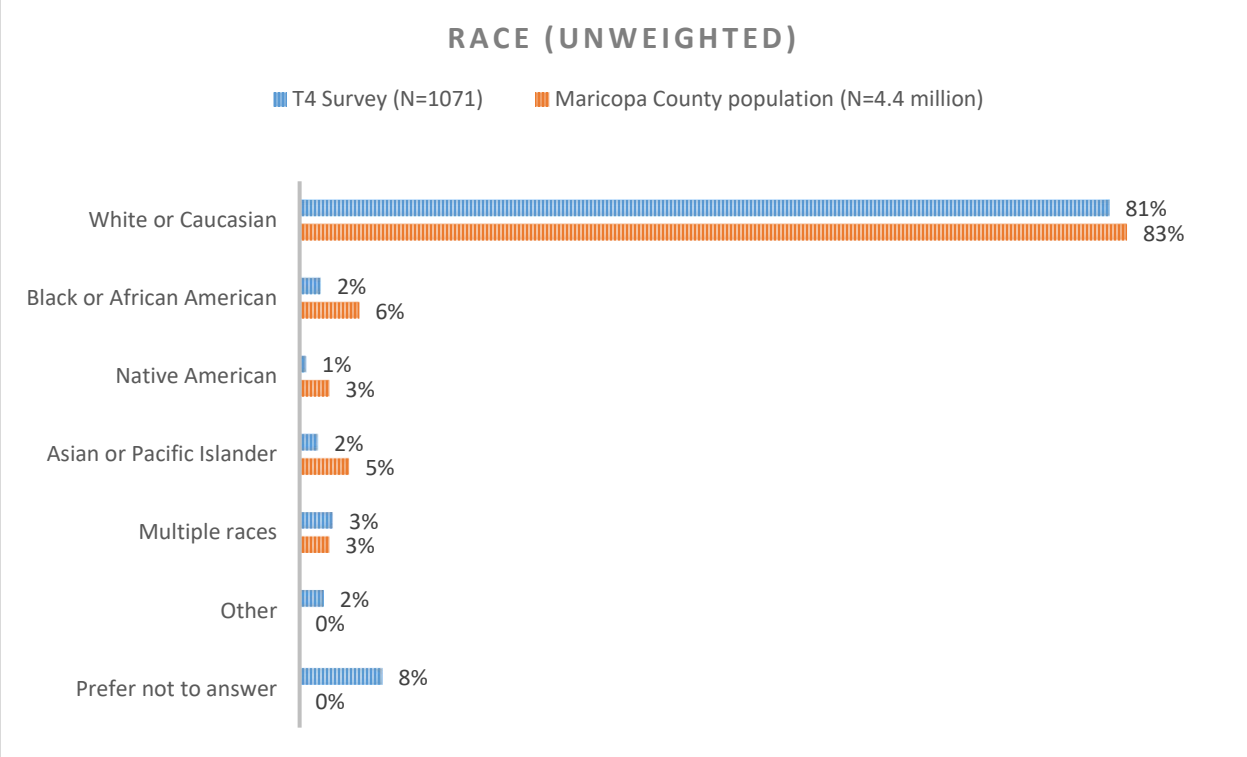


Figure 4 Race Distribution, Unweighted

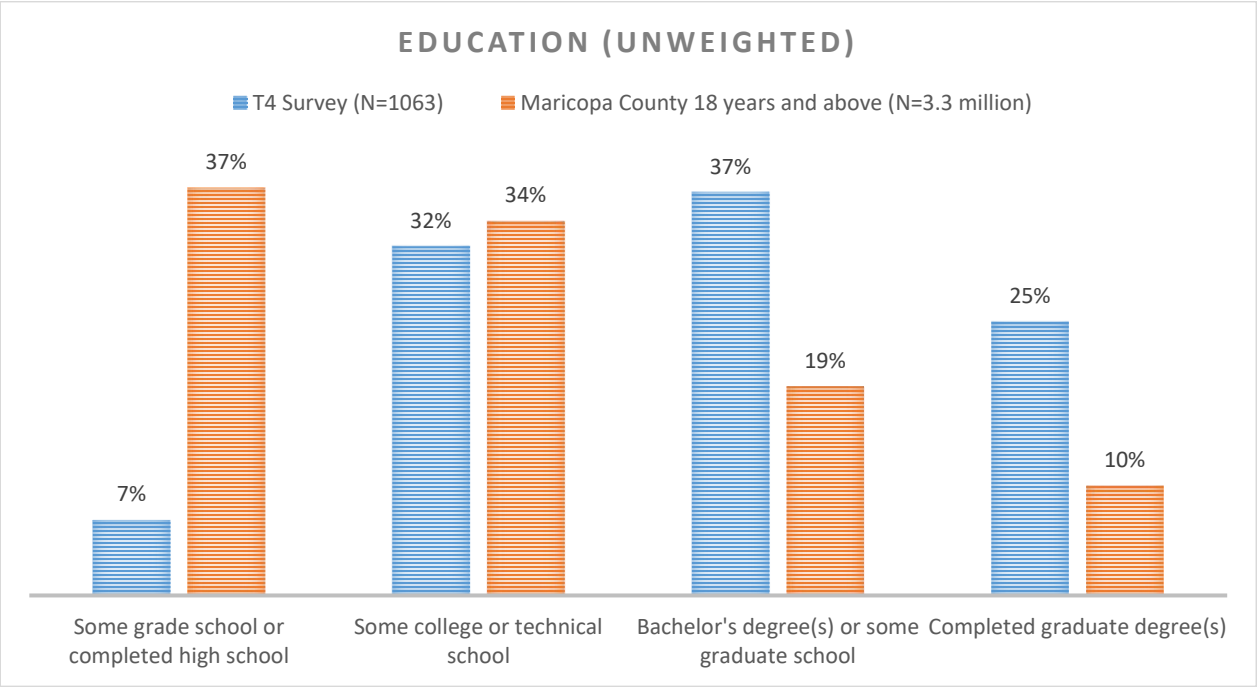


Figure 5 Distribution of Highest Level of Education Attained, Unweighted

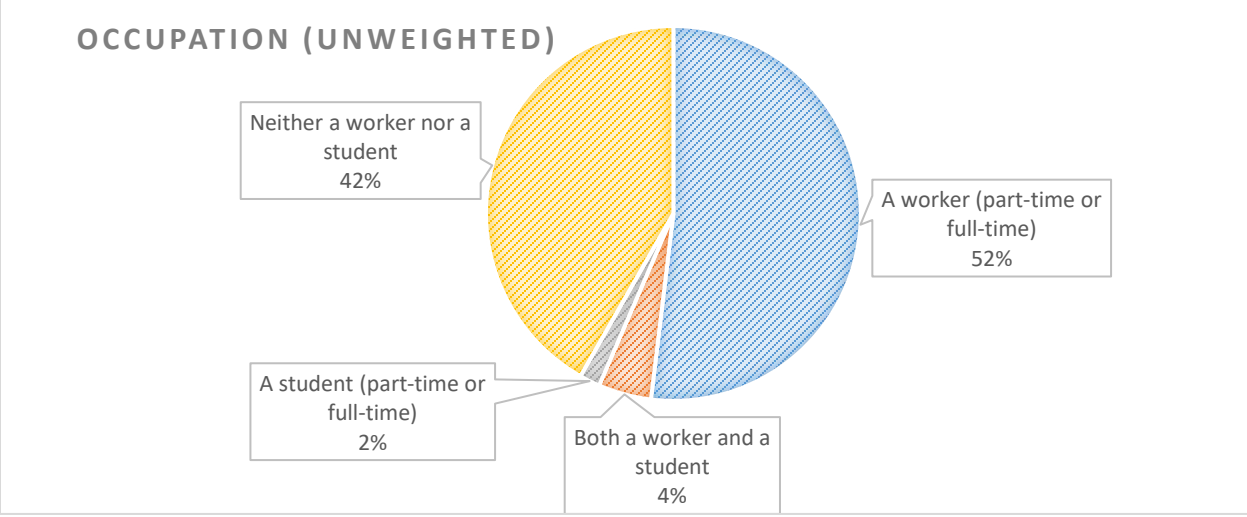


Figure 6 Occupation Distribution, Unweighted

Figure 7 shows the home location cities for nine main cities in Maricopa County. As expected, the city with most respondents is Phoenix (24 percent), followed by Mesa (14 percent) and Scottsdale (10 percent). Although there are differences between the percentage of respondents in our survey and Maricopa County in Phoenix and 'Other' cities, the other eight cities seem to have similar proportions to the county households. Similarly, the work location was asked in the survey. Despite comparisons to Maricopa County not being possible due to lack of such information, it is seen in Figure 8 that Phoenix concentrate the largest group of work location (39 percent). The distribution for other cities looks to follow the same pattern seen in Figure 7 for home location, except for Tempe. Although only 6 percent of respondents live in Tempe, 13 percent

of them work there.

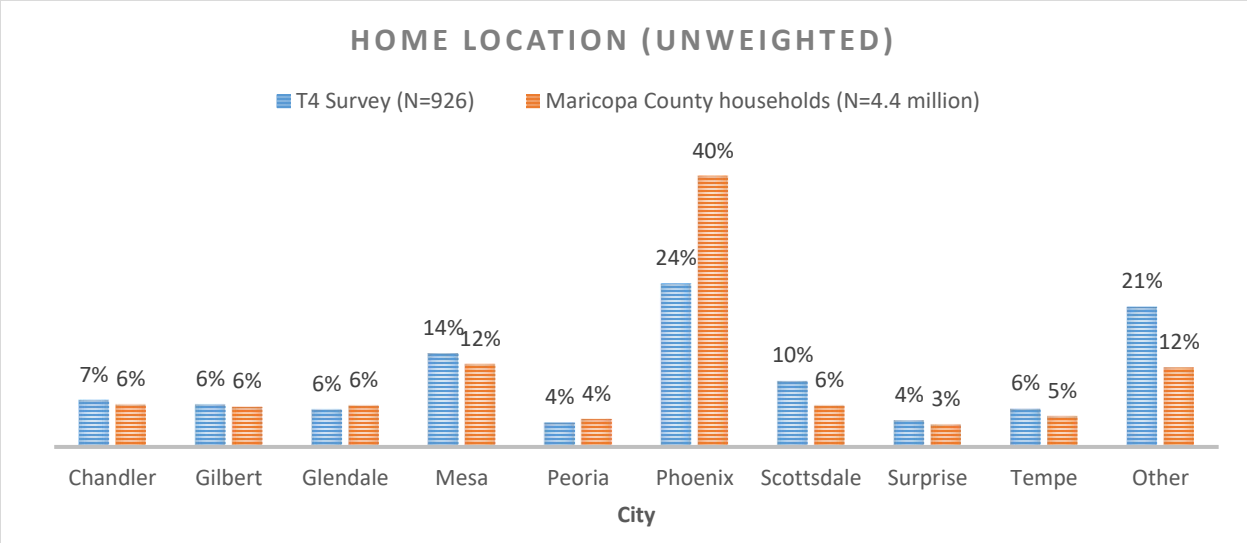


Figure 7 Home Location Distribution, Unweighted

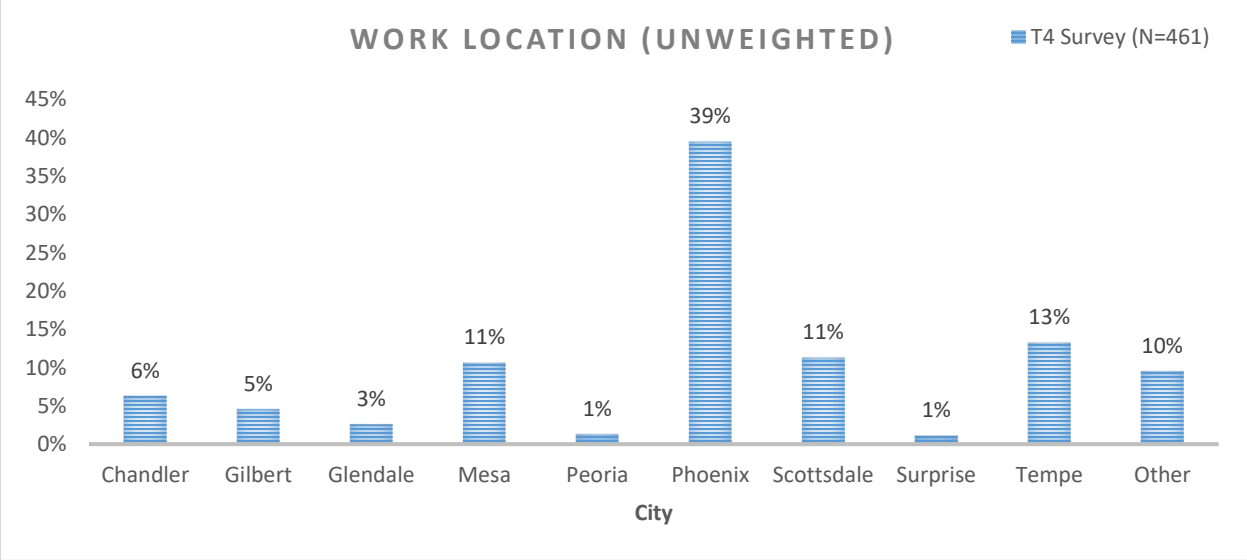


Figure 8 Work Location Distribution, Unweighted

Figure 9 shows the presence of limiting abilities to perform different types of traveling activities among the survey respondents. 27 percent and 22 percent of participants said they have conditions that prevent them, at least to some extent, from Bicycling and Walking, respectively. When asked about other adult household members (other than self), 11 percent of respondents reported living with individuals (18 years old or older) with conditions that either partially or fully limit their ability to drive.

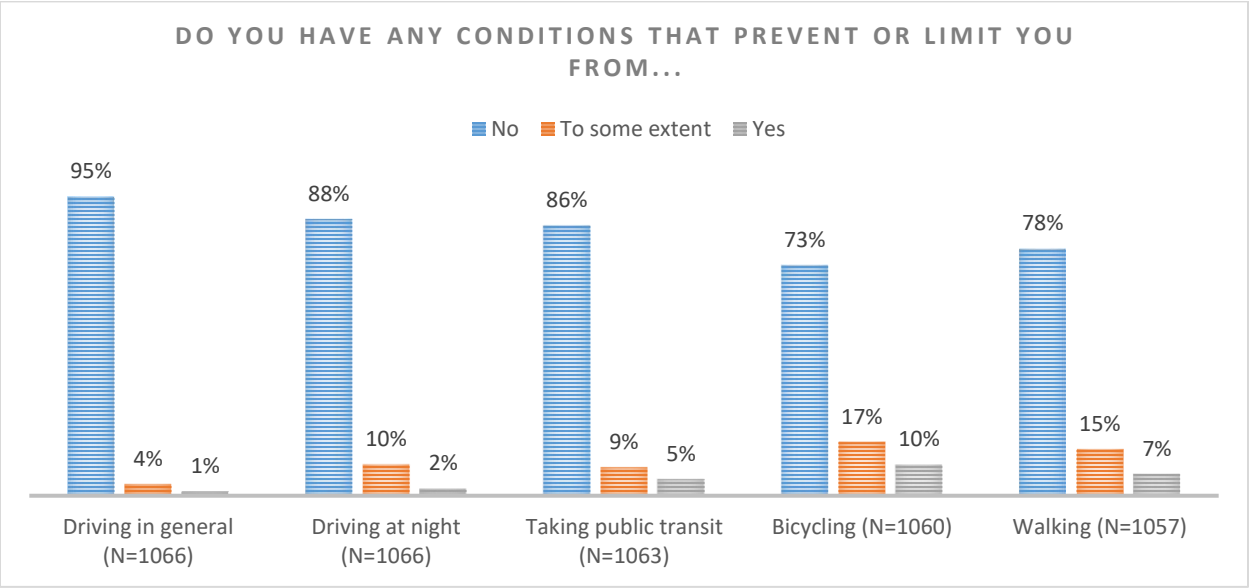


Figure 9 Conditions Limiting Respondents' Mobility, Unweighted

When asked about household size, it is seen in Figure 10 that almost half (47 percent) of participants stated that they belong to two-person households which is more than the county's similar proportion (34 percent). On the other hand, an underrepresentation is seen for single households among survey respondents. While the county has around 27 percent of single households, only 17 percent of respondents said they live alone. Regarding household composition, 13.7 percent of respondents indicated they live with one or more children 17 years or below. Considering the relationship with the respondent (meaning that someone's child might be older than 18 years old), 22 percent of respondents live in nuclear family households, 6 percent live in single-parent households, 41 percent live in households of married couples with no children, 17 percent live alone, and 14 percent live in other types of households.

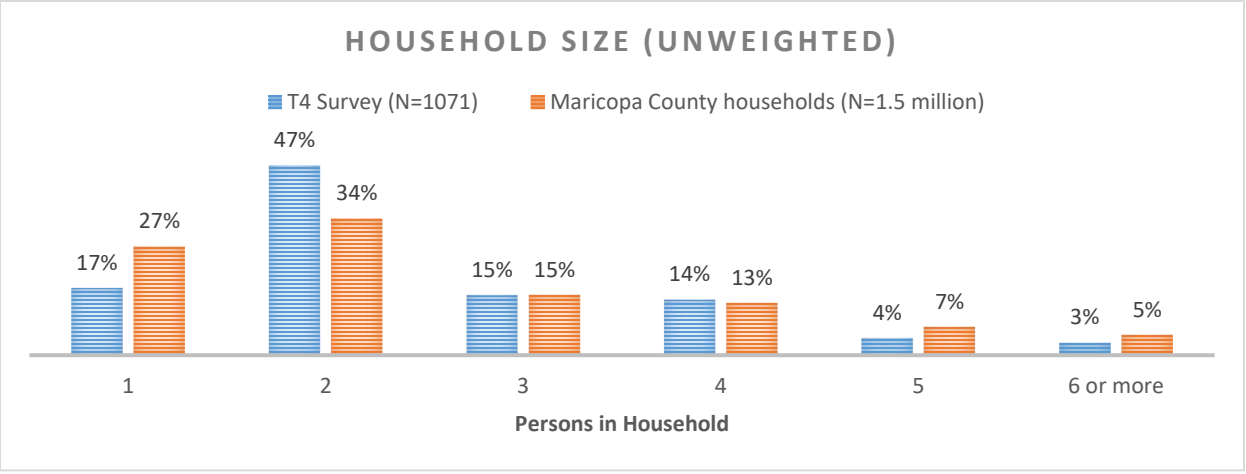


Figure 10 Household Size Distribution, Unweighted

Respondents' driver status was also included in the survey questionnaire. 97 percent of the respondents (18 years or older) have a driver's license. Regarding drivers in the household, Figure 11 shows that, for 58 percent of respondents, two household members have a driver's license. Based on our survey sample, almost all households have at least one member holding a driver's license (only one respondent reported to live in a household with zero drivers). In Figure 11, the number of motorized vehicles available in the household is also illustrated. The largest group belongs to households with two vehicles (43 percent); and, 21 percent of respondents stated there is only one vehicle in their households, while around the same proportion (20 percent) said there are three vehicles available in their households. Interestingly, only 2 percent of respondents reported having no vehicles available in their households.

According to the ACS, in Maricopa County 6 percent of households have no vehicles available, 37 percent have one vehicle, 39 percent have 2 vehicles, and 18 percent of the households have 3 vehicles or more available. Thus, the collected sample overrepresents households with a larger number of vehicles available and underrepresents households with one or no vehicles. Considering that a vehicle sufficient household has at least the same number of vehicles as the licensed drivers, 86.6 percent of the sample reported living in households that are vehicle sufficient. The remaining 13.4 percent of respondents live in vehicle deficient households.

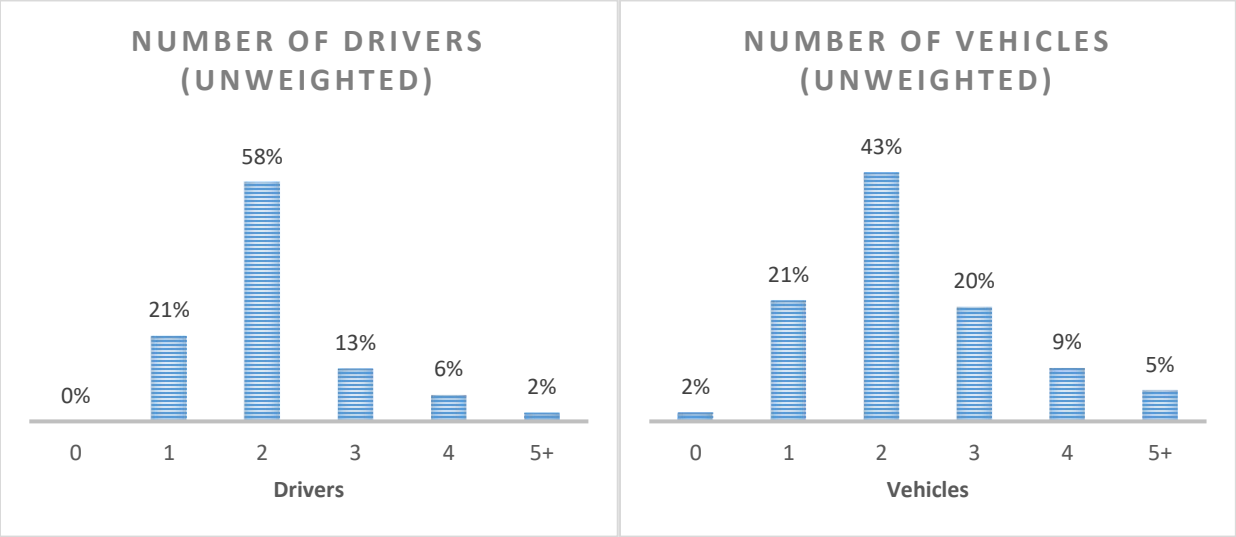


Figure 11 Number of Motorized Vehicles and Drivers in the Household, Unweighted (N=1071)

In Figure 12, it is illustrated that 81 percent of respondents own the place they live, while 15 percent rent their homes. In Maricopa County, 61 percent of households are owner-occupied, and 39 percent are renter-occupied, thus the sample overrepresents homeowners. The majority of the reported homes are Stand-alone homes (82 percent), followed by Condo/apartment (10 percent) and Attached home/townhome (5 percent).

Concerning the household income distribution (Figure 13), the survey results show an underrepresentation of low-income categories (below $50,000), and overrepresentation of high-income households (above $75,000), when compared to the county ACS data. In our survey, only 6 percent of respondents said their annual income is lower than $25,000, compared to 20 percent of the households in the county in this low-income group. One possible explanation could be limited to internet access to low-income households.

In general, the survey shows a good representation of the population gender distribution, but the sample age distribution is skewed towards older groups. The sample provides a somewhat good representation of the county race distribution, however, it overrepresents the U.S. born residents, and

underrepresents the Latino/Hispanic population. The data overrepresents high income, high vehicle ownership, and high education groups. Lastly, the collected sample has fewer single households and more two-person households compared to the survey population. To make the survey results be more representative of the population characteristics of the study, weighting schemes are adopted to compensate for the observed skews in the study sample. The next section explains the applied weighting procedure and the forthcoming sections represent the results for the weighted sample.

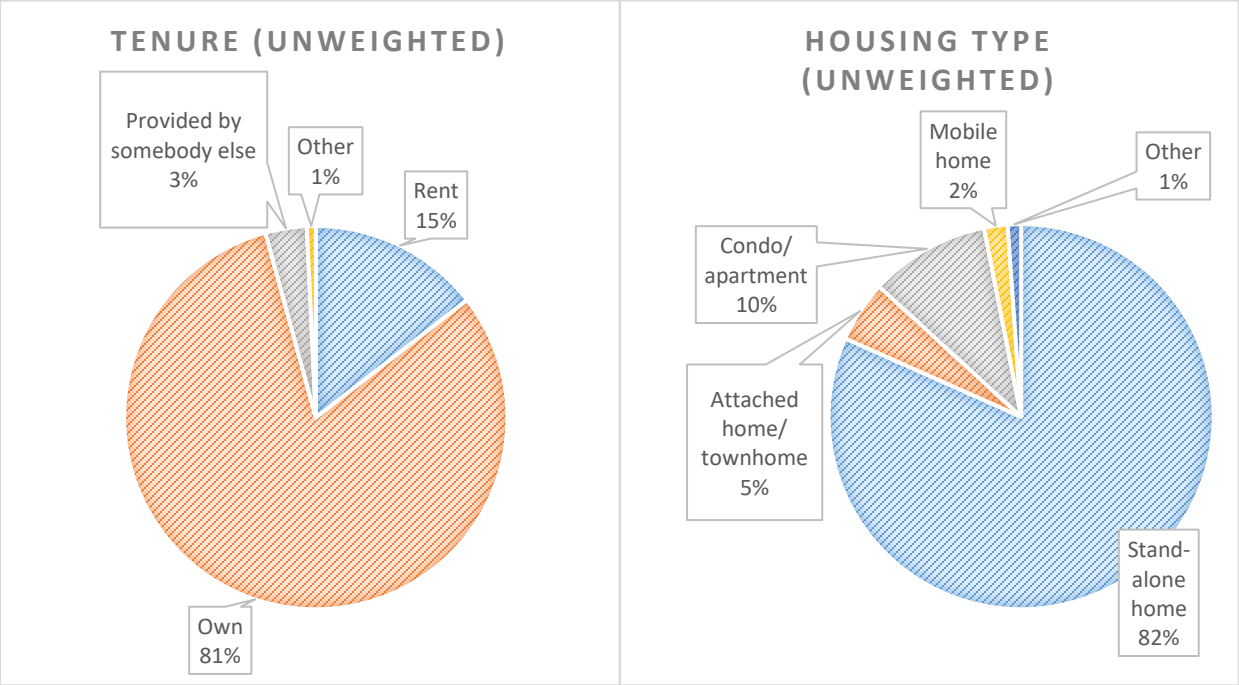


Figure 12 Tenure Status and Housing Unit Type, Unweighted

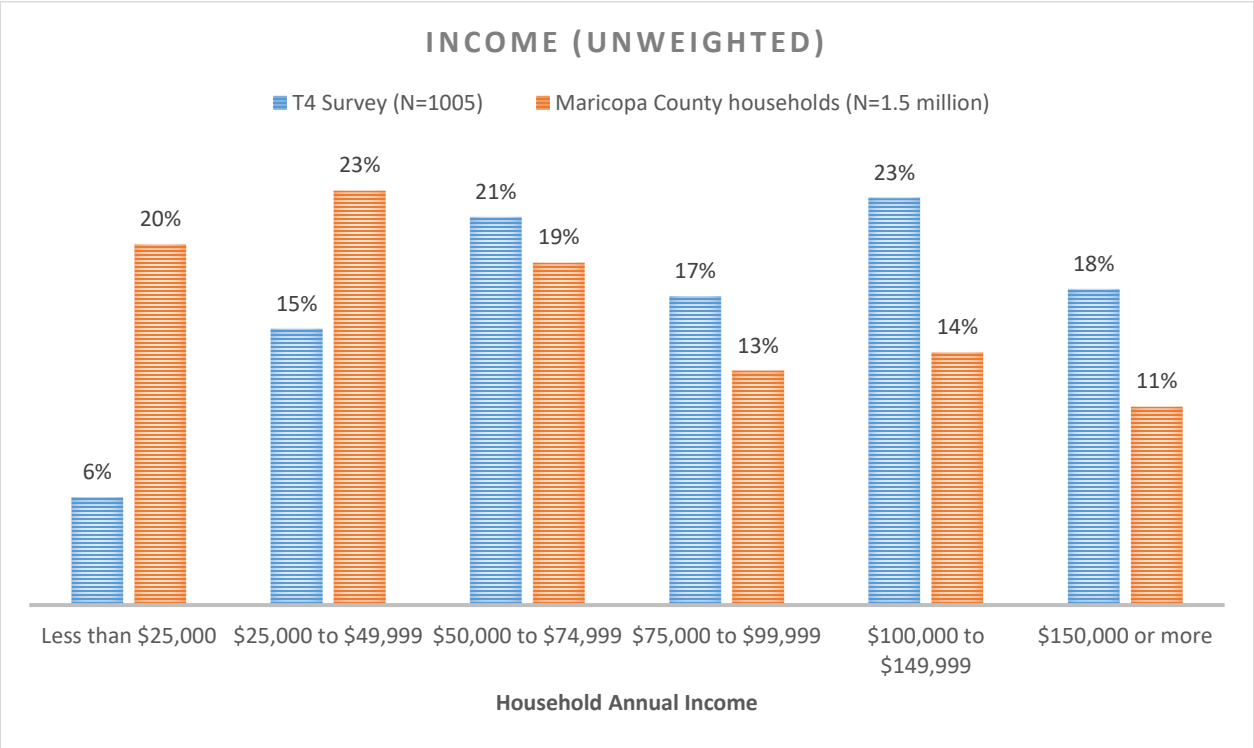


Figure 13 Household Income Distribution, Unweighted

Data Weighting

Due to the discrepancy between the sample socioeconomic characteristics and the population, the survey results should be weighted to more accurately represent the public attitudes and perceptions toward new transportation technologies. This chapter explains the procedure to estimate the data weights for the full deployment survey data. The remainder of this chapter is organized as follows: section 2.2.1, illustrates the household income imputation using the Ordered Probit model and the Monte Carlo simulation to impute income for the records with missing data; section 2.2.2explains the weighted variables adopted with brief description of the sample weighting algorithm (iterative proportional fitting - IPF - algorithm embedded in PopGen2.0 software); Lastly, section 2.2.3 presents the distribution of the weighted data compared to the marginal distribution obtained by the 2017 American Community Survey (ACS) 5-year estimates 2013-2017.

Income Imputation

In most surveys, the household income variable often shows substantially more missing data than other variables. However, since household income plays an important role in the sample weighing process, replacing missing data with substituted values (i.e., imputed values) is necessary. The Ordered Probit model was utilized to impute household income. The observed number of individuals that responded to the survey questions with sufficient information to have income imputed is 1,052. Out of these respondents, 47 individuals did not report income. Therefore, the Ordered Probit model was estimated using 1,005 responses to impute the 47 missing income values.

The first step is to use the declared income levels of individuals (i.e., dependent variables) and the explanatory variables selected through a stepwise regression to calibrate the Ordered Probit model. Second, based on the estimated parameters, the replication is implemented. Third, a Monte Carlo simulation is used to validate the replicated results and imputing household income for the records with missing income. More detailed descriptions of the estimated results are addressed below.

The income is considered for the Ordered Probit model dependent variable in the following 6 categories: less than $25,000, $25,000 - $49,999, $50,000 - $99,999, $100,000 - $149,999, $150,000 - $249,999; and $250,000 or more. Table 3 illustrates the socioeconomic distributions of the unweighted sample per each income group. The first income category (i.e., less than $25,000) is selected as the baseline for the model estimation.

Table 4 presents the Ordered Probit model estimation results for income imputation, predicting income for the households with missing income values. The estimated model used almost all the possible variables collected in the survey in addition to socioeconomic attributes. The estimating coefficients' signs and magnitude seem intuitive. Households with a higher number of members aged between 45-64, workers, and vehicles are more likely to fall into higher income groups. On the other hand, if the number of children in the household increases, those groups are less likely to fall into higher income groups. The likelihood of falling into higher income levels may be highly associated with the number of people available for work and the number of available vehicles in the household. Besides, households defined as nuclear families and married couples with no children are more likely to belong to higher income groups, while households with multiple adults are less likely to fall into those groups. *A*s expected, those who are employed reported higher levels of household income. Also, highly educated respondents are likely to fall into higher income levels.

Moreover, people who preferred to live in a spacious home, even if the public transit

accessibility is low and those who preferred to live near good public schools show a higher likelihood of falling into higher income categories. Usage of ride-hailing services on weeknights, weekend nights, and weekend days are positively correlated with higher income groups, compared to those who were not ridehailing users. Concerning AVs, individuals who stated, “early AV adopter” and “not AV adopter” are likely to fall into higher income categories. Interestingly, respondents with low sensitivity or concern about the safety of autonomous vehicles are associated with higher income levels. In Table 5, the goodness of fit is examined by log-likelihood values and the null model, which is only developed by constant values.

To validate the estimation results given by the Ordered Probit model, the replication and the observed responses are compared (Figure 14). The replication is conducted in two steps: first, the proposed model calculates the probability that individuals belong to 6 different income categories. Second, based on the probabilities, the Monte Carlo simulation is utilized to replicate and predict the income categories at the individual level. According to Figure 14, the replicated distribution follows the observed pattern well except for the two income classes: less than $25,000 and $250,000 or more. A low frequency of those income groups may account for poor performance. Despite the small discrepancy for the lowest and the highest income levels, the calibrated model is considered appropriate to predict the 47 missing values by assuming that the unreported values are likely to be distributed similarly to the rest of the sample.

