FTA RESEARCH

FEDERAL TRANSIT ADMINISTRATION

An Evaluation of the Valley Metro–Waymo Automated Vehicle RideChoice Mobility on Demand Demonstration

Final Report

AUGUST 2021

FTA Report No. 0198
Federal Transit Administration

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U.S. Department of Transportation
Federal Transit Administration

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liter	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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14. ABSTRACT

In 2016, the Valley Metro Regional Public Transportation Authority (Valley Metro) of the Greater Phoenix metropolitan area was awarded a grant as part of the Federal Transit Administration (FTA) Mobility on Demand (MOD) Sandbox program. Through the grant, Valley Metro and Waymo partnered to pilot the use of Waymo autonomous vehicles (AVs) as certified vehicles for Valley Metro's RideChoice program, a subsidized curb-to-curb individual mobility service (via taxi or ride-hailing services) for paratransit-certified people under the Americans with Disabilities Act (ADA) and for older adults age 65 and over living in Greater Phoenix. The project engaged current RideChoice participants and catered to their mobility needs. Three surveys were conducted on a self-selected group of RideChoice users from the part of the region where the Waymo service was offered. In addition, two focus groups and a policymaker roundtable were held. Key findings were that participants felt safe, found the AV services more convenient than typical RideChoice options, and engaged in more out-of-home activities (i.e., made new trips) as a result of the AV option. Participants indicated a willingness to ride alone in AVs and to ride with family or friends. Riding with strangers in an AV mobility future was the least desirable option. Their ratings of wait time, travel time, convenience, and comfort of the AV option were in all cases higher than for traditional options available through RideChoice. A majority of participants expressed positive feelings about the introduction of AVs, both for RideChoice services and more generally on the roads. Their expectation was that AVs would increase safety on the roads. Planners and policymakers who participated in the focus groups felt there was a need to explore more use cases within the region and were keen to see additional pilot projects.

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ABSTRACT

In 2016, the Valley Metro Regional Public Transportation Authority (Valley Metro) of the Greater Phoenix metropolitan area was awarded a grant as part of the Federal Transit Administration (FTA) Mobility on Demand (MOD) Sandbox program. Through the grant, Valley Metro and Waymo partnered to pilot the use of Waymo autonomous vehicles (AVs) as certified vehicles for Valley Metro's RideChoice program, a subsidized curb-to-curb individual mobility service (via taxi or ride-hailing services) for paratransit-certified people under the Americans with Disabilities Act (ADA) and for older adults age 65 and over living in Greater Phoenix. The project engaged current RideChoice participants and catered to their mobility needs. Three surveys were conducted on a self-selected group of RideChoice users from the part of the region where the Waymo service was offered. In addition, two focus groups and a policymaker roundtable were held. Key findings were that participants felt safe, found the AV services more convenient than typical RideChoice options, and engaged in more out-of-home activities (i.e., made new trips) as a result of the AV option. Participants indicated a willingness to ride alone in AVs and to ride with family or friends. Riding with strangers in an AV mobility future was the least desirable option. Their ratings of wait time, travel time, convenience, and comfort of the AV option were in all cases higher than for traditional options available through RideChoice. A majority of participants expressed positive feelings about the introduction of AVs, both for RideChoice services and more generally on the roads. Their expectation was that AVs would increase safety on the roads. Planners and policymakers who participated in the focus groups felt there was a need to explore more use cases within the region and were keen to see additional pilot projects.

EXECUTIVE SUMMARY

Access to transportation facilitates economic opportunity and well-being. Mobility-disadvantaged people lack consistent access to employment and educational opportunities, health care and other key services, and social engagements. This project was designed to explore the use of autonomous vehicles (AVs) to meet the needs of those residents by providing point-to-point transport that would facilitate their access to opportunities and services.

In this temporary pilot research project, Valley Metro Regional Public Transportation Authority (Valley Metro) of Phoenix, Arizona partnered with Waymo to gauge RideChoice user perceptions and attitudes towards AVs with respect to safety, comfort and satisfaction, and traveler behavior. The Waymo service was added to and a subset of Valley Metro's demand responsive RideChoice service and included ambulatory persons who volunteered in the pilot and whose trip origins and destinations were within the Waymo mapped geographic area. RideChoice is a subsidized curb-to-curb individual mobility service (via taxi or ride-hailing services) for paratransit-certified people under the Americans with Disabilities Act (ADA) and for older adults age 65 and over living in Greater Phoenix. The evaluation of the pilot, which was conducted by Arizona State University, was funded in part by the Federal Transit Administration's (FTA's) Mobility on Demand (MOD) Sandbox program.

Project partners designed the pilot to understand the potential for AVs to meet the daily needs of otherwise mobility-disadvantaged citizens. The project engaged current RideChoice participants and catered to their mobility needs. The results provide an evidence base for further exploration into how transit services might facilitate and subsidize point-to-point mobility through AVs for mobility-disadvantaged residents, particularly if the operating costs decrease sufficiently to facilitate much broader use of AVs, making the service budget-friendly (affordable) for low-income households.

Project Overview

Key Results

- Participants felt safe.
- Participants found the AV services more convenient than typical RideChoice options.
- Participants engaged in more out-of-home activities (i.e., made net new trips) as a result of the AV option.
- Participants feel that they would be comfortable riding alone, without a safety operator.

Purpose

The purpose of this six-month demonstration project (September 15, 2019–March 15, 2020) was to understand the potential behavioral impacts of AV

MOD services, including the perceptions and attitudes of users (and non-users) towards such new technologies and services. ASU researchers conducted surveys and focus groups and analyzed trip data to understand how experiencing AVs might affect perceptions of safety, rider experience and satisfaction, and travel behavior. The study also aimed to understand how AVs might serve mobility and accessibility needs of transportation-disadvantaged populations. A policymaker roundtable was also held with local stakeholders to understand what they perceive as implications of AVs for policy and planning in the region.

AV Technology

This project employed fully-autonomous, Level 4[1] AVs, provided by Waymo. Safety operators were present in the vehicles, and participating riders were made aware that the AVs were driving without any human intervention, despite the presence of a safety operator.

Timeline and Geography

AV rides were offered in a geo-fenced area of about 100 square miles between September 2019 and March 2020. Surveys were administered prior to, during, and after service availability, and focus groups and roundtable discussions took place in Summer 2020.

Participants

A majority of respondents reported some limitations in mobility, ranging from limitations to drive a car to limitations to walk three city blocks. Study participants self-selected to participate from the larger population of RideChoice riders and were, on average, younger than the overall population of RideChoice riders. The study sample was relatively small (n=51). Results may not be generalizable to the entirety of the general population but nevertheless demonstrate enthusiasm for AV services and a willingness to embrace AV technologies.

Cost to Participants

AV rides with origins and destinations within the operational territory were offered at a $3.00 fixed fare to enrolled participants, regardless of trip length. Typical non-AV RideChoice options cost $3.00 for the first eight miles, with a per-mile charge for each additional mile over eight miles.

[1]According to J3016 JUN2018, Level 4 is defined as High Driving Automation—the sustained and ODD-specific performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene.

Project Findings

Participants felt safe.

- Participants felt that AVs would improve safety on the roads and meet the mobility needs of all people and agreed that it would be good to see more AVs on the roads.
- Among participants who used AV and non-AV services during the pilot, only 29% strongly agreed that traditional RideChoice services were safe;70% strongly agreed that AV services were safe.

Participants found the services more convenient than typical RideChoice options.

- Participants indicated strong satisfaction with the wait time, travel time, cost, and comfort in their AV rides.
- On measures of impedance—wait time, travel time, and cost—AV rides were rated as providing greater satisfaction compared to non-AV RideChoice services.

Participants made new trips as a result of the new AV option.

- In the During Survey, 59% of participants indicated that they were taking more trips in the RideChoice program since AVs were introduced.
- Between 12:00–6:00 AM, participants used AVs significantly more compared to non-AV options.
- AV services were used considerably more than non-AV RideChoice options during the core months of the pilot program, suggesting that participants in this pilot study embraced AVs as a mobility option.
- Participants indicated they would take longer trips if the service area was expanded.

Participants are interested in riding alone, without a safety operator.

- Although participants in this demonstration project always rode AVs with a safety operator present, 70–80% of survey respondents consistently indicated they were willing to ride without a safety operator across all three surveys.
- Of three scenarios—riding alone, riding with friends or family, or riding with strangers in an AV—riding with friends or family was, as expected, the most preferred scenario.
- A majority of participants would like to be among the first to use AVs when they become widely available.

Next Steps

- The policymaker roundtable participants felt there was a need to explore more use cases within the region; similarly, subject matter experts were keen to see additional pilot projects.

- Such use cases and pilot projects could further explore:
  - Changing perceptions of AVs when no safety operator is present in the vehicle
  - Challenges related to first/last mile connectivity and transit service in low density areas
  - Infrastructure needs for AV operations
  - Collaboration to provide seamless mobility across jurisdictional boundaries
  - Mitigation of data-sharing, privacy, and cybersecurity issues/concerns

SECTION

1

Introduction

Background

This report documents the results of an evaluation of a temporary demonstration research project that aimed to obtain insights on attitudes and perceptions towards autonomous vehicle (AV) mobility-on-demand (MOD) services. In the project, Valley Metro Regional Public Transportation Authority (Valley Metro) of Phoenix, Arizona partnered with Waymo to gauge RideChoice user perceptions and attitudes towards AVs with respect to safety, comfort and satisfaction, and traveler behavior. The Waymo service was a subset of Valley Metro's demand responsive RideChoice service and included ambulatory persons who volunteered in the pilot and whose trip origins and destinations were within the Waymo mapped geographic area. RideChoice is a subsidized curb-to-curb individual mobility service (via taxi or ride-hailing services) for paratransit-certified people under the Americans with Disabilities Act (ADA) and for older adults age 65 and over living in Greater Phoenix. The evaluation of the pilot, which was conducted by Arizona State University, was funded in part by the Federal Transit Administration's (FTA's) Mobility on Demand (MOD) Sandbox program.

In this pilot demonstration project, Waymo, which operates fully autonomous vehicles (Fiat Chrysler Pacifica hybrid minivans, operated by the Waymo "Driver," Waymo's unique combination of hardware, software, and computer intelligence that powers vehicles to safely get people and things where they are going), was introduced as an additional mobility service provider to serve the mobility needs of individuals within Valley Metro's RideChoice program. The vehicles operated at Level 4 automation, according to Society of Automotive Engineers (SAE) International J3016 standards,[2] and in an area of more than 100 square miles during the time of the demonstration project and included service in communities within the Greater Phoenix (Maricopa County) East Valley area—Chandler, Mesa, Gilbert, Tempe, Guadalupe, the Gila River Indian Community, and Ahwatukee. A map of the service area is shown in Figures 1-1 and 1-2.

This area represents the southeast valley of the Greater Phoenix metropolitan area. Waymo has been in the Phoenix area for a few years, largely in the southeast valley (Chandler and parts of adjoining communities). Waymo has been mapping the area and driving vehicles in its service territory to continuously improve vehicle operations. Waymo started providing AV rides in 2018 to people who applied and were selected to be in the early rider program. This program was open to the public and offered a Transportation Network Company (TNC)

[2]According to J3016 JUN2018, Level 4 is defined as High Driving Automation – the sustained and ODD-specific performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will

type of service. A mobile app was used to request service and paid for each ride, the same as for any other ride-hailing service. A safety operator was on-board to serve as a backup, but the vehicles were fully autonomous and did not require any human intervention.