Table 3 Income Imputation Model Estimation Data Characteristics

Gender	**Less than $25,000 (N=60)**	**$25,000 to $49,999 (N=154)**	**$50,000 to $99,999 (N=388)**	**$100,000 to $149,999 (N=227)**	**$150,000 to $249,999 (N=123)**	**$250,000 or more (N=53)**	**All (N=1,005)**
Male	38.3%	45.5%	45.9%	57.5%	48.8%	69.8%	49.6%
Female/other	61.7%	54.5%	54.1%	42.5%	51.2%	30.2%	50.4%
Employment Status	**Less than $25,000 (N=60)**	**$25,000 to $49,999 (N=154)**	**$50,000 to $99,999 (N=388)**	**$100,000 to $149,999 (N=227)**	**$150,000 to $249,999 (N=123)**	**$250,000 or more (N=53)**	**All (N=1,005)**
Employed	40.0%	50.6%	52.1%	62.6%	69.9%	75.5%	56.9%
Not employed	60.0%	49.4%	47.9%	37.4%	30.1%	24.5%	43.1%
Education	**Less than $25,000 (N=60)**	**$25,000 to $49,999 (N=154)**	**$50,000 to $99,999 (N=388)**	**$100,000 to $149,999 (N=227)**	**$150,000 to $249,999 (N=123)**	**$250,000 or more (N=53)**	**All (N=1,005)**
High School or Less	18.3%	13.6%	6.7%	4.0%	0.8%	3.8%	6.6%
Some College or Associate degree	50.0%	45.5%	35.8%	23.8%	17.9%	11.3%	31.9%
Bachelor's degree or Higher	31.7%	40.9%	57.5%	72.2%	81.3%	84.9%	61.1%
Household Size	**Less than $25,000 (N=60)**	**$25,000 to $49,999 (N=154)**	**$50,000 to $99,999 (N=388)**	**$100,000 to $149,999 (N=227)**	**$150,000 to $249,999 (N=123)**	**$250,000 or more (N=53)**	**All (N=1,005)**
HH Size 1	45.0%	26.0%	19.8%	7.5%	4.1%	5.7%	16.8%
HH Size 2	28.3%	44.2%	47.9%	51.1%	49.6%	49.1%	47.2%
HH Size 3+	26.7%	29.9%	32.2%	41.4%	46.3%	45.3%	36.0%
Household Vehicles	**Less than $25,000 (N=60)**	**$25,000 to $49,999 (N=154)**	**$50,000 to $99,999 (N=388)**	**$100,000 to $149,999 (N=227)**	**$150,000 to $249,999 (N=123)**	**$250,000 or more (N=53)**	**All (N=1,005)**
No vehicles	8.3%	1.9%	1.5%	0.4%	0.8%	0.0%	1.6%
1 vehicle	46.7%	37.7%	26.0%	9.3%	4.1%	1.9%	21.3%
2 vehicles	35.0%	37.7%	45.6%	51.5%	32.5%	39.6%	43.2%
3+ vehicles	10.0%	22.7%	26.8%	38.8%	62.6%	58.5%	33.9%

Table 4 Ordered Probit Model Results for Income Imputation

Explanatory variables	**Category or Continuous**	**Description**	**Coefficients**	**t -**

				value
Number of members in HH	Continuous	Age between 45-64	0.093	1.837
Number of workers in HH	Continuous		0.096	1.513
Number of children in HH	Continuous	17 years and below in HH	-0.161	-2.853
Number of vehicles in HH	Continuous		0.224	7.195
Agree with the tax policy	base: disagree	The government should raise the gas tax to help reduce the negative impacts of transportation on the environment.	0.241	3.029
Preference for home location	base: not prefer	I prefer to live in a spacious home, even if it is farther from public transportation or many places I go.	0.173	2.385
Preference for living close to good public schools	base: not prefer		0.079	1.050
Preference for transit accessibility	base: not prefer		-0.303	-3.818
Homeowner	base: rent or provided by others	Home ownership	0.356	3.365
Employed	base: unemployed	Employment status	0.282	2.817
Standalone home	base: other housing unit types (e.g., mobile home)	Housing type	0.777	3.893
Townhome			0.511	2.091
Condo/Apartment			0.633	2.790
Ridehailing service use on a weeknight	base: not a ridehailing user	Usage of ridehailing services	0.377	3.023
Ridehailing service use on a weekend night			0.364	3.213
Ridehailing service use on a weekend day			0.667	3.734
Early AV adopter	base: eventually adopt AV	Autonomous vehicle (AV) adoption scenario	0.777	3.524
Not AV adopter			0.301	4.036
Male	base: female		0.051	0.726
Nuclear family	base: live alone	Household structure	0.547	4.803
Married couple with no children			0.642	7.200
Multiple adults' household			-0.320	-2.180
Impact on a long-distance trip by AV	base: disagree	I would make more long-distance trips when AVs are available because I wouldn't have to drive.	-0.177	-2.145
Safety concern by AV	base: disagree	AVs should prioritize the safety of pedestrians and bicyclists on the road over that of passengers in the vehicle.	-0.086	-1.250
Bachelor's degree	base: less than bachelor's degree	Education attainment	0.499	6.221
Graduate degree			0.703	7.624

Table 5 Income Imputation Model: Intercepts and Goodness of Fit

	1: (< $25,000) – baseline)	**Coefficients**	**t - value**
1|2	2: ($25,000 to $49,999)	0.721	3.179
2|3	3: ($50,000 to $99,999)	1.762	7.709
3|4	4: ($100,000 to $149,999)	3.182	13.319
4|5	5: ($150,000 to $249,999)	4.093	16.614
5|6	6: ($250,000 or more)	4.970	19.340
	Current fitted model (df=31)	**Null model (df=5)**	**Ratio**
Log likelihood ratio	-1312.644	-1579.297	0.831
R-squared (McFadden)	0.169		

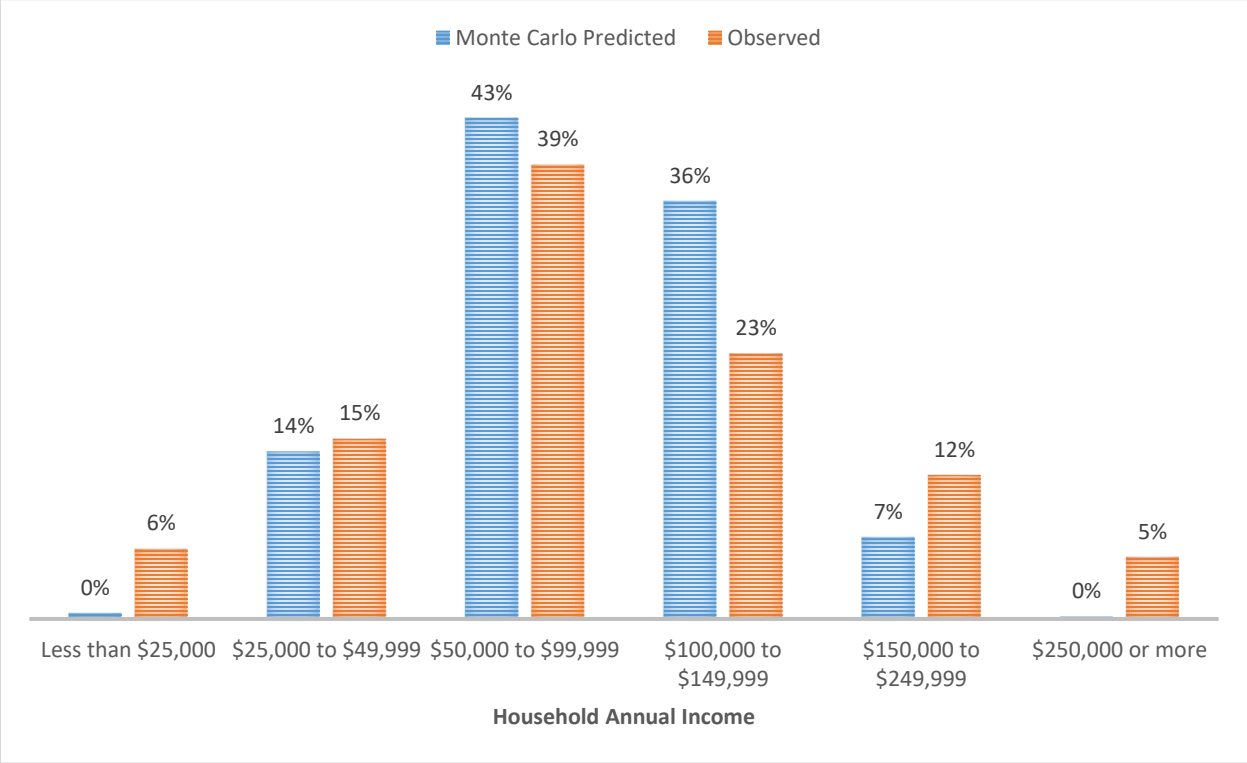


Figure 14 Income Imputation Replication Results - Monte Carlo Simulation (N=1005)

Weights Estimation

After controlling for the missing income records, sample weights were calculated using the synthetic population generator, PopGen2.0 software. The process of computing weights for the survey data is associated with weighting the marginal distribution of the selected variables in the survey data, to match the characteristics of the true population marginal. The detailed description of the synthetic population generator and its algorithms can be found in Ye et al. (2009) and Konduri et al. (2016). This report presents a brief description of the data weighting process.

***Step 1 – Choosing the control variables*:** sample size and software operation limit the number of variables that can be used as control variables. To ensure that the best set of variables were selected, an iterative process evaluated alternative combinations. As the original sample over-represents

older individuals and under-represents low-income households, age, and income were always controlled for across all the weighting scenarios. Alternative variables were also tested in combination with income and age are the number of workers in the household, the number of vehicles in the household, household size, education, and employment status. The final set of variables was chosen based on its overall performance on replicating the distributions observed for Maricopa County. Finally, the sample was weighted based on **age, gender, education attained, employment status, household income, and the number of vehicles in the household.** Different variables categories were chosen in such a way to allow comparison with census data (see Table 6 and Table 7). Age was classified into four groups, namely 18-29 years, 30-44 years, 45-59 years, 60 years and above. Education attainment was categorized into three levels: high school, some college degree, and bachelor's degree or higher. Gender was classified as male or female. Employment status was defined as worker or non-worker. Additionally, household income was categorized as low, middle, and high-income levels, and the number of vehicles was specified as 0, 1, 2, and 3 or more vehicles available to the household (Table 7).

***Step 2* – Compute marginal distributions for Maricopa County:** To obtain the marginal distribution to explore the characteristics of the true population, the American Community Survey (ACS) 5-year estimates for 2013-2017 is utilized. As the total population, 18 years and above is around 3 million while the number of stated responses is 1,027, instead of expanding the sample data to reach the marginal distribution of the true population, population-wide marginal control distributions are replicated to match the total number of the survey data responses. Thus, the data weighting aims to match the distribution pattern of the true population with the distribution pattern of the controlled variables, keeping the sample size equal to the actual collected data.

***Step 3 – Calculate weights*:** The computation of the weights is executed in the following steps. First, a multi-dimensional matrix composed of the specified control variables (i.e., joint distribution), is formed. Second, using the formed joint distribution as a seed matrix, an iterative proportional fitting algorithm (IPF) is executed to match the seed matrix with the univariate marginal control distributions of the ACS 5-year data. By implementing the IPF algorithm embedded in PopGen2.0 software, the distribution of each control variable at the person level and the household level is replicated to follow the true population characteristics. For instance, the distributions of the unweighted data in Table 6 and Table 7 are formed to replicate the distributed characteristics shown in the Maricopa County column. The estimation results for the weighted socioeconomic and demographic variables are discussed in the following subsections.

Table 6 Person Level Control Variables Used for Weighting

Age	**Unweighted Data (N=1,027)**	**Maricopa Population (N=3,124,636)**
18-29 years	62 (6.0%)	699502 (22.4%)
30-44 years	139 (13.5%)	838469 (26.8%)
45-59 years	305 (29.7%)	778131 (24.9%)
60 years and above	521 (50.7%)	808534 (25.9%)
Education	**Unweighted Data (N=1,027)**	**Maricopa Population (N=3,124,636)**
High school graduate or less	69 (6.7%)	1162905 (37.2%)
Some college or associate degree	327 (31.8%)	1067735 (34.2%)
Bachelor's degree or higher	631 (61.4%)	893996 (28.6%)
Employment	**Unweighted Data (N=1,027)**	**Maricopa Population (N=3,124,636)**
Employed	581 (56.6%)	1891807 (60.5%)

Not employed/not in the labor force	446 (43.4%)	1232829 (39.5%)
Gender	**Unweighted Data (N=1,027)**	**Maricopa Population (N=3,124,636)**
Male	514 (50.0%)	1,529,273 (48.9%)
Female	513 (50.0%)	1,595,363 (51.1%)

Table 7 Household Level Control Variables Used for Weighting

Household Income	**Unweighted Data (N=1,027)**	**Maricopa Households (N=1,489,533)**
Less than $50,000	213 (20.7%)	636522 (42.7%)
$50,000 to $99,999	404 (39.3%)	464079 (31.2%)
$100,000 or more	410 (39.9%)	388932 (26.1%)
Number of Household Vehicles	**Unweighted Data (N=1,027)**	**Maricopa Households (N=1,489,533)**
No vehicle available	16 (1.6%)	94126 (6.3%)
1 vehicle available	215 (20.9%)	546849 (36.7%)
2 vehicles available	438 (42.6%)	579531 (38.9%)
3+ vehicles available	358 (34.9%)	269027 (18.1%)

Weighted Socioeconomic Distributions

This section addresses comparisons of the Maricopa County distributions with the weighted survey distributions. As aforementioned in the previous section, the controlled socio-economic and demographic attributes were age, education, employment, gender, household income, and the number of vehicles in the household. Based on the controlled variables, we compare the distribution pattern of the true population (Maricopa County Census data) with the weighted results, both for the variables that were controlled and not controlled.

Figure 15 presents the bivariate distribution of age by gender. The distributed pattern observed in the survey is consistent with the pattern of Maricopa County (18 years and above). Interestingly, while the total sample mimics the county distribution (as it was controlled for), the male sample is older than the female sample. The weighted results show that the largest percentage of the male respondents is found in the 60+ years group, and the largest share of the female respondents is observed in the 30-44 years group.

Figure 16 and Figure 17 illustrate the weighted distributions of the place of birth, Hispanic origin, and race. After the weighting implementation, the weighted survey data are still more representative of US-born, not Hispanic, and White population but with much less intensity compared to the unweighted sample. It should be noted that the Hispanic or Latino origin variable was not a control variable in the weighting process.

As expected, the distribution of the educational attainment is consistent with the Maricopa County pattern (Figure 18), as this variable was one of the control variables for the weighting process. Figure 19 displays the weighted employment status data. It is important to understand that while this variable was controlled for, the weights account for the difference between employed and non-employed individuals only.

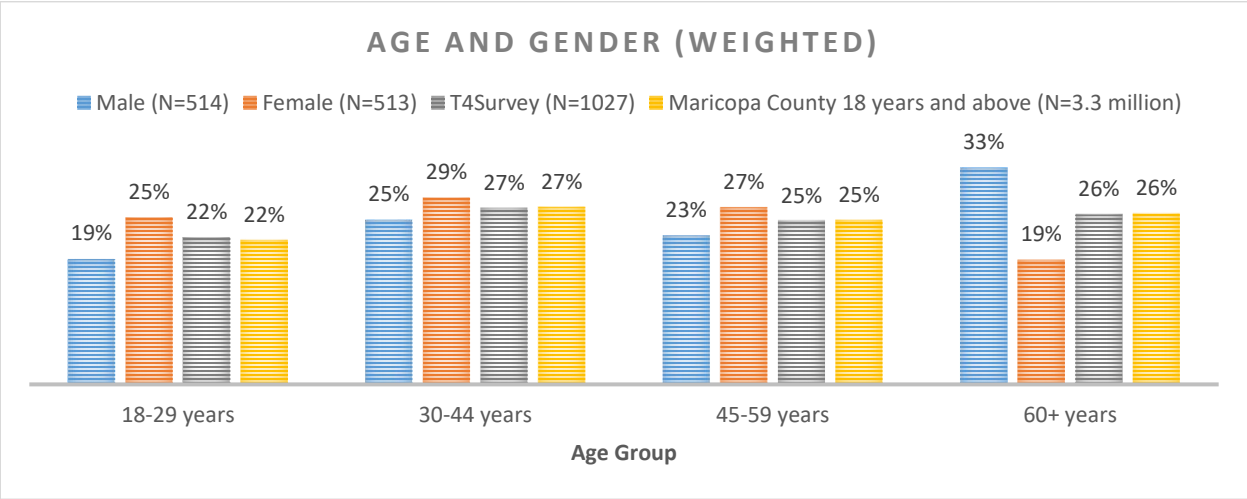


Figure 15 Age and Gender Distributions, weighted

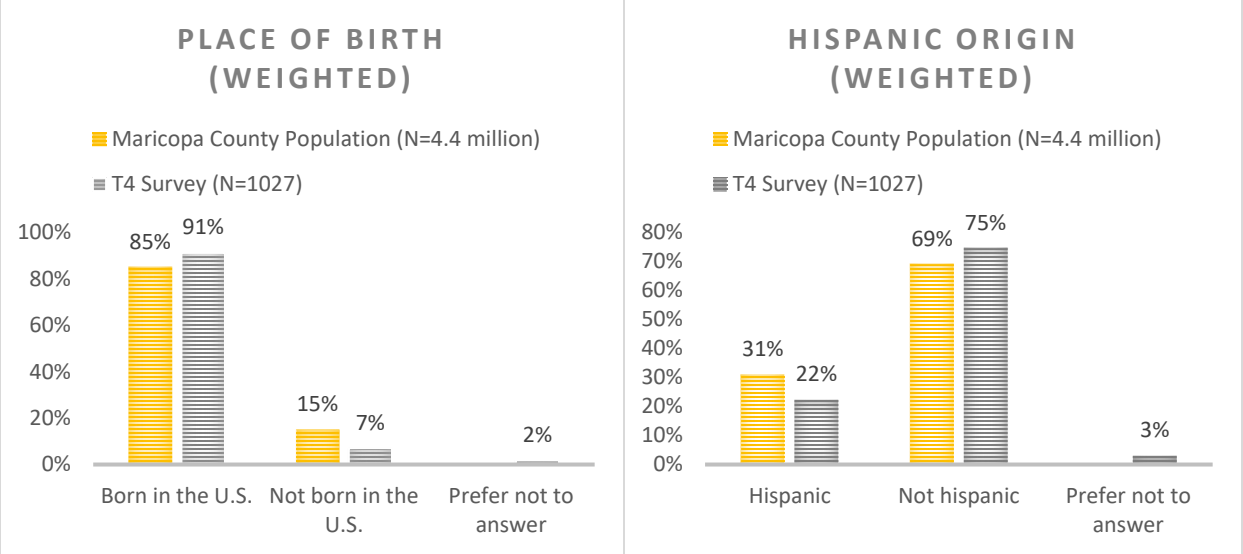


Figure 16 Place of Birth and Hispanic/Latin Origin, Weighted

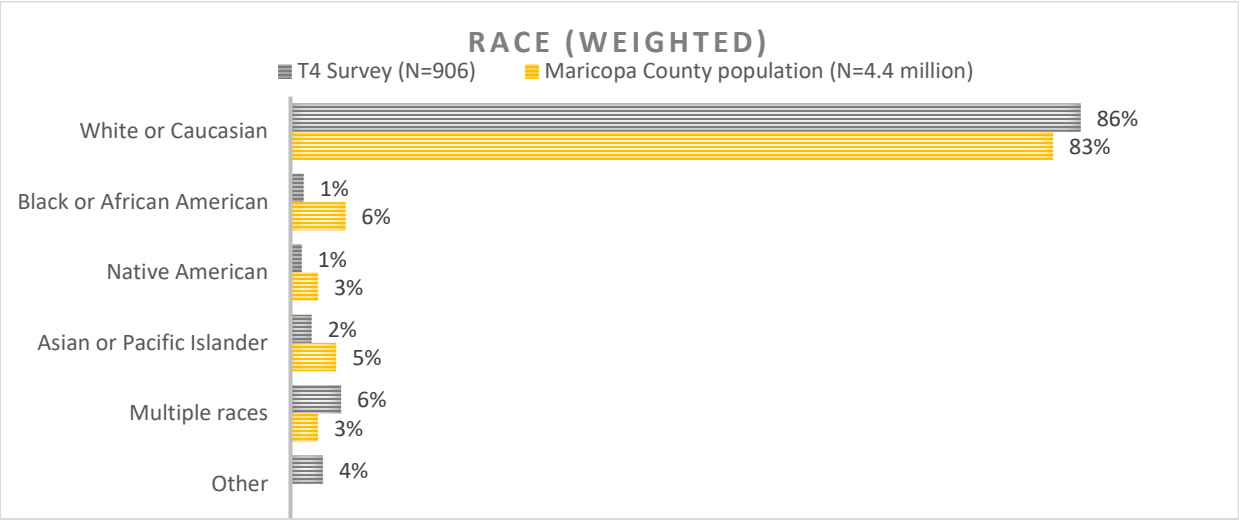


Figure 17 Race Distribution, Weighted

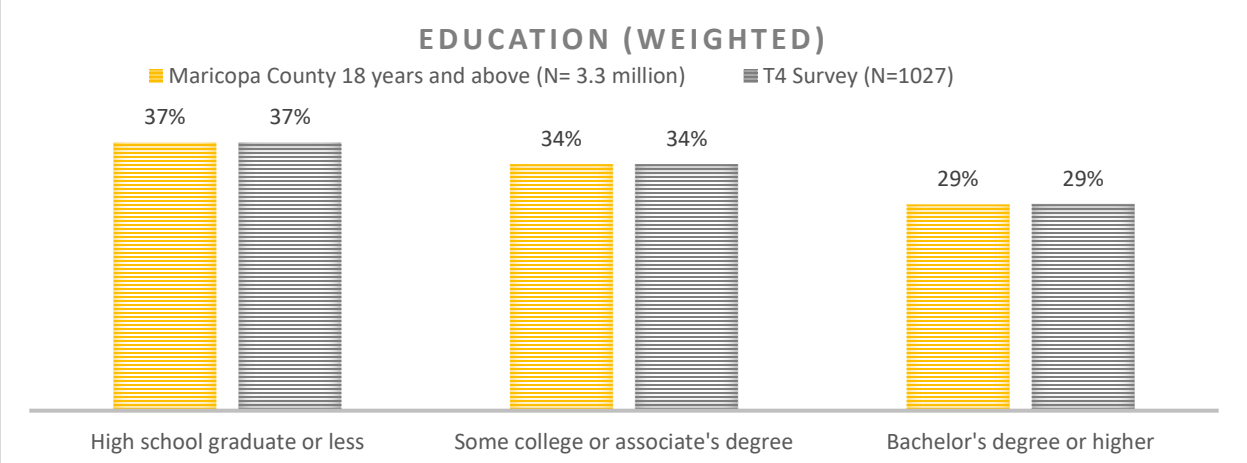


Figure 18 Highest Level of Education Attained, Weighted

In Figure 20, the distribution of the respondent's home location is displayed by nine main cities in Maricopa County. The weighted sample under-represents residents of the city of Phoenix, which is the central part of the metropolitan area.

Figure 21 presents the distribution of household size between the weighted survey and the population in Maricopa County. Household size was not among the control variables and so the weighted sample does not exactly follow the population distribution; however, the weighted sample distribution is much more similar to the population distribution compared to the unweighted sample presented earlier.

Figure 22 presents the weighted distributions of the number of vehicles in the household. The weighted sample distribution is very consistent with the population distribution considering that the number of vehicles was among the control variables.

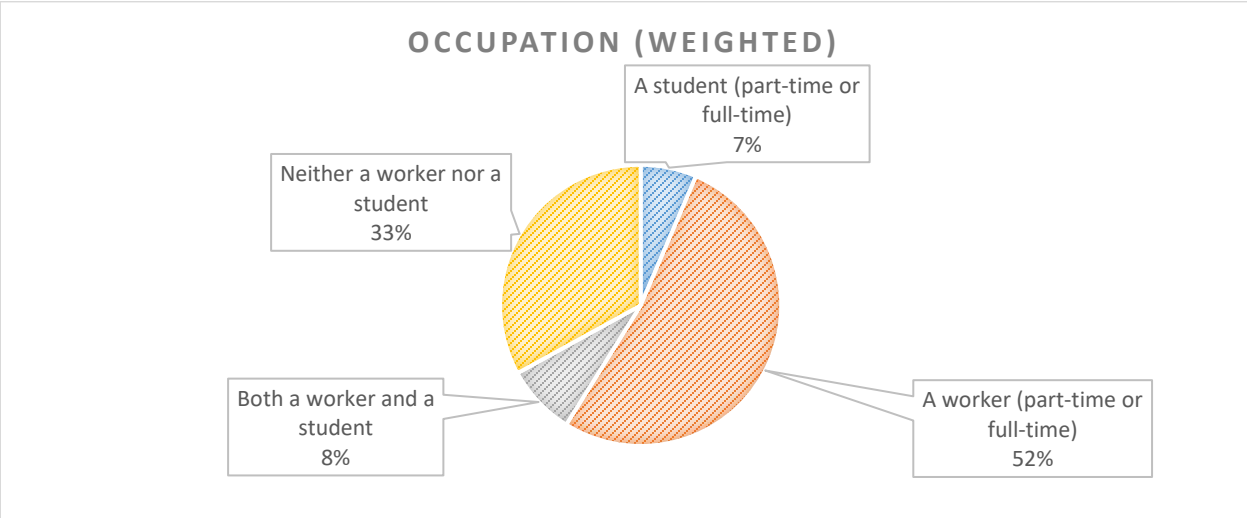


Figure 19 Occupation Distribution, Weighted (N=1,027)

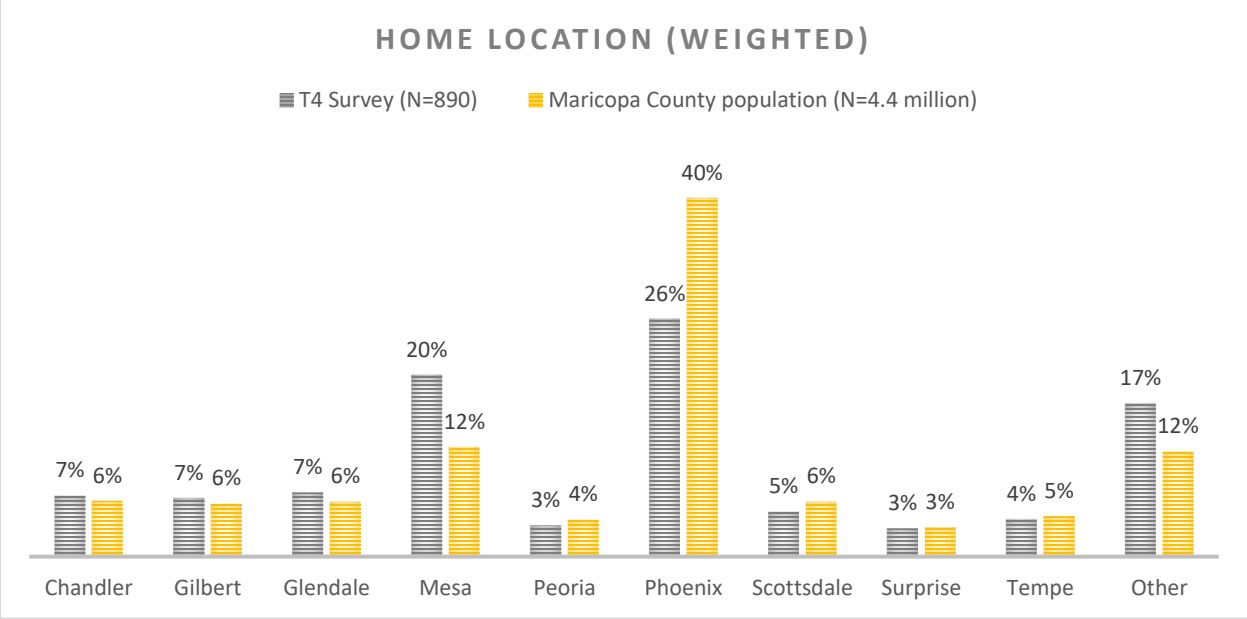


Figure 20 Respondents' Home Location, Weighted

The proportion of the weighted results associated with tenure status and household unit type is shown in Figure 23. Exploring the difference between unweighted and weighted sample distributions (Figure 12 and Figure 23) highlights a noticeable pattern. The percentage of homeowners decreases from 81 percent to 61 percent after weighting implementation. Even though tenure status was not one of the control variables on the weighting process, correcting the sample representativeness for household income and other attributes adjusted the representation of non-homeowners. Similarly, the distribution of housing unit type is improved using the sample weighting process to be a better representative of the population.

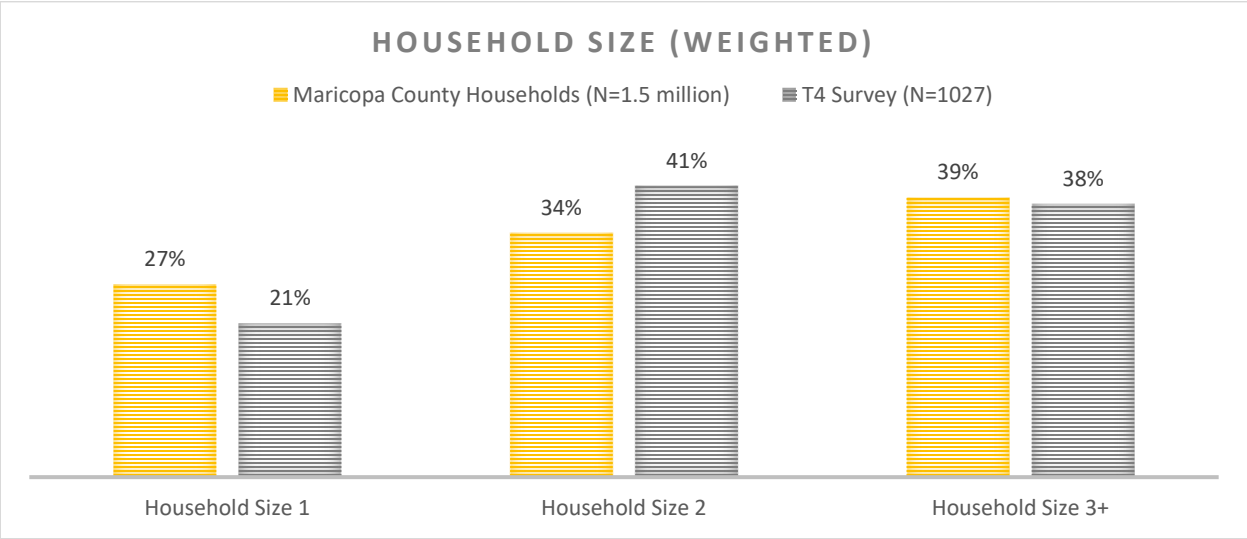


Figure 21 Household Size Distribution, Weighted

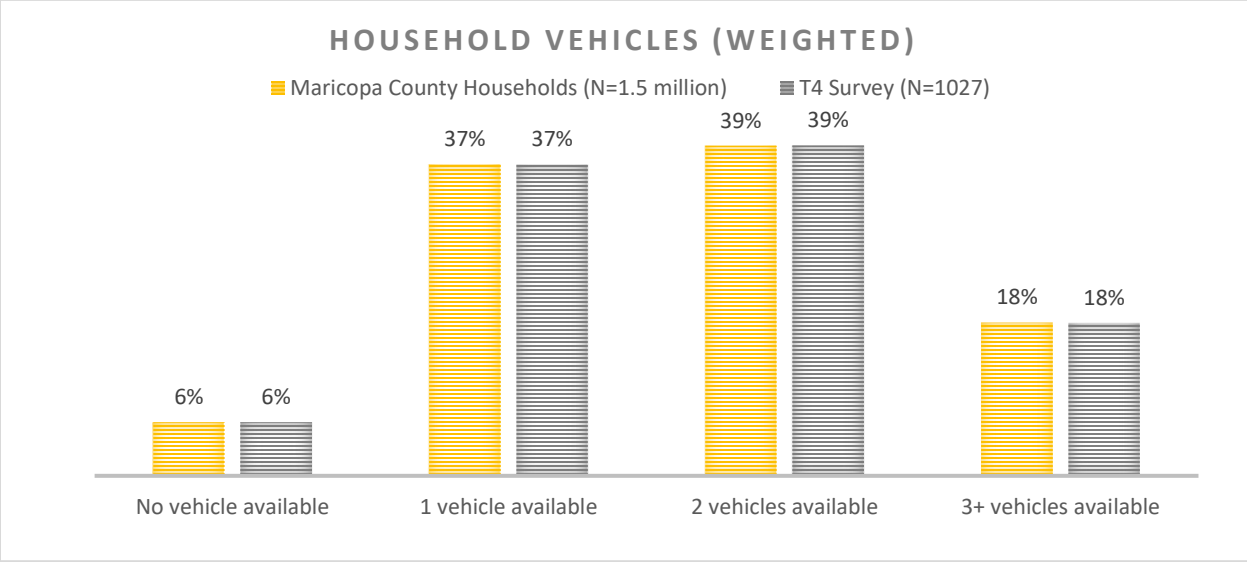


Figure 22 Number of Motorized Vehicles in the Household, Weighted

Figure 24 depicts the distribution of household income between the weighted sample and the population. Household income was one of the control variables on the weighting process, and the weighted sample significantly performs better on representing the Maricopa County population.

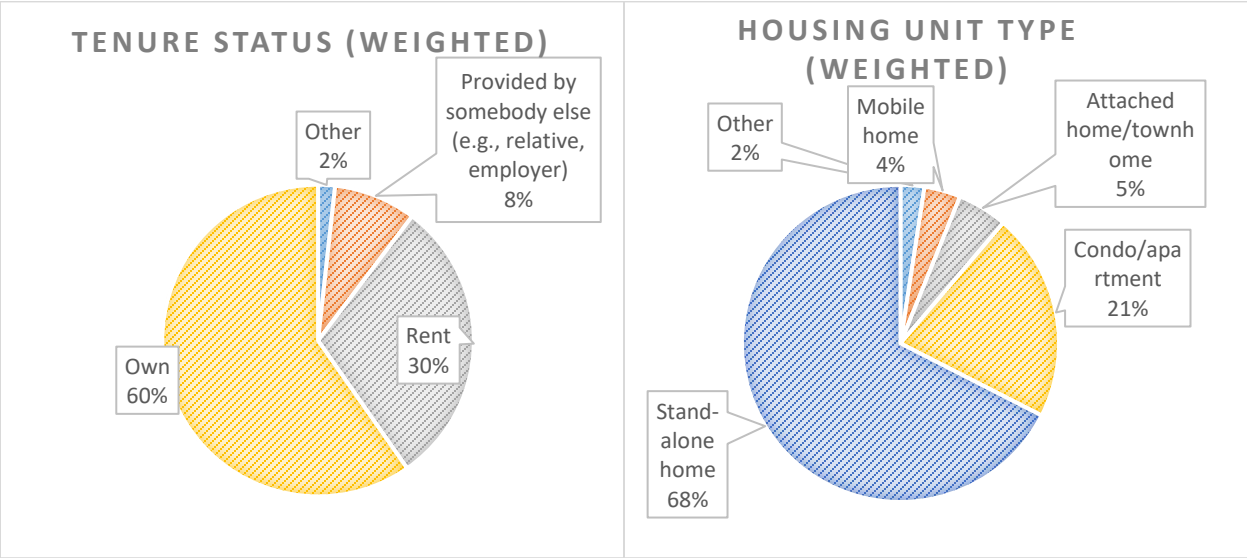


Figure 23 Tenure Status and Housing Unit Type, Weighted

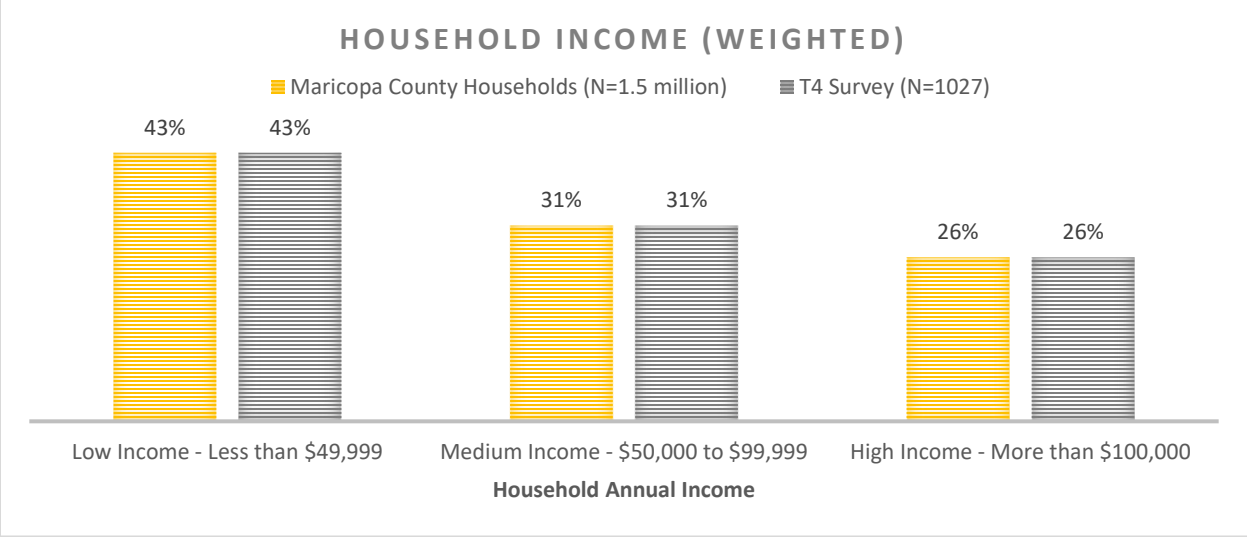


Figure 24 Household Income Distribution, Weighted

After successfully developing the weights, the remaining sections of the report present the collected responses of the **weighted sample data** regarding general attitudes, residential preferences, and vehicle ownership, current travel behavior, and perception and attitudes towards ridehailing services and autonomous vehicles.

It should be noted that a significant portion of the survey consists of Likert scale agree/disagree statements with five response options (strongly disagree, somewhat disagree, neutral, somewhat agree, and strongly agree). It has been observed that quite numerous respondents chose the neutral option. Selecting a neutral option does not always mean that people are between agreeing and disagree; albeit it can mean that the issue is not understandable or not important for the respondent.

Table 8 presents the number of agree/disagree statements and the portion of neutral

responses in each survey section. Considering the weighted responses, the lowest percentage of neutral responses belongs to the general attitude section with 19 percent followed by autonomous vehicle section with 26 percent, residential preference section with 30.5 percent, and ridehailing section by 35.7 percent. The highest percent of neutral responses associated with the ridehailing section may be related to the fact that the majority of the respondents are not using these services and they may be not very assertive on their use or potential benefits, and concerns.

Table 8 Percent of Neutral Responses to Agree/Disagree Statements

	N Statements	Average Percent of Neutral Responses (weighted)	Average Percent of Neutral Responses (unweighted)
General attitudes	28	19.0%	17.5%
Residential preferences	11	30.5%	30.5%
Ridehailing	15	35.7%	34.4%
Autonomous vehicles	33	26.0%	22.8%

Geocoding

Respondents were asked to provide their home location, and those who reported being commuters, reported they work or school address. Addresses were geocoded using the assistance of an online tool (Geocod.io). The procedure of geocoding the addresses involved a combination of manual classifications, software-assisted geocoding, and manual quality checks. The first step in the process was to individually read and classify the level of detail provided on the respondents' answers. Table 9 shows the result of that step for both home and work locations. Noticeably, the home location was provided with a higher level of detail. For the home location, respondents' provided information was used only when the data from the survey was provided as a complete address (535 cases). All other responses had home locations geocoded based on the address provided by the marketing company. A flag was recorded indicating the level of detail provided, and how well that matched with the marketing company information. Out of the 312 cross streets provided, 264 were a mile or less from the addresses on file from the marketing company, and 26 were farther than one mile from the on-file address but were on the same ZIP code. For work addresses, as no information was available from the marketing company, the locations provide as cross-streets were geocoded at the intersection level. Out of 552 commuters, 497 commute locations were recorded. After processing the address on The Geocodio (www.geocod.io), a manual quality check was performed by checking the location of the geocoded point with the provided information. Problematic cases were manually geocoded on Google Maps. Three home locations and 30 work locations could not be geocoded due to insufficient information. The map visualization shown in Figure 25 was obtained using ArcGIS.

Table 9 Level of Detail Provided by Respondent for Home and Work Location

Level of Detail Provided by Respondent	Home Location (N=1052)	Work Location (N=552)

Complete Address	50.9%	40.0%
Cross-Street	29.7%	35.9%
Incomplete Address/ Other	13.5%	14.1%
Seen but not Answered	6.0%	10.0%

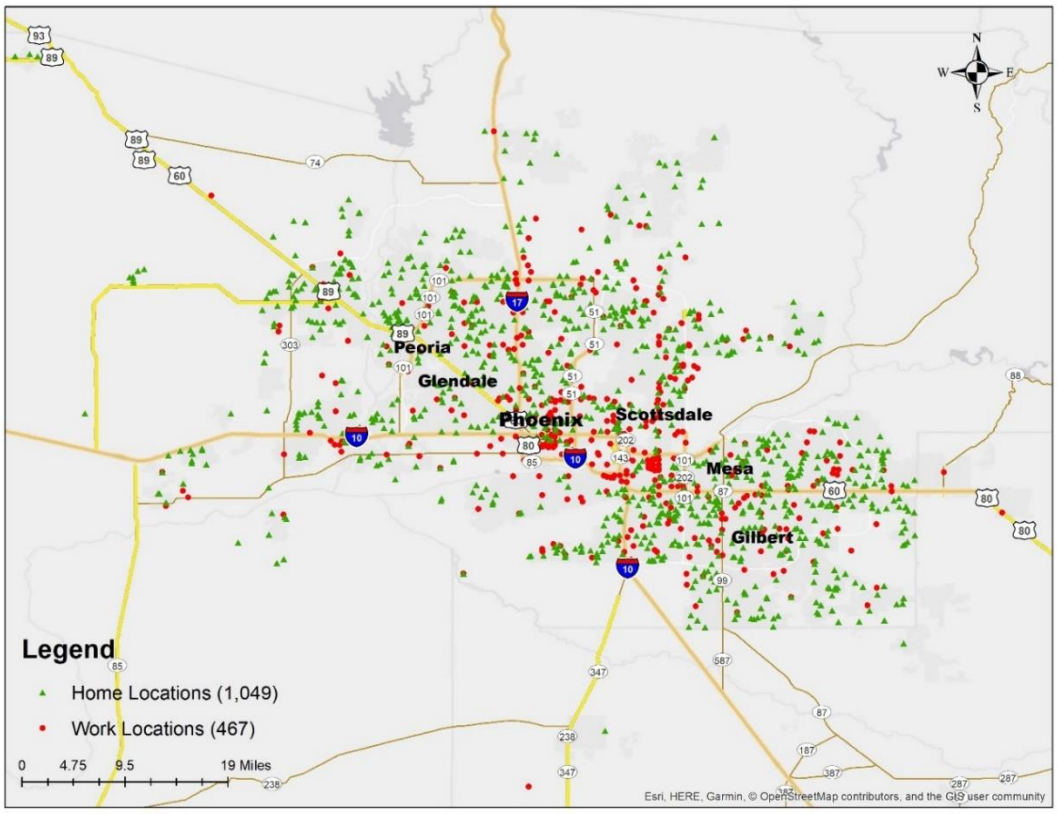


Figure 25 Home and Work Location Distributions on Maricopa County

ATTITUDES AND PREFERENCES

Previous studies have shown the significance of the relationship between general and transport-related attitudes and travel behavior (Handy et al., 2005; Cao et al., 2009; Van de Covering et al., 2016). This section presents the descriptive data collected in the first section of the survey, regarding general and transport-related attitudes and preferences.

Figure 26 presents the survey results about the extent to which respondents agree or disagree with three statements about privacy and sharing. The first statement depicts the respondent's comfort level when around people they do not know. The results indicate that 39 percent of the respondents do not feel uncomfortable while 33 percent feel uncomfortable and 28 percent feel neutral around people they do not know. The results for the second and third statements show a much clearer pattern. Most of the respondents disfavor the idea of renting out their cars to people they do know as only 6 percent of the people agreed that renting out their cars to strangers would be fine. Similarly, when the respondents were asked if sharing their personal information or location via internet-enabled devices concerns them a lot, 70 percent of them either somewhat or strongly agreed with the statement.

These results demonstrate that not many people feel uncomfortable around people they do not know, indicating that the idea of riding in autonomous vehicles with strangers would not be so unrealistic in the future. However, the results also imply a certain barrier to the concept that foresees people renting out their autonomous vehicles to other people when unused as only 6 percent of the respondents favored the idea of renting out their cars to people they do not know. The results also show that people are highly sensitive to sharing their personal information or location via internet-enabled devices, suggesting another significant barrier that should be addressed in a potential autonomous vehicle future.

Figure 27 presents the survey results about the extent to which respondents agree or disagree with three statements on environmental friendliness. The first statement depicts the respondents' perception of the gas tax raise to help reduce the negative impacts of transportation on the environment. The results showed that more than half (54 percent) of the respondents disagreed with the statement while those strongly or somewhat agreed correspond to 27 percent, suggesting a clear opposition toward gas tax raise. The second statement aimed at exploring if respondents are committed to an environmentally friendly lifestyle. The results revealed that 68 percent of the respondents expressed that commitment. The third statement aimed to explore the respondents' commitment level to using less polluting means of transportation (e.g., walking, biking, and public transit). The results revealed that 39 percent of the respondents strongly or somewhat agreed with the statement while 30 percent strongly or somewhat disagreed. Overall, the results of these three statements suggest that although the majority of the respondents clearly express that they are committed to an environmentally friendly lifestyle, just short of one-third of them support the gas tax raise and are committed to using less polluting means of transportation. This indicates that there is a clear dissonance between the environmentally friendly lifestyle commitment and the commitment to the mechanisms that intend to support protecting the environment in real practice.

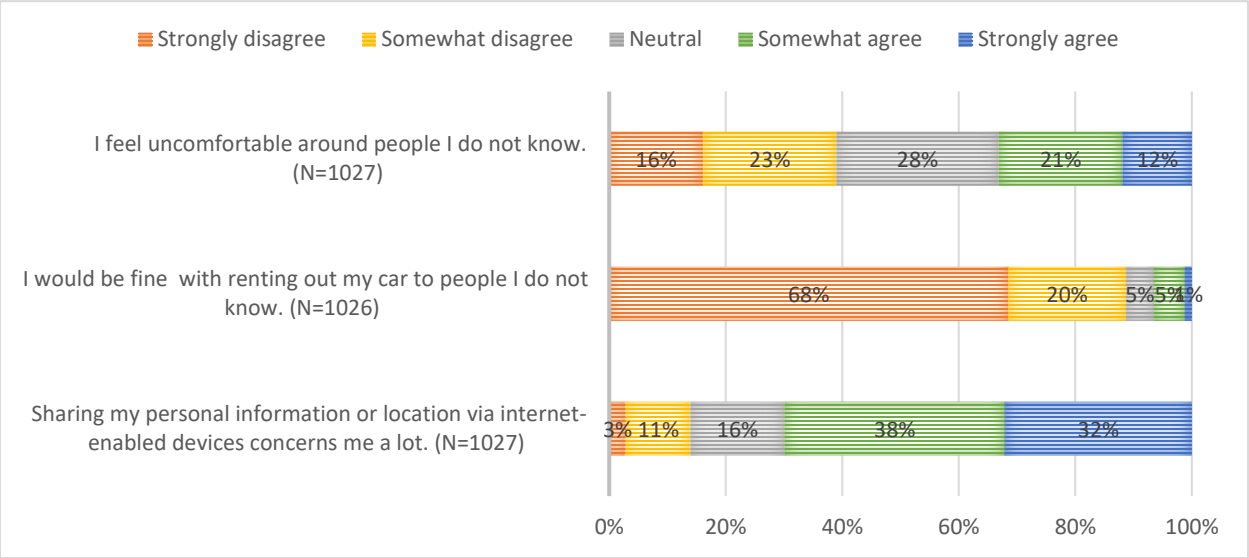


Figure 26 Attitudinal Statements on Privacy and Sharing

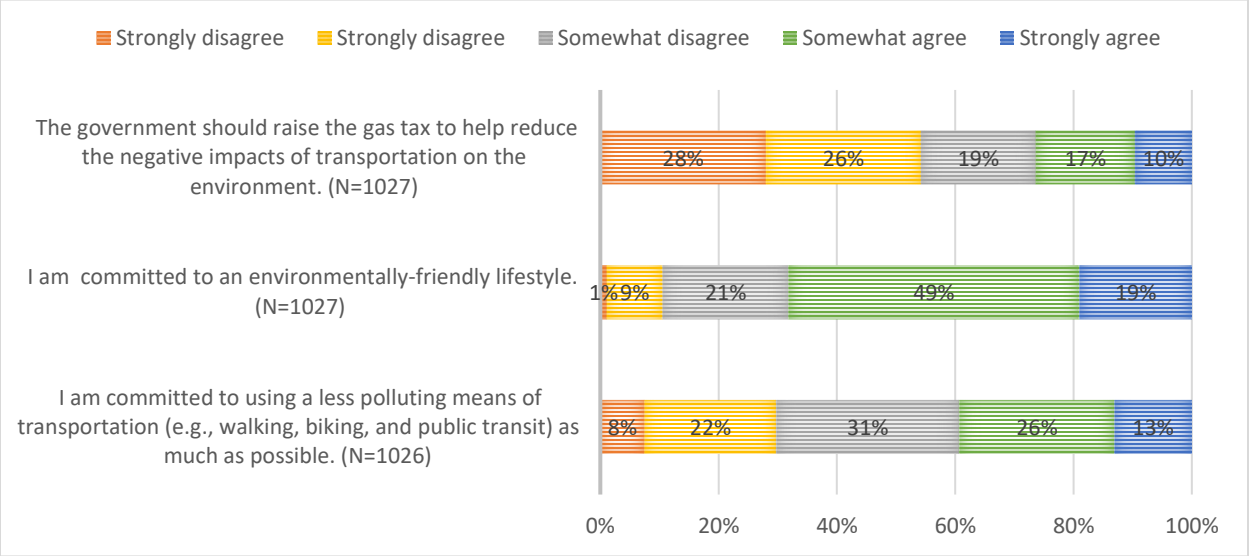


Figure 27 Attitudinal Statements on Environment Friendliness

Figure 28 presents the survey results about the extent to which respondents agree or disagree with the statements regarding tech-savviness. The first statement intends to capture the share of the respondents who like to be among the first users of the latest technology. The results indicated that more than half of the respondents agreed with the statement, meaning that they like to be among the first people to have the latest technology. The second statement depicts the respondents' preference for online shopping over in-store shopping. The results show a somewhat well-balanced distribution as those who agreed with the statement represent 39 percent of the respondents while those who disagreed are 31 percent. The third statement aims to explore if learning how to use new technologies is frustrating. The results showed that more than half (62 percent) of the respondents disagreed with the statement, suggesting that many of the respondents

find learning how to use new technologies untroubling, even after controlling for the age of the respondents. The fourth statement depicts the importance of internet connectivity to the respondents. The results showed a clear pattern that just about 69 percent of the respondents agreed that having internet connectivity everywhere is important to them while only 15 percent disagreed with the statement. Similarly, the fifth statement depicts the appreciation level of the respondents for trying new and different things. The results indicated that a big majority of the respondents (83 percent) agreed that they like trying new and different things. This large inclination towards using new technology and the importance of having internet connectivity appear highly promising for a potential AV future. However, using new technology being frustrating for a notable portion of respondents and low willingness for online shopping shows that adapting new technology might not happen easily although people are expressing willingness for adoption.

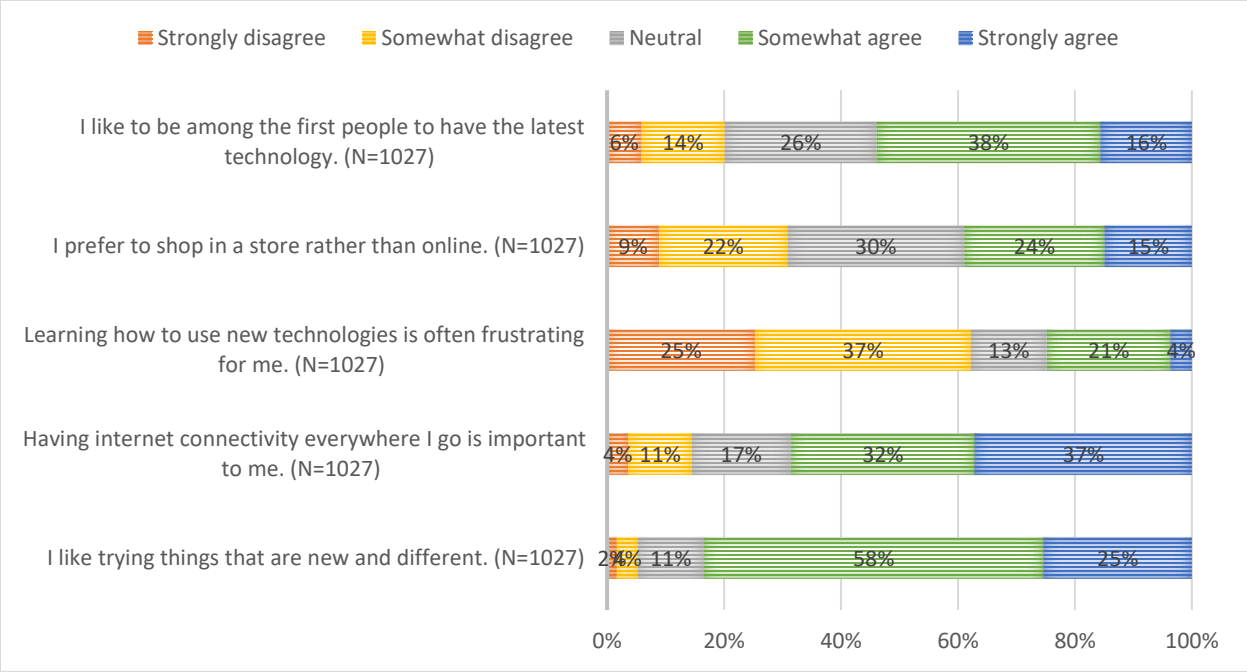


Figure 28 Attitudinal Statements on Technology Savviness

Figure 29 presents the survey results about the extent to which respondents agree or disagree with five different statements that intend to understand personal time use characteristics. The first statement is about the respondents' preference for doing one thing at a time. The results showed similar amount of agreement and disagreement with multitasking, while 19 percent stayed neutral. The second statement depicts the time poverty degree of the respondents that inhibits them from doing many of the things they like to do. The results revealed that 43 percent of the respondents strongly or somewhat agreed that they are too busy to do many of the things they like to do while 39 percent disagreed with the statement. The third statement is about the respondents' view on if having to wait can be a useful pause in a busy day. The results indicated that more than half of the respondents agreed that it is a useful pause in a busy day while those who disagreed corresponded to 31 percent. The fourth statement depicts the respondents' preference for making good use of time during traveling. The results show a clear preference for making good use of time during traveling as 77 percent of the respondents agreed with the associated statement. The fifth

statement intends to explore if people agree that the time spent on traveling places provides a useful transition between activities. The results revealed that 49 percent strongly or somewhat agreed, and 35 percent stayed neutral. In general, the majority of the sample wants to make good use of their travel time and about half of the respondents enjoy the time spent on traveling as a useful transition or pause between activities. Less than half of the sample favors multitasking and similarly less than half of the sample feel that they are time-poor.

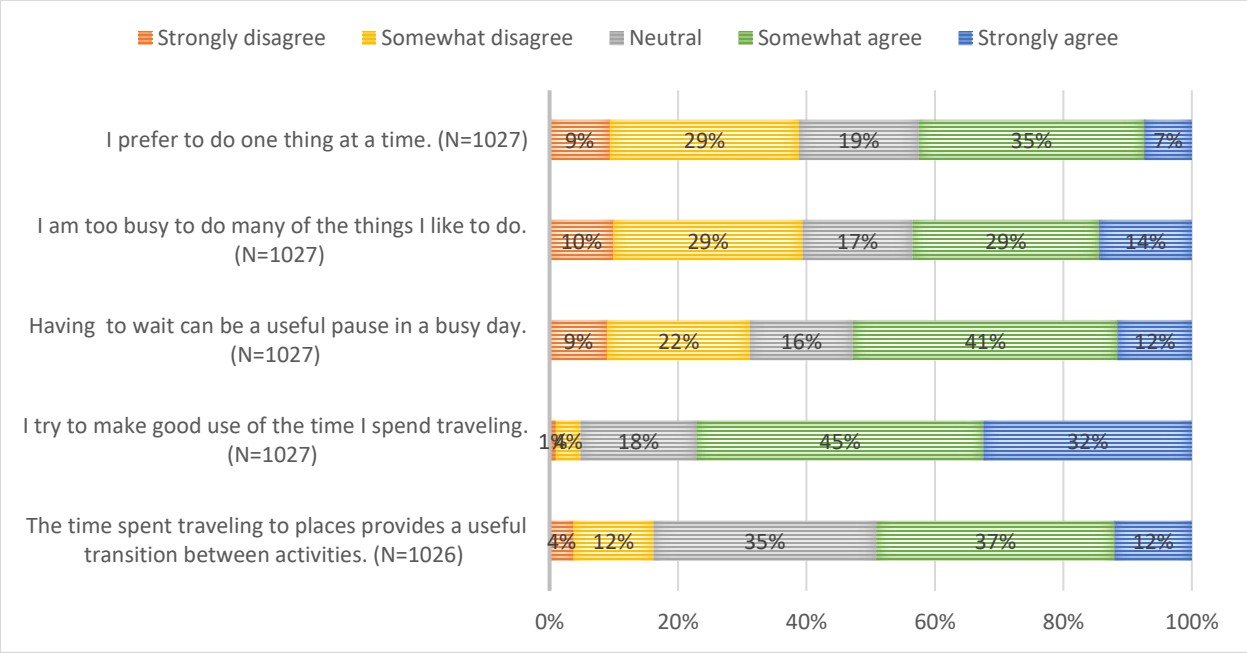


Figure 29 Attitudinal Statements on Personal Time Use

Figure 30 presents the survey results about the extent to which respondents agree or disagree with seven different statements about transportation. Results for the first statement indicated that 62 percent agreed with that most of the time, they do not have reasonable alternatives to driving. The result for the second statement shows that the number of respondents who disagreed (48 percent) that car crash deaths are an unavoidable part of the modern efficient transportation system outnumbered the number of those who agreed (36 percent). The result for the third statement suggests that 69 percent of the respondents agreed that their daily travel routine is generally satisfactory. On the contrary, results for the sixth statement show that the level of congestion during daily travel bothers 62 percent of the respondents. The results for the fifth statement suggested that 66 percent of the respondents do not find public transit a reliable means of transportation for daily travel needs. When asked if the respondents definitely like the idea of owning their car in the seventh statement, nearly 93 percent of the respondents strongly or somewhat agreed with the statement. However, 54 percent of the respondents favored being a driver rather than a passenger during traveling in a vehicle. This suggests that although almost all the respondents prefer owning a personal car, not as many people enjoy driving them.

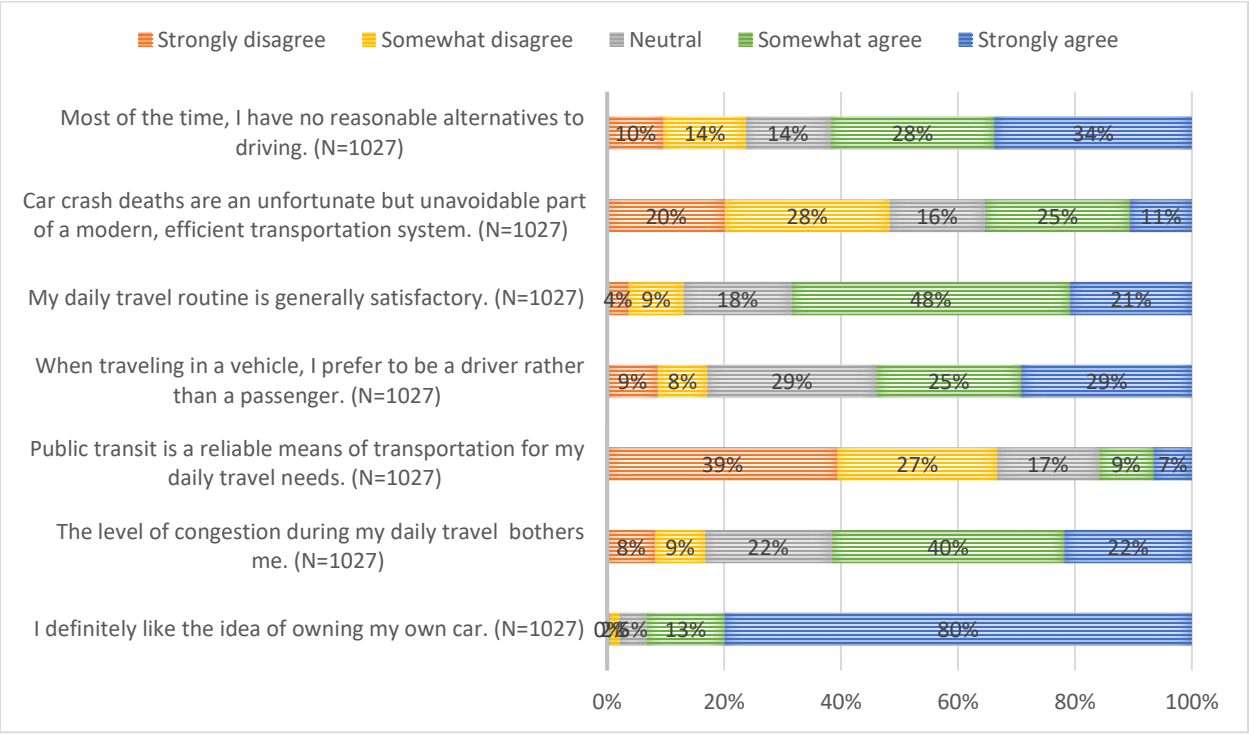


Figure 30 Attitudinal Statements on Transportation Issues

Figure 31 presents the survey results about the extent to which respondents agree or disagree with three statements about their residential location preferences. The first statement depicts the respondents' level of agreement with preferring to live close to transit, even if it means having a smaller home and living in a denser area. The results showed that just about 52 percent disagreed with the statement, suggesting that many people prioritize the size of their home over living close to transit. The second statement intends to understand the respondents' preference for living in a spacious home even if it is farther from public transportation or many places they go. The results revealed that the number of those who indicated such preference (41 percent) is slightly higher than those who indicated otherwise (31 percent). Similarly, the third statement depicts if respondents favored the mixed-use urban development which suggests mixing the stores, restaurants, and offices among the homes in a neighborhood. The results showed that the majority of the respondents (71 percent) favor this type of development. This finding should be considered in the context of the Phoenix metro area in which transit and alternative modes of transportation are not widely adopted and accessible.

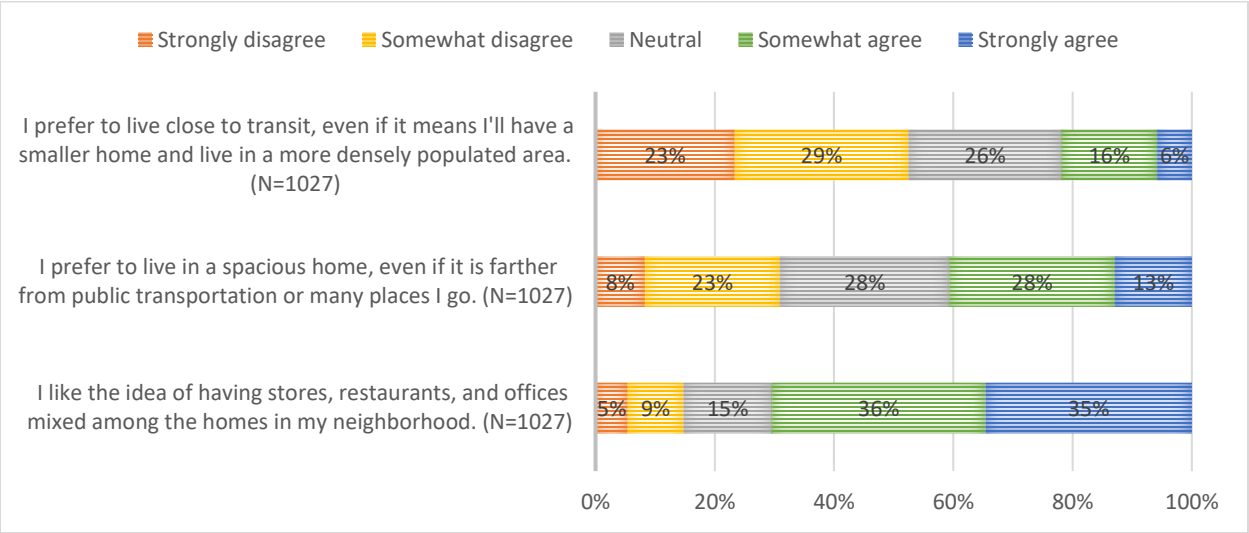


Figure 31 Attitudinal Statements on Residential Location Preferences

Figure 32 presents the survey results about the extent to which respondents agree or disagree with two general statements which are the last attitudinal statements. The first statement intends to explore what percent of the respondents feel sick when reading in a moving vehicle. Results showed that reading in a moving vehicle is problematic for 41 percent of the respondents. This finding could impact the quality of the time spent inside autonomous vehicles for a significant number of people. The first statement depicts how much importance the respondents put on the reliability and quality of a car compared to its brand. The results revealed that close to 90 percent of the respondents agreed that the importance of reliability and quality of a car is greater than its brand.

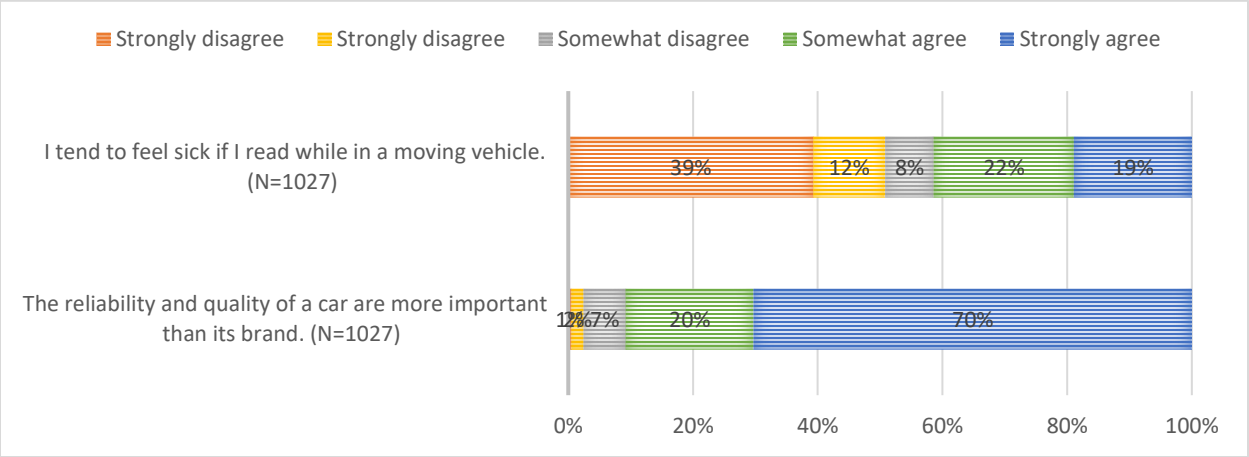


Figure 32 Other Attitudinal Statements

VEHICLE OWNERSHIP AND RESIDENTIAL CHOICE

This section details the results from Section B of the survey, regarding respondents' vehicle ownership status and residential characteristics and preferences.

Vehicle Ownership

This subsection presents the survey results on the characteristics of the respondents' reported household vehicles. These include vehicle make, model, model year, fuel type, annual driven mileage, and driving assistance features. Figure 33 reports on the make of the most used vehicle of the survey respondents. Among the reported household vehicles, Toyota has the largest share by 18 percent, which is followed by Ford with 13 percent, Nissan with 11 percent, Honda with 9 percent, and Chevrolet with 7 percent. While these five brands correspond to 58 percent of all reported household vehicles, other brands represent the remaining 42 percent. Considering fuel type, 95 percent of the vehicles run on gasoline. The remaining 5 percent is shared by electric vehicles with less than 1 percent, hybrid vehicles with 3 percent, and other fuel types with 2 percent.

A vehicle was considered to be acquired new if the model year is equal to year acquired or model year is equal to year acquired plus one. The vehicle was considered acquired used if the year acquired is greater than the model year. If either model year or year acquired were missing, the information of the purchasing condition was not computed. Given these criteria, 51 percent of vehicles were acquired new and 49 percent of the vehicles were acquired used.

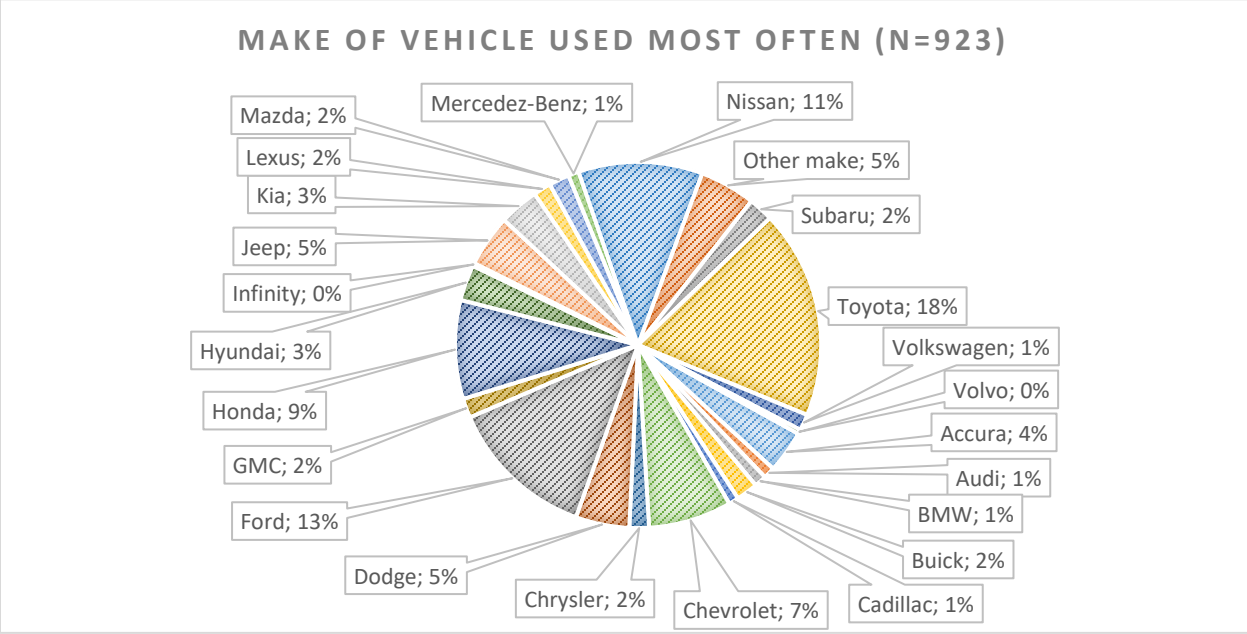


Figure 33 Make Share of Vehicles Used Most Often by Respondent (N=923)

Figure 34 presents the survey results on annual miles driven with vehicles the respondents used most often. The results show that just about 72 percent of the vehicles the respondents used most often were driven less than 15,000. Figure 35 presents the distribution of vehicle model year for the vehicle the respondent used most often. Results suggest two peaks of purchasing vehicles. One is around 2005-2007 which is right before the recession and one is around 2014-2016 which is right after the recession corresponding to the improved economy.