Figure 1-1
Waymo Service Area

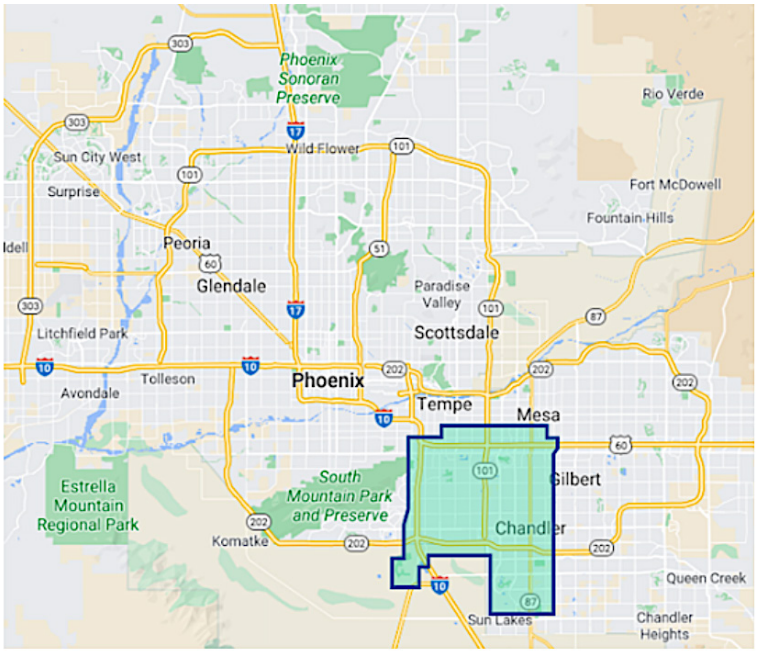
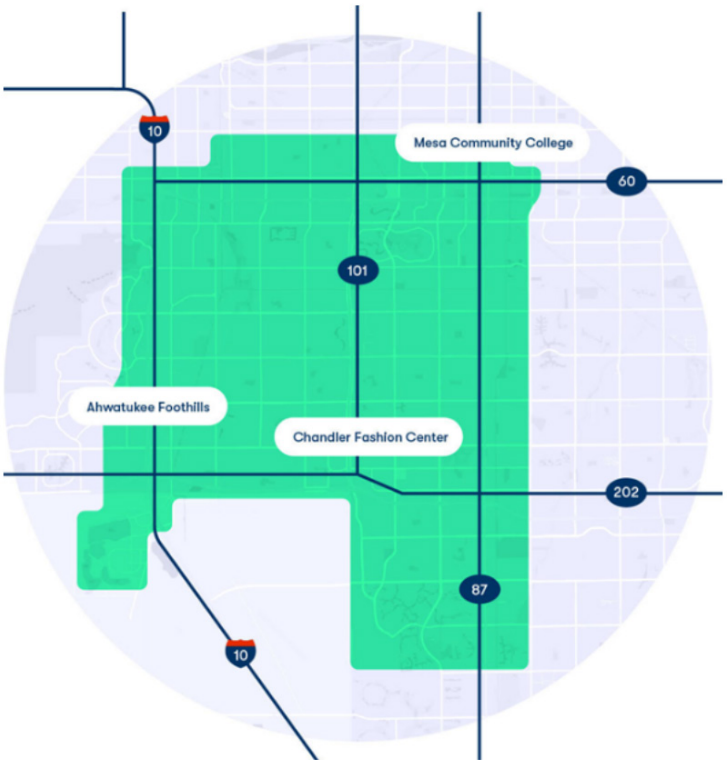


Figure 1-2
Waymo Service Area (Enlarged)



In July 2018, Valley Metro partnered with Waymo to explore use cases for collaboration as part of the FTA MOD Sandbox program. Phase I, the employee phase, began in September 2018 and provided Valley Metro employees in the Chandler area the ability to use Waymo to get to transit park-and-ride lots from their homes, thus providing a home-end first/last-mile connection for Valley Metro employees. The service for Valley Metro employees was largely targeted to serve commuting to and from Valley Metro in Downtown Phoenix. As part of this partnership, Valley Metro employees rode Waymo and provided feedback, participated in focus groups internal to Valley Metro and Waymo, and responded to surveys internal to Waymo and Valley Metro. Phase I also paved the way for determining barriers to entry before launching into Phase II, the RideChoice customer phase (the focus of this report).

Phase II incorporated RideChoice customers into the project. RideChoice provides curb-to-curb taxi/Uber/Lyft service for mobility-disadvantaged individuals (older adults, persons with disabilities or who are or low-income). RideChoice provides highly-subsidized rides, with a user fare for each ride of $3.00 up to eight miles and an additional $2.00 per mile over eight miles. Users can hail a taxi by calling a taxi company on the certified list or use Uber/Lyft and receive an individualized ride on-demand between an origin and destination. Individuals must apply and qualify to be part of the RideChoice program, which is different from the ADA-required paratransit service that provides a higher level of service (no limit on number or length of trips within the service area, no additional fees for longer trips, no trip denials, additional assistance when needed) for those who have a disability that prevents them from independently using regular bus or rail transportation.

As part of the MOD project, Valley Metro and Waymo entered into an agreement to have Waymo added as a certified mobility provider as part of the RideChoice program for participants living and traveling within the Waymo service territory. This was a six-month pilot, conducted solely in conjunction with the FTA grant award. Waymo is no longer part of the RideChoice program; however, RideChoice participants are still eligible to ride Waymo outside the RideChoice program at full cost as long as they are part of the Early Rider or Waymo One program. The AV MOD pilot, conducted in conjunction with the FTA grant, ran from September 2019 through March 2020, when Waymo paused operations in response to the COVID-19 pandemic.

During the six-month AV MOD pilot, selected RideChoice participants installed the Waymo app on their phone and could use Waymo under the RideChoice program at $3.00 per ride.[3] To ride Waymo, both the origin and destination had to be within the Waymo service territory; therefore, although some participants were selected to participate in the pilot study because they lived in the service territory, they did not end up using Waymo, at least in part because

their destinations were (for the most part) not in the territory. The selected RideChoice study participants were asked to answer survey questions and were provided incentives for doing so and for riding Waymo. The pilot participants responded to a survey before Waymo was available to them (the Prior Survey) and during and after Waymo was available to them (During and Post Surveys) as a highly-subsidized RideChoice option (similar to other RideChoice services).

A Note on Terminology

In this study and throughout this report, there is no distinction between the terms "self-driving," "autonomous," or "automated" when characterizing the vehicular driving technology that was deployed in the pilot demonstration project. These terms were used interchangeably throughout the study, and "self-driving" was used extensively in all communications with study participants and throughout the survey forms. In the context of this study, the three terms are synonymous and represent full automation (Level 4) in the SAE International J3016 standards and definitions. Throughout the study, it was made clear to participants that they were riding in fully-automated vehicles capable of navigating an entire trip without any human intervention. Study participants understood the nature and capabilities of the technology when they signed up to participate.

The study team is aware that, subsequent to the launch of this pilot, the term "self-driving" was used to characterize and describe driver-assist systems in certain vehicles, which require a human driver to be present at the wheel, alert and ready to take control at all times.

To be consistent with the terminology presented to study participants, this report uses the term "self-driving" extensively. This term refers to the "autonomous" vehicle technology in Waymo vehicles and does not refer to driver-assist systems that require human drivers to be alert and ready to take control at any instant. Thus, this demonstration pilot constituted a study of user experiences and attitudes and perceptions towards Waymo's AV technology that requires no human intervention or presence at the wheel. Although the technology is SAE Level 4 and requires no human operator, all rides undertaken by study participants in this pilot had a safety operator present in the vehicle who remained alert for the duration of the ride but did not engage in any vehicular driving or navigation tasks and activities.

[3]As explained subsequently, RideChoice users generally pay $2.00 per additional mile for rides over eight miles, but this policy was not enforced for Waymo rides during the demonstration project.

Outline of Report

The report is organized as follows:

- Section 2: Description of project objectives, methodology, and recruitment of participants
- Section 3: Description of three surveys undertaken prior to, during, and after the demonstration project
- Section 4: Description of current and recent mobility and choice behaviors
- Section 5: Comparison of trip characteristics among the three surveys, with additional insights from data shared by Valley Metro and Waymo
- Section 6: Results of analysis of perceptions about and attitudes towards RideChoice and Waymo services
- Section 7: Comparison of trip characteristics of Waymo and non-Waymo RideChoice rides based on trip data shared by Valley Metro and Waymo, with additional insights from survey results
- Section 8: Discussion of results of focus groups
- Section 9: Conclusions

SECTION

2

Project Objectives and Methodology

Research Objectives and Questions

Valley Metro is actively engaged in connecting communities and enhancing mobility and is exploring innovative solutions to enhance the customer experience and respond to changing mobility needs. This includes leveraging technology and partnerships that offer customers a seamless transportation experience between public and private services and making fare payment and trip planning more convenient and customized. RideChoice is a program operated by Valley Metro for ADA paratransit-certified people with disabilities and older adults age 65 and above who reside in participating communities (https://www.valleymetro.org/ridechoice). Customers in the program have access to a large network of transportation providers including Uber, Lyft, and taxi companies and are able to obtain rides at a subsidized cost.

Valley Metro partnered with Waymo under a grant from FTA to pilot a new type of service that offers a subset of eligible RideChoice customers the option to use a mobile app to hail on-demand trips in AVs with a vehicle safety operator on-board. Throughout this report, the terms self-driving vehicle, automated vehicle, and autonomous vehicle are used interchangeably. Although each term could refer to different types of vehicles and services, such distinctions are not critical for the purposes of this study. In general, respondents were told that the vehicles are entirely capable of driving themselves with no human intervention and that the Waymo service would have a vehicle operator on-board; thus, there was no ambiguity in how the respondents interpreted the nature of the vehicle and service. The actual language used to describe the vehicles and service is available in the survey instruments, which are included as appendices in this report.

Through this project, Valley Metro aimed to assess the impacts of AVs on travel behavior and better understand perceptions and attitudes towards AVs among Valley Metro's RideChoice and paratransit customers. The agency also aimed to assess the potential for including AV MOD services as a permanent option in the RideChoice program. The project team partners worked collaboratively to define research questions stemming from shared project goals to help guide the research evaluation methods and project outcomes. The research questions

helped identify the data needs and guided the design of surveys and focus groups. The following are the research questions originally identified[4] for this project:

- How can Valley Metro reduce costs to serve ADA paratransit customers but improve convenience and service to the paratransit customers?
  - Evaluate impact of subsidizing AV MOD service.
  - Evaluate AV MOD trip lengths and costs within the RideChoice program.
  - Evaluate how AV MOD trip costs compare to competing modes or service providers (TNCs, Taxis) within the RideChoice program.
- For RideChoice customers, does having access to on-demand, self-driving cars alter transit (i.e., bus, light rail) usage?
  - Identify changes in travel demand for transit and AV MOD service.
  - Identify rate of adoption, active use and occasional users for transit and AV MOD service.
- What value can on-demand, self-driving car service provide to people who currently do not have access to or may not have the ability to use transit?
  - Document RideChoice customers' perception of value added by AV MOD service.
- Can adding on-demand, self-driving cars to the RideChoice program help Valley Metro make progress on project goals?
  - Evaluate changes in attitudes and awareness of AV technology and MOD services before and after use of AV MOD service.
  - Evaluate change in individual use of RideChoice and paratransit.
- Does having access to on-demand, self-driving cars improve RideChoice customer perception of safety and/or the overall customer experience?
  - Identify concerns or barriers before and after use of AV MOD service.
  - Identify the attributes of AV MOD service and technology that improve travel experience, access, and convenience for a subset of eligible ADA paratransit customers.
  - Evaluate MOD AV service effectiveness and attractiveness compared to other modes and service providers serving RideChoice customers (e.g., taxis, TNCs).
- How does on-demand, self-driving car service improve access and mobility options for older adults in the low-demand or hard-to-serve transit markets?
  - Identify changes in trip generation, mode choice, and time of day of travel for transit and AV MOD service.

[4]These research questions were identified in the original proposal and experimental plan but not all could be addressed in this project due to data limitations.

- Document rider accessibility needs and level of accommodation offered by AV MOD service by tracking accessibility feature use (e.g., screen reader, screen magnification, cane, seeing-eye dog).
- Evaluate trips taken in areas served and not served by transit or ADA paratransit services.
- Document activity centers or areas of interest currently not served by transit, paratransit, RideChoice, and/or AV MOD services.

Partly as a result of the COVID-19 pandemic and partly as a result of the practicalities of the actual demonstration project, not all questions could be addressed. However, the majority were addressed, and results are described in the remainder of this report.

Experimental Plan

This project provided a unique opportunity to collect real-world data within a pilot project environment to obtain valuable insights regarding attitudes and perceptions towards fully self-driving cars (AVs) and on-demand services (MOD) within the RideChoice network. The ASU TOMNET University Transportation Center assisted this effort by deploying three surveys—one before the Waymo AV MOD service began and the other two during and after the service was provided.