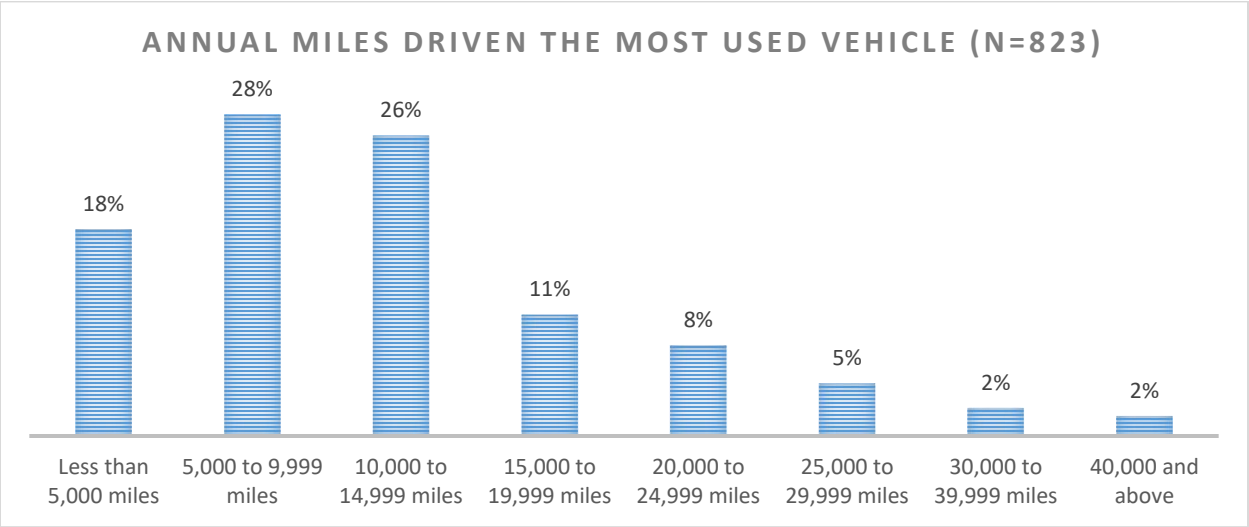


Figure 34 Reported Estimated Annual Miles Driven for Vehicles Used Most Often by Respondent (N=823)

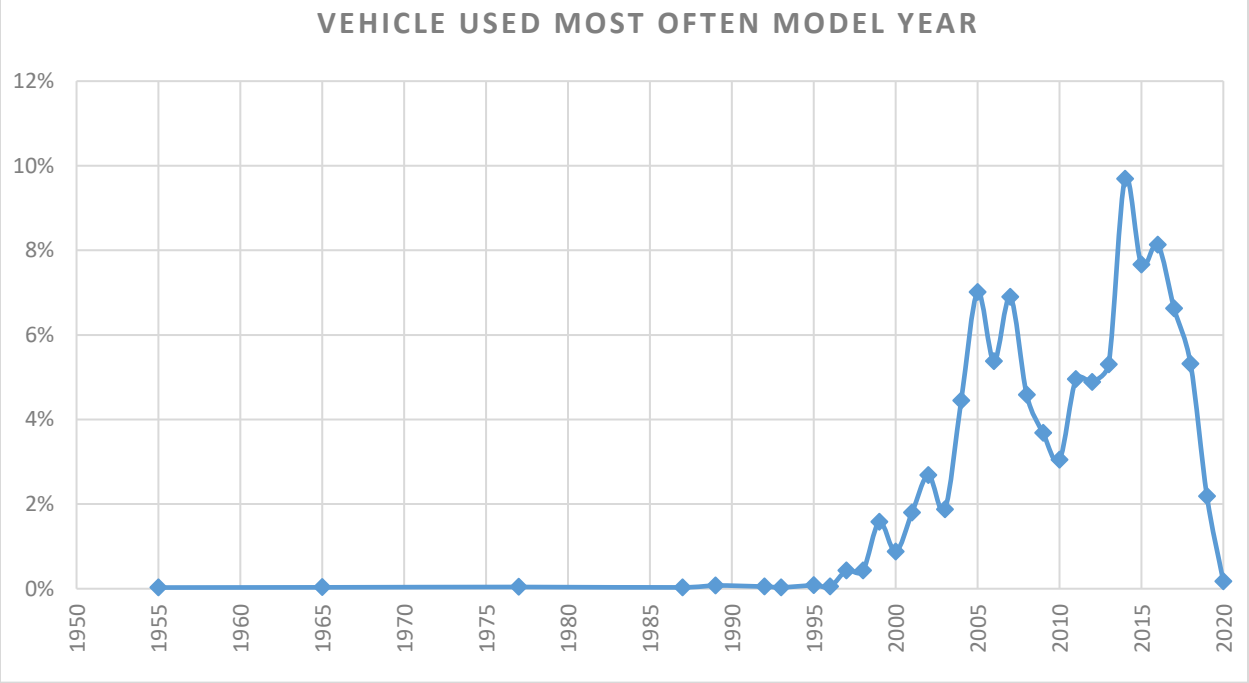


Figure 35 Distribution of Vehicle Model Year for Vehicles Used Most Often by Respondent (N=863)

Figure 36 presents the results on the availability and type of driving assistance features of vehicles the respondents used most often. The results showed that the top three features available in the vehicles are the backup camera, adaptive cruise control, and automated braking system, respectively while blind-spot monitoring and lane-keeping system are relatively less available features on the vehicles. Furthermore, 23 percent of the vehicles the respondents used most often are reported not having any of the given driving assistance features.

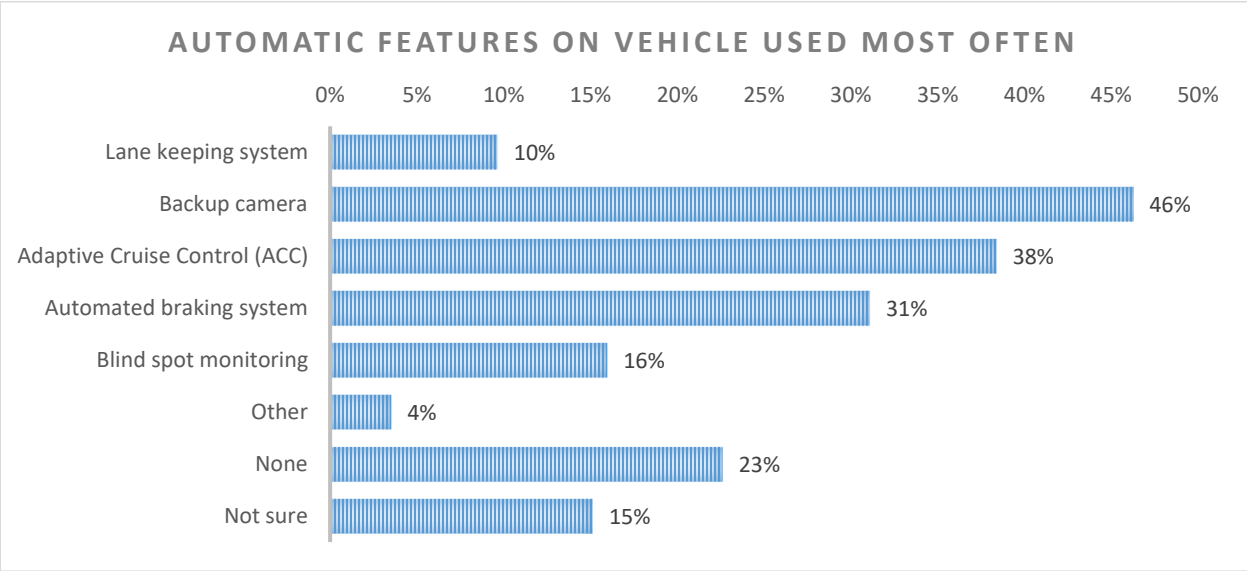


Figure 36 Features Available on the Vehicle Respondent Uses Most Often (N=960; Multiple selections were allowed)

Residential Choice

This subsection presents the survey results on the respondents' residential choice preferences. It was presented in the previous section that based on the weighted sample data, 60 percent of respondents are homeowners and 30 percent are renters. Figure 37 shows the distribution of years when the respondents moved to their current homes. The results suggest that the number of moves increases in recent years, particularly in 2017 and 2018 although a notable number of people reported living in the same home for at least 20 years. Moreover, 68 percent live in stand-alone houses and 21 percent live in apartments or condos.

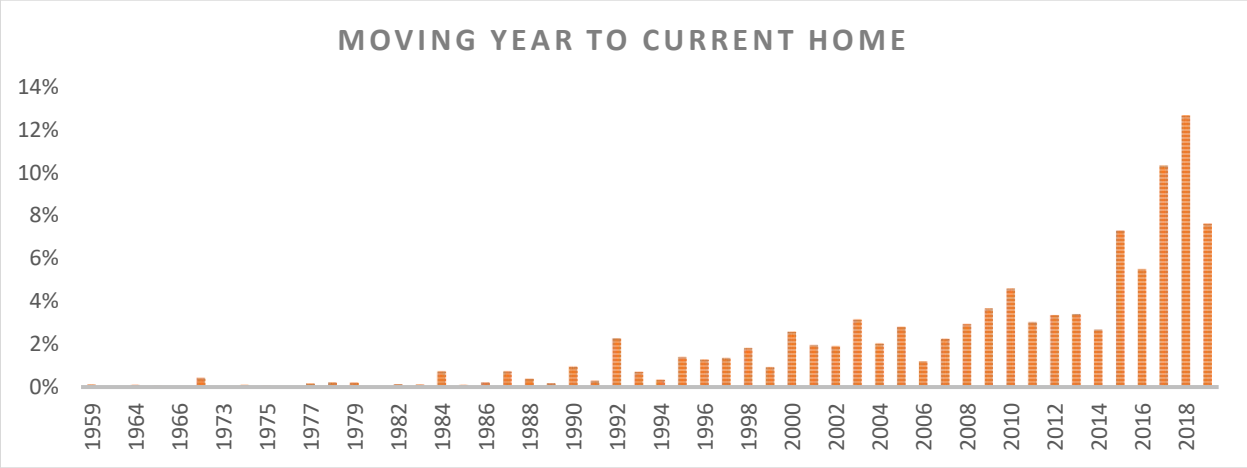


Figure 37 Year Moved to Current Home (N=1023)

Figure 38 presents the survey results on home choice preferences. Respondents were asked "Which of the following features would you seek for your next home? Or did you seek when moving to your current home?" Those who already chose their home location (75 percent) saw the question in the past tense and

those who did not choose their home location (25 percent) saw the question in the future tense. The results are shown in Figure 38.

The combined results revealed that top must-have features include low crime neighborhoods with 52 percent, single-family home (stand-alone home) with 38 percent, backyard with 29 percent, close to good work/school location with 25 percent, and good public schools with 23 percent. The top desired features include close to shops and services with 58 percent, easy to walk or bike around with 51 percent, and close to park and nature with 47 percent. Top unwanted features include large home with 20 percent, good public schools with 11 percent, and backyard with 6 percent. The top least caring features include good access to public transit with 58 percent, close to family and friends with 41 percent, and good public schools with 39 percent. Overall, the results suggest that many people want to live in stand-alone homes with a backyard in a neighborhood that is safe, walkable, bikeable, with and close to shops/services, and work/school location. It is also notable that not many people seek large homes neither good access to public transit when choosing their home.

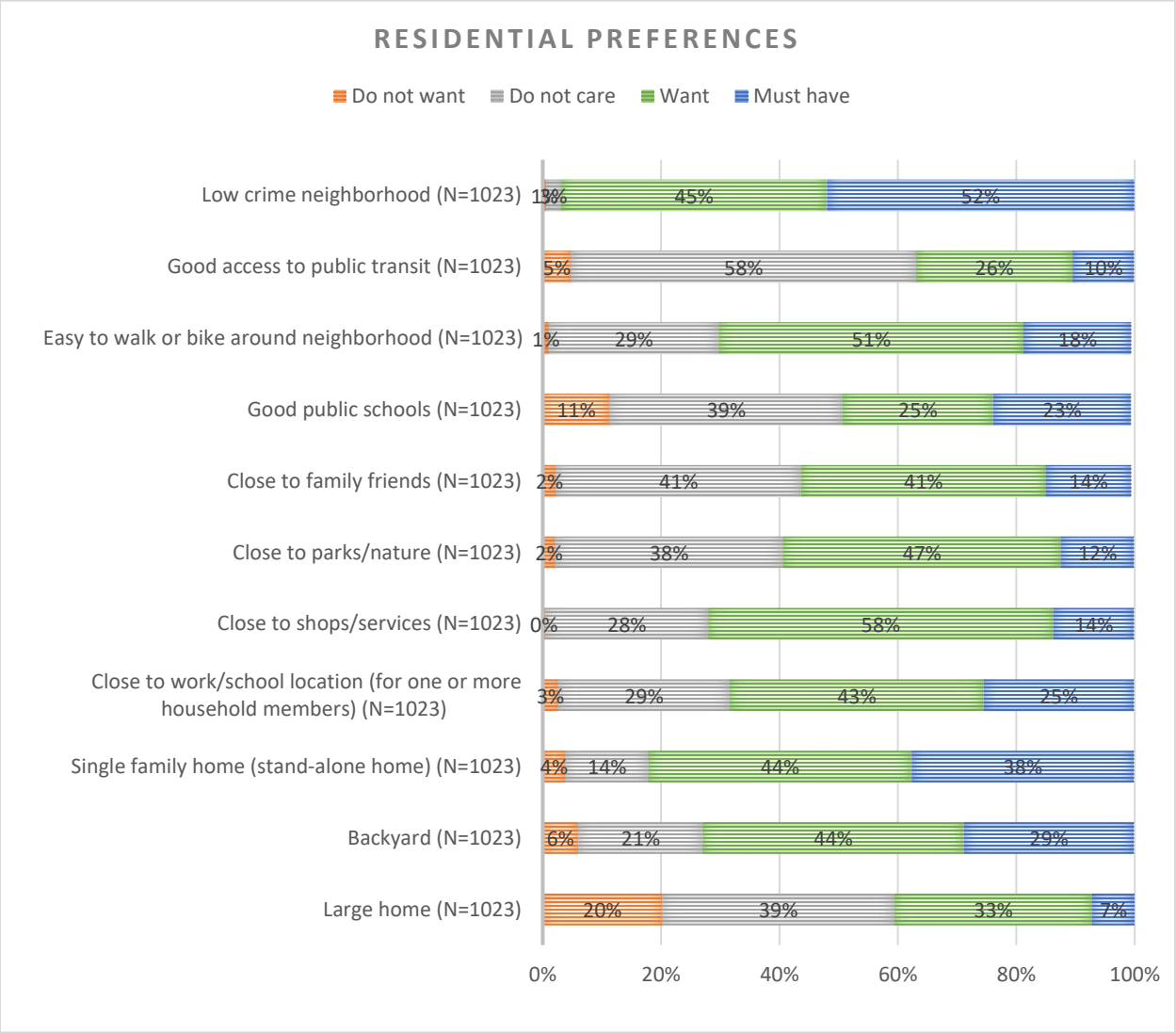


Figure 38 Preferences for Home Location and Home Features

1. CURRENT TRAVEL PATTERNS

This section of the survey focuses on understanding the current travel patterns of the respondents. The survey asked about general travel behaviors, commute behaviors, and long-distance travel patterns, in addition to the frequency of online shopping, and the number of items delivered to the house. Collecting this information is important to understand how users' perceptions of new technology are related to their current travel patterns and needs.

Figure 39 shows that for non-commute trips 58 percent of the respondents drive private vehicles alone three or more days a week, while 30 percent drive private vehicles with passengers and 13 percent ride in private vehicles with others. While 61 percent indicated that public transit by bus is available, but they never use it and only 7 percent of the weighted sample use the bus for non-commuting purposes weekly. Similarly, 35 percent of respondents never use light rail even if it is available, while 42 percent of the respondent said that the light rail is not available. Ridehailing services also do not have many frequent users with 63 percent indicating that the service is available, but they never use it. About 20 percent of the weighted sample do walk for non-commuting trips weekly and 13 percent do walk similarly monthly. Biking has much fewer users in comparison to walking, with less than 5 percent weekly users for non-commute trips. In summary, a private vehicle is the main mean of transportation for non-commute trips in single or higher occupancy forms.

Figure 40 indicates the responses from respondents about how many miles do they drive in a week, on average while they are not “on the clock” for work. About 26 percent of the respondents indicated that they drive more than 100 miles in a week, while 38 percent indicated that they drive between 1-50 miles in a week. The distribution appears to be balanced with about 28 percent indicating that they driver 51-100 miles in a week. Lastly, 7 percent of the respondents who stated to have driver’s license reported zero miles driven during the week.

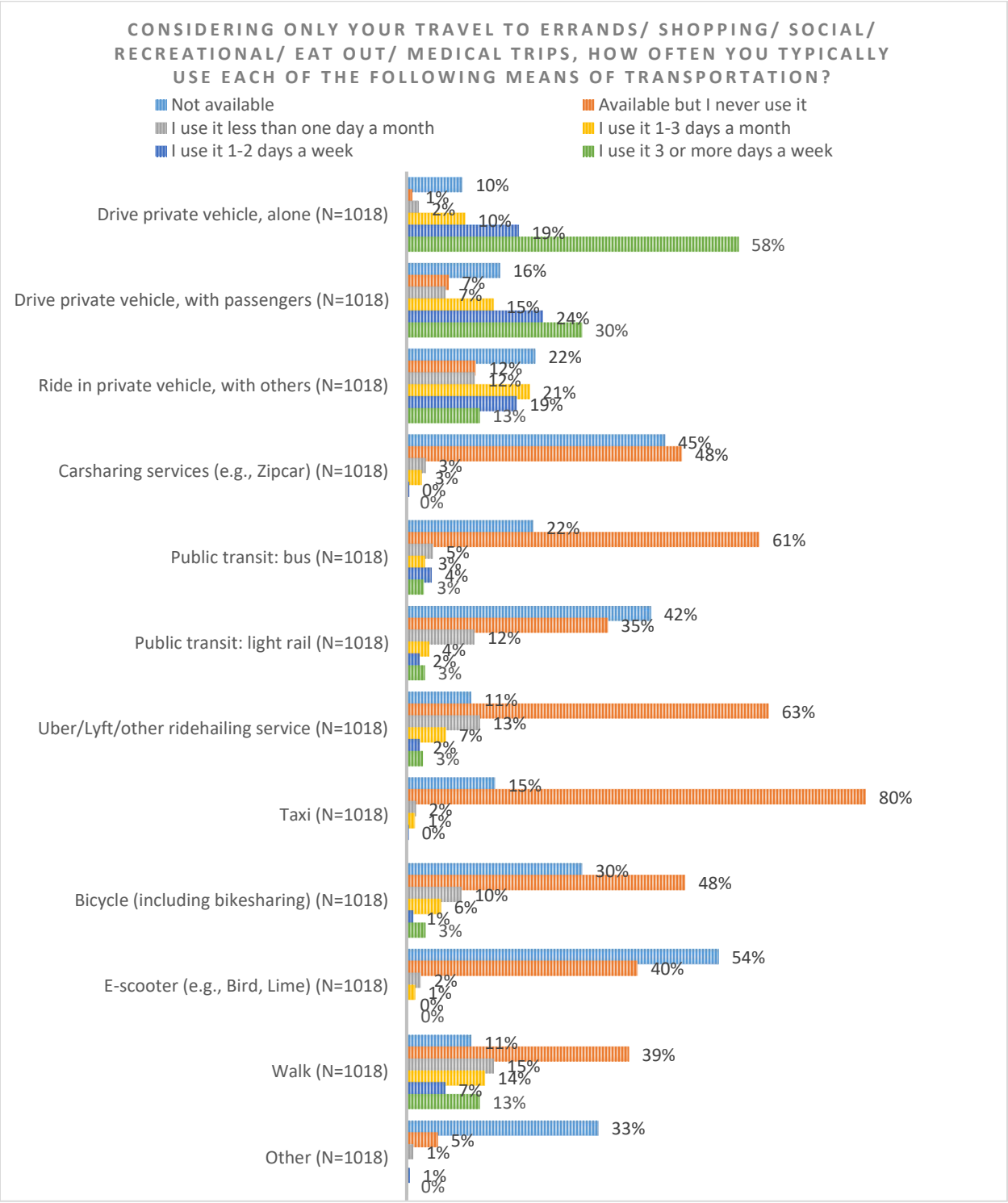


Figure 39 Frequency of Mode Use on Non-Commute Trips

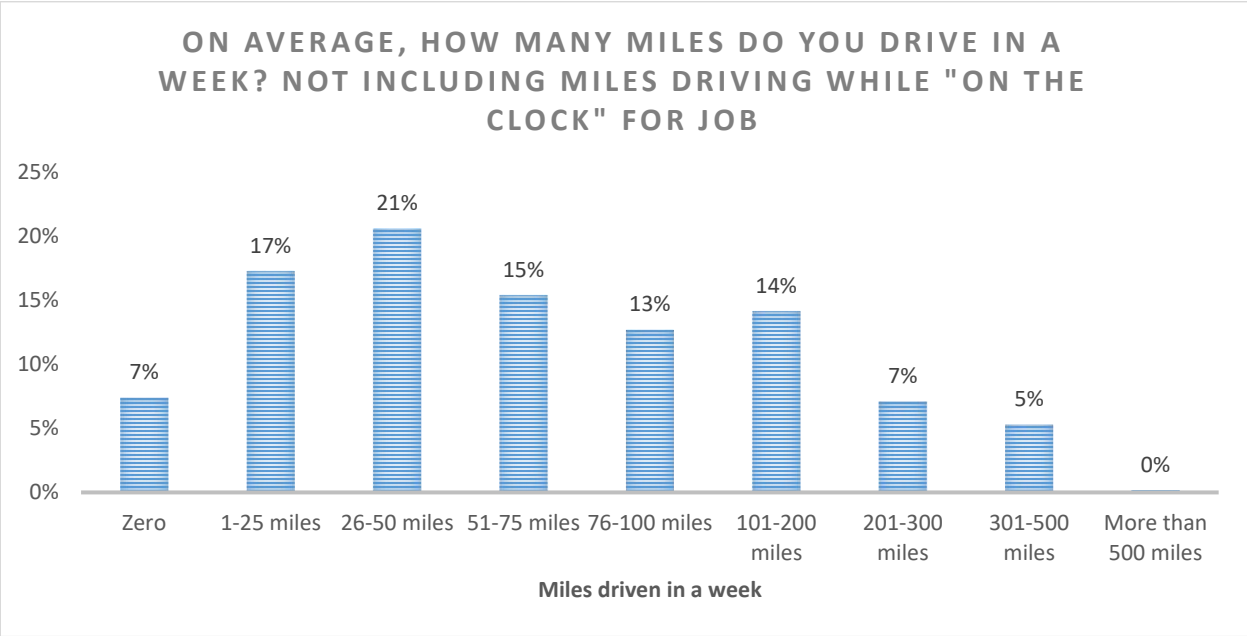
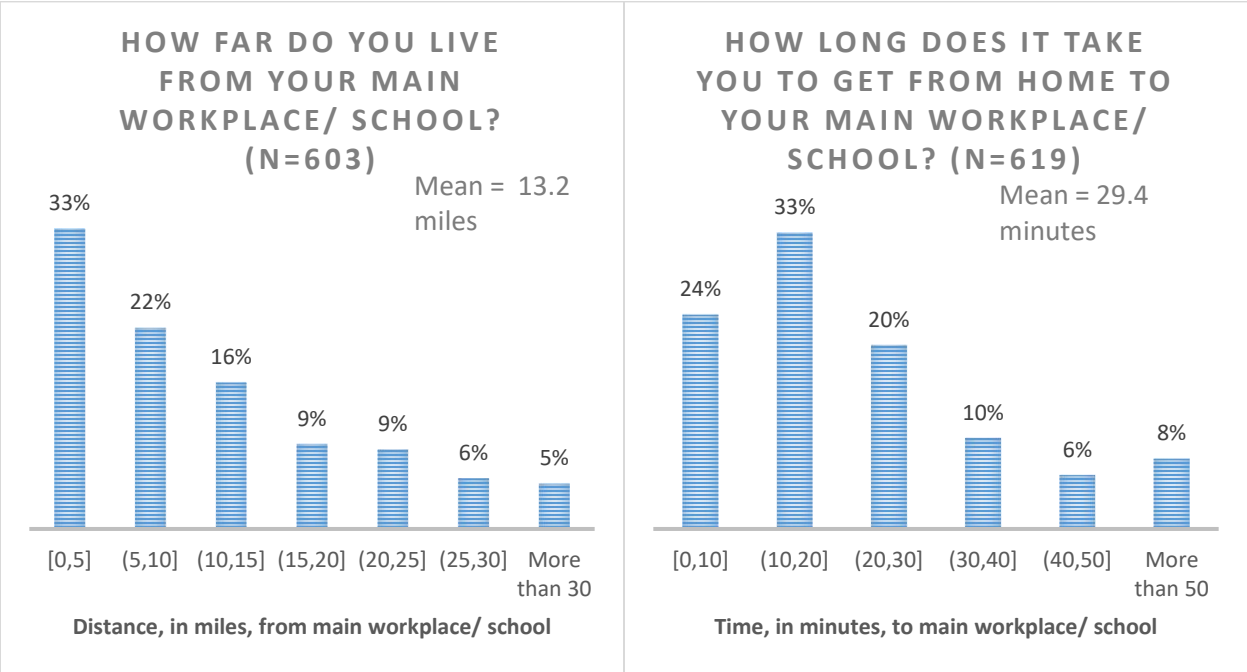


Figure 40 Average Weekly Miles Driven (N=1027)

1.1 Commute Trips

The survey asked about the number of days respondents traveled, on average, to work and school trips, respectively, as indicated in Figure 41. For the work destination, 57 percent of respondents indicated that they travel five days a week to work with average being nearly 4.3 days a week. In case when the destination is school, 49 percent of respondents travel 5 days a week to school with average being nearly 3 days a week. About one-quarter of the student indicated that they do not travel to school weekly. On average, the respondents indicated that they telecommute 1.2 days a week for work.



41 indicates that 65 percent of respondents do not telecommute for work, while 9 percent indicated 1 day a week and 6 percent indicated 5 days a week.

The distance (in miles) and the time is taken to travel (in minutes) from home to the main workplace/school location is shown in Figure 42. About one-third of the respondents live in between 0-5 miles from the main workplace/school location, while about 20 percent of the respondents live at a distance greater than 20 miles from the workplace/school location. The average travel distance is 13.2 miles for the respondents and the average travel time is 29.4 minutes. It takes between 10 to 30 minutes for 53 percent of the weighted sample to get to their main commute location.

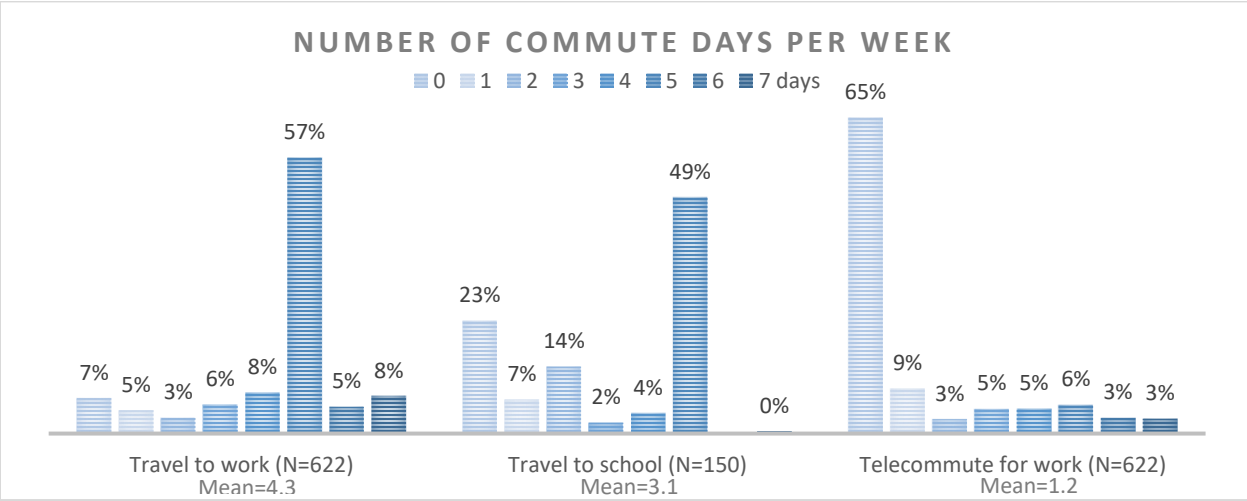


Figure 41 Frequency of Commute to Work and School and Telecommute

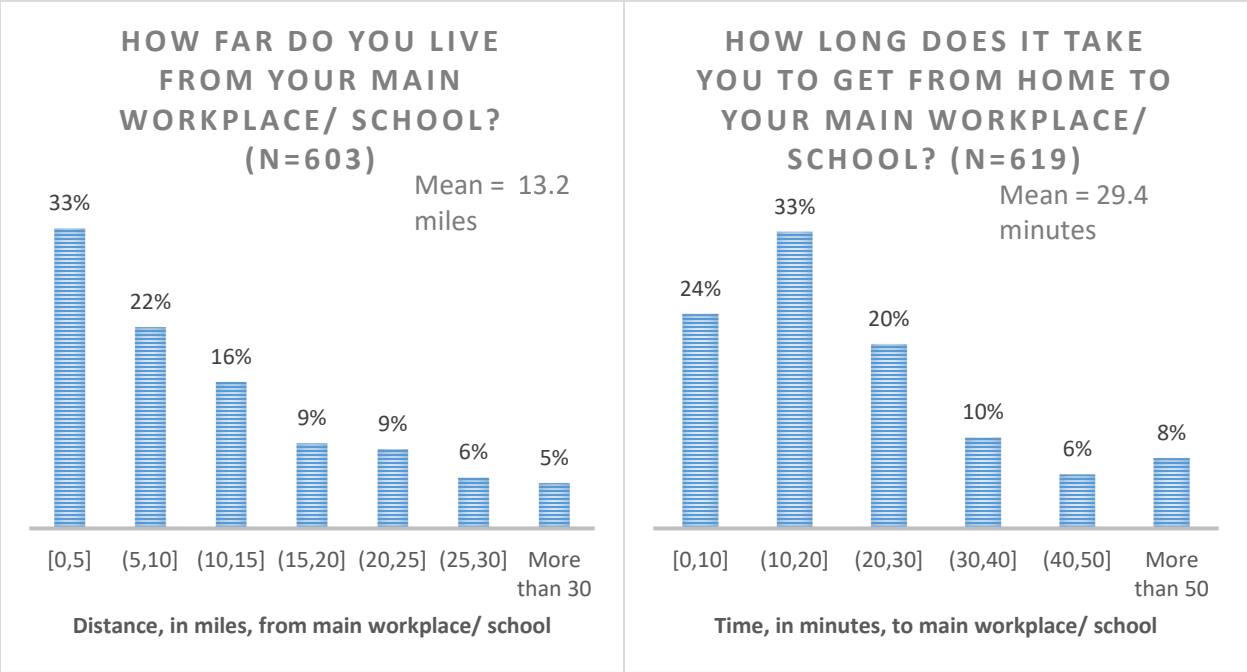


Figure 42 Commute Average Distance and Duration

Figure 43 indicates that 70 percent of the respondent selected driving alone in a private vehicle as the most often means of transportation for commuting, while 13 percent carpool in a private vehicle and 10 percent indicated public transit (bus and light rail) as the most often used mode of transportation. According to the American Community Survey (2017 5 years estimates), among workers 16 years and over in Maricopa County and excluding those who work from home, 82 percent drive alone to work, 12 percent carpool, 2 percent uses public transit, 2 percent walk, 1 percent bike to work, and 2 percent uses other modes to get to work.

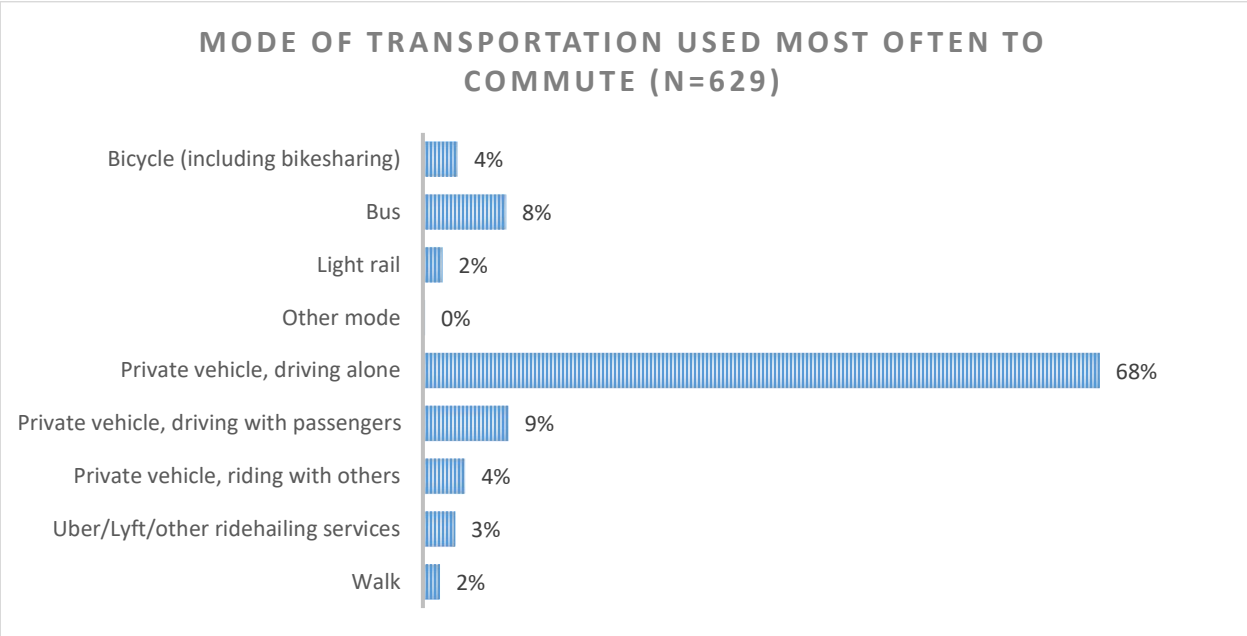


Figure 43 Means of Transportation Used Most Often on Commute Trips (N=629)

Figure 44 shows that for commute trips, three or more days a week, 71 percent of the respondents drive private vehicles alone, while 20 percent drive private vehicles with passengers and 20 percent ride in private vehicles with others. In comparison to non-commute trips, people use personal vehicles alone significantly more than other modes. While 50 percent indicated that public transit by bus is available, but they never use it and only 15 percent of the weighted sample use the bus for commuting purposes weekly. Similarly, 24 percent of respondents never use light rail even if it is available, while 50 percent of the respondent said that the light rail is not available. Ridehailing services also do not have many users with 67 percent indicating that the service is available, but they never use it. About 13 percent of the weighted sample do walk for commuting trips weekly and 6 percent do biking weekly. In summary, a private vehicle is the main mean of transportation for commute trips in single or higher occupancy forms. Bus, walking, and light rail are the next commute modes used most often on a weekly basis. In comparison to not-commuting trips, people use transit (bus and light rail) more for commute and use walk more for non-commuting trips.