Before the first survey, an Expression of Interest survey was conducted to recruit a sample to participate in the pilot. It was hoped that those who expressed interest and otherwise met criteria to participate in the study would respond to all three subsequent surveys. A total of 72 individuals expressed interest and met all other criteria for participating in the pilot. The Prior Survey was deployed in September 2019, and 51 valid responses were collected. The During Survey was deployed in March–April 2020 (at about the time that the Waymo AV MOD service was suspended due to COVID-19), and 35 valid responses were recorded. The Post Survey (conducted in May-June 2020, two months after the Waymo pilot ended), with 39 valid responses, was intended to assess the extent to which respondents may have changed their attitudes towards AVs, travel behavior, and mobility patterns following the pause in Waymo operations (beginning March 15, 2020) due to COVID-19. The Post Survey was intended to gather information on the extent to which patrons wished the service was still in place, would like to see it restored, and were interested in continuing to use it for their travel. For this demonstration study, the cost of a Waymo AV ride was capped at $3.00 per trip for all study participants, regardless of trip length. For all non-Waymo RideChoice options (providers), if the trip length exceeded eight miles, RideChoice customers paid $2.00 per mile for each mile over eight and a $3.00 flat rate for any trip eight miles or less). RideChoice customers were limited to a maximum of 50 trips per month.

Although there are thousands of RideChoice customers residing in the metro Phoenix region, the actual number of eligible RideChoice participants was naturally limited by the AV service provider's operational territory, with approximately 300 customers enrolled in the RideChoice program at the time of the project and approximately 100 actively using the program, taking about six rides per month, on average.

It was originally envisioned that 75 participants would be recruited to participate in the demonstration; of these, 50 would be recruited to use the AV MOD service at their discretion. These would-be participants, who would have met all criteria for participation and use of the service, would comprise the "treatment" group from an experimental design perspective; the remaining 25 would be those recruited as a "control" group. By including a "control" group in the experimental design, it was envisioned that it would be possible to isolate the effects of the AV MOD service experience on traveler behavior and values, attitudes, and perceptions while controlling for other external factors that may contribute to changes in behaviors and attitudes over the duration of the pilot. The project team planned to recruit participants, screen them, and place them in appropriate groups (treatment vs. control); however, the actual response rate to the Expression of Interest survey was lower than anticipated and a total of 72 people were recruited. The Prior Survey (i.e., the survey deployed before the Waymo AV MOD service was available as an option) was sent to these 72 individuals, and 51 responses were obtained. With this lower sample size of respondents (to the Prior Survey), it was not possible to establish formal treatment and control groups. However, 9 of the 51 respondents did not use the AV MOD service for the life of the pilot. Of those, 8 responded to the During Survey and 9 responded to the Post Survey. Although these sample sizes were smaller than had been hoped, an analysis of the two subgroups was conducted with the view that the 9 respondents who never used Waymo could serve as an informal "control" group.

It is important to note that the samples for these surveys were not random samples. Rather, the initial recruits constituted a self-selected sample of people who were eligible for Waymo service and who responded to the Expression of Interest. A subset of the recruits responded to the Prior Survey; the samples for the During Survey and the Post Survey are both subsamples of the Prior Survey sample. Because the two subsamples contained a number of respondents in common, but also included respondents who answered only one of the two surveys; these are defined as overlapping samples.[5] Because the samples were not random, great care was taken in drawing conclusions from the survey responses. All conclusions drawn in this study pertain to the self-selected individuals who participated in the study and should not be extended to the RideChoice population as a whole or the general population at large.

[5]Stopher, P.R. (2012). *Collecting, Managing, and Assessing Data*, Cambridge University Press, Cambridge, UK.

Valley Metro and Waymo each record trip data on the use of RideChoice services by each registered user. Trip data were provided to the research team for individuals in the sample who responded to the Prior Survey. Valley Metro provided trip roster data for December 2018–February 2019 (well before Waymo service was introduced through this pilot) and December 2019–February 2020 (when Waymo service was part of the RideChoice program); Waymo data were provided for the December 2019–February 2020. These data provided information on trip origins and destinations, time of day, cost, travel time, wait time, and distance, thereby obviating the need to request extensive trip data from respondents to the surveys. For privacy reasons, protections were put in place to ensure there was no sharing of personally identifiable information (PII).

In addition to conducting surveys and gathering trip data, the project team believed that additional insights could be obtained through focus groups, with in-depth discussions centered on key questions that could further illuminate underlying motivations, attitudes, and perceptions that could drive the future of AV MOD services. Although the surveys and data collection activities described provided critical and detailed information about what occurred in the context of the specific AV MOD experiment conducted in this project, they might not offer sufficient insights about the future of such services as they become increasingly pervasive in the transportation landscape. The purpose of the focus groups was to understand better how, why, and under what conditions the public may embrace AV MOD services on a large scale and what that might mean for the future of public transit as it exists today. In addition, the project team was interested in learning about the perceptions of City officials and agency stakeholders and how they plan to prepare for the advent of AV MOD services in their jurisdictions. Therefore, the project team conducted two focus groups and a policymaker roundtable.

One focus group involved the participants in the AV MOD experiment and included about a dozen individuals ; moderators with expertise in facilitating discussions were tasked with conducting the focus group event. The project team worked with Valley Metro and Waymo to identify key topics to be covered, key questions that needed to be addressed, and the extent to which participants would be allowed to digress and share perspectives on a variety of issues related to the future of AV-based MOD services. The second focus group comprised subject matter experts, with 27 urban and transportation planners providing an overview from a planning standpoint, helping to understand how such projects involving AVs may impact the Phoenix metropolitan area. The discussion focused on how such AV pilot project experiences may affect Valley Metro transit users, especially in terms of potential long-term benefits, allowing local cities to learn and adapt to this emerging technology together. The focus group sessions were recorded for subsequent analysis and extraction of key insights.

The policymaker roundtable involved local planning and transit agency stakeholders, primarily from jurisdictions in the Phoenix metropolitan area. This roundtable engaged about a dozen stakeholders, with discussions largely centered on how cities and jurisdictions are preparing for a future of AV and MOD services. With the increasing adoption and market penetration of these technologies and services, there are a number of considerations—including but not limited to the need for parking as it exists today, street design, safety of pedestrians and bicyclists, meeting mobility needs of the transportation disadvantaged, concerns about induced travel demand, increased traffic congestion due to zero-occupant vehicles[6] (ZOVs), and the role of public transportation in an AV- and MOD-based mobility future. Concerns about equity and environmental quality were also discussed, and participants in the focus group were asked to share their ideas on how they plan to welcome this technology into their jurisdictions in a manner that enhances mobility while minimizing any unintended consequences. In other words, the discussion addressed the theme of "anticipatory governance" as related to an automated mobility future.

Recruitment of Pilot Participants: Expression of Interest Survey

Valley Metro, in close coordination with ASU and Waymo, identified the appropriate subpopulations for participation in the AV MOD service experiment. The project team of Valley Metro, ASU, and Waymo collectively whitelisted a pool of eligible pilot demonstration participants. Participant eligibility criteria included:

- Current participant in the Valley Metro RideChoice program or paratransit service program
- Ownership of a compatible smartphone and ability to use a smartphone app to hail and pay for service
- Residence location within the service territory of Waymo
- Trip destinations largely within the service territory of Waymo
- Ability and willingness to go through an on-boarding process that will enable the individual to summon and use the AV service safely and properly
- Willingness to share person and household travel trajectory data and provide secondary activity-travel data that is not easily collected through passive means (e.g., trip purpose)
- Ability and willingness to respond to periodic surveys that collect information about user experience, perceptions, attitudes, values, service usage, and feedback

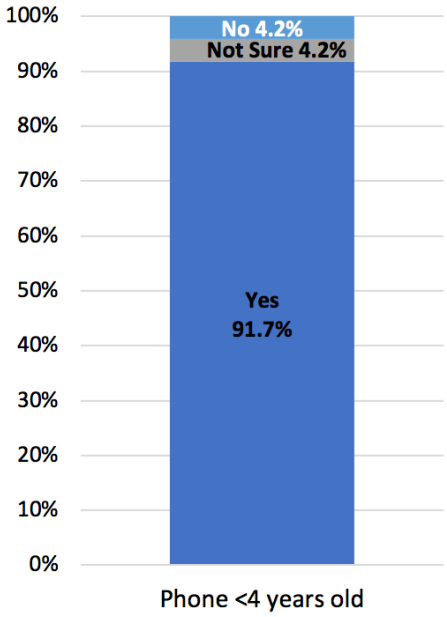
[6]When zero-occupant vehicles have to reposition themselves for the next use, they generate deadhead travel that can add considerably to existing traffic congestion.

The Expression of Interest Form was distributed in August 2019 (see Appendix B) and was conducted through an online platform, Qualtrics, in which participants could complete the form by phone or computer. The form captured information about current RideChoice usage and ability to perform different tasks or activities (needed to participate in the AV MOD experiment). Because participants need to use a mobile app to book and pay for their trips in the AV MOD experiment, it was important to verify that they had a smartphone purchased within the recent past. Although the Waymo app can run on a phone older than four years, this study adopted a conservative technological timeframe of four years to ensure that participants would not encounter any technology compatibility issues.

A total of 72 valid responses were obtained. Figure 2-1 shows that most participants had a smartphone purchased within the past four years (91.7%). In the Prior Survey (conducted in September 2019), respondents were almost equally split between Android phones (47.1%) and Apple/iOS phones (52.9%).

Figure 2-1

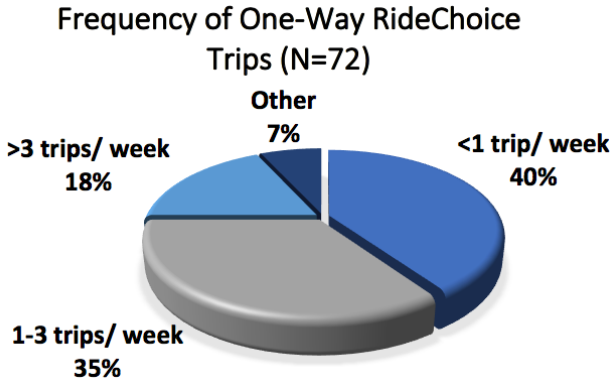
Participant Smartphone Holding



To obtain a baseline measure of current level of RideChoice program usage, respondents were asked how many rides (trips), on average, they made using RideChoice services. Having this baseline of current travel patterns was useful to identify potential changes after participation in the AV MOD experiment. As seen in Figure 2 2, 40% did not make RideChoice trips every week, about a third (35%) made 1–3 trips per week, and 18% were regular users, making more than 3 trips per week.

Figure 2-2

Baseline RideChoice Usage



Only 6 participants (8%) were already familiar with Waymo autonomous vehicles, and 92% (66) were not. Although 96% of respondents to the Expression of Interest Form were willing and interested in participating in the Valley Metro-Waymo Demonstration program, 4% were unsure about it. Note that it is unlikely that individuals not interested in the project would go through the trouble of answering the Expression of Interest form in the first place.

Respondents were asked if they could perform, on their own or with the help of a Personal Care Assistant (PCA), seven different activities. The results are shown in Table 2 1. Possible reasons for the lower proportion for the last activity (navigate to or from a self-driving vehicle) could be a lack of knowledge about self-driving vehicles and how to access them[7] or possible mobility limitations, because the targeted population was composed of ADA paratransit-certified people with disabilities or older adults age 65 years and above. All respondents were able to perform at least most of the activities, so no one was excluded on the basis of responses to these questions.

Table 2-1

Respondent Ability to Perform Activities

Criterion	Question Text	Number	Percent
1	Speak and understand English sufficiently to communicate with support staff	63	88%
2	Board, secure themselves, and ride in a self-driving vehicle	62	87%
3	Carry and secure their own possessions within the vehicle	62	87%
4	Speak, write, and understand English sufficiently to complete surveys	62	87%
5	Use a mobile app to book and pay for trips	60	84%
6	Download and install a mobile app	60	84%
7	Navigate to or from a self-driving vehicle	56	77%

[7]This is consistent with the idea that much of the general public is unfamiliar with AVs and does not necessarily understand their capabilities

In a final question, respondents were asked if they wanted a follow-up call to discuss aspects of the pilot experiment further; 71% (51) of respondents said they did. An analysis of responses to the Expression of Interest form yielded a self-selected sample of 72 respondents identified as being eligible to continue with the main surveys of the project.

SECTION

3

Overview of Surveys and Respondent Demographics

In this section, the three surveys administered throughout the pilot study and the respondent samples are described briefly. The survey forms are shown in Appendices C through E. The respondent demographics are summarized in this section, offering a comparison of survey samples and showing statistical significance of any differences between the samples. It is important to note that the samples were self-selected and that results cannot be generalized to the broader population; the results apply to RideChoice customers who, prior to the demonstration project, were willing and interested to take part in this pilot study, met certain criteria, and indicated a willingness to respond to surveys and share trip data.

Prior Survey

The Prior Survey, shown in Appendix C, was deployed in September 2019 and was conducted through the Qualtrics online platform, in which participants could complete the form either on a phone or a computer. To boost the response rate, two rounds of reminders were sent, one in each week after the survey was deployed. In addition, cards were offered to all respondents who provided a completed Prior Survey as a form of incentive for their participation. On average, it took 30 minutes for participants to complete the Prior Survey. Of the 72 individuals who expressed interest and met the criteria to participate in the study, 52 provided valid responses; 1 provided contradictory responses about the use of RideChoice between this survey and the Post Survey and was subsequently removed from analysis.

Prior to the Waymo onboarding phase, the Prior Survey was administered to all 72 recruited participants. The Prior Survey comprised three sections:

- *Section A – Current RideChoice Service Use Patterns* gathered detailed information about the most recent RideChoice trip including day of week and time of day, origin-destination locations, travel time, wait time, trip start and end times, service cost, travel companion presence, trip purpose, and availability of alternative travel modes. It also gathered information about the general frequency of use of RideChoice service and perceptions of and attitudes towards the current RideChoice service.

- *Section B – Thoughts About Self-Driving and On-Demand Mobility Services* gathered information on respondent level of familiarity with AVs, willingness to adopt or ride in AVs, attitudes and perceptions about the operation of AVs, expected changes in travel behavior with the advent of mobility-on-demand AVs, and expectations around AV on-demand mobility services.
- *Section C – Background Information* gathered sociodemographic information, including age, gender, education attained, employment/student status, work/school locations, vehicle ownership, household location, household size, type of housing, income, and residential and work locations. The goal of this section was to better understand the socioeconomic profiles of respondents so the influence of socioeconomic and demographic variables on attitudes towards and use of MOD AV services could be quantified in subsequent analyses.

During Survey

The During Survey was sent to 46 study participants. The reduction in sample size occurred because 5 of the original 51 respondents to the Prior Survey did not enroll in the RideChoice program and thus were ineligible to take rides under the RideChoice program. The survey was deployed in early March 2020, and responses were collected between March 4 and April 5, 2020. The During Survey was conducted through the Qualtrics online platform, and the same reminders and incentives were used as in the Prior Survey. On average, it took 20 minutes for participants to complete the During Survey. It proved challenging to obtain a strong response rate for the During Survey despite reminder and incentive protocols; as a result of the onset of the pandemic and the beginning of the state shutdown on March 15, 2020, it is likely that study participants were distracted by pandemic-related concerns and could have been affected by the reduced amount of travel in the wake of the pandemic. A total of 35 responses were obtained (out of the 46 individuals who received the survey).

The During Survey was intended to be conducted during the experimental phase, in which participants were onboarded and had Waymo as an option for their RideChoice rides, to understand how AV MOD services were being used by study participants and to compare data collected in the During Survey with data collected in the Prior Survey. The During Survey comprised three sections:

- *Section A – Transportation Choices* gathered detailed information about recent transportation choices of participants, including opinions about Waymo and non-Waymo RideChoice services. In addition, details about the most recent ride taken by both types of services were collected, including month and year of ride, day of week and time of day, origin-destination locations, travel time, wait time, travel companion presence, trip purpose, availability of alternative travel modes, ride satisfaction levels, and use of time during the reported ride.

- *Section B – Thoughts About Self-Driving and On-Demand Mobility Services* gathered information on level of familiarity with self-driving cars, willingness to adopt or ride in AVs, attitudes and perceptions towards the operation of AVs, expected changes in travel behavior with the advent of MOD AVs, expectations around AV on-demand mobility services, and comparative ratings on attributes of regular taxi, Uber/Lyft, and Waymo.
- *Section C – Background Information* gathered sociodemographic information, specifically employment/student status, work/school locations, vehicle ownership, household location, household size, and income. The goal of this section was to understand the socioeconomic profiles of respondents so the influence of socioeconomic and demographic variables on attitudes towards and use of MOD AV services could be quantified in subsequent analyses. Collecting these data also enabled a comparison of respondent profiles across surveys, thus making it possible to determine if differences in socioeconomic profiles of respondent samples may have contributed to any observed differences in attitudes and travel behavior between surveys.

Post Survey

Participants in the project were invited to answer the Post Survey, which is shown in Appendix E. The survey was deployed in May 2020 to the same 46 participants who received the During Survey, and responses were collected from May 27 to June 17, 2020. Because the project worked with the same population from the beginning, each During Survey and Post Survey sample was a sub-sample of respondents who responded to the Prior Survey. The Post Survey was administered through the Qualtrics online platform, in which respondents could complete the forms either on a phone or computer, and the same reminders and incentives were used as in the Prior and During surveys. On average, respondents took about 10 minutes to complete the Post Survey. At the time of this survey, the shutdown of many businesses and reduction in travel due to the COVID-19 pandemic were in full effect; therefore, the results of this survey reflect much of this reduction in travel. In total, 40 responses were received to the Post Survey, with all but one deemed valid responses, giving a final Post Survey sample of 39 responses.

The Post Survey was administered about one month after respondents no longer had Waymo as an option for their RideChoice rides. This enabled an understanding of how travel patterns and behaviors had changed over time, including COVID-19 impacts on transportation. The Post Survey comprised three sections:

- *Section A – Travel Choices and Experiences* gathered general information about the recent transportation choices of respondents, including their Waymo experiences. Data also were collected regarding basic travel patterns before the COVID-19 pandemic and potential changes that might occur after the pandemic to analyze how it might affect the travel behaviors of participants and their RideChoice usage.

- *Section B – Thoughts About Self-Driving and On-Demand Mobility Services* gathered respondent perceptions of and expectations related to new mobility services and technologies, considering transportation needs and experiences in general and not necessarily focused exclusively about RideChoice or Waymo vehicles and services. Respondents were asked to indicate their preferences and behaviors under the assumption that the COVID-19 pandemic had ended.
- *Section C – Employment Status and Incentive* had only two questions, one regarding respondent employment status, which allowed comparisons to the During Survey and Prior Survey (particularly in the wake of employment disruptions that occurred due to the pandemic) and another regarding the gift cards they would receive as an incentive to complete the survey.

Groups of Interest in the Analysis

For the analysis presented in this report, several groupings of the data are of interest. Whereas the goal of recruiting a control group was not achieved because of the small sample size, the final datasets contained a small group of respondents who did not use the Waymo service option throughout the experiment. Although this group was not identifiable until the Post Survey (by which time it could be ascertained that they did not use Waymo at any time during the pilot demonstration), these respondents could be tracked back through the During and Prior Surveys because the During and Post Survey respondents were subsamples of the Prior Survey respondents. To maintain a consistent identification and labeling of the groups of interest, a specific naming convention was adopted for these groups.

First, in naming the groups, it is important to keep in mind that they were all RideChoice users. Therefore, each group is preceded with the abbreviation RC for RideChoice. Second, it is also important to remember that these groups were from the data of respondents to the three surveys. They were not, by any means, all RideChoice users that were able to participate in the pilot demonstration. Therefore, each group is identified as Respondents to indicate that they are survey respondents only. The final group names are as follows:

- **RC Respondents (All)** – all valid respondents to a particular survey
- **RC Respondents (Waymo)** – valid respondents who reported in the Post Survey that they had used Waymo at least once in the pilot demonstration
- **RC Respondents (non-Waymo)** – valid respondents who reported in the Post Survey that they had never used Waymo during the pilot demonstration

In addition, there were occasions when the analysis reports on the opinions and experience of respondents about traditional RideChoice services (i.e., providers other than Waymo) or about Waymo RideChoice services specifically. In these cases, the following groupings were used, with the survey or surveys from which the data were taken being identified in the caption of the figure:

- **RC Respondents (Waymo) – Trad RC** – experiences with traditional RideChoice services for respondents who used Waymo at least once during the experiment
- **RC Respondents (Waymo) – Waymo RC** – experiences with Waymo RideChoice services for respondents who used Waymo at least once during the experiment
- **RC Respondents (non-Waymo) – Trad RC** – experiences with traditional RideChoice services for respondents who never used Waymo during the experiment
- **RC Respondents (All) – Trad RC** – experiences for all respondents (of any survey) with traditional RideChoice services

Comparison of Demographics Among Survey Samples

Background on Respondents

Before reporting on the demographics of the survey participants, it is useful to consider experiences with the use of Waymo during the demonstration project and the use of RideChoice services in general. Recall that RideChoice is a program operated by Valley Metro for ADA paratransit-certified people with disabilities and older adults age 65 years and above who reside in participating communities. In the Prior Survey, respondents were asked about how often they had used RideChoice services in the prior 12 months; in the Post Survey, they were asked if they had used Waymo in the past 12 months and if they had used non-Waymo RideChoice services in the past 12 months.

In total, 38 respondents answered the Prior Survey question on frequency of use of RideChoice and the questions on use of Waymo and non-Waymo RideChoice in the Post Survey. In terms of the questions asked in the Post Survey, Table 3-1 defines three potentially interesting groups. The first group comprises respondents who used both Waymo and non-Waymo RideChoice services in the 12 months preceding the Post Survey; 24 respondents fell into this category. The second group comprises respondents who used only non-Waymo RideChoice services in the past 12 months; 8 respondents who fell into this group. There were 2 participants who did not answer the question regarding RideChoice usage in the 12 months preceding the administration of the Prior Survey (not included in Table 3-1), leaving 6 respondents in the third group—those who used Waymo but did not use any non-Waymo RideChoice services in the 12 months preceding the administration of the Post Survey. Of these, only 1 had not used non-Waymo RideChoice services in the 12 months before the Prior Survey, so this group was assumed to have some knowledge of RideChoice services and was combined with the Waymo group. The 30 participants who used Waymo are called RC

Respondents (Waymo), and the 8 participants who did not use Waymo at all are called RC Respondents (non-Waymo), as outlined in Groups of Interest in the analysis.

Table 3-1

Use of RideChoice and Waymo in Preceding 12 Months

Used RideChoice Before Prior Survey	Used RideChoice Before Post Survey	Used Waymo Before Post Survey		Total
		Yes	No	
Yes	Yes	20	5	25
	No	5	1	6
No	Yes	4	2	6
	No	1	0	1
Total		*30*	*8*	*38*

An extensive set of demographics was collected in the Prior Survey. Because each respondent had a unique ID, these responses could also be attributed to the corresponding respondents in the During and Post Surveys. In the During Survey, only employment status, student status, occupation, and income were collected; in the Post Survey, only employment status was collected. The following comparisons, where demographics were not collected in the specific survey, are drawn from the corresponding person's responses to the Prior Survey. Of the 51 respondents to the Prior Survey, 35 were present or answered the demographic questions in the During Survey, and 34 answered and were present in all three surveys.

In this section, statistics are compared between surveys. However, only aggregate numbers or percentages of responses are shown. No individual can be identified from the information reported here. All individual-level records (survey records and trip records) are maintained on secure ASU servers and are subject to all protections associated with research involving human subjects. All Institutional Review Board (IRB) protocols have been followed and approvals obtained to ensure data security and respondent privacy. Only aggregate summary statistics are documented in study reports, thus ensuring that individual privacy is protected, and respondents remain anonymous.

Table 3-2 provides a summary of the demographics of the three survey samples and a subdivision of respondents into RC Respondents (Waymo) and RC Respondents (non-Waymo). Sample sizes shown in Table 3-2 may vary slightly from one demographic to another. For occupation, no statistics are provided for these last two categories, because the RC Respondents (non-Waymo) included no employed persons. A more detailed presentation of demographic statistics is provided in Appendix I. Comparisons of these sample demographic characteristics to the eligible population for RideChoice services was not possible, because statistics on the latter population are not available. Nonetheless, Figure 3-1 shows a comparison between the age distribution of the entire RideChoice population and that of the sample who participated in the Prior Survey.