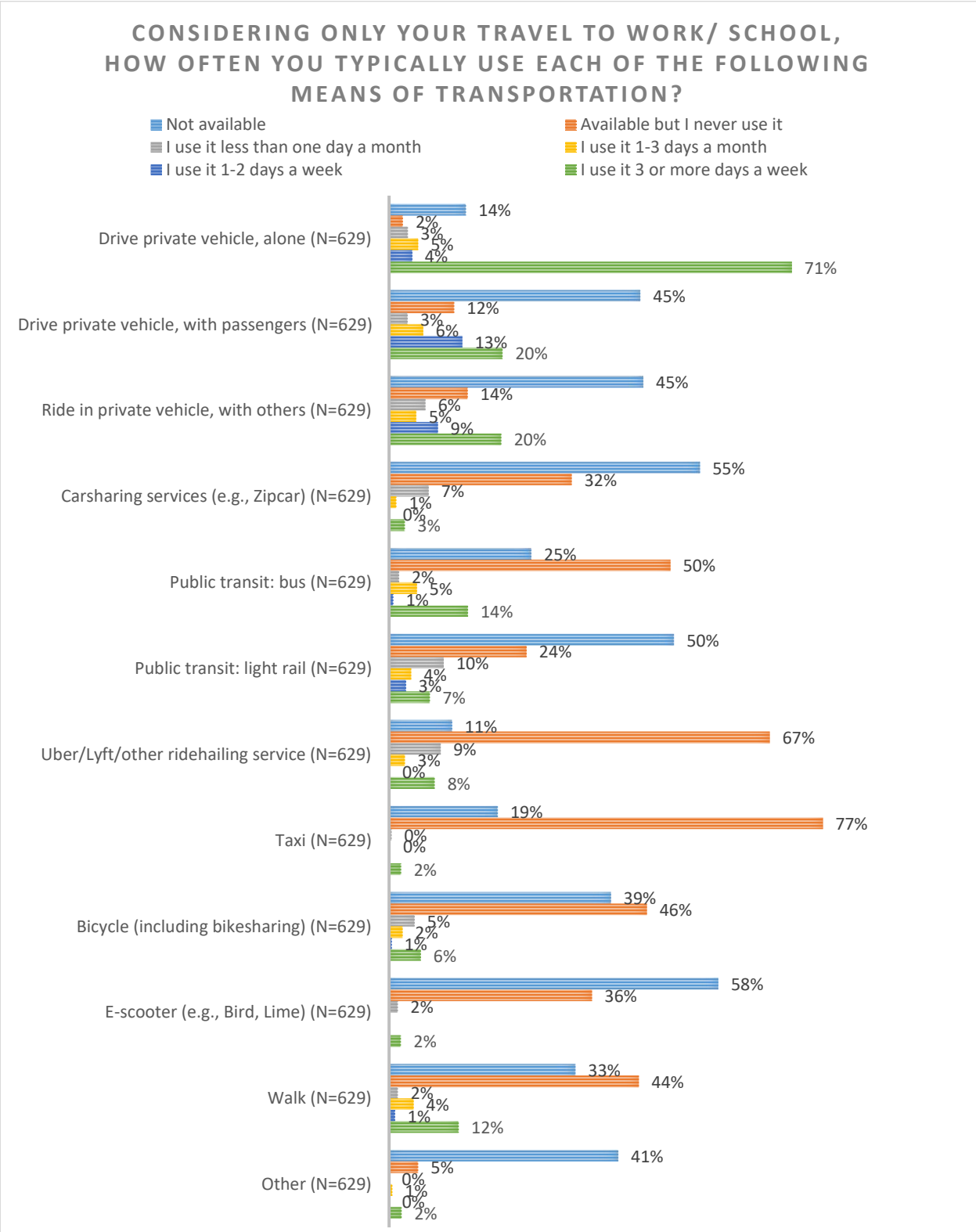


Figure 44 Frequency of Mode Use on Commute Trips

1.2 Long-Distance Trips

This sub-section of the survey tries to gauge the respondents' long-distance travel. Autonomous vehicles could make long-distance trips less burdensome by eliminating driving. To understand the extent AV adoption might impact long-distance trips mode choice is one of the objectives of the T4 survey. In this study, long-distance travel was defined as trips that were at least 75 miles long (one-way), not including commute trips for about a half-year period (from the beginning of 2019 to the Jun-July 2019).

Figure 45 shows the frequency of the mode used to make personal long-distance trips. The car emerged as the most often used mode with about 11 percent of respondents indicated using car 6 or more times for long-distance travel, while 3 percent of the respondents used airplanes for 6 or more times for long-distance trips. The average number of long-distance trips with car is 2.6 while the same number is 1.1 for airplane and 0.5 for other modes of travel. More than half of the respondents had at least one long-distance trip by car and less than half of the respondents had at least one long-distance trip by airplane.

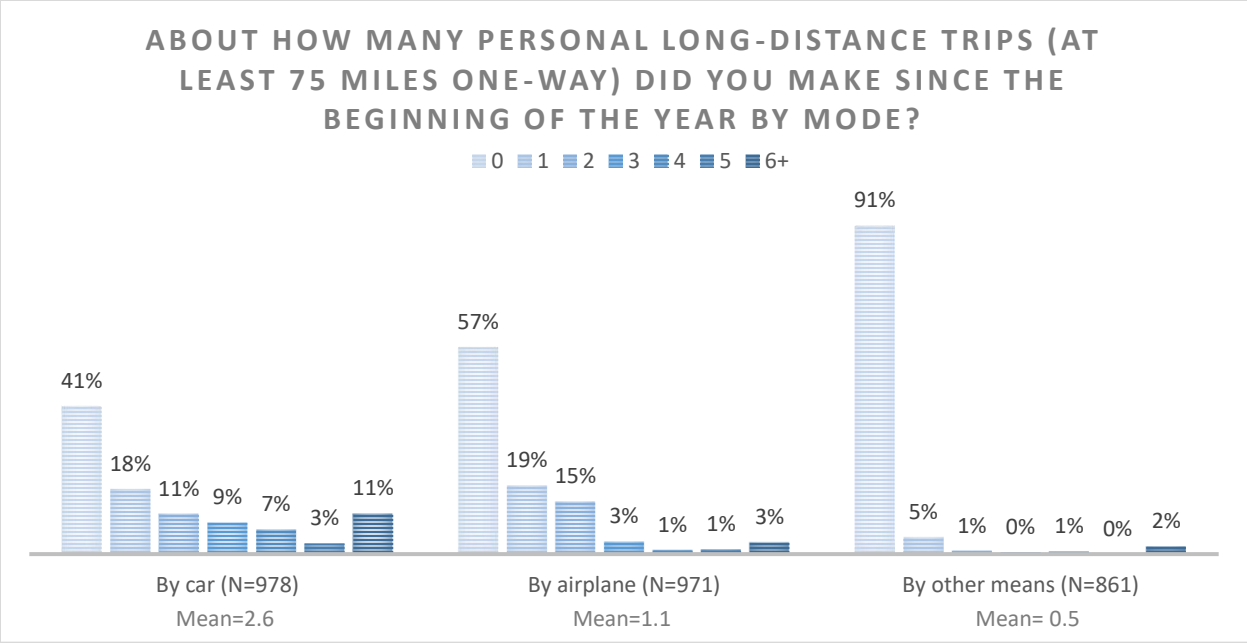


Figure 45 Frequency of Long-Distance Trips for Personal Purposes Since the Beginning of the Year 2019

In the case of frequency of long-distance trips made for business (Figure 46), 86 percent of the respondents didn't make any long-distance trip by car and 87 percent of the respondents didn't make any long-distance trip by airplane. The average number of business trips by car (1.3) is more than airplane business trips (0.7) per each weighted respondent similar to personal trips.

This section of the survey also asked about trips to the local airport. 58 percent of the respondents (N=1,071) reported having been to the Phoenix Sky Harbor or Mesa Gateway airports since the beginning of the year to either travel or to pick-up/drop-off someone else who was traveling. The purpose of asking if the respondent had visited the local airport was to improve the relevance of stated preference questions on mode choice in a scenario with automated options, asked later in the survey.

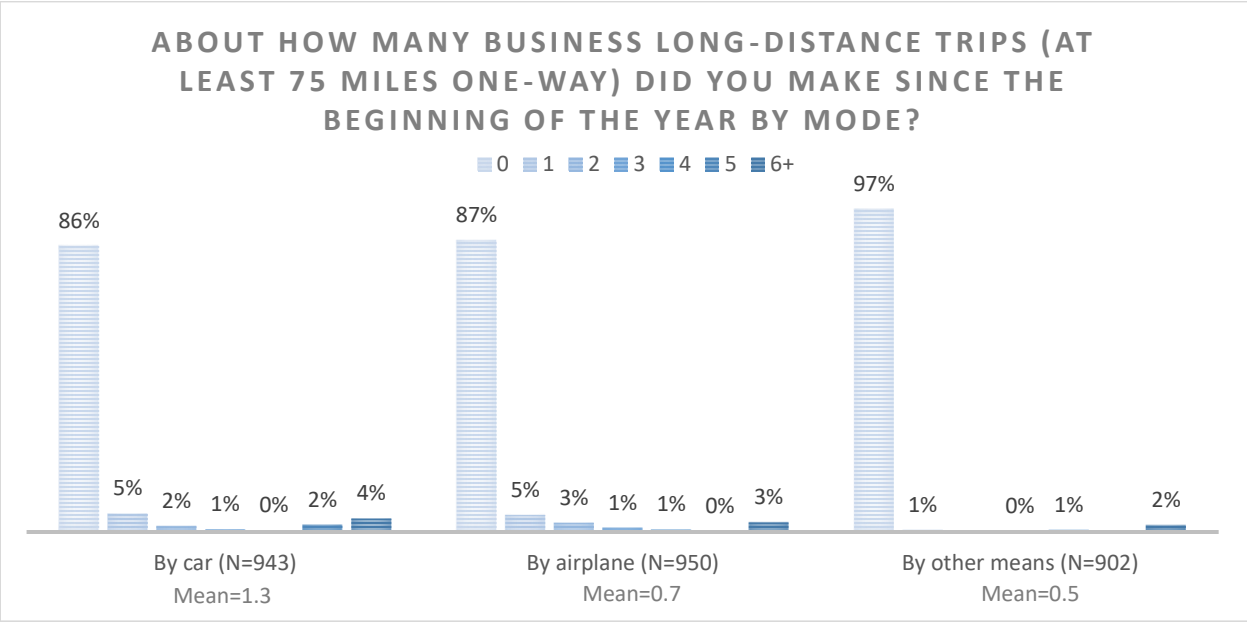


Figure 46 Frequency of Long-Distance Trips for Business Purposes Since the Beginning of the Year 2019

1.3 Items Delivered to the House

Because AV and mobility-on-demand services have the potential to serve freight deliveries, this section of the survey explores the current patterns of using online shopping in different categories of parcels, meals, and groceries. When asked about the item delivered to the house in the past 30 days, 37 percent of the respondents indicated that they purchased items online 2-3 times, while about 15 percent of the respondent indicated purchasing the item online more than 7 times. Most of the respondents (80 percent) did not have prepared meals delivered to the home and 88 percent did not have grocery items delivered in the past 30 days (Figure 47).

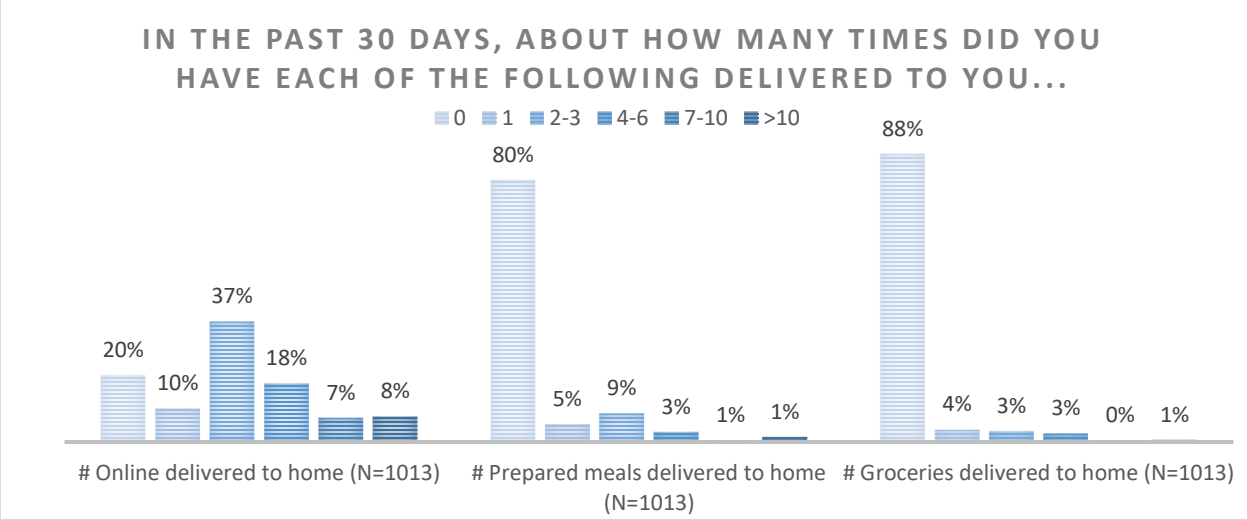


Figure 47 Frequency of Items Delivered to the House in the Past 30 Days

2. MOBILITY-ON-DEMAND SERVICES

This section focuses on the mobility-on-demand services and asks respondents about familiarity, use, attitudes, and perceptions of these services. In this section, mobility-on-demand refer to private and shared ridehailing services, car sharing, bike sharing, and e-scooter sharing services. Respondents were asked to detail their last trips using ridehailing services, and bike-sharing/e-scooter sharing, when applicable. In the question of this section of the survey, respondents were asked about their willingness to share ridehailing services under specific scenarios (stated preference).

2.1 Familiarity with Mobility-on-demand Services

Figure 48 illustrates how much respondents in the Phoenix metro area are familiar with and use mobility-on-demand services. The mobility-on-demand service which is less familiar to respondents is carsharing (e.g., car2go, Zipcar). Among all the asked mobility-on-demand services, private ridehailing services are the most common with 14 percent of the respondents using it weekly or monthly and only 10 percent of the respondents not familiar with them. The remaining 76 percent of the respondents either use it rarely or are familiar with it but do not use it. It should be noted that shared ridehailing services were not available to users in Phoenix metro area, and so it is expected that 38 percent of the respondents were not familiar with them and less than one percent of the respondents reported using them (in other locations).

Bikesharing services are available in the Phoenix metropolitan area through an initiative from the local city governments that implemented in 2017 a docked system of bikesharing in Phoenix, Mesa, and Tempe. Free-floating bikesharing was not extensively available in the Phoenix metropolitan area at the time of the survey, however, a few bicycles and e-bikes were available sparsely. As for carsharing services, close to half of the respondents are not familiar with bike-sharing services and almost the remaining half are familiar with them but do not use them. Less than one percent of respondents reported using carsharing and one percent use bike sharing on a weekly basis in the Phoenix metro area.

E-scooter sharing services had the largest share of individuals who are familiar with the service but have never use it (61 percent). E-scooter services arrived in the Phoenix area during Summer 2018 and have been growing ever since. Currently, there are several different e-scooter sharing companies operating in the area (e.g., Bird, Razor, Jump, Spin, Lime, Lyft, among others). About 5 percent of the respondents are using E-scooter sharing services rarely and about two percent are using weekly or monthly.

2.2 Bike-share and E-scooter-share Services

This section of the survey was proposed only to the 72 respondents that reported having used either bike-sharing or e-scooter services. The attributes of the last trip with E-scooter or bike-sharing services were asked. About 24 percent of the respondents used bike-sharing and 76 percent used e-scooter sharing.

In terms of the time of day when these services were used, most of the trips (62 percent) occurred during weekday daytime (Figure 49). Regarding trip length using E-scooter or bike-sharing services, most of the trips (53 percent) were between 1 to 2 miles long; 22 percent of the trips were less than a mile, and the remaining 24 percent was over the two miles mark (Figure 50).

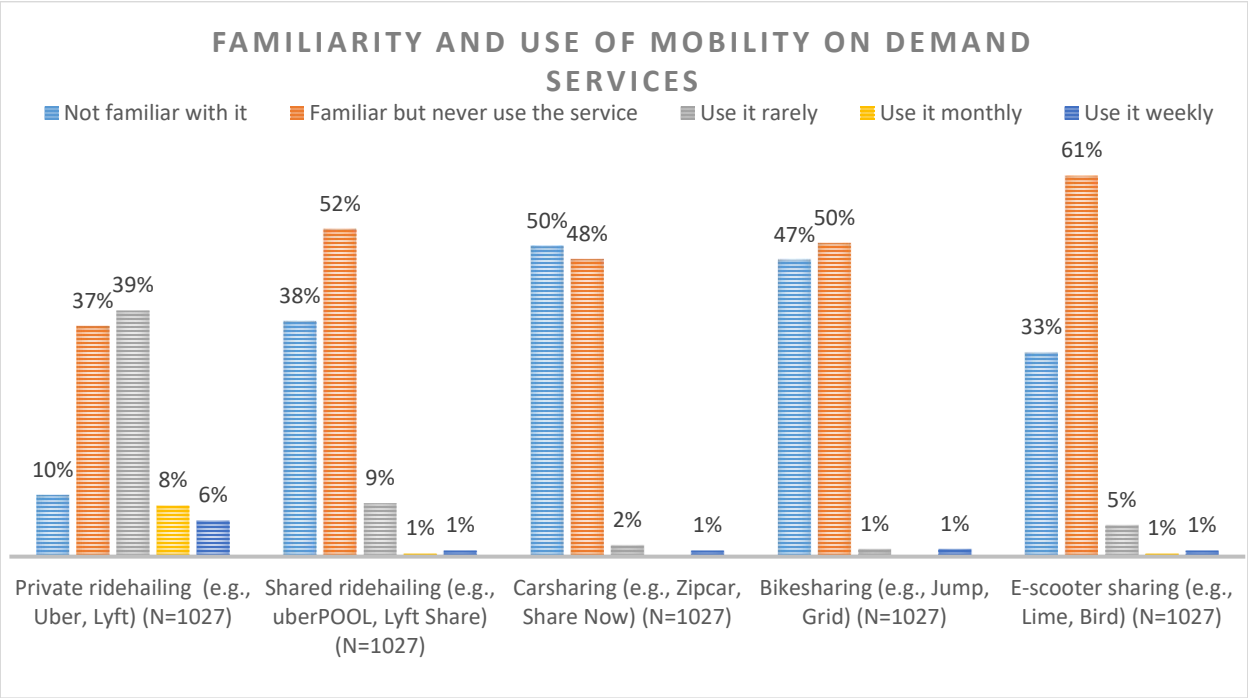


Figure 48 Familiarity and Use of Mobility-on-demand Services

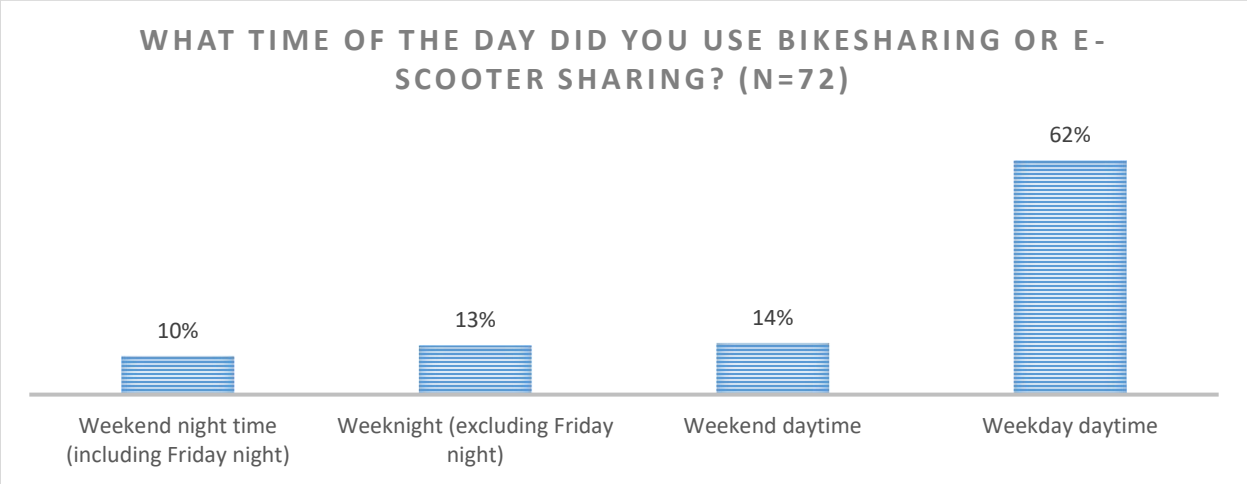


Figure 49 Time of Day of Bikesharing or E-scooter Sharing Usage

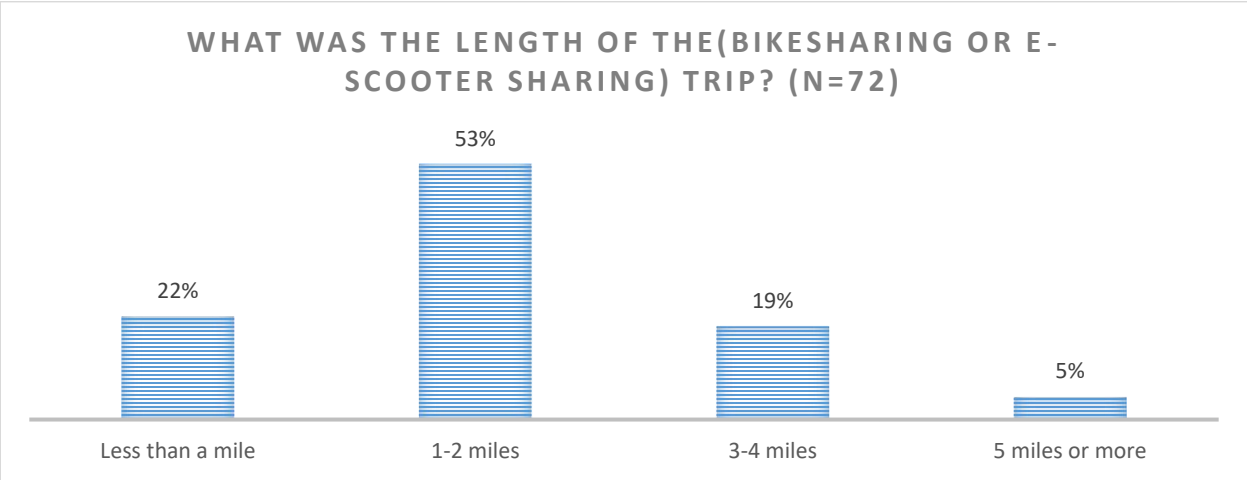


Figure 50 Trip Length on Bikesharing or E-scooter Sharing Trips

Regarding the primary purpose of the trip using either e-scooter or bike-sharing services (Figure 51), most respondents reported using the service on shopping/errands (30 percent), social/recreational trips (28 percent) and eating/drinking (13 percent). These services have been used for commuting only on 20 percent of the reported trips. Also, 8 percent of respondents indicated that their trip had the main purpose of just enjoying the ride or trying a new service.

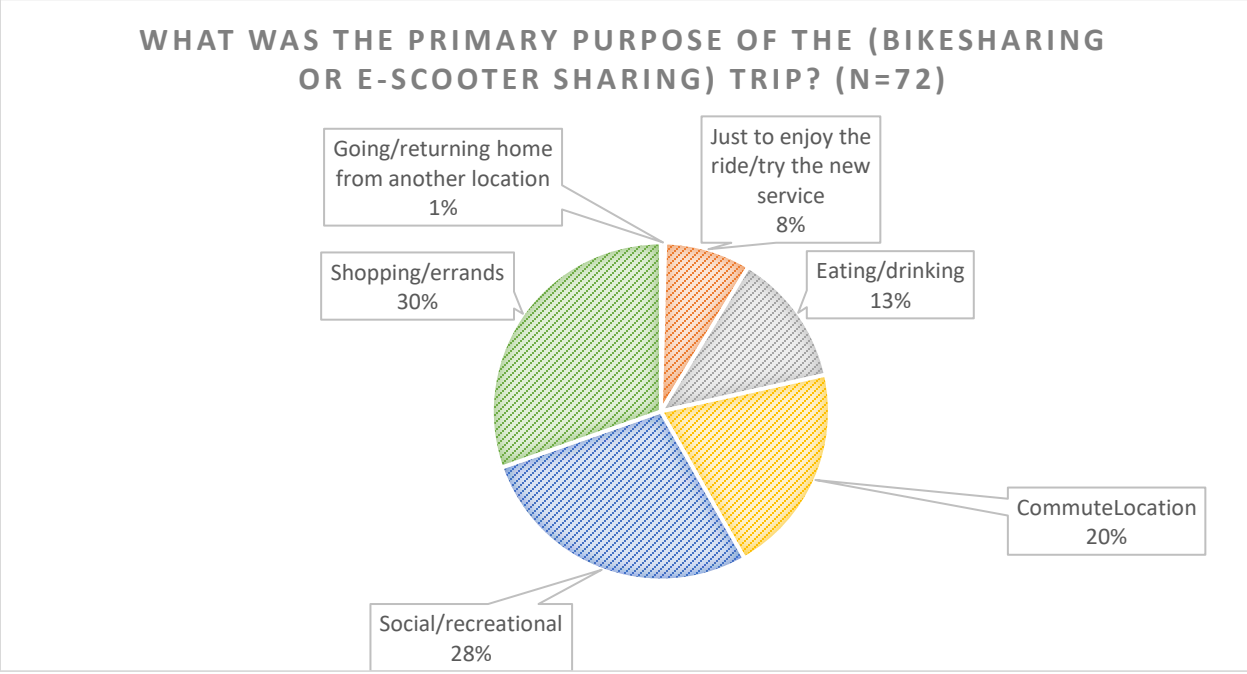


Figure 51 Trip Purpose for Bikesharing or E-scooter Sharing Trips

When asked about the reasons why bike-sharing or e-scooter sharing service was selected for the trip, the most common reason reported was "*Just to enjoy the ride/try a new service"*, selected by 72 percent of the respondents (Figure 52). The second and third most common reasons for selecting those services were, respectively, "*No need to park/ parking was expensive or scarce"* and *"To save time"*. In this particular question, respondents were able to select up to three reasons for why they have selected the

service for the trip.

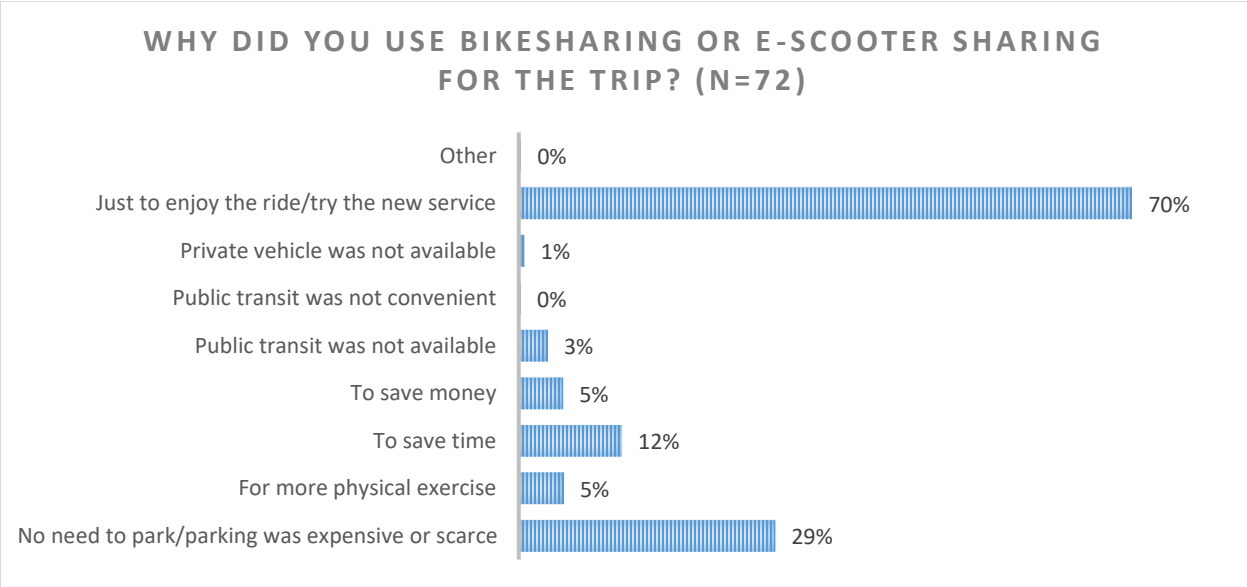


Figure 52 Reasons Why Bikesharing or E-scooter Sharing Was Selected for the Trip

Figure 53 shows the distributions of selected alternative modes for the respondents' last trip using bike-sharing or e-scooter sharing. About 33 percent of respondents reported they would have walked if the service was not available, 23 percent said they would have used their own bike/scooter, 11 percent reported they would have not made the trip and 14 percent would have used the light rail. About 17 percent of the users would have used private vehicles in private or HOV mode. This finding suggests that bike-sharing and e-scooter sharing services are possibly replacing walking and light rail trips and inducing extra demand for the trips that would not have been taken otherwise (corresponding to 58 percent of the total trips). On the other hand, these new services have absorbed some trips from private vehicles and ridehailing services (corresponding to 19 percent of the total trips).

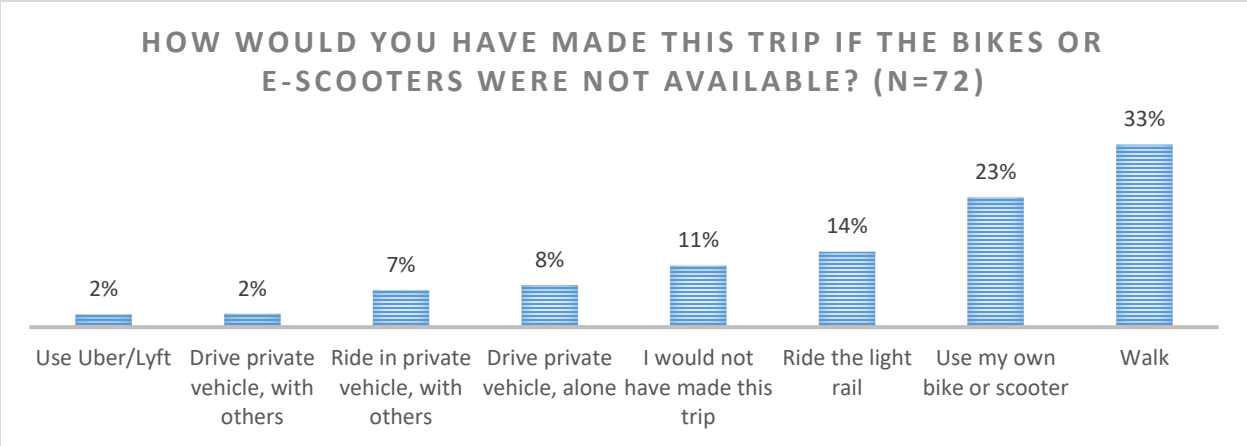


Figure 53 Alternative Mode to Bikesharing or E-scooter Sharing Trips

2.3 Ridehailing Services

This section of the survey was proposed to those who have indicated that they have used ridehailing services

(N=560). The detailed attributes of their last trip with ridehailing services plus their perceptions were asked. The majority of the ridehailing users in the Phoenix metro area (95 percent) reported their last trip to be with private ridehailing (*e.g.*, Uber, Lyft), while 5 percent used shared ridehailing (*e.g.*, uberPOOL, Lyft Share). Figure 54 shows that most ridehailing trips were placed during weekday daytime (43 percent), followed by weekend nighttime which includes Friday night (29 percent), and weeknights, excluding Friday nights (21 percent).

An important attribute of ridehailing trips includes wait times for the trip as well as the in-vehicle travel times, which adds up to the total travel time. Figure 55 shows the distributions of both wait times and in-vehicle travel times reported by the survey respondents for the last ridehailing trip they recall. While most respondents (57 percent) reported wait times of 5 minutes or shorter, 15 percent of the respondents reported 11 minutes or more for their wait time. In-vehicle travel times were more distributed with 53 percent of the trips having between 6 to 20 minutes in-vehicle travel time. Only 7 percent of the trips take less than 5 minutes in the vehicle, while 16 percent of the trips take more than 30 minutes.

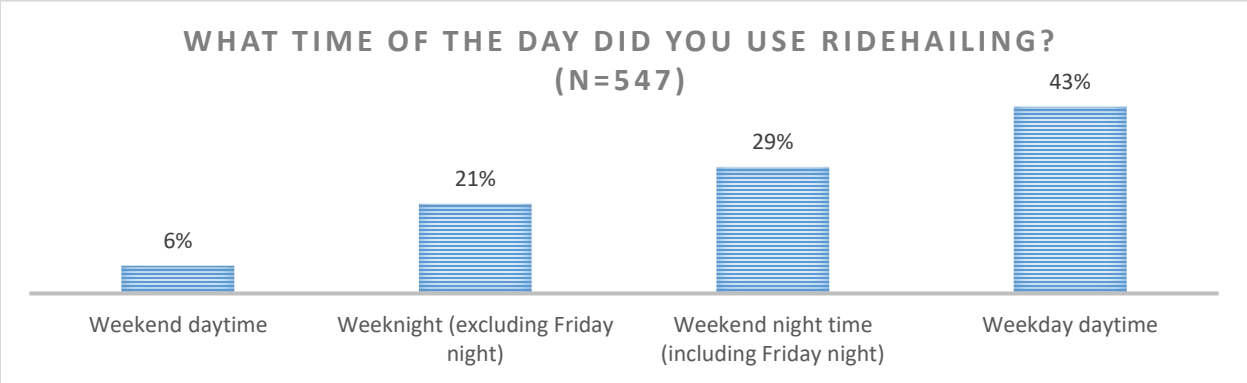


Figure 54 Time of Day Distribution for Ridehailing Trips

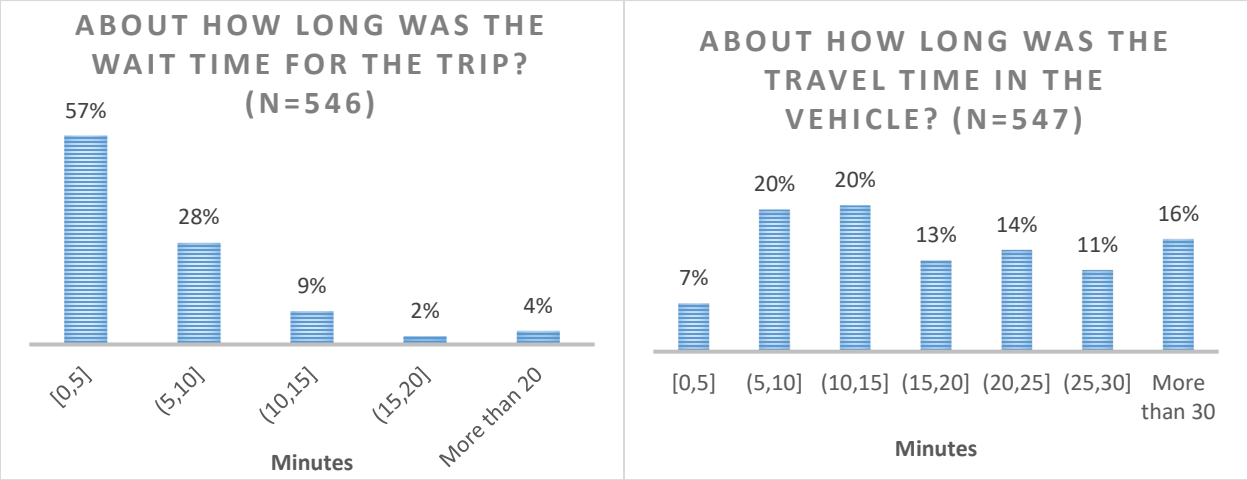


Figure 55 Wait Time and In-vehicle Travel Time for Ridehailing Trips

When asked about companionship on their last ridehailing trip, 50 percent of ridehailing users (N=554) declared to be the only passenger in the trip, while 47 percent reported traveling with family members, friends, or colleagues, and 3 percent traveled with other passengers matched via the app (for shared ridehailing).

When asked about the alternative mode respondents would have used for this trip if ridehailing

were not available (Figure 56), the most common alternative private vehicles alone or in HOV mode (40 percent). The second and third most common alternative modes to ridehailing trips were, respectively, taxi (19 percent) and bus (13 percent). Interestingly, 11 percent of the users would have not made this trip if ridehailing services were not available. These findings illustrate the addition of induced demand (11 percent) and switched demand from transit (16 percent for bus and light rail) that these services add to the transportation network and it is very important to consider them when planning for the autonomous vehicle demand.

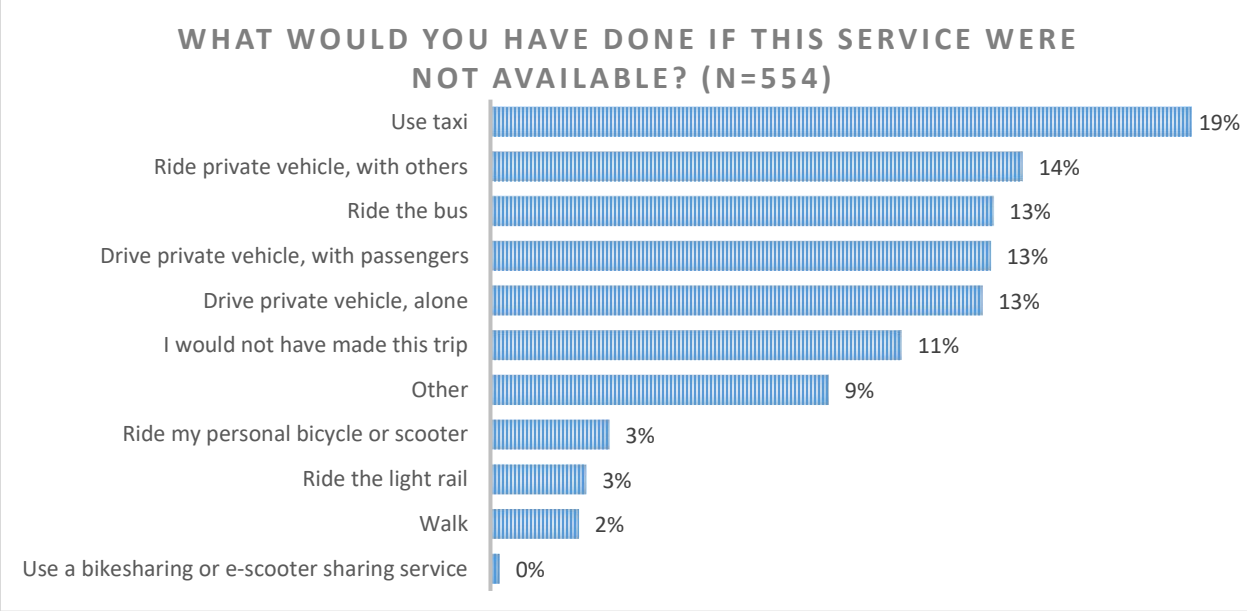


Figure 56 Alternative Modes to Ridehailing Trips

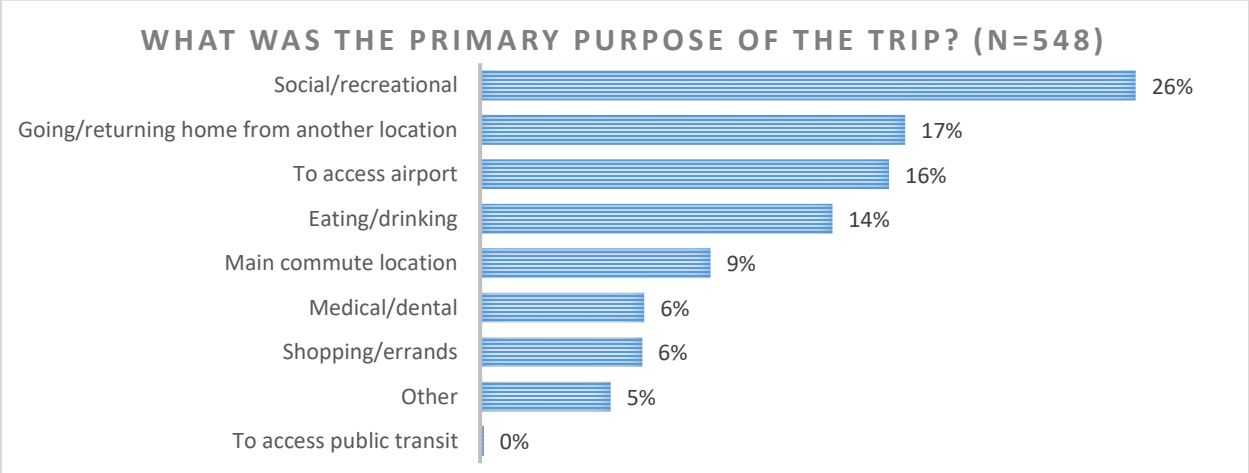


Figure 57 illustrated the distribution of the primary purpose of the ridehailing trips. Traveling to commute location represent only 9 percent of the trips, while traveling to social and recreational places represent 26 percent of the trip. Traveling to the airport (16 percent) and traveling home (17 percent) represent the two other major trip purposes. Unfortunately, access to transit contributes to less than one percent of the ridehailing trips.

Respondents who reported they have used private ridehailing were asked the maximum additional travel time they would have accepted to use shared ridehailing if the service were available for half of the

cost; Figure 58 shows the distribution of responses. Only 27 percent of respondents reported they would not have accepted the shared ridehailing trip, even if the cost was half of what they paid for the private version of the same service. 16 percent of the respondents reported to accept between 1 to 5 minutes increase in their travel time, 24 percent said to accept between 6 to 10 additional minutes, and 33 percent reported to accept 11 minutes or longer on shared ridehailing services for half of the price they have originally paid. These findings highlight that there is a willingness to share ridehailing services when the price justifies it. It should be noted that ridehailing services in private form are not helping much in reducing the load on the transportation network, energy consumption, and emission production. In other words, in the future, ridehailing services using autonomous vehicles are sustainable and will improve transport systems if the services are used mainly in sharing mode.

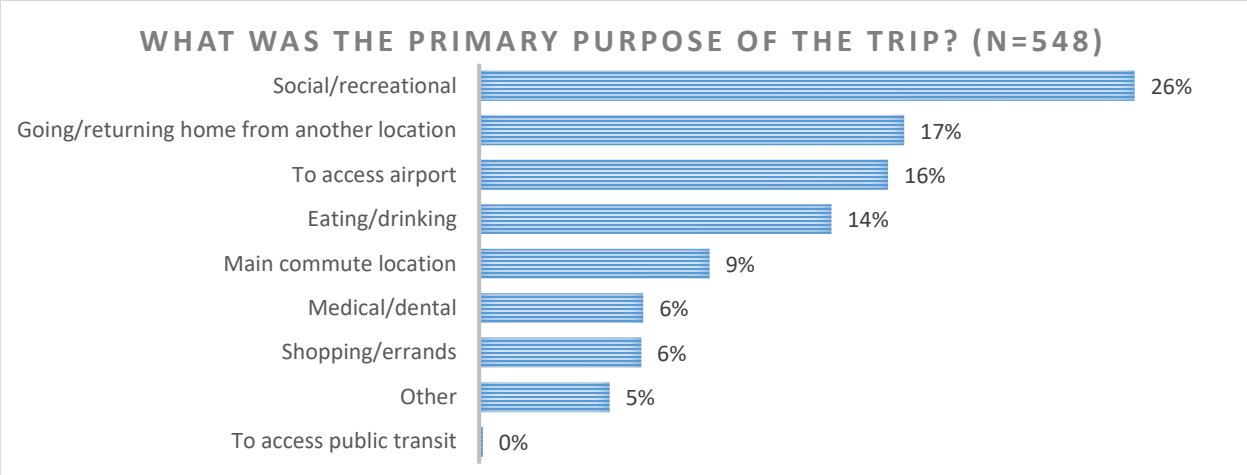


Figure 57 Primary Purpose of Ridehailing Trips

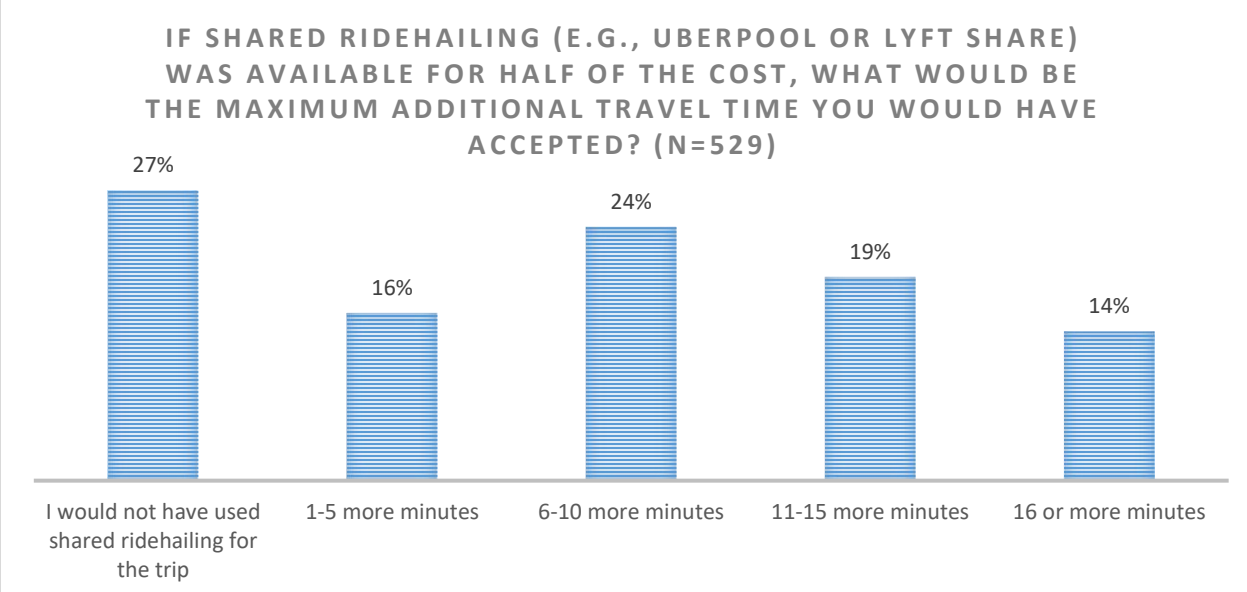


Figure 58 Additional Travel Time Accepted for Ridehailing Trips

In addition to the question about their last trip using ridehailing services, ridehailing users were

asked general questions about their use of those services.

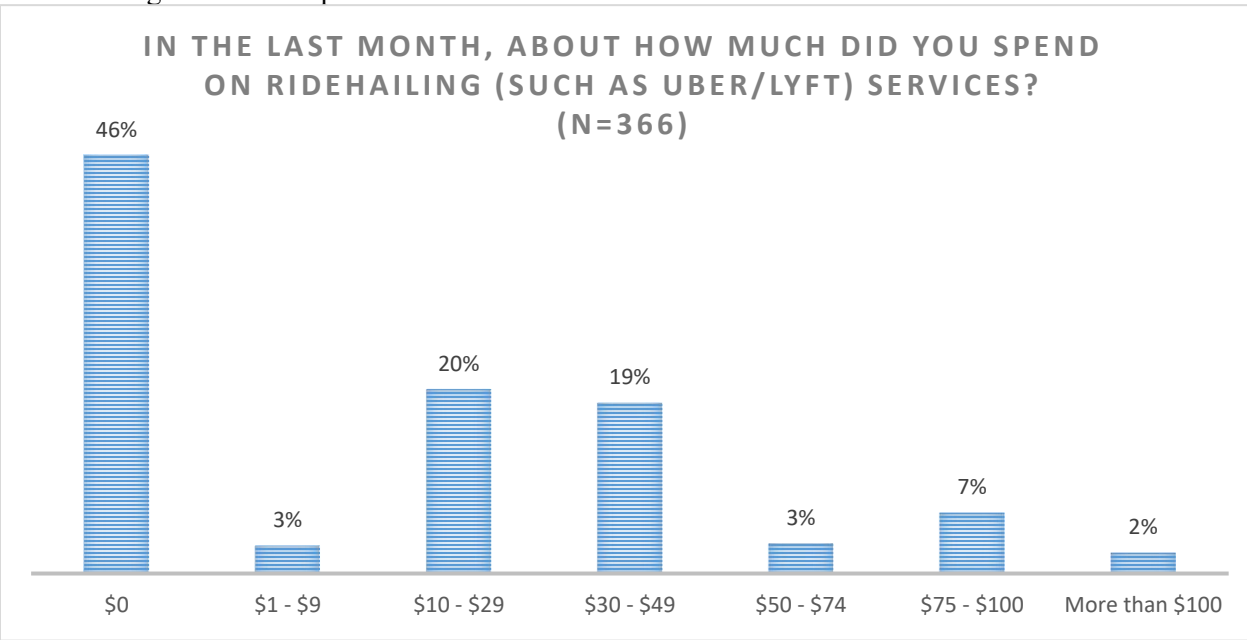


Figure 59 shows the distribution of monthly expenditures reported by ridehailing users in the month previous to the survey. 46 percent of respondents reported having spent zero dollars on ridehailing trips during the previous month, suggesting those respondents are sporadic users. 9 percent of respondents reported having spent more than $75 in the previous month on ridehailing trips, suggesting those are heavy ridehailing users. And, 39 percent of the respondents reported spending $10 to $49 on these services during the past month before the survey, representing the occasional users of the system.

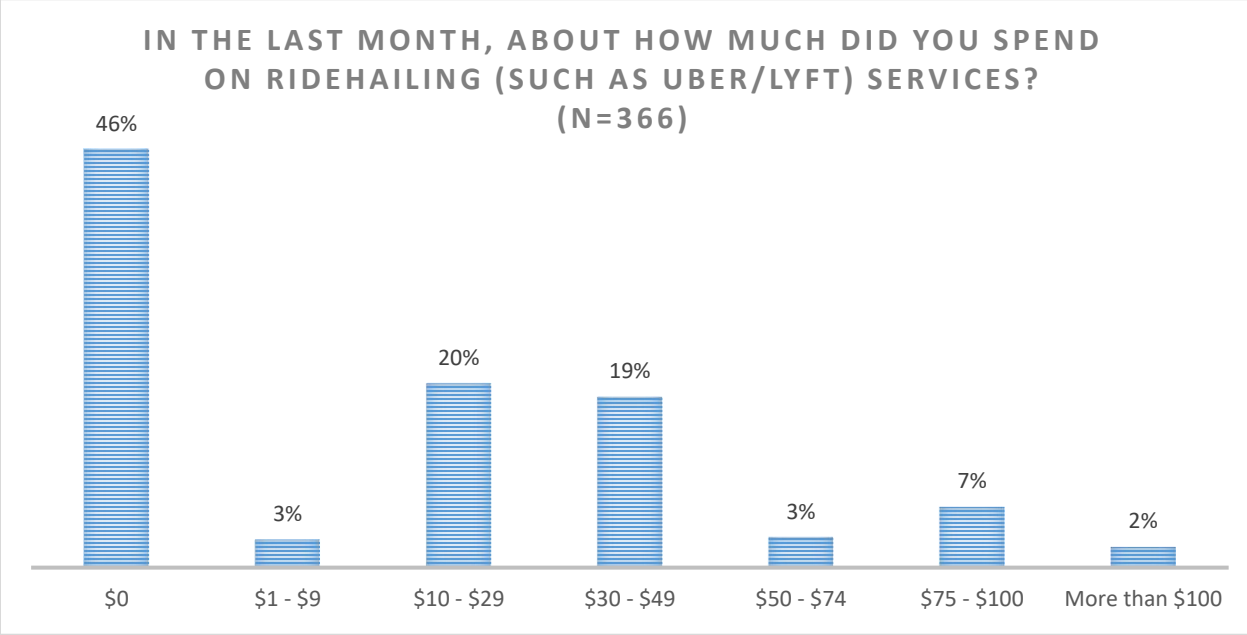


Figure 59 Monthly Expenditures on Ridehailing Trips

Ridehailing users were asked about how their use of different transportation modes have changed

after they began using Uber or Lyft (Figure 60). Thirteen percent of respondents reported to drive alone less often, 11 percent reported to drive with passengers less often, and 16 percent reported to take rides less often because of ridehailing services, indicating that these services are contributing to reduced use of private vehicles. However, 8 percent of respondents reported using buses less often, and 13 percent indicated to use light-rail less often, suggesting that ridehailing services might have a negative impact on transit ridership in the Phoenix area. Regarding non-motorized modes, 9 percent of respondents reported to have decreased their bicycle or e-scooter use.

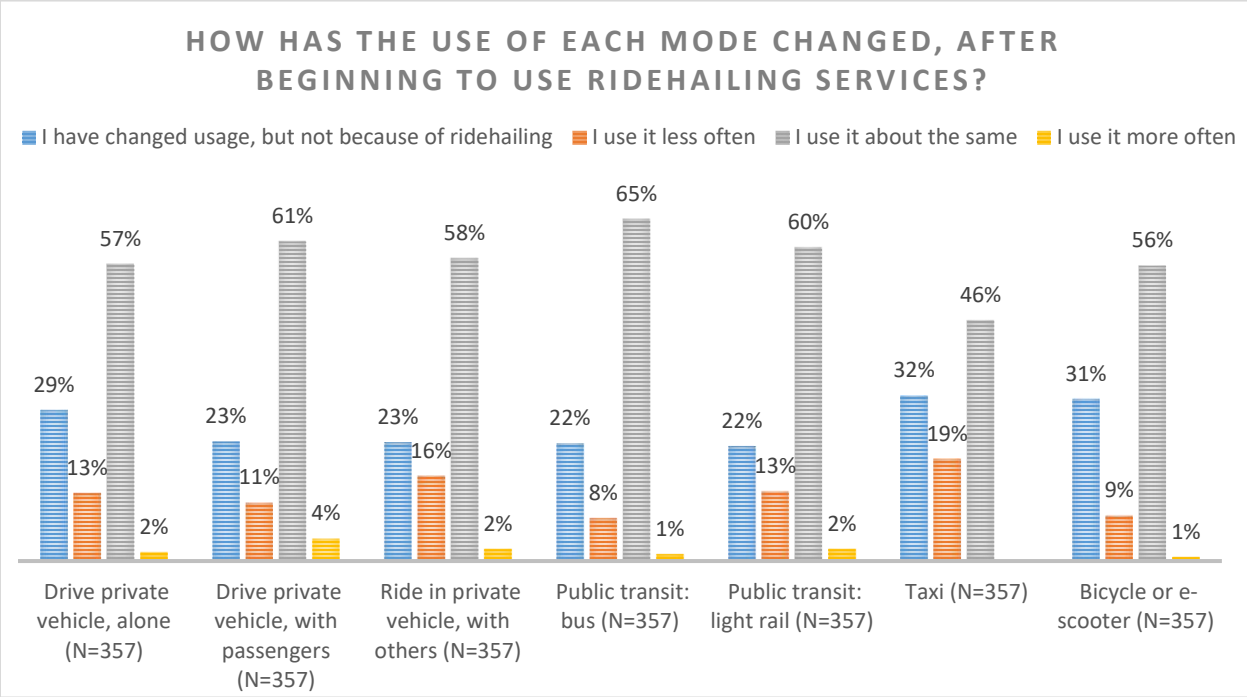


Figure 60 Impact of Ridehailing on Usage of Other Modes

2.4 Attitudes Towards Ridehailing Services

This subsection will detail the answers obtained regarding respondents' attitudes towards ridehailing services. It is important to note that all respondents were asked to answer those questions, regardless of their reported use of ridehailing services. Figure 61 details general perceptions towards ridehailing; Figure 62 describes attitudes that relate to the interaction of ridehailing services and other transportation modes; and Figure 63 shows attitudes towards shared ridehailing services and privacy.

Regarding the relationship between ridehailing services and home, work, and school location, 53 percent of respondents strongly or somewhat disagree with the fact that ridehailing availability affects where they choose to live, work, and/or go to school. Only 9 percent of respondents identified that service availability influences their home and work location preferences. About 10 percent of respondents identified that the lack of equipment to accommodate disabilities prevents them from using ridehailing. The lack of a child safety seat was identified as a barrier to adopting ridehailing services for 16 percent of the respondents. About 59 percent of the respondents identified ridehailing services as a good travel option when they are away from home. Reliability was seen as a concern for 25 percent of the respondents, and 47 percent reported to be neutral to the statement “I would use ridehailing services more often if the service was more reliable”. About the cost of these services, 52 percent of respondents strongly or somewhat agreed that ridehailing services are too expensive to be used on a daily or weekly basis; and only 14 percent think otherwise.

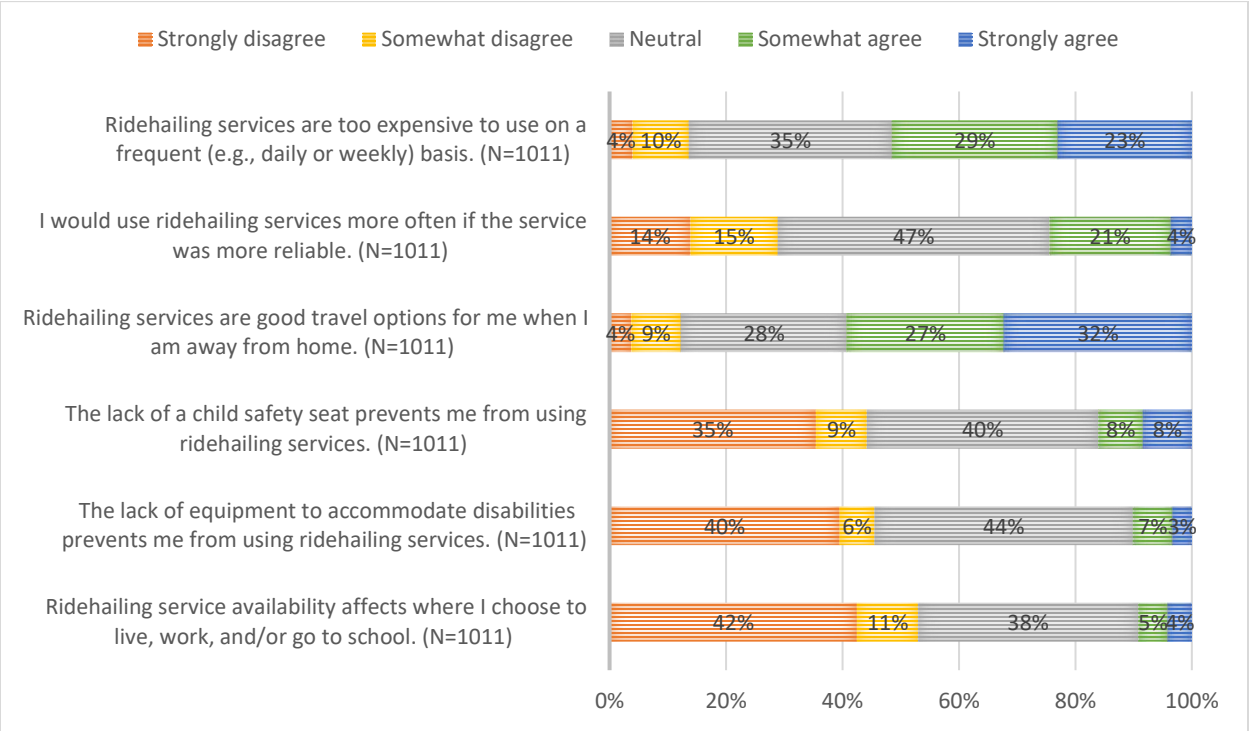


Figure 61 Attitudes Towards Ridehailing Services – General Perceptions

Figure 62 shows the respondents' agreement with the statements that explores the relationship between ridehailing and other modes of transportation. This relationship is very important in assessing the impacts of ridehailing services on the transport network. Regarding vehicle ownership, 16 percent of respondents reported that ridehailing services help them to live with fewer or no cars, while 43 percent disagree with the impact of ridehailing on their car ownership. Fifty-four percent of respondents strongly or somewhat agree that ridehailing services are good options when or where public transit is not available, however only 20 percent strongly or somewhat agree that ridehailing services help them get to or from public transit stops. This finding suggests that ridehailing services might complement public transit when or where it is not available and to some extent assist in the public transit accessibility when it is available. The majority (66 percent) of respondents strongly or somewhat agree that ridehailing services are good alternatives when their cars are temporarily unavailable, such as when it is being repaired. For close to half (50 percent) of respondents, ridehailing services help them avoid impaired driving. About 38 percent of respondents strongly or somewhat agree that ridehailing services help them save time and money on parking.

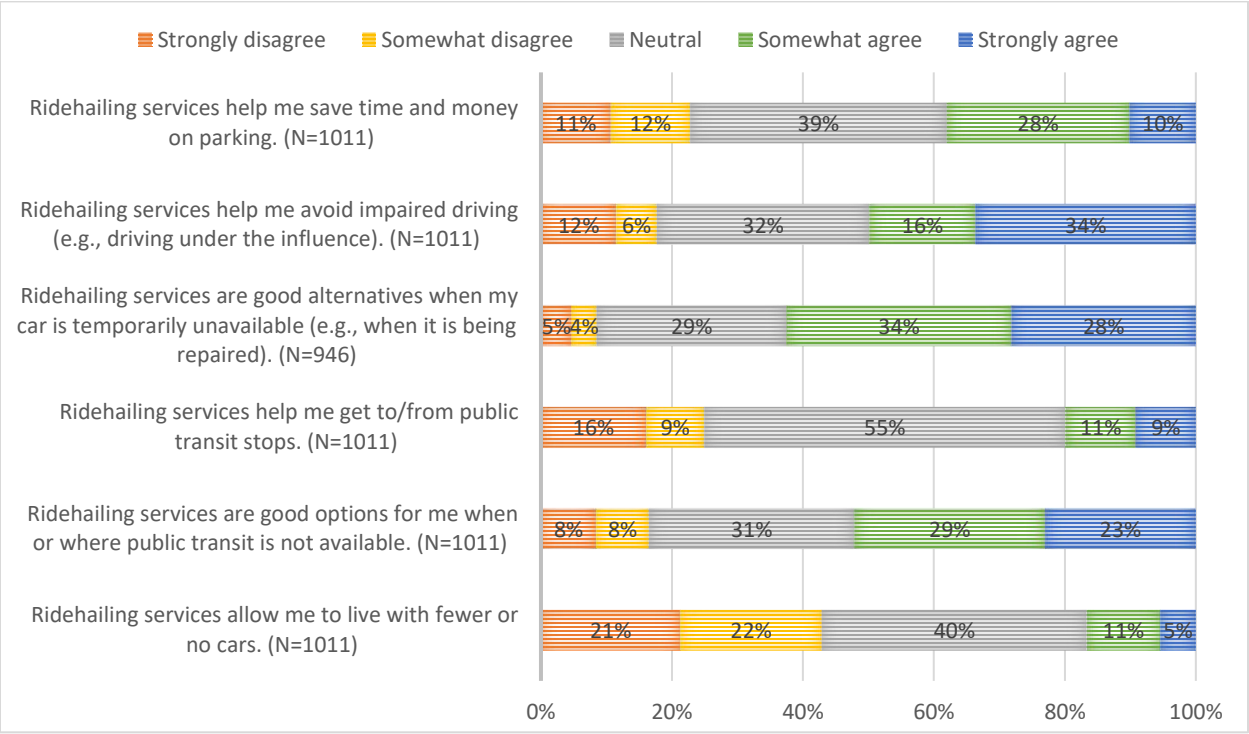


Figure 62 Attitudes Towards Ridehailing Services and Other Transportation Modes

Figure 63 shows respondents' preferences towards privacy and sharing rides on ridehailing trips. Only 28 percent of respondents somewhat or strongly agree that the lower cost of shared ridehailing is worth the additional time picking up and dropping off other passengers, while 26 percent of respondents somewhat or strongly disagree with the same statement; and, the remaining 47 percent stay neutral. This finding in addition to the findings of the next section on stated preference question suggests that the amount of difference in cost and travel time really matters in decision making to share the ride. For more than half of the respondents (55 percent), traveling with unfamiliar passengers on shared ridehailing trips makes them uncomfortable; and 50 percent stated that traveling with a driver they do not know makes them uncomfortable as well. This finding suggests that respondents on the sample have concerns regarding being around unfamiliar people and sharing rides with unknown travelers. This privacy concern is very important to consider when transport policies want to promote shared ridehailing rides. Strategies liked writing reviews for drivers or passengers, matching women with only female passengers or any other strategy that can increase the perceived, as well as the real safety and privacy of the ridehailing trips, could increase the portion of shared ridehailing trips and consequently enhance sustainability and consumers satisfaction.

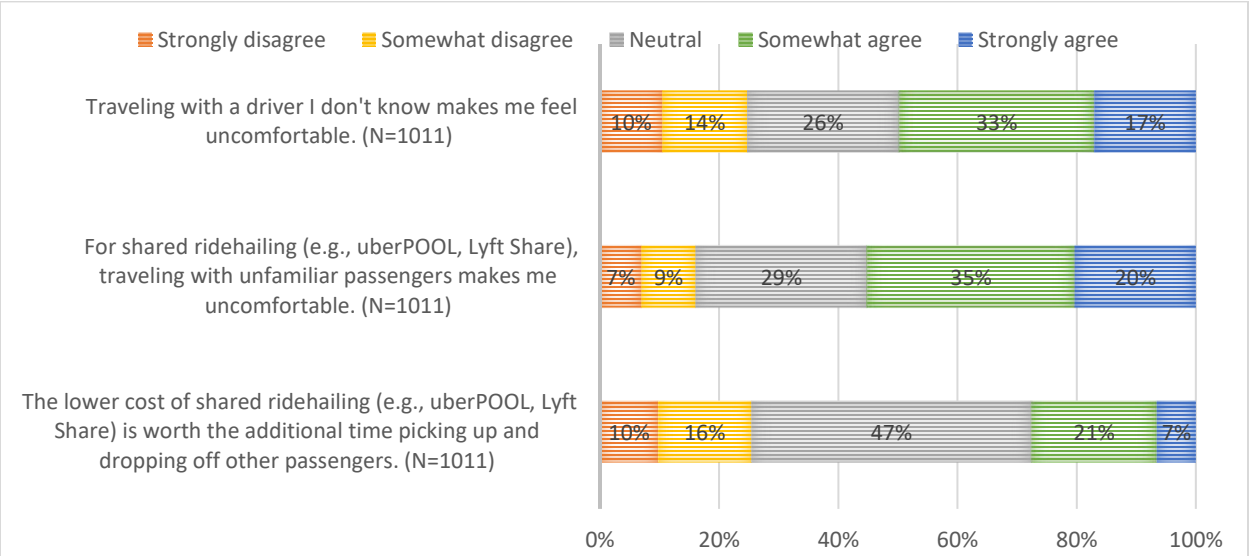


Figure 63 Sharing and Privacy Attitudes Towards Ridehailing Services

2.5 Stated Preference: Shared versus Private Ridehailing

At the end of the mobility-on-demand section, respondents were given different scenarios where they have to decide between share and private ridehailing services based on cost, travel time, and the presence of additional passengers for three different trip purposes: going to work or school, going on a shopping trip, and going on a social/recreation trip. The combination of the different trip attributes in block design produced 16 different scenarios presented to the respondents. For the sake of this report, only two scenarios are presented in the illustration. Future publications based on this data will shed light on the actual sharing preferences of the respondents as a function of the cost, travel time, and the number of additional passengers on the trip.

Figure 64 shows one scenario in which private trip costs $18 and takes 20 minutes; while the shared ridehailing trip costs $1.75 less and takes 5 minutes more with an additional passenger matched by the service app. The trip purpose with the highest acceptance of the shared service was social/leisure trips (39 percent). Shopping trips had the lowest share of respondents choosing the shared version of the trip (22 percent), possibly due to the constraint imposed by carrying the purchased items. Only 23 percent of respondents chose the shared service for their commute trip, given the described conditions.

Similarly, Figure 65 illustrates the same question with different values in another stated preference scenario. In this scenario, the distinction between the costs of the two options is larger. While the private ride costs $13 and takes 10 minutes, the shared ride costs $3.25 less and only 3 minutes more with two additional passengers. With a larger distinction in cost in Scenario 2 compare to the first scenario, a significantly larger proportion of respondents chose the shared option. In scenario 2, 65 percent chose the shared option for social/leisure; 42 percent chose the shared ride for shopping trips; and, 15 percent chose the shared ride for commute trips. These findings suggest that increasing the discount on the shared option significantly impacts the users' choice toward the shared option, especially for trip purposes such as shopping and social/leisure trips which do not have a strict time commitment. However, the choice between the shared and private options did not significantly change for commute trips, which have more seriousness in terms of schedule and time commitment, even with a lower price for the shared option. Perhaps,

commuters would have chosen the share option more frequently if they were offered similar travel time reliability.

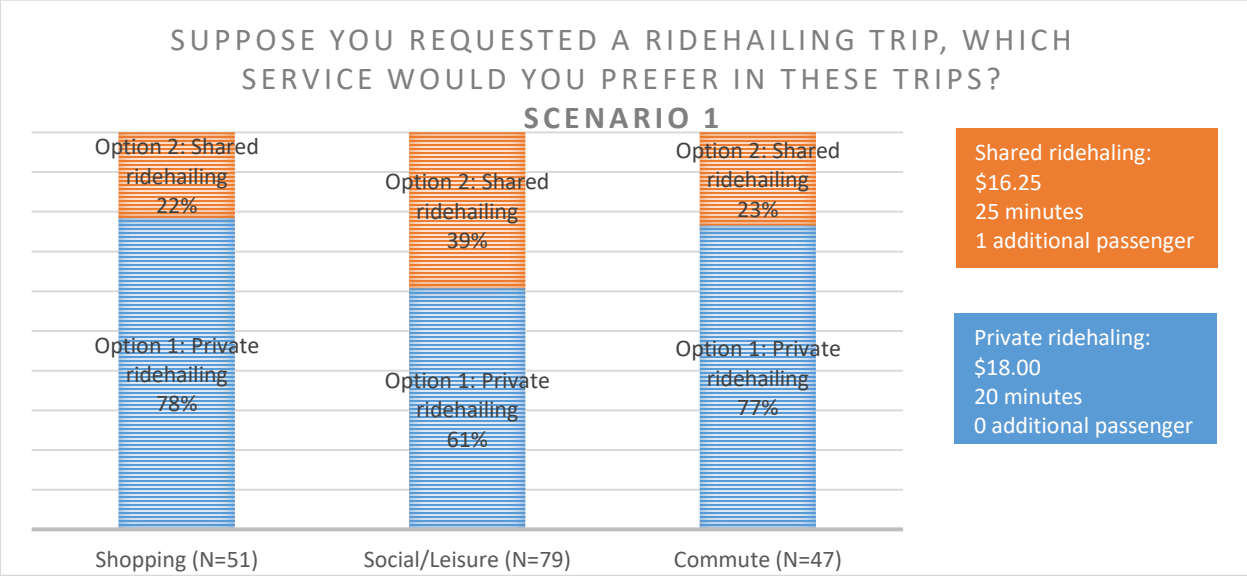


Figure 64 Stated Preference: Shared versus Private Ridehailing, Scenario 1

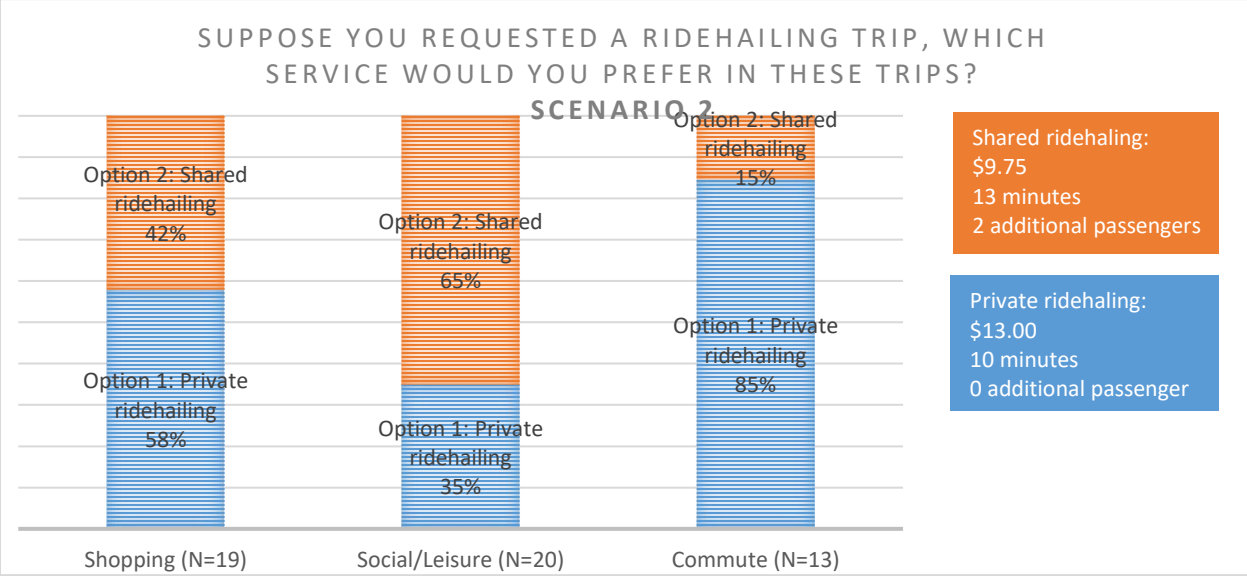


Figure 65 Stated Preference: Shared versus Private Ridehailing, Scenario 2

3. AUTONOMOUS VEHICLES

This section explains the results of the Autonomous Vehicle (AV) section of the survey. At the beginning of the section the survey participants were introduced with AV with the following quote:

> *"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."***

The first subsection describes respondents' familiarity with AVs, and the second subsection illustrates respondents' attitudes towards AVs; the third subsection explains other aspects covered by the survey that are not in the previous sections such as impacts on other modes due to automated mobility use. The last subsection shows the brief results of the random scenario stated preference questions.