Table 3-2

Summary Demographics of Three Survey Samples

Demographic	Prior Survey (N=51)	During Survey (N=35)	Post Survey (N=37)	RC Respondents (Waymo) (N=30)	RC Respondents (non-Waymo) (N=8)
Age					
18–30	21%	20%	22%	23%	12%
31–40	16%	11%	11%	13%	0%
41–50	10%	6%	8%	10%	0%
51–60	21%	23%	24%	27%	12%
61–70	16%	20%	19%	17%	38%
71 and older	16%	20%	16%	10%	38%
Gender					
Male	59%	48.5%	51%	48%	71%
Female	41%	51.5%	49%	52%	29%
Household Size					
1	20%	21%	16%	16%	12%
2	31%	27%	30%	27%	17%
3	31%	24%	35%	40%	13%
4 or more	18%	29%	19%	17%	38%
Type of Home					
Stand-alone	67%	68%	70%	67%	86%
Attached home/townhome	6%	3%	3%	3%	0%
Condo/apt	23%	26%	24%	27%	14%
Mobile home	2%	3%	3%	3%	0%
Other	2%	0%	0%	0%	0%
Vehicle Ownership					
0	26%	27%	24%	30%	0%
1	33%	32%	38%	33%	50%
2	29%	27%	24%	27%	25%
3 or more	12%	15%	14%	10%	25%
Household Income					
Less than $25,000	28%	29%	32%	30%	37%
$25,000–$49,999	29%	34%	32%	40%	0%
$50,000–$74,999	14%	11%	16%	10%	50%
$75,000–$99,999	16%	14%	5%	7%	0%
$100,000–$149,999	14%	9%	14%	13%	13%
$150,000 and over	0%	3%	0%	0%	0%

Table 3-2 (cont.)

Summary Demographics of Three Survey Samples

Demographic	Prior Survey (N=51)	During Survey (N=35)	Post Survey (N=37)	RC Respondents (Waymo) (N=30)	RC Respondents (non-Waymo) (N=8)
Employment Status					
Employed full time	29%	14%	13%	23%	0%
Employed part time	8%	14%	8%	10%	0%
Self-employed	4%	3%	5%	7%	0%
Retired	22%	31%	28%	20%	37%
Homemaker	0%	3%	2%	0%	0%
Unable to work	25%	17%	26%	33%	25%
Looking for work	6%	6%	2%	4%	25%
Not looking for work	0%	0%	3%	0%	0%
Other	6%	12%	13%	3%	13%
Occupation					
Sales or service	24%	36%	25%		
Clerical/admin support	10%	9%	17%		
Manufacturing, construction, maintenance, or farming	19%	18%	17%		
Professional, managerial, or technical	33%	0%	33%		
Education, training, or library	5%	18%	0%		
Other	10%	18%	8%		
Educational Attainment					
Completed high school, GED, or less	16%	15%	16%	21%	0%
Some college/technical school	49%	47%	51%	48%	62%
Bachelor's degree/some grad school	20%	21%	16%	21%	0%
Completed grad degree(s)	16%	18%	16%	10%	38%

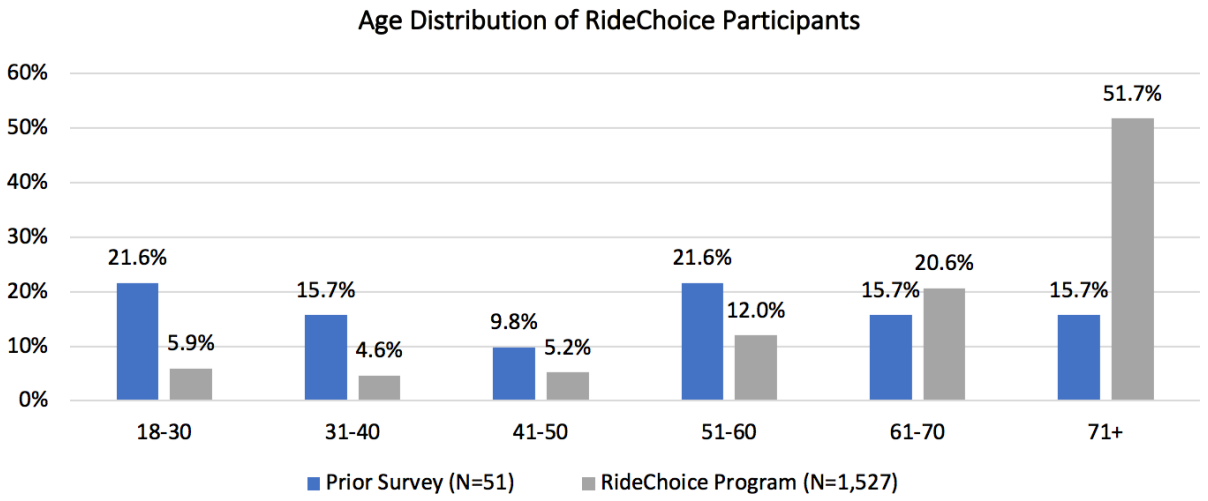


Figure 3-1

Comparison of Age Distribution Between RideChoice Population and Pilot Participants

Given that RideChoice services are provided for those who have some mobility-limiting condition, respondents were asked to indicate limitations they experienced with respect to driving a personal vehicle, riding public transit, riding a bike, and walking three city blocks. The results are shown in Figures 3-2 through 3-5, which show that a little over 40% of respondents had limitations to drive and 26–32% were somewhat limited; 31% were limited in using public transit services and 29% were somewhat limited in their use; about 50% were limited in riding a bicycle and 14% were somewhat limited, around 34% (50% of RC Respondents [non-Waymo]) had limitations to walk three city blocks and 25–32% of all respondents and RC Respondents (Waymo) were somewhat limited in walking.