3.1 Familiarity with Autonomous Vehicles

Figure 66 shows that most respondents (40 percent) are somewhat familiar with the autonomous vehicles' technology. While 12 percent of respondents had never heard of autonomous vehicles prior to taking the survey, 35 percent of the respondents declared they have heard of AVs, but do not know much about them. It is important to note that Arizona is currently the testbed for a few autonomous vehicle companies, most noticeably Waymo. Until March 2018, Uber was offering demonstration AV rides on their autonomous vehicle prototype, and Waymo is currently offering rides through its Early Rider program (blog.waymo.com/2019/08/waymos-early-rider-program-one-year-in.html). In this context, it is reasonable that 12 percent of the respondents reported being very familiar with autonomous vehicles, and 1 percent (corresponding to approximately 10 respondents) said they have taken a ride in an AV.

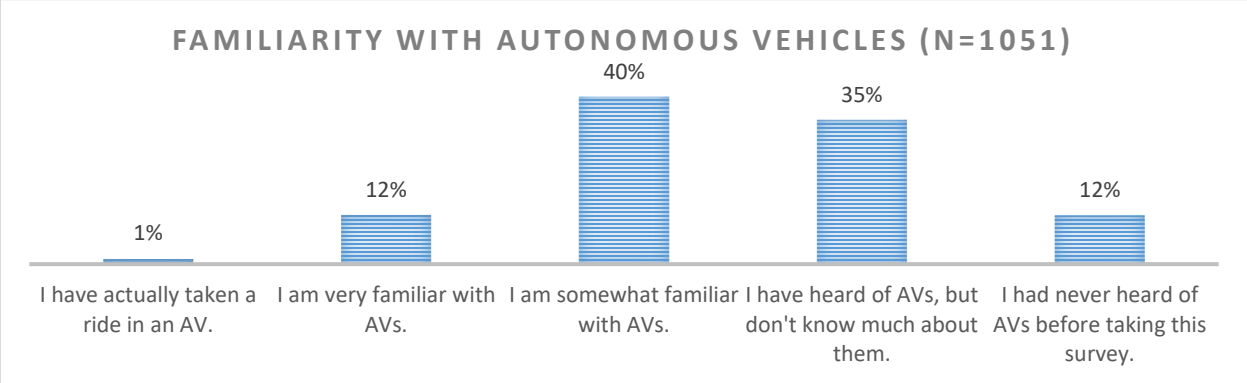


Figure 66 Familiarity with Autonomous Vehicles

3.2 Attitudes Towards Autonomous Vehicles

This section presents the survey results on respondents' attitudes toward potential benefits and concerns of AVs.

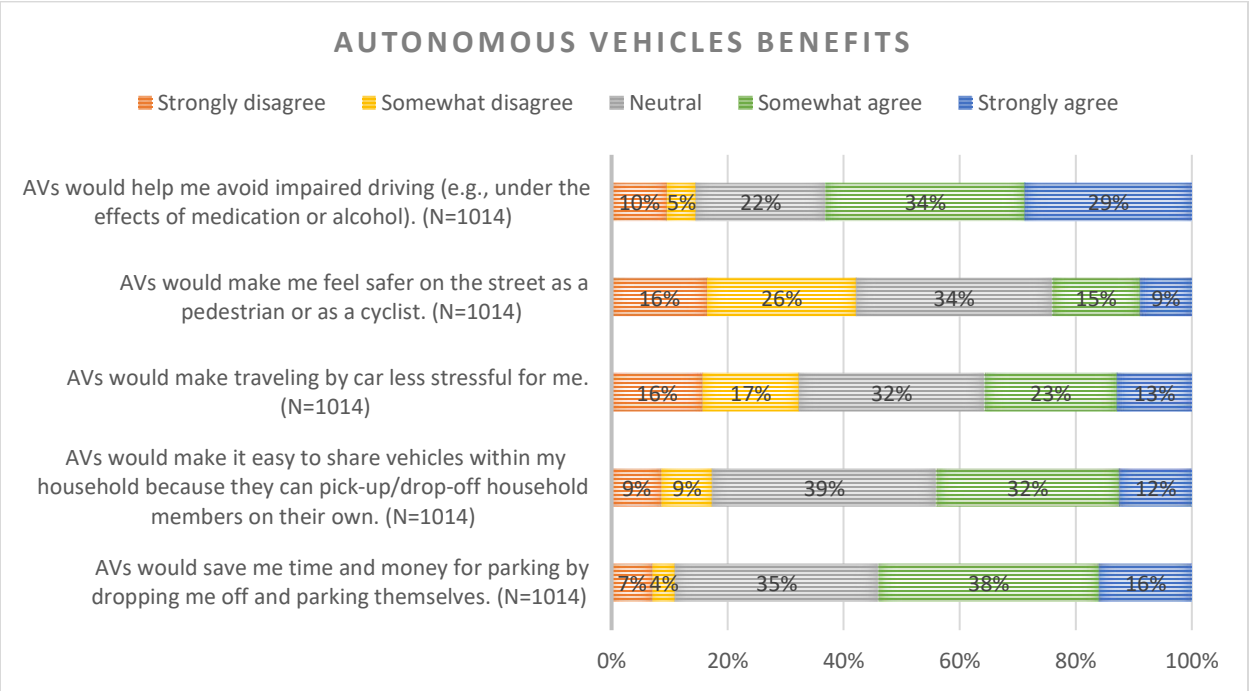


Figure 67 shows the distribution of respondents' answers to attitudinal statements that capture their perceptions toward the potential benefits of AV. Most respondents (54 percent) expect that autonomous vehicles will help them save time and money on parking by dropping them off and parking themselves, while 11 percent think otherwise. With respect to the convenience of sharing AV across household members, 44 percent expect that autonomous vehicles will make it easier to share vehicles within their households since those vehicles would be able to pick-up and drop-off household members on their own (39 percent being neutral).

Respondents had mixed opinions about the potential benefit of AV to make car trips less stressful. While 36 percent of the respondents expect their car trips to be less stressful in the AV world, almost the same amount (33 percent) strongly or somewhat disagree with the statement. More on the safety aspect of AVs, the majority of the respondents (42 percent) reported to strongly or somewhat disagree with the statement that "AVs would make me feel safer on the street as a pedestrian or cyclist" (34 percent being neutral). The responses to these two attitudinal statements suggest that safety might not be seen by all as a potential benefit of autonomous vehicles yet, although one of the main stated goals of the AV industry is to improve safety by eliminating human errors. Regarding the potential to avoid impaired driving, 63 percent of respondents reported they somewhat or strongly agree that AVs would help them avoid impaired driving.

Respondents were asked to rate their agreement with statements capturing potential concerns (Figure 68) with the implementation of autonomous vehicles. These statements were mixed with the potential benefits statements
(

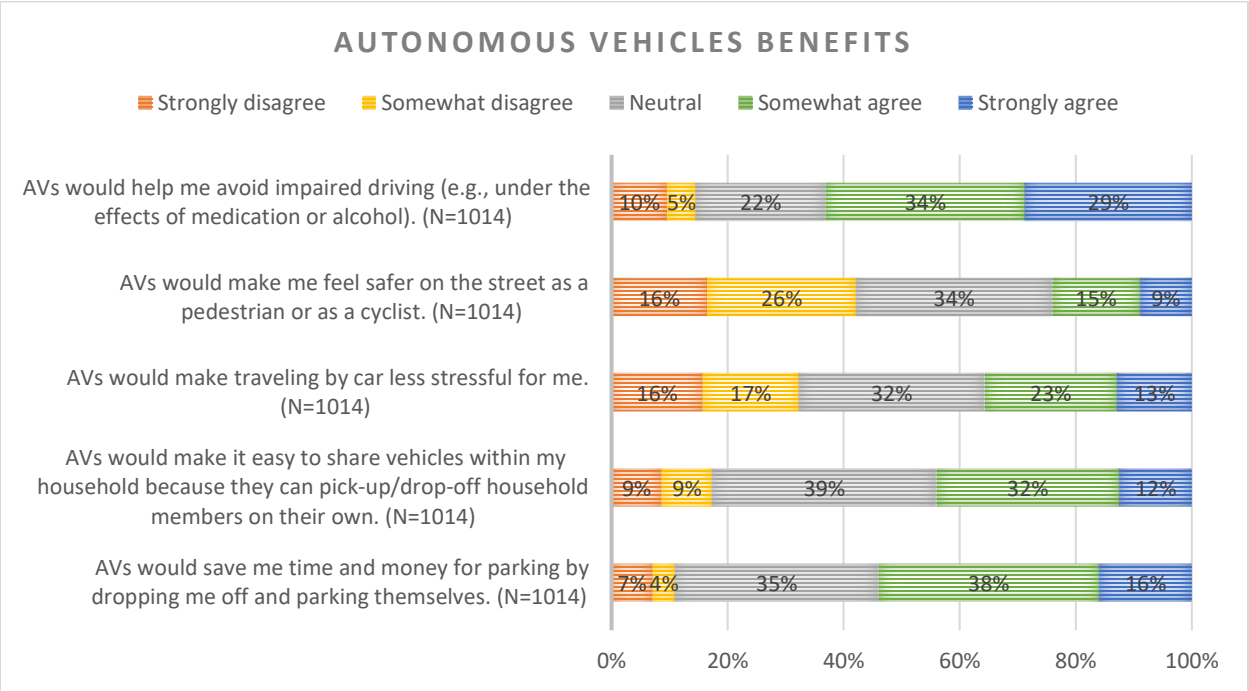


Figure 67) and statements about the expected use of autonomous vehicles (Figure 69). For more details on the order in which the statements were presented to respondents, please refer to APPENDIX I - SURVEY INSTRUMENT.

With respect to safety perception of respondents, 70 percent of respondents strongly or somewhat agree that they want the ability to take control of the autonomous vehicle any time during the ride, suggesting a potential barrier to autonomous vehicles that do not have steering wheels. Regarding data security, 46 percent of respondents said to be concerned that their travel logs and personal information could be leaked (26 percent being neutral). Regarding technology reliability, 67 percent of the respondents strongly or somewhat agree that they are concerned with the potential failure of AV sensors, equipment, technology, or programs. Concerning children's riding AVs unsupervised, 60 percent of respondents reported they would not feel comfortable having an AV pick-up or drop-off children without supervision (19 percent being neutral). Repeatedly, this finding along with previous statements related to safety implies that people are not yet generally convinced that AVs are reliable and they could improve safety. About 37 percent of respondents said they strongly or somewhat agree that AVs will eliminate their joy of driving. Overall, respondents still feel very strongly when it comes to potentially negative outcomes of autonomous vehicle implementation, and concerns with privacy and safety could impact the adoption and adaptation patterns of automated mobility.

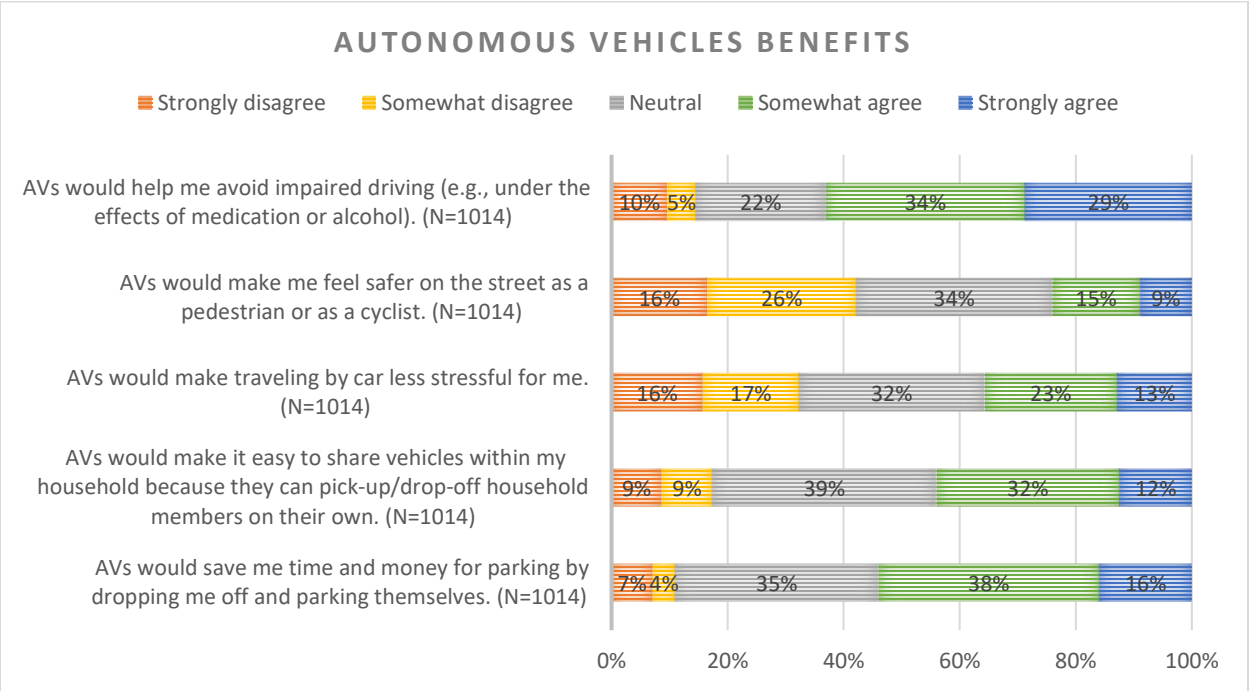


Figure 67 Attitudes Towards Potential Benefits of Autonomous Vehicles

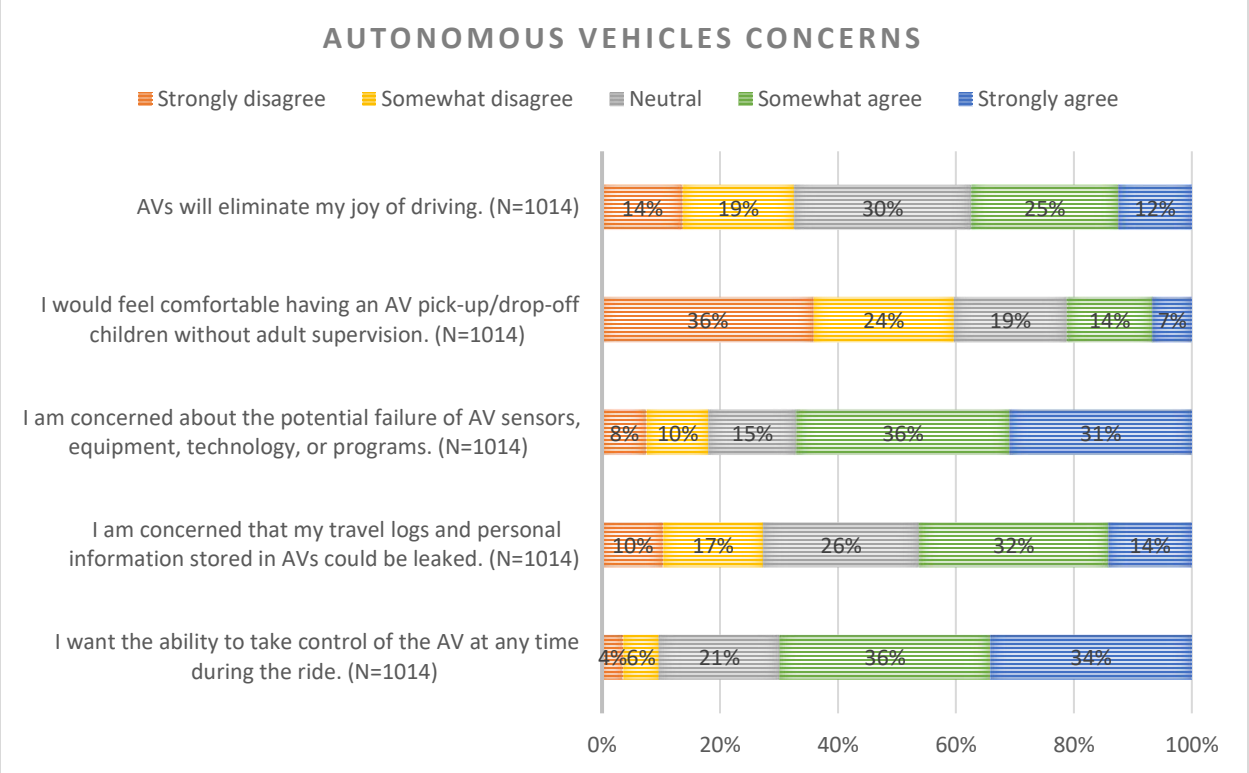


Figure 68 Concerns about Automated Mobility

Figure 69 shows the distributions of respondents' answers to statements measuring autonomous

vehicle adoption and potential stated use. Regarding AV adoption, only 20 percent of respondents strongly or somewhat agree that they would never ride in an AV, while 49 percent of respondents disagree with that. About potential uses of AVs, 51 percent revealed they would send an AV to pick-up groceries/laundry/food orders by itself. When asked about long-distance trips, only 34 percent of respondents expect an increase in the frequency of such trips. About 51 percent of respondents strongly or somewhat disagree that they would feel comfortable sleeping while traveling in AV. These results indicate that respondents still have concerns about how the technology will perform, which is consistent with the results observed before.

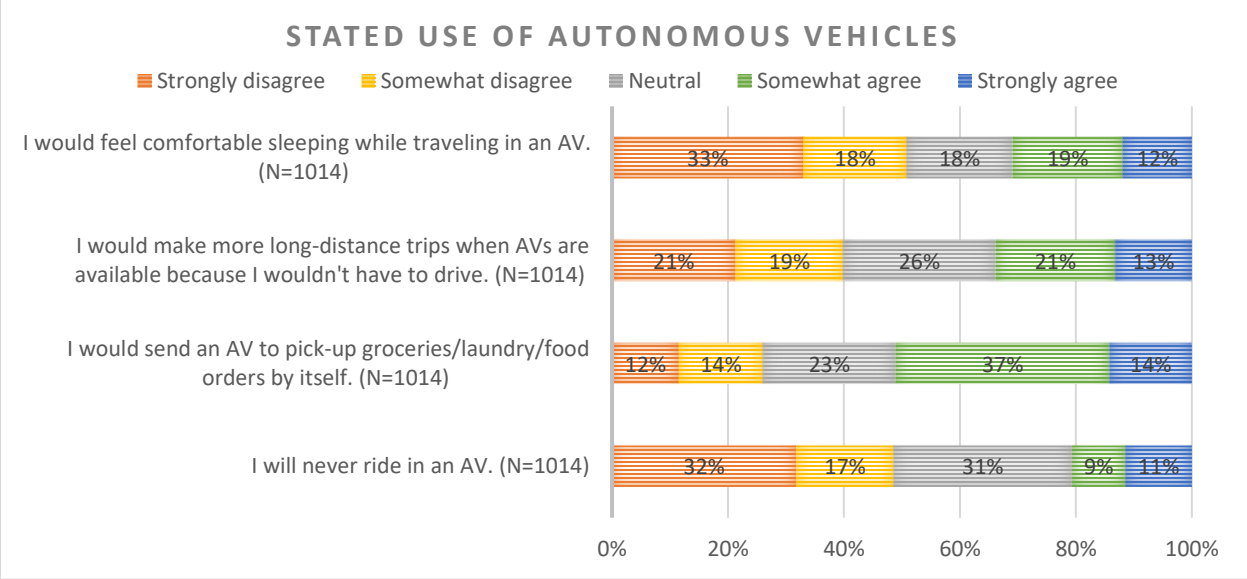


Figure 69 stated Use of Autonomous Vehicles

Exploring the perceptions toward AVs further, respondents were asked about their attitudes towards ridehailing services using autonomous vehicles. It is expected that in the future such mobility-on-demand services will use AVs to provide rides to the public. Figure 70 shows the distributions of respondents' answers to attitudinal statements exploring the relationship between automated mobility and ridehailing services. Almost half of the respondents (44 percent) strongly agree or somewhat agree that they would use AV ridehailing services alone or with coworkers, friends or family (30 percent being neutral). However, only 19 percent of respondents would be willing to use AVs on ridehailing services with passengers that are unfamiliar to them (32 percent being neutral). These results show that there are more barriers to the adoption of shared ridehailing services, in comparison to private ridehailing services in terms of privacy and safety concerns of riding with strangers.

Regarding leasing their personal AV to ridehailing companies to earn money, almost half (48 percent) of the respondents reported they would not feel comfortable doing that when they are not using their vehicle. About 36 percent of respondents would be willing to pay extra for having a backup human operator inside the AV during their ride, reinforcing the idea that many respondents have concerns regarding the AV performance.

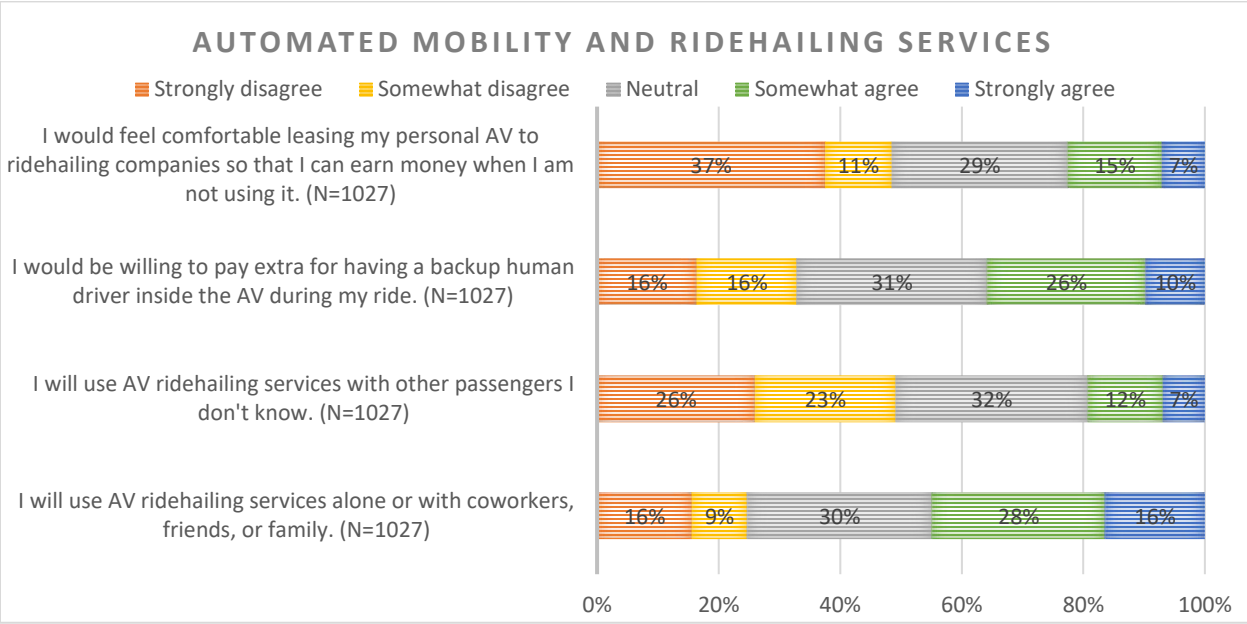


Figure 70 Perceptions of Autonomous Vehicles on Ridehailing Services

The results regarding respondents' perceptions toward AVs related policies are shown in Figure 71. The majority of the respondents generally agree or feel neutral about the suggested AV policies in the survey. Concerning AV-only lanes/areas, 52 percent of respondents strongly or somewhat agree that the government should establish such dedicated facilities. Regarding liability in the event of a crash, the majority of respondents (54 percent) agree that in an AV crash, vehicle manufacturers and their insurance companies should be held responsible, instead of the AV owner, passenger or operator (33 percent being neutral).

Concerning legal aspects of AVs, respondents were not as favorable to have laws limiting the speed of AVs to 25mph or less on city streets; only 23 percent of respondents said to strongly or somewhat agree with such policy and the significant portion (38 percent) stated being neutral. Safety settings are an important feature of an autonomous vehicle; however, the choice of whose safety should be prioritized in the event of a crash is not as straightforward. When asked if AV owners should be able to program how their AVs prioritize the safety of different groups in the event of a crash (e.g., pedestrians, bicyclists, other vehicles, or AV passengers), 31 percent of respondents strongly or somewhat disagree with it and 35 percent strongly or somewhat agree. In a similar context, 43 percent of respondents strongly or somewhat agree that AVs should prioritize the safety of pedestrians and bicyclists over that of passengers in the vehicle (34 percent being neutral).

Lastly, the vast majority of the respondents (79 percent) strongly or somewhat agree that AVs should only be allowed on the market when they prove to be at least as safe as human drivers. Once again, respondents reported having strong feelings regarding the expected safety of AVs. This finding motivates the initiatives that are trying to systematically test different AV technologies outside public roads before permitting them to be on public roads for testing or on the market for actual selling.

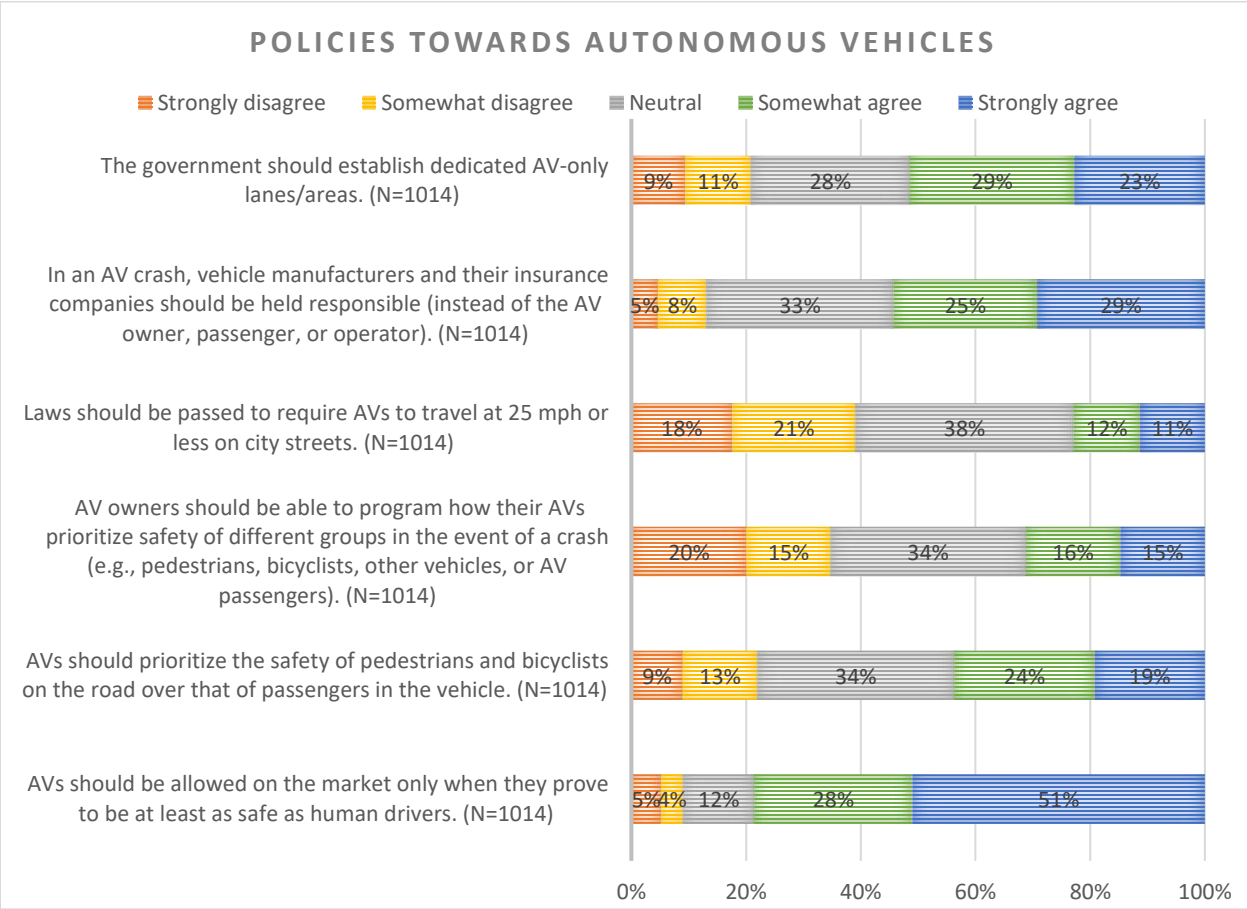


Figure 71 Attitudes Towards Autonomous Vehicles Policies

3.3 Other Aspects of Autonomous Vehicles Use

This section will show the results obtained in other aspects of autonomous vehicles focusing on the impact of using AV on travel behavior, mode choice, vehicle availability, and residential choice. Figure 72 shows the distribution of the additional time commuters are willing to accept in their current trips, once they have access to AVs. While 32 percent of commuters would not accept any additional time on their one-way travel to work or school, 18 percent would accept an increase of up to 5 minutes, 29 percent would accept between 5 and 15 additional minutes, and 21 percent of commuters would accept more than 15 additional minutes on their commute. This finding suggests that AV has the potential ability to increase commute times which is not in line with transportation sustainability goals unless some sort of sharing or pricing mechanism could compensate that.

Respondents were asked about how likely they would change in a set of different ways with respect to their travel behavior. Regarding car ownership, 75 percent of respondents (N=1,023) declared their current household is likely to own the same number of cars, while 16 percent expect their household to own fewer cars than today, and 9 percent of respondents expect their household to increase the number of cars they currently own.

Figure 73 shows the distribution of respondents' answers on how likely they would change in other ways. Better tolerating congestion is one of the ways most respondents expect to change; 43 percent reported to be very likely, or somewhat likely that they would tolerate congestion better because they do not have to drive. Changing the workplace to a different location and moving to a better location or home

were the ways that respondents were expecting changes the least. Only 18 percent of respondents indicated that they may change their work location and only 18 percent of respondents indicated that they may change their home location due to the availability of AVs. About 39 percent of respondents believe to be somewhat or very likely to travel more in peak hours because they would be able to engage in other activities while in the AV. Also, 38 percent of respondents expect to make more long-distance road trips; 41 percent expect to travel and do more activities after dark; 37 percent expect to travel farther to go to social/recreational activities; 34 percent expect to travel farther to eat out, and 24 percent of respondents expect to make additional trips they do not make now.

Although most respondents answered they were very or somewhat unlikely to change their travel behavior in all the proposed ways, the significant portion of respondents who are willing to travel more due have the potential to produce significant extra load to the transportation network and exacerbate the traffic condition. It should be noted that AV connectivity can produce an extra capacity of the transportation network, but reasonable pricing and sharing policies should be in place in a timely manner to control the potential induced demand for autonomous vehicle use.

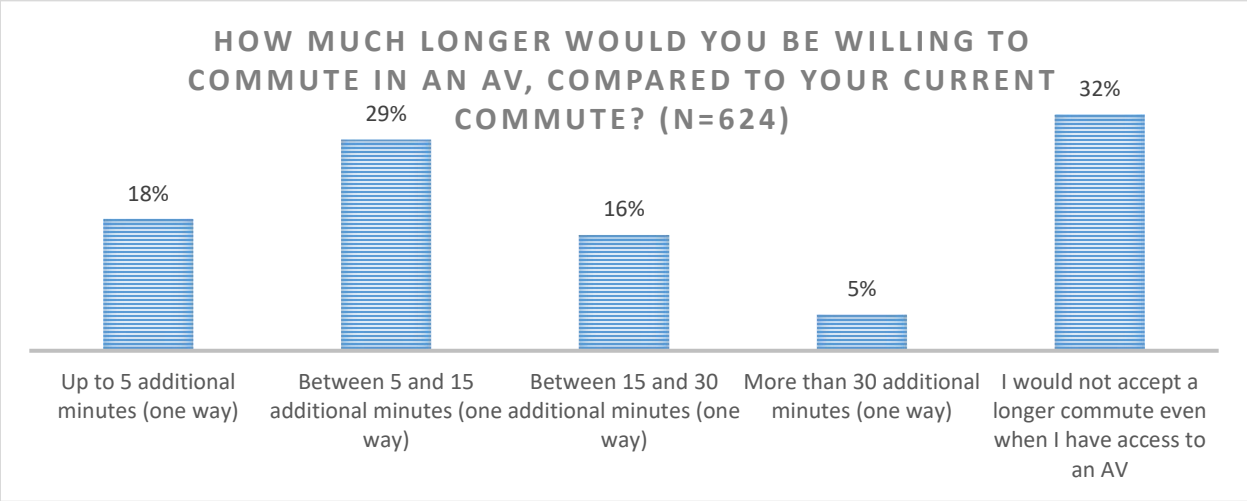


Figure 72 Accepted Additional Time on Commute Assuming AVs are Available

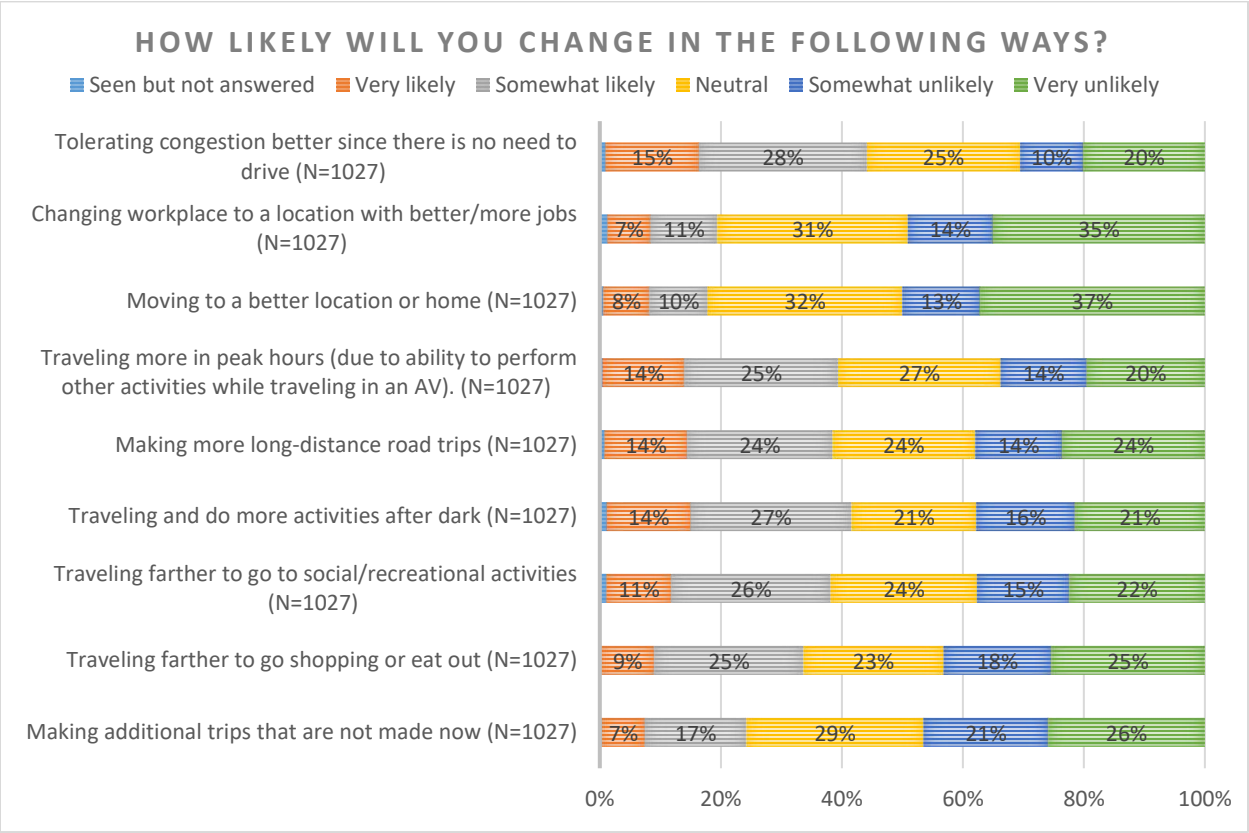


Figure 73 Expected Changes in an Automated Future

Figure 74 shows expected changes in the use of different modes, given the respondents had access to autonomous vehicles. The respondents expect the least change in their usage of the airplane, to which 82 percent of respondents expect to use the same. However, 12 percent of respondents are decreasing their usage meaning that they may switch to AV for their long-distance travel. Human-driven ridehailing services and public transit (bus and rail) were the modes where respondents were more willing to decrease their use, between 36 to 39 percent of respondents expect such change. Also, 33 percent of respondents expect a decrease in the usage of human driving personal vehicles. When asked about walking, 73 percent of respondents expect no change in the frequency of their walking trips, while 18 percent are expecting to walk less. Lastly, 66 percent of respondents expect no change in the frequency of bicycle or scooter usage, while 27 percent are expecting to decrease their bike use.

The quite significant potential decrease in public transit, bike, and walk trips can become one of the negative impacts of the deployment of autonomous vehicles and should be considered ahead of time. Again, reasonable pricing and sharing policies could facilitate the impact of AV use of more environment-friendly modes. For instance, AVs can work with public transit to increase its accessibility. Another potential policy recommendation could be increased cost of AVs for short trips so people who are trying to replace their walk or bike trips using AVs would encounter barriers to do so.

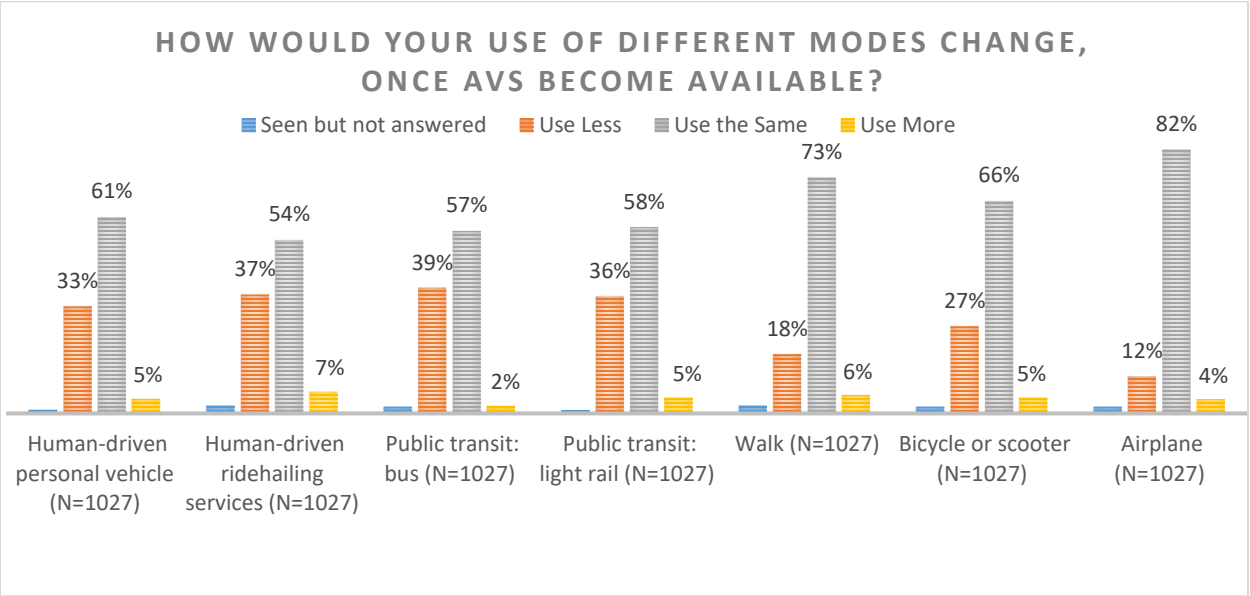


Figure 74 Expected Changes in Usage of Other Modes Due to Automated Mobility

Respondents were asked to choose up to three activities they would engage when inside an autonomous vehicle for five different trip purposes: alone to work or school; alone to the store; with family members to a neighborhood park; long-distance alone; and long-distance with family members. Figure 75 shows the distribution of the selected choices in all scenarios. The activities chosen most often across all trip purposes were talking on the phone/texting/teleconferencing (chosen, on average, by 42 percent of respondents), enjoying the scenery (chosen, on average, by 36 percent of respondents), and watching the road (chosen, on average, by 35 percent of respondents).

Considering only work or school trips, the same activities mentioned before were the most frequent followed by work or study chosen by 37 percent of respondents. When asking the same question only for trips alone to the store, the same three activities were the most frequent (9 percent). However, 29 percent of the respondents would not ride alone to store with AV. When considering a trip with family members to a neighborhood park, in addition to the top three activities, the majority (51 percent) of respondents chose to interact with other passengers as one of their chosen activities. For long-distance trips, the activities selected are more distributed across different types. While 49 percent chose to talk on the phone, texting, and teleconferencing as their top activity during long-distance trip alone, between 18 to 28 percent of the respondents chose to sleep, enjoying the scenery, watching the road, eating and drinking, watching movies/ TV/ other entertainments, and reading among their top three activities. If the long-distance trip was with family members, interacting with other passengers and enjoying the scenery have been chosen the most (42 percent of respondents), followed by enjoying the scenery (41 percent), talk on the phone/ text teleconferencing (25 percent), reading (25 percent), sleeping (22 percent), and watching movies/ TV/ other entertainments (20 percent).

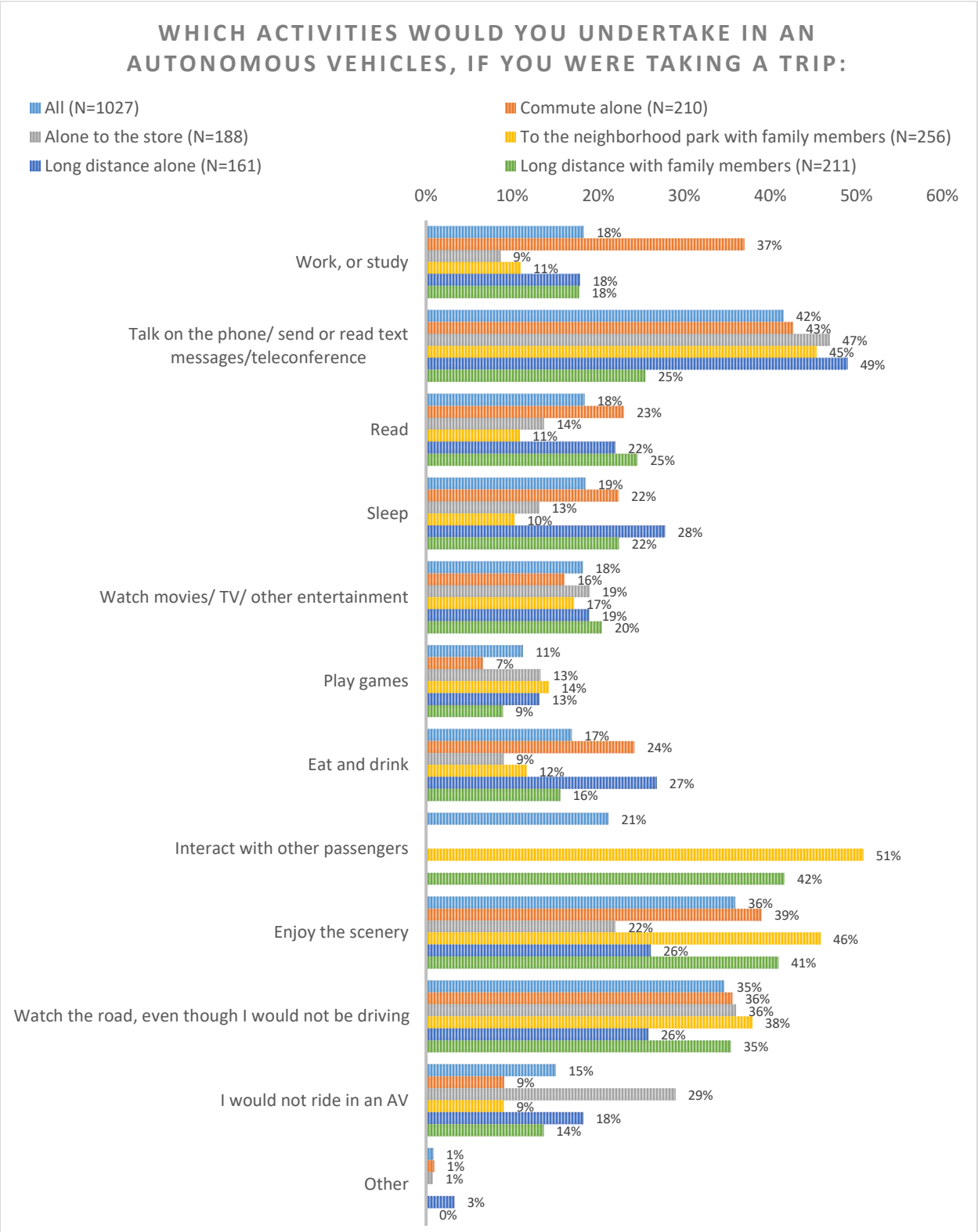


Figure 75 Activities Respondents Expect to Engage When Traveling in an Autonomous Vehicle

3.4 Stated Preference for Purchasing AV

This subsection briefly describes the stated preference responses when it comes to making a decision about buying AVs. In general, 42 percent of respondents (N=1014) reported they would never purchase an AV, while 5 percent expect to be one of the first to people to buy an automated vehicle. 52 percent of respondents reported they would eventually purchase an Autonomous Vehicle, but only after these vehicles are in common use. Later the survey asked respondents who are willing to buy AV (either as first buyers or eventual buyers) about their willingness to pay for AV purchase in comparison to a regular human-driven vehicle which costs $25,000. Figure 76 shows that 30 percent of respondents who were interested in purchasing an AV would not be willing to pay any additional amount for the AV version of a regular vehicle that costs $25,000. Five percent of respondents (N=595) were willing to pay up to only $1,000 more; 19 percent were willing to pay between $1,000 and $3,000 more; 22 percent were willing to pay between $3,000 and $5,000 more; 15 percent were willing to pay between $5,000 and $8,000 more, and 10 percent of the respondents were willing to pay more than additional $8,000 for the autonomous version of the vehicle.

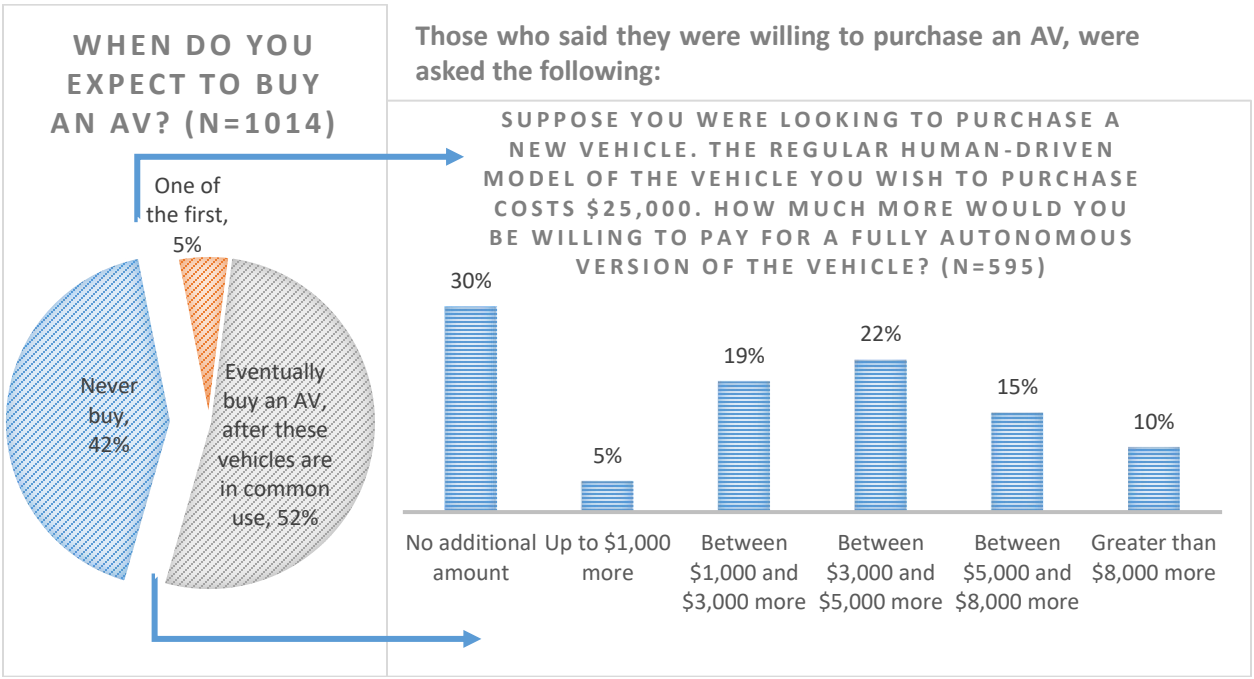


Figure 76 Willingness to Purchase and Pay for an Autonomous Vehicle

The stated preference questions measured willingness to pay for AVs as a function of the cost compared to buying regular vehicles and relying only on AV-based ridehailing services. The question was presented to respondents twice, randomly selecting from 18 pre-specified scenarios. Each scenario had a unique combination of fixed costs, variable costs, and average wait time for each alternative. Respondents were asked to rank their preferences of three alternatives for two different scenarios that were randomly selected.

Figure 77 illustrates the first scenario of the random experiment (out of 18 possible scenarios). In this case, all respondents saw the same values for fixed costs and variable costs of AV, regular vehicle, and AV-based ridehailing only. About 22 percent of respondents didn't answer the question. Among the remaining complete responses, 39 percent chose regular vehicles as their first option and 24 chose AV as their first option. Only 14 percent chose AV-based ridehailing as their first option.

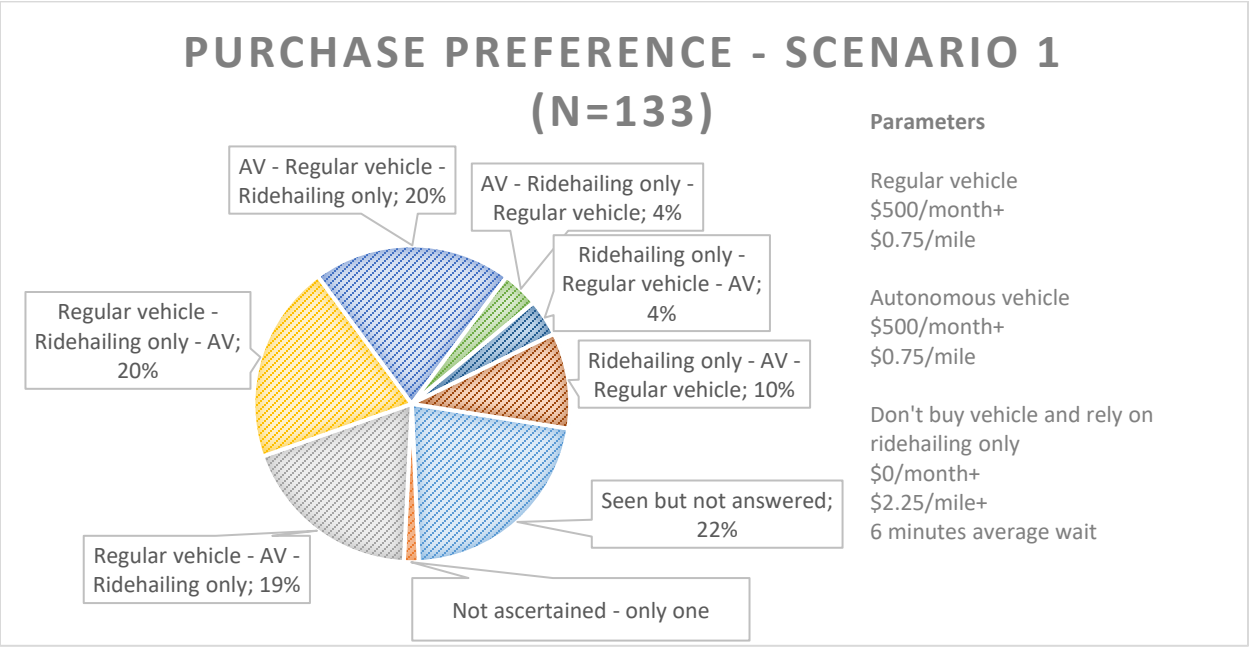


Figure 77 Ranking Stated Preference Question Measuring Willingness to Purchase Autonomous Vehicles, Scenario 1

Figure 78 illustrates the second scenario of the random experiment. In this case, all respondents saw the same values for fixed costs and variable costs of AV, regular vehicle, and AV-based ridehailing only (which were different from the scenario presented in Figure 76). AV costs more compared to the regular vehicle, and AV-based ridehailing costs three times more per mile than AV with an average wait time of 6 minutes. With an increase in the cost of AV, 68 percent chose to purchase a regular vehicle as their first choice, and only 11 percent chose AV as their first choice. Similarly, 8 percent chose ridehailing as their first choice. About 11 percent of the respondents did not answer the question.

In summary, at the time of the survey, people in the Phoenix metro area are less willing to buy AV compared to regular vehicles and their preference is very sensitive to cost. Ridehailing services have mostly been the respondent last option to choose them as their only transport mode. This finding raises concerns about the potential low use of shared ridehailing services in an AV world with the existence of an attitude of having a personal vehicle. Again, pricing and taxation mechanism should work around these issues if the right policies can be placed with thoughtful timelines to motivate shared AV use and prevent the increase in induced demand for AV.

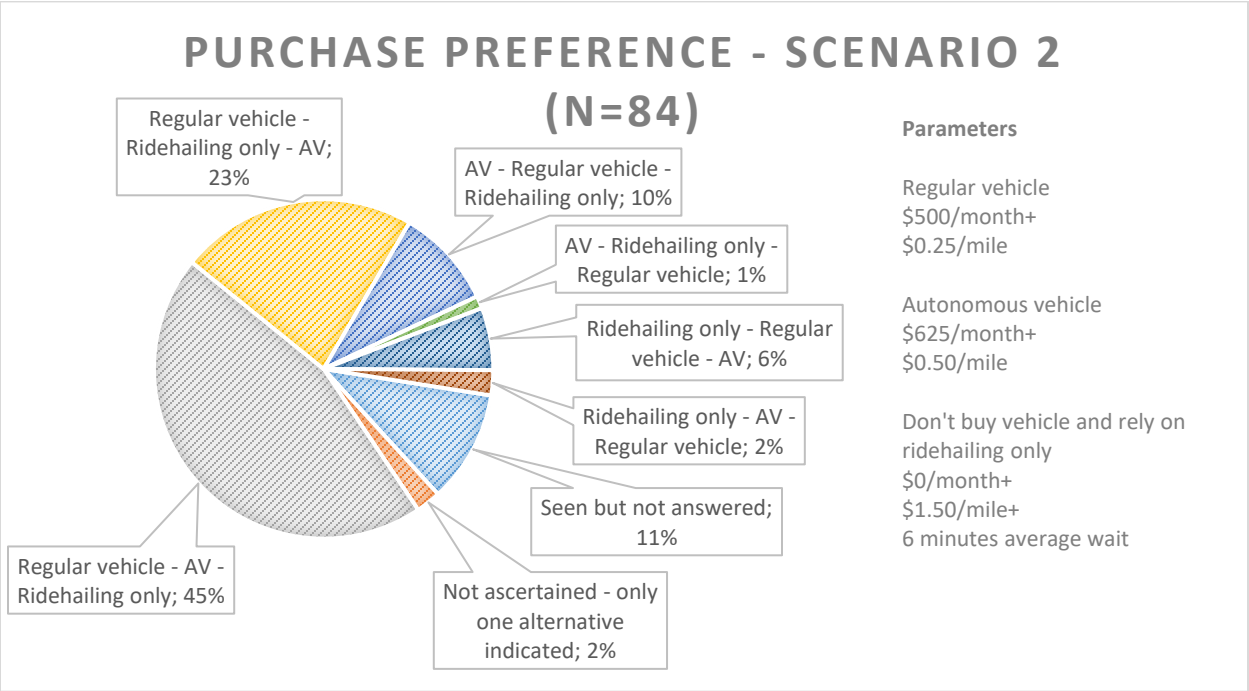


Figure 78 Ranking Stated Preference Question Measuring Willingness to Purchase Autonomous Vehicles, Scenario 2

4. CONCLUSION

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's goal is to collect such information in multiple jurisdictions through a comprehensive attitudinal and behavioral survey. This report particularly covers the full deployment of data collection in the Phoenix metro area and presents the univariate weighted distribution of responses to all the survey questions. An earlier report covers the pilot phase of data collection which included a literature review, development of survey goals, objectives, detailed research questions, survey questionnaire design, and pilot deployment. The pilot phase of data collection was conducted during fall 2018 and the full deployment was conducted in summer and fall 2019 in the Phoenix metro area. This project provides a data collection protocol and methodology that can be widely adopted in addition to survey results output and econometric modeling and travel behavior analysis that is forthcoming.

As part of a coordinated effort among TOMNET partners, Georgia Tech will collect the data for a similar sample size from Atlanta metro area, Georgia; and the University of South Florida will apply the survey in the Tampa metro area, Florida. Moreover, the University of Texas at Austin, who has been our close collaborator for many years, will also deploy the same data collection, which is supported by the D-STOP University Transportation Center at the University of Texas at Austin. The data collected across multiple jurisdictions will soon be aggregated to produce a single dataset with a sample size of more than four thousand responses. This dataset will be unique in terms of sample size, contents, and coverage of multiple metropolitan areas in the Southern United States.

The T4 survey explicitly collected detailed 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. With respect to people's attitudes, a battery of attitudinal statements measures various general and transport preferences of the survey participants. Previous studies have shown that the application of attitudes can significantly improve travel demand modeling and forecasting accuracy (Golob et al., 1977; Cao et al., 2008; Tardiff, 1977; and Paulseen et al., 2014). For example, a significant portion of respondents (38 percent) expressed willingness to use less polluting means of transportation; internet connectivity is important for the majority (69 percent) of respondents; 77 percent want to make good use of their travel time; And, 79 percent like the idea of owning a personal car.

Regarding usage and familiarity with new mobility services, a little over half of the respondents are familiar with the mobility-on-demand services including private and shared ridehailing services, carsharing, and micro-mobility services (bike and e-scooter sharing). However, a small percent of the participants are using these services frequently. For example, in the Phoenix metro area where shared ridehailing services are not available, five to seven percent of the respondents use private ridehailing services weekly for non-commute and commute purposes. The ridehailing users believe that their usage of these services decreased their walk, bike, e-scooter, and transit trips between 8 to 13 percent. A little over half of the respondents find ridehailing services a good alternative mode during traveling, and/or when transit is not available, and/or when their car is temporarily not available, and/or in assisting them avoiding impaired driving. About half of the respondents believe that ridehailing services are too expensive to be used on a regular basis.

Micro-mobility services have been used by one percent of the Phoenix metro area residents weekly with the majority (62 percent) of the trips happening during weekdays and 78 percent of the trips being less than two miles. Close to half of the micro-mobility users stated that they would walk or not make this trip if this service was not available and the majority of the respondents (71 percent) mentioned using of the service just to enjoy and give it a try as one the three reasons for using these services.

Considering the fact that the Phoenix metro area is the testbed for multiple autonomous companies, a little over half (54 percent) of the respondents stated to be very or somewhat familiar with AVs and one percent have actually taken a ride. With this high rate of familiarity, 22 percent stated that they will never ride in an AV and 42 percent stated that they are not willing to buy an AV. Respondents' perceptions about various benefits and concerns around AVs have been asked. In general, safety is among the top concerns for respondents rather than a benefit. Only a quarter of the respondents think AV would make it safer for pedestrians and bicycles, and about three quarters have concerns about the technical failures and are willing to take control of the AV at any time. In this respect, 79 percent want AVs to be allowed on the market only when they are at least as safe as human drivers. In addition to safety, close to half of the respondents have concerns about data security.

In addition to the stated concerns, respondents think the convenience brought by AV can impact their choices. Close to half of the respondents (43 percent) believe that they can tolerate congestion better in AV and so the majority (69 percent) are willing to commute longer in AV. About 16 to 18 percent of respondents would change their home or work locations in the presence of AVs; one quarter makes additional trips; and, 33 to 39 percent would travel more often during peak hours and/or after dark and/or to farther destinations. All of these findings, in addition to stated 36 to 39 percent decrease in transit use and 19 to 29 percent decrease in active transportation modes use, highlights a significant potential negative impact of automation on sustainability and eventually wellbeing goals of our transportation system and calls for thoughtful and timely planning and policymaking efforts.

With respect to sharing perception, more than half of the respondents are uncomfortable sharing their ride with people they do not know and only 28 percent think that lower cost of shared ridehailing services worth the addition of travel time. Lastly, 16 percent think that ridehailing services can help them decrease their vehicle ownership or live with no car and 20 percent use these services to access transit. With respect to sharing the AV ride, only 18 percent are willing to share their ride with people whom they do not know, and 22 percent are willing to share their AV by leasing it to ridehailing companies while they are not using it.

Overall it is important to consider that all the convenience and comfort that mobility-on-demand services and autonomous vehicles provide for the users of transportation systems are in combination with the additional costs they may produce not just out of the users' pocket but from the entire people and the built and natural environment. These new mobility services and technologies could potentially decrease transit and green modes usage, increase the trip frequency and travel distance, change travel schedule and pattern, impact the home, work, and destination choices, exacerbate congestion, and increase energy consumption, emission production and induced demand for travel. Policymaking and planning practices with respect to smart pricing and sharing could maximize the positive impacts and minimize the negative impacts of these new revolutions to guide them wisely in the direction of sustainability, productivity, wellbeing, health, efficiency, accessibility, mobility, and socio-economic growth to serve human beings.

5. REFERENCES

Abraham, H., Lee, C., Brady, S., Fitzgerald, C., Mehler, B., Reimer, B., & Coughlin, J. F. (2017, January). Autonomous vehicles and alternatives to driving: trust, preferences, and effects of age. In Proceedings of the Transportation Research Board 96th Annual Meeting (TRB'17).

Alemi, F., Circella, G., Mokhtarian, P., & Handy, S. (2018). On-demand ride services in California: Investigating the factors affecting the frequency of use of Uber/Lyft (No. 18-05563).

Asgari, H., Jin, X., & Corkery, T. (2018). A Stated Preference Survey Approach to Understanding Mobility Choices in Light of Shared Mobility Services and Automated Vehicle Technologies in the US. Transportation Research Record, 2672(47), 12-22.

Bailey, N., Rosenfield, A., & Zhao, J. (2018). Attitudes Toward Effective Time Use in Autonomous Mobility-on-Demand Services in Singapore (No. 18-00783).

Becker, F., & Axhausen, K. W. (2017). Literature review on surveys investigating the acceptance of automated vehicles. Transportation, 44(6), 1293-1306.

Cao, X., Mokhtarian, P. L., & Handy, S. L. (2009). Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. Transport reviews, 29(3), 359-395.

Circella, G., Alemi, F., Tiedeman, K., Handy, S., & Mokhtarian, P. (2018). The adoption of shared mobility in California and its relationship with other components of travel behavior.

Driverless car market watch. 2019.
www.driverless-future.com. Accessed May 8, 2019.

Feigon, S., & Murphy, C. (2018). Broadening understanding of the interplay among public transit, shared mobility, and personal automobiles (No. Project J-11/Task 25).

Frankfurter Allgemeine Zeitung. 2015.
www.faz.net/aktuell/wirtschaft/unternehmen/verkehrsminister-foxx-selbstfahrende-autos-in-10-jahren-standard-13811022.html. Accessed June 8, 2019.

Golob, T. F., Horowitz, A. D., & Wachs, M. (1977). Attitude-behavior relationships in travel demand modeling (No. GMR-2398).

Online Geocoding Tool. 2020
www.geocod.io/. Accessed January, 2020.

Gurumurthy, K. M., & Kockelman, K. M. (2018). Analyzing the dynamic ride-sharing potential for shared autonomous vehicle fleets using cellphone data from Orlando, Florida. Computers, Environment and Urban Systems, 71, 177-185.

Hao, M., Li, Y., & Yamamoto, T. (2018). Assessing Public Preference and Willingness to Pay for Services of Shared Autonomous Vehicles: a Stated Preference Study in Nagoya, Japan (No. 18-02485).

Handy, S., Cao, X., & Mokhtarian, P. (2005). Correlation or causality between the built environment and travel behavior? Evidence from Northern California. Transportation Research Part D: Transport and Environment, 10(6), 427-444.

Harb, M., Xiao, Y., Circella, G., Mokhtarian, P. L., & Walker, J. L. (2018). Projecting travelers into a world of self-driving vehicles: estimating travel behavior implications via a naturalistic experiment. Transportation, 45(6), 1671-1685.

IEEE news. 2012. www.ieee.org/about/news/2012/5september_2_2012.html. Accessed June 6, 2017.

Konduri, K. C., You, D., Garikapati, V. M., & Pendyala, R. M. (2016). Enhanced synthetic population generator that accommodates control variables at multiple geographic resolutions. Transportation Research Record, 2563(1), 40-50.

Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. Transportation research part F: traffic psychology and behaviour, 32, 127-140.

Lahkar, P., Murray-Tuite, P., & Hancock, K. (2018). Familiarity and Use of Transportation Network Company (TNC) Services in Virginia (No. 18-00230).

Nazari, F., Noruzoliaee, M., & Mohammadian, A. (2018). Shared Mobility Versus Private Car Ownership: a Multivariate Analysis of Public Interest in Autonomous Vehicles (No. 18-04289).

Noblet, C. L., Rubin, J., Eslin, A., & Jennings, R. (2018). What's 'Driving' Adoption of Automated Vehicles? (No. 18-01448).

Paulssen, M., Temme, D., Vij, A., & Walker, J. L. (2014). Values, attitudes and travel behavior: a hierarchical latent variable mixed logit model of travel mode choice. Transportation, 41(4), 873-888.

Petrik, O., Martínez, L. M., Furtado, F., & Kauppila, J. (2018). Are transport users willing to share? Focus groups and stated preferences study on shared mobility in Auckland, NZ, Dublin, IR, and Helsinki, FI (No. 18-04866).

Schoettle, B., & Sivak, M. (2014). A survey of public opinion about autonomous and self-driving vehicles in the US, the UK, and Australia. University of Michigan, Ann Arbor, Transportation Research Institute.

Sener, I. N., Zmud, J., & Williams, T. (2019). Measures of baseline intent to use automated vehicles: A case study of Texas cities. Transportation research part F: traffic psychology and behaviour, 62, 66-77.

Shabanpour, R., Golshani, N., Shamshiripour, A., & Mohammadian, A. K. (2018). Eliciting preferences for adoption of fully automated vehicles using best-worst analysis. Transportation research part C: emerging technologies, 93, 463-478.

Tardiff, T. J. (1977). Causal inferences involving transportation attitudes and behavior. Transportation Research, 11(6), 397-404.

US Census Bureau. American Community Survey (ACS). 2017.
www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2017/ . Accessed May 8, 2019.

van de Coevering, P., Maat, K., & van Wee, B. (2018). Residential self-selection, reverse causality and residential dissonance. A latent class transition model of interactions between the built environment, travel attitudes and travel behavior. Transportation Research Part A: Policy and Practice, 118, 466-479.

Wadud, Z., & Huda, F. Y. (2018). The potential use and usefulness of travel time in fully automated vehicles (No. 18-01566).

Wang, S., & Zhao, J. (2018). How Risk Preferences Influence the Usage of Autonomous Vehicles (No. 18-00785).

Waymo Early Rider Program. 2019.
blog.waymo.com/2019/08/waymos-early-rider-program-one-year-in.html. Accessed February 27, 2020.

World Data. World Data Email Marketing Calendar. 2019.
www.worldata.com/calendar/. Accessed September 19, 2019.

Ye, X., Konduri, K., Pendyala, R. M., Sana, B., & Waddell, P. (2009, January). A methodology to match distributions of both household and person attributes in the generation of synthetic populations. In 88th Annual Meeting of the Transportation Research Board, Washington, DC.

APPENDIX I - 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 **leisure/personal** purposes since the beginning of the year:
    _____Trips by car _____Trips by airplane _____Trips by other means

    b. Number of long-distance trips for **business** 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	○ 0 to 4 years old ○ 5 to 12 years old	○ Male ○ Female	○ Part-time worker ○ Full-time worker

	grandchild ○ My or my partner's parent or grandparent ○ Other	○ 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		○ 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.