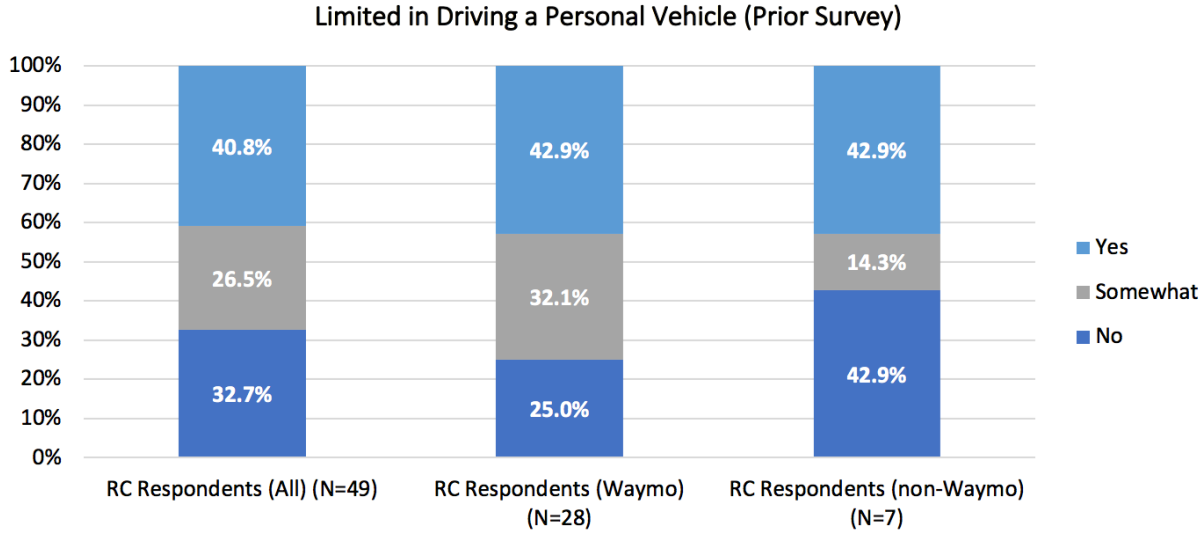


Figure 3-2

Percent of Respondents Limited in Driving a Personal Vehicle

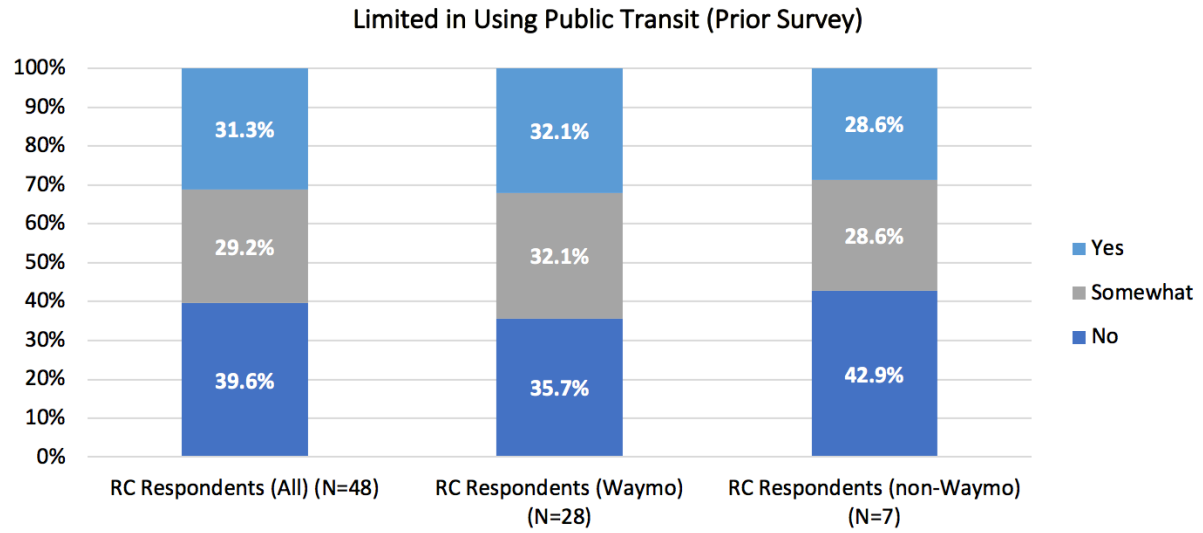


Figure 3-3

Percent of Respondents Limited in Using Public Transit

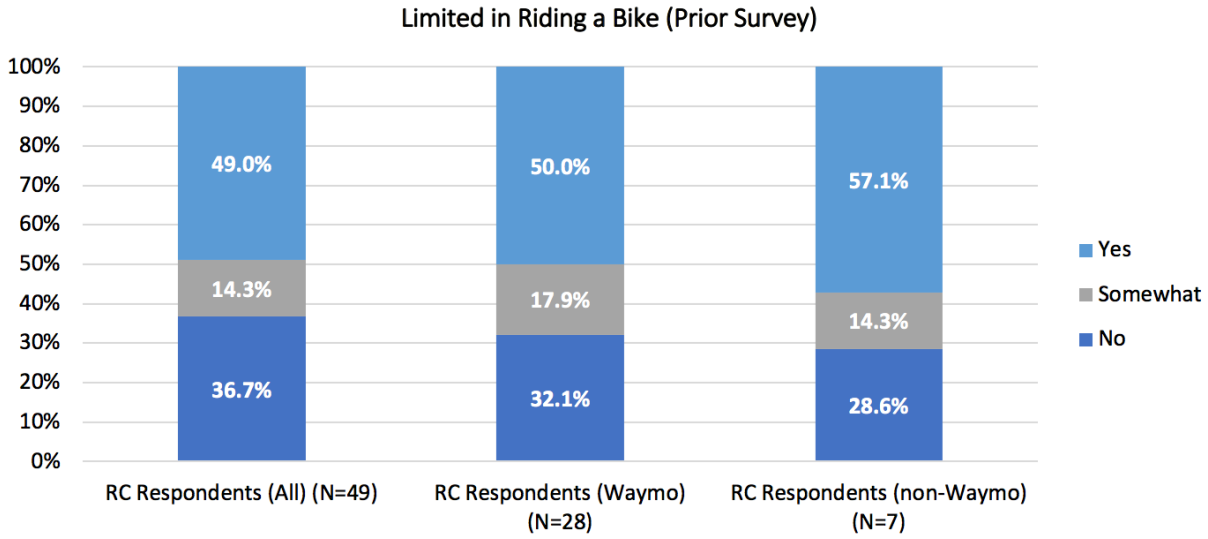


Figure 3-4

Percent of Respondents Limited in Riding a Bike

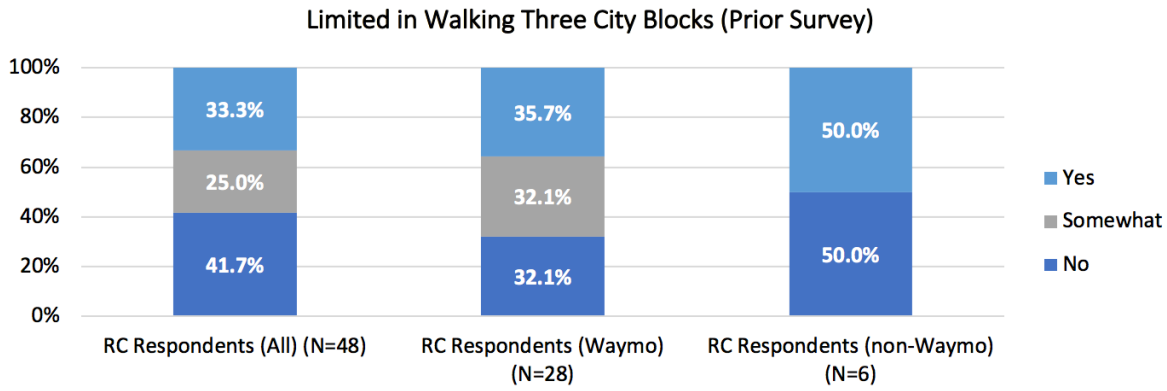


Figure 3-5

Percent of Respondents Limited in Walking Three City Blocks

Respondents were also asked if they used way-finding mobility assistance systems or tools. Multiple responses were permitted to this question. In all, 64.7% of respondents (63.3% of RC Respondents [Waymo] and 28.6% of RC Respondents [non-Waymo]) reported not using any such systems or tools. Figure 3-6 shows the results for the types of systems or tools used by all respondents to the Prior Survey and subdivided into RC Respondents (Waymo) and RC Respondents (non-Waymo). RC Respondents (Waymo) and the full set of respondents to the Prior Survey showed little difference, with magnification/zoom/large font being the most frequently used, and a screen reader/text-to-speech the second most frequently used technology. In both cases, 56% of responses indicated no use of such a system or tool. However, among RC Respondents (non-Waymo), these two systems were used equally as often and also as often as keyboard and voice control. The results show that the RC Respondents (non-Waymo) were much more dependent on way-finding mobility systems or tools than the RC Respondents (Waymo).

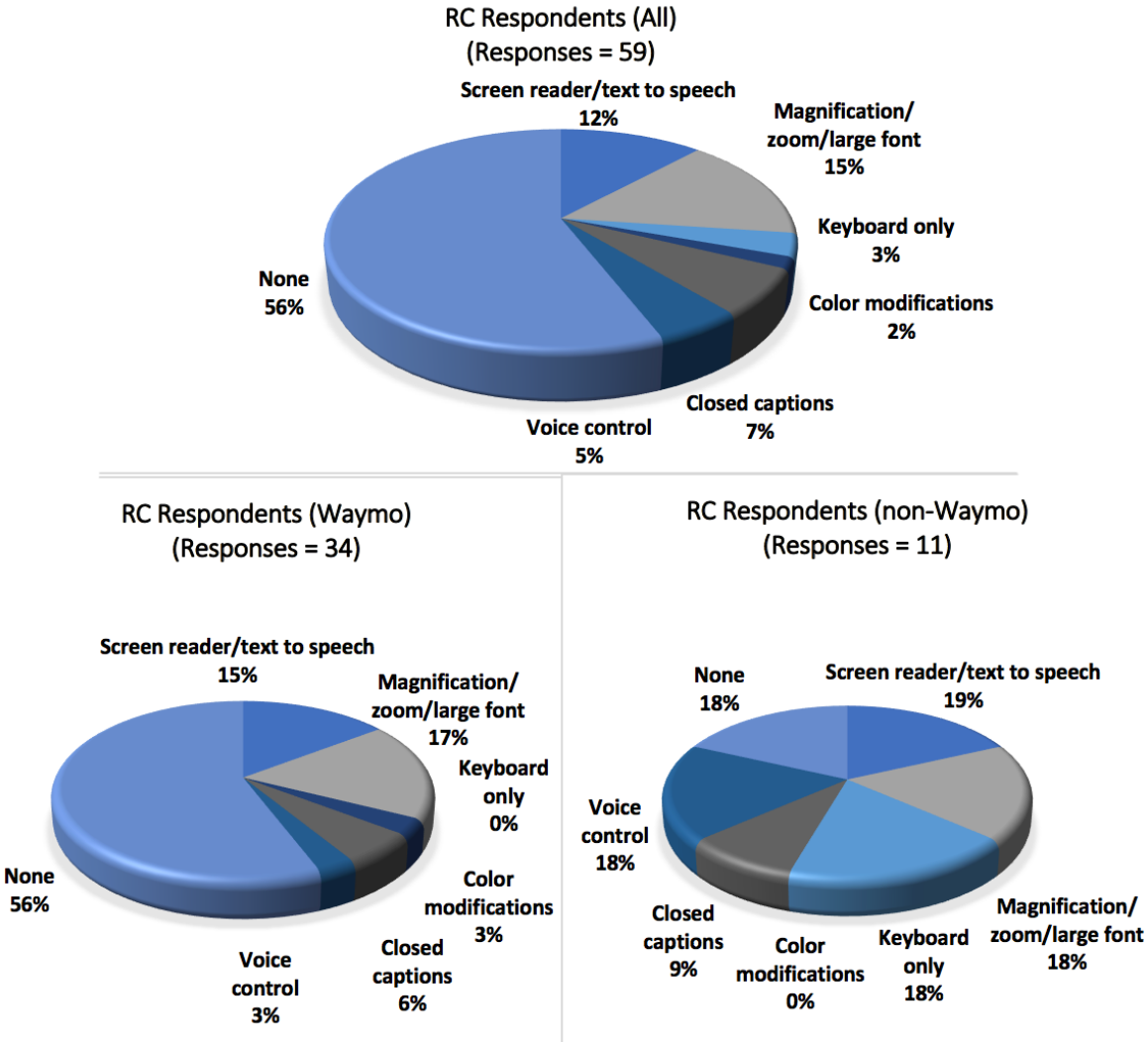


Figure 3-6

Use of Way-Finding Mobility Assistance Systems or Tools (Prior Survey)

Conclusions on Demographic Comparisons

In general, the study sample exhibited heterogeneity in demographic characteristics with individuals in all demographic categories. The only demographic that could be compared to that of the overall RideChoice population was age, which showed an expected study sample bias away from older adult users of these services and towards younger age groups. This was expected because of the greater acceptance of new technologies by younger people in general. For most of the demographics collected in the Prior Survey, there were few significant differences among the surveys, with most occurring between the During Survey and either or both of the Prior and Post Surveys. The biggest differences appeared in employment status, student status, and occupation; for these three variables, there were clear differences between respondents and non-respondents that led to some impact on the results

obtained from the During and Post Surveys. These differences should be kept in mind when looking at comparisons of experiences, preferences, and other attributes discussed in the balance of this report. The main conclusion to be drawn is that the During and Post Surveys had a considerably smaller proportion of employed people, particularly in the Professional, Managerial, and Technical occupations.

Comparing RC Respondents (Waymo) with RC Respondents (non-Waymo) (i.e., those who had taken at least one Waymo ride during the experiment vs. those who had not used Waymo at all during the experiment), there were notable differences (few of which are statistically significant, probably due to the very small sample size) in almost all demographic variables. The RC Respondents (non-Waymo) were generally older than the RC Respondents (Waymo), were predominantly male, belonged to larger households with more vehicles, were not currently working, included a higher proportion of students, had a higher income level, were more likely to live in a gated community, were better educated, and were more likely to use some way-finding mobility assistance tool or system (see Figure 3-6 for the types of mobility assistance tools). Although some of these differences stem from the small size of the sample of RC Respondents (non-Waymo), several differences were very plausible, as such variations may exist more widely in the population. Given these variations, it is worthwhile to look at differences on some key attitude and preference questions; these differences are explored further in subsequent sections of this report.

SECTION

4

Mobility Behaviors and Choices: Past, Present, and Future

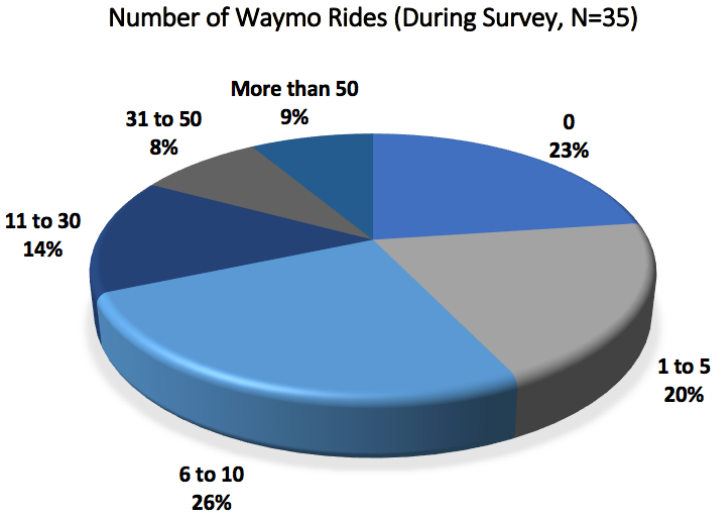
This project aimed to document changes in RideChoice service usage that accompanied the introduction of the Waymo AV service and the extent to which Waymo AV service was used. The impact of Waymo on the use of ride-hailing services was also investigated. The use of these three types of service (RideChoice Waymo, RideChoice non-Waymo, and ride-hailing services outside of the RideChoice Program) and that of other modes is discussed in the remainder of this section of the report.

Waymo Service Usage

Figure 4 1 shows the frequency distribution of Waymo rides of participants in the experiment. The During Survey was administered over a 33-day period, starting on March 4, 2020, and ending on April 5, 2020. However, Waymo suspended service on March 15, 2020 due to the COVID-19 pandemic; therefore, participants could use the Waymo service for only 12 of the 33 days. Overall, 23% of all survey respondents did not take a single Waymo ride throughout the AV MOD experiment. A few RC Respondents (Waymo) did not respond to the During Survey and were not reflected in the respondent dataset.

Figure 4-1

Number of Waymo Rides Taken Since Beginning of Demonstration Project (Sept 2019)

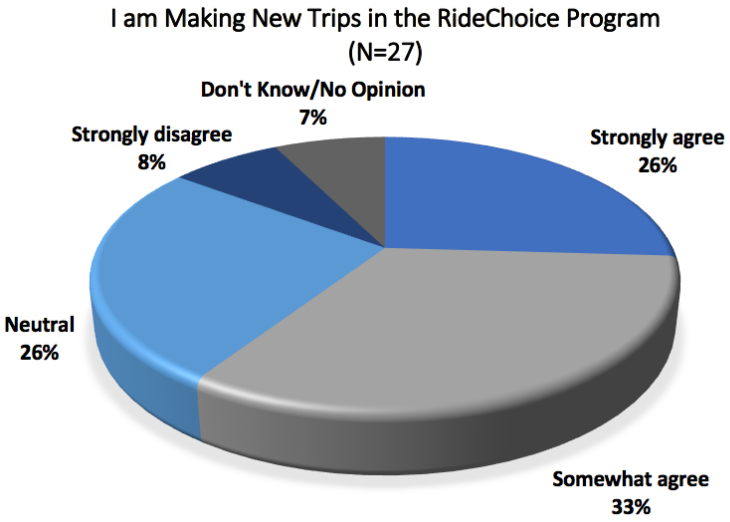


In the Post Survey (39 responses), the question was asked if the respondent had taken any rides with Waymo during the demonstration. Of the 39 respondents, 30 indicated having taken rides and 9 indicated never having taken a ride. This is consistent with the During Survey, which showed that 23% of respondents had not taken a ride with the Waymo service. It should be recognized, however, that both of these groups—RC Respondents (Waymo) and RC Respondents (non-Waymo)—were no longer taking Waymo rides at the time the Post Survey was conducted; however, there was considerable consistency in these two groups between the During Survey and the Post Survey.[8]

Waymo users were asked in the During Survey if they were making new trips on RideChoice as a result of having Waymo available as a service option. As shown in Figure 4-2, almost 60% of RC Respondents (Waymo) agreed or strongly agreed with this statement; only 8% strongly disagreed. The remainder were either neutral or did not know.

Figure 4-2

Making New Trips as a Result of Waymo Option in RideChoice Services (During Survey)



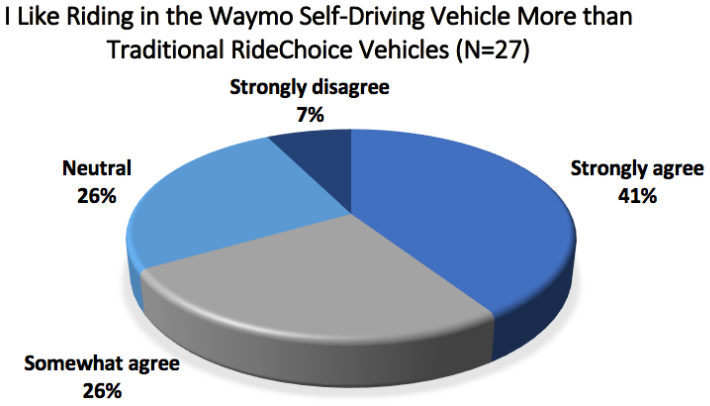
Affinity Towards Waymo AV Rides

When asked in the During Survey if they liked riding in Waymo AVs more than in a traditional RideChoice vehicle, 67% either agreed or strongly agreed and 7% strongly disagreed, as shown in Figure 4-3. Just over one quarter of respondents were neutral.

[8]Seven persons who indicated taking no rides with Waymo during the demonstration program answered both surveys, and six of the seven indicated no rides on both surveys; one indicated having taken one Waymo ride in the previous 12 months, but this could have been outside the demonstration program, so remains consistent.

Figure 4-3

Riding in Waymo Vehicles Preferred to Traditional RideChoice Vehicles (During Survey)



All respondents in the During Survey were also asked if they like riding in traditional RideChoice vehicles rather than in Waymo AVs. Not surprisingly, the majority of RC Respondents (non-Waymo) (60%) indicated that they did not know; the remaining 40% were neutral. As expected, 60.7% of RC Respondents (Waymo) disagreed or disagreed strongly, and only 21.4% agreed or strongly agreed, as shown in Figure 4-4.

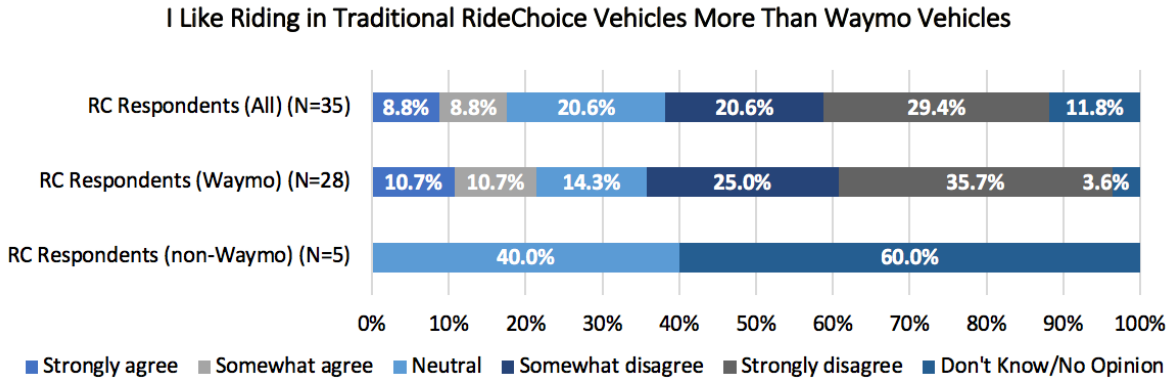


Figure 4-4

Riding in Traditional RideChoice Vehicles Preferred to Waymo Vehicles (During Survey)

Based on the comments respondents submitted at the end of the survey, it appears that the main reason most of the nine people did not use Waymo at all was because the travel locations they sought to visit were outside of Waymo's service territory (which was about 100 square miles during the time of the demonstration pilot). Some respondents lived near the eastern border of the service area, thus rendering many of their destinations just across the border and hence outside the service area.

The majority (35) of the sample responding to the Post Survey had the Waymo app on their phones at the time of the survey; those who did not were two RC Respondents (Waymo) and three RC Respondents (non-Waymo). It is worth

noting that six of the nine RC Respondents (non-Waymo) still had the app on their phones at the time of the Post Survey; it is not clear if they kept the app on their phones because they believed they would eventually use Waymo service in the future or that they simply neglected to delete the app.

Finally, RC Respondents (Waymo) were asked if they would like to have Waymo as a regular and permanent RideChoice option. The vast majority (82.8%) of those who answered this question were in strong agreement with the statement, 10.3% were somewhat in agreement, and the remaining 6.9% were neutral. None of the RC Respondents (Waymo) disagreed.

Non-Waymo RideChoice Service Usage

In the Prior Survey, respondents were asked questions about their most recent RideChoice ride. In presenting the results of these questions, the responses of all respondents to the Prior Survey are shown, labeled RC Respondents (All), together with a subdivision of the respondents into groups that were eventually identified as RC Respondents (Waymo) and RC Respondents (non-Waymo). It should be kept in mind that Waymo was not available to RideChoice users when the Prior Survey was administered, so the subdivision was based on the Post Survey question about use of Waymo in the 12 months preceding the administration of the Post Survey. This sample subdivision was done to determine if the responses prior to the availability of Waymo service might have influenced their subsequent use of Waymo during the pilot experiment. Also, it should be noted that not all respondents to the Prior Survey could be categorized into these two groups, so the total of RC Respondents (Waymo) and RC Respondents (non-Waymo) summed to less than the total Prior Survey respondents. This is true for all results that relate to the Prior survey in this report.

Respondents to the Post Survey were asked about non-Waymo RideChoice use in the preceding 12 months and since March 15, 2020. This latter time point represents the date when Waymo service was suspended because of COVID-19 and near the time that stay-at-home orders were promulgated in Arizona. Figure 4 5 shows the results for this question, subdivided by RC Respondents (Waymo) and RC Respondents (non-Waymo).

In total, 33 respondents reported having taken a ride on a non-Waymo RideChoice service in the prior 12 months. Of these, 24 were RC Respondents (Waymo) and 9 were RC Respondents (non-Waymo), indicating that a higher proportion of RC Respondents (non-Waymo) used RideChoice services in the past 12 months, which is consistent with their desired destinations being outside the Waymo service area. The differences between RC Respondents (All) and RC Respondents (Waymo), between RC Respondents (All) and RC Respondents (non-Waymo), and between RC Respondents (Waymo) and RC Respondents

(non-Waymo) were all statistically significant. The effects of the COVID-19 stay-at-home orders are clear, however, in the response about post-March 15 rides, although eight respondents—one RC Respondent (non-Waymo) and seven RC Respondents (Waymo)—did not respond to this question; only 1 RC Respondent (non-Waymo) and 10 RC Respondents (Waymo) had used any RideChoice service since March 15. The differences between RC Respondents (Waymo) and RC Respondents (non-Waymo) on the second question were not statistically significant.

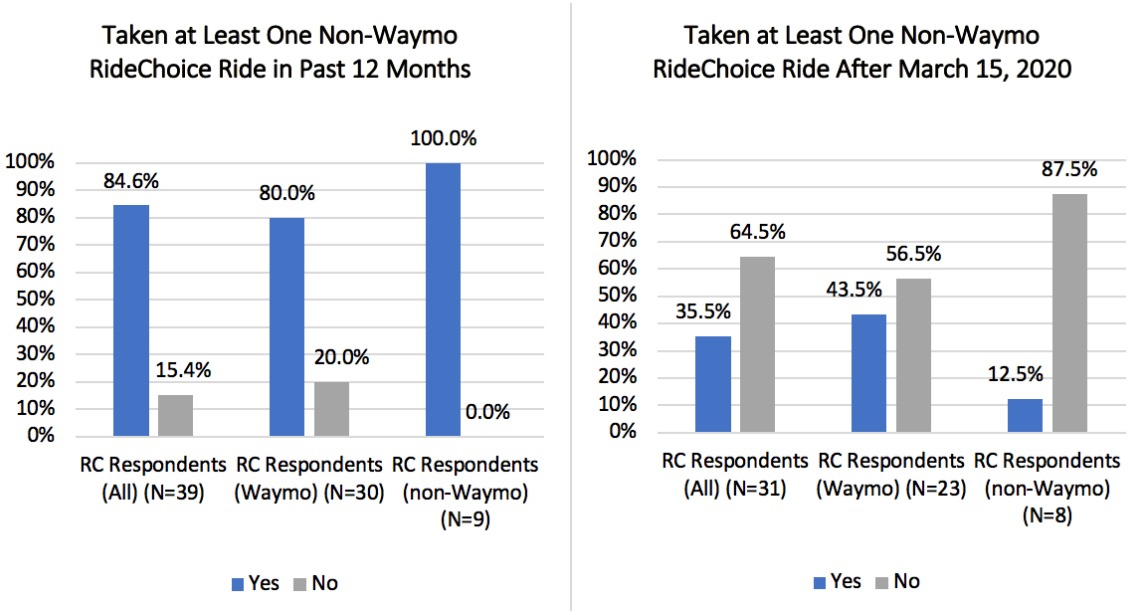


Figure 4-5

Use of non-Waymo RideChoice Services in Past 12 Months and During COVID-19 Pandemic (Post Survey)

Figure 4-6 shows the changes in respondent use of RideChoice services over the three surveys. It must be noted that the question in the Prior Survey was different from that in the During and Post Surveys; the Prior Survey asked about RideChoice usage in general and included a category of Never, and the During and Post Surveys asked about RideChoice usage in the prior 30 days. If a respondent indicated not using RideChoice in the past 30 days, they were categorized as "Less than monthly." Categories in the Prior Survey were recoded to match those of the Post Survey as closely as possible for comparison purposes.

The effect of the COVID-19 pandemic on respondent RideChoice usage is quite noticeable in Figure 4-6; the frequency of RideChoice service use decreased dramatically in the Post Survey when compared to the Prior and During surveys. In the Prior and During surveys, about one third of respondents (31–35%) did not use RideChoice in the past 30 days (combining Never Used and Less Than Monthly in the Prior Survey), whereas during the pandemic (the past 30 days from when the survey was administered in mid-May), nearly three-quarters of

respondents (73%) did not use the service. In the Prior and During surveys, 23–26% used RideChoice less than one day a week, compared to 17% in the Post Survey. Similarly, weekly or more frequent use was reported by 42% of respondents in the Prior Survey and 43% in the During Survey compared to 10% in the Post Survey. It is evident that the COVID-19 pandemic substantially restricted travel and the use of RideChoice services. Statistical tests showed that the Prior Survey results were not significantly different from the During Survey results, but that the Post Survey statistics were very significantly different (at 99% confidence) from both the Prior and During surveys.

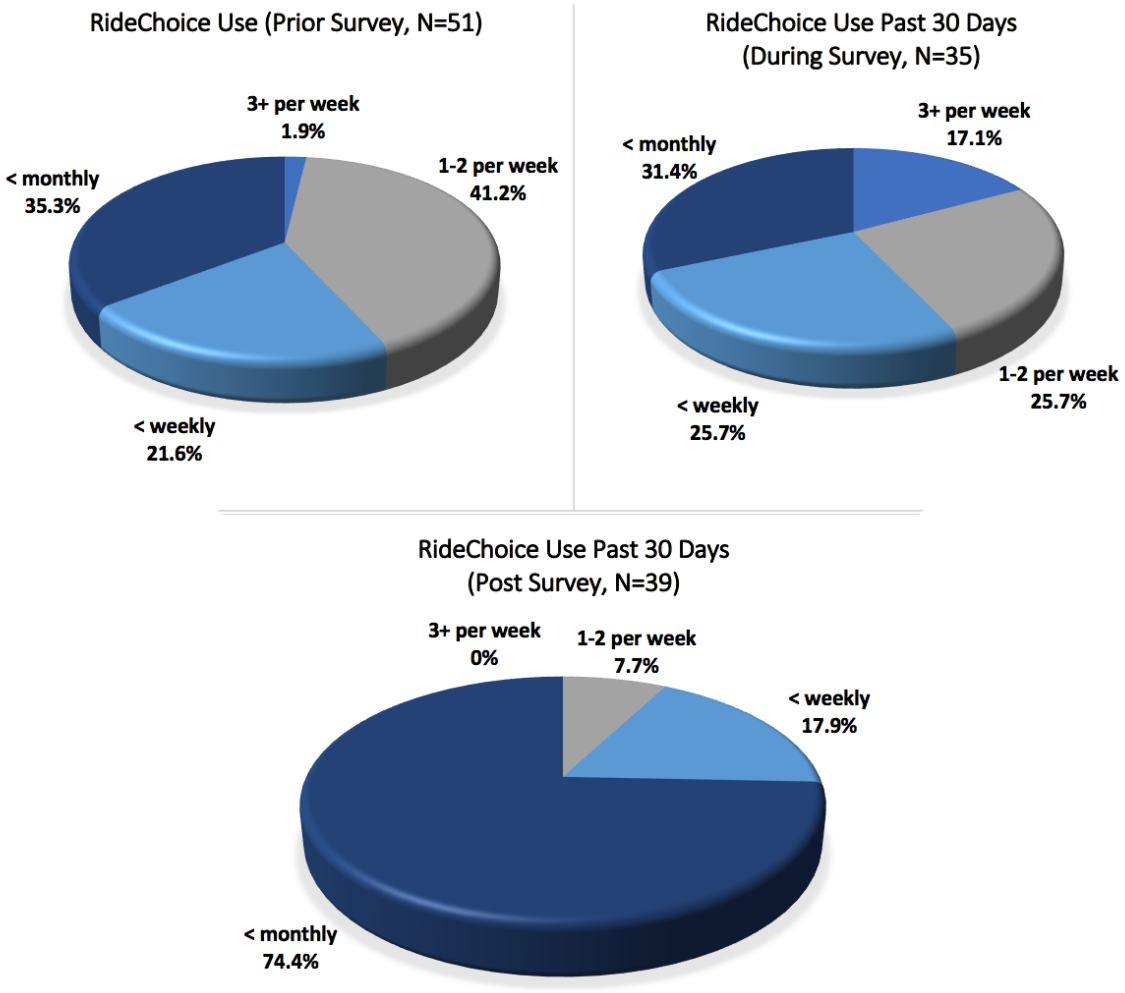


Figure 4-6

Changes in non-Waymo RideChoice Usage

It is also useful to look at the differences in RideChoice usage between RC Respondents (Waymo) and RC Respondents (non-Waymo) across all three surveys. This is shown in Figure 4-7. These graphs suggest that the RC Respondents (non-Waymo) tended to be less frequent users of RideChoice Services than the RC Respondents (Waymo), as shown by the fact that none of

the RC Respondents (non-Waymo) reported using RideChoice services more often than 1–2 days per week in any of the three surveys and were consistently the highest frequency for less than monthly use in all three surveys. Again, it should be noted that the Prior Survey asked the question without a specified time period, whereas the other two surveys asked about the past 30 days. In both the During and Post Surveys, RC Respondents (non-Waymo) were more likely to have used RideChoice Services 1–2 days per week than their RC Respondents (Waymo) counterparts. Again, the effects of the COVID-19 travel reductions are clear, with all groups showing about twice the frequency of less-than-monthly use in the Post Survey compared to the Prior and During surveys. When considering all respondents, the Prior and During surveys were not significantly different for RC Respondents (Waymo), but usage patterns reported in the Post Survey were statistically different from each of the Prior and During surveys. Differences between the RC Respondents (non-Waymo) were not statistically significantly across surveys, presumably because this group exhibited lower levels of travel in general (even prior to the pandemic).

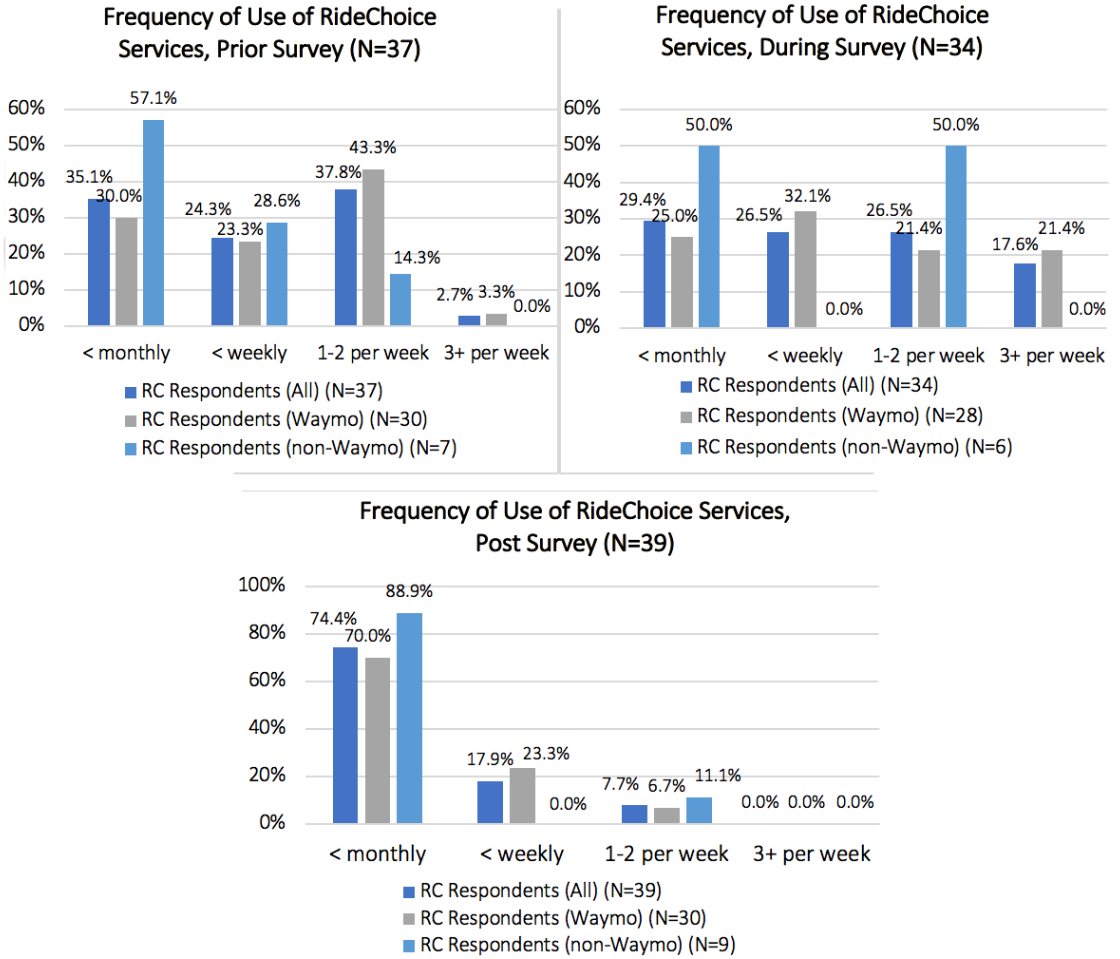


Figure 4-7

Frequency of Use of RideChoice Services

In the Prior Survey, respondents were asked how much they would expect to pay for a ride in a self-driving vehicle. The majority expected to pay the same amount as they did currently, with more respondents expecting to pay less than those expecting to pay more, as shown in Figure 4-8. RC Respondents (non-Waymo) were more optimistic that they would pay the same as current, and no RC Respondents (non-Waymo) expected to pay more. RC Respondents (Waymo) had the highest proportion expecting to pay up to $3.00 more than for current traditional RideChoice services. Differences, however, were not statistically significant.

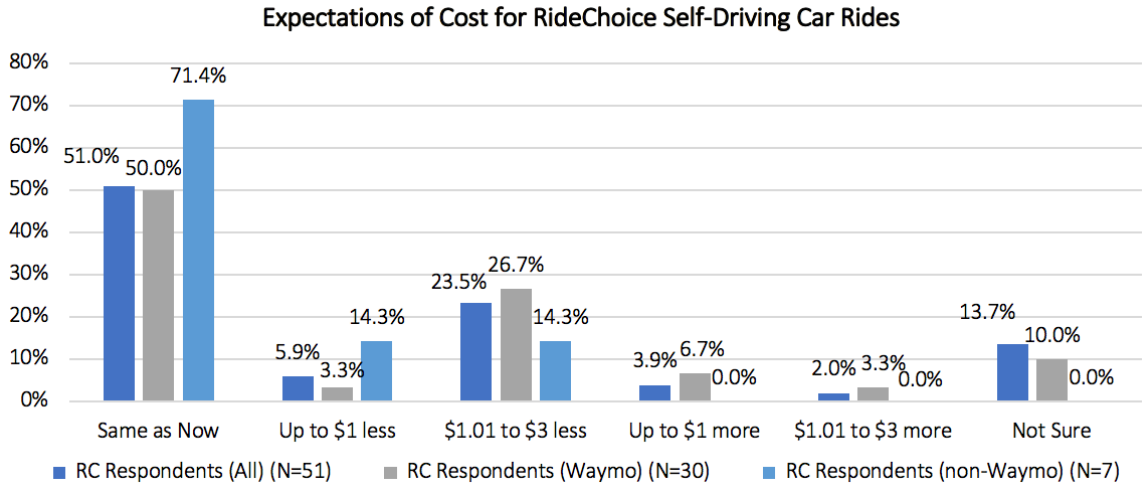


Figure 4-8

Expectations of Cost for Self-Driving Vehicle RideChoice Service (Prior Survey)

In the Prior Survey, respondents were asked to report how much they had spent on RideChoice services in the past month. The amounts are shown in Figure 4-9. About 20% of respondents reported spending nothing, and 50% of all respondents spent less than $30. Although there were some small differences between RC Respondents (Waymo) and RC Respondents (non-Waymo), these differences were not statistically significant.

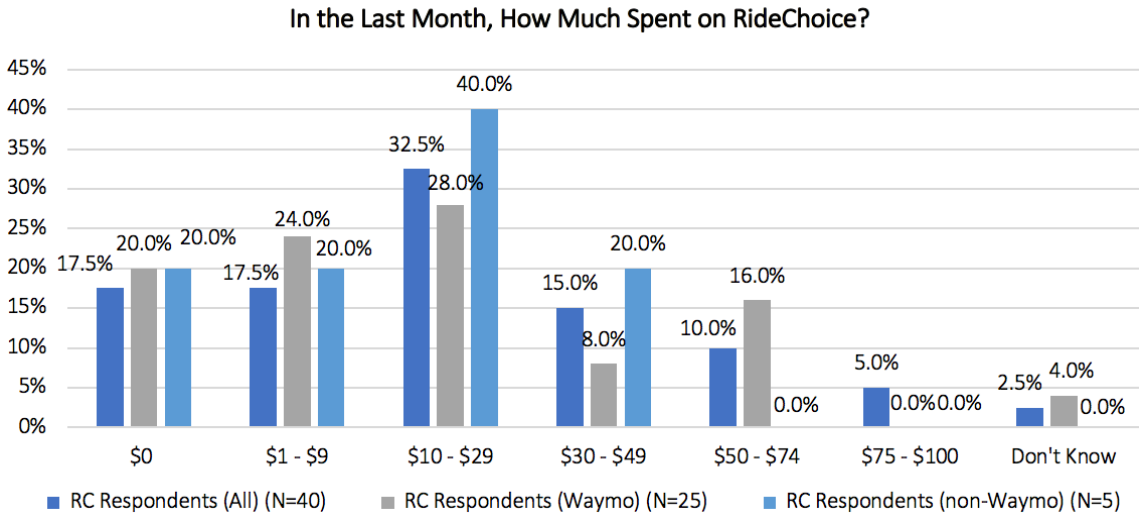


Figure 4-9

Amount Spent in Past 30 Days on RideChoice Services (Prior Survey)

In the Post Survey, respondents were asked about their anticipated future use of RideChoice services once the COVID-19 pandemic was over; responses are shown in Figure 4-10. For RC Respondents (All) (38%) , RC Respondents (Waymo) (37%) , and RC Respondents (non-Waymo) (45%) , the largest proportions expected to use such services at least weekly but not every day. The next largest proportion in each group expected to use RideChoice services 1–3 times per month, with RC Respondents (All) at 28%, RC Respondents (Waymo) at 27%, and RC Respondents (non-Waymo) at 33% . Interestingly, all respondents indicated they would use RideChoice services, although a small number were unsure about expected future frequency of use, with RC Respondents (All) at 13%, RC Respondents (Waymo) at 13%, and RC Respondents (non-Waymo) at 11%. There were no statistically significant differences between RC Respondents (All) and either of RC Respondents (Waymo) or RC Respondents (non-Waymo) samples on this question nor between RC Respondents (Waymo) and RC Respondents (non-Waymo).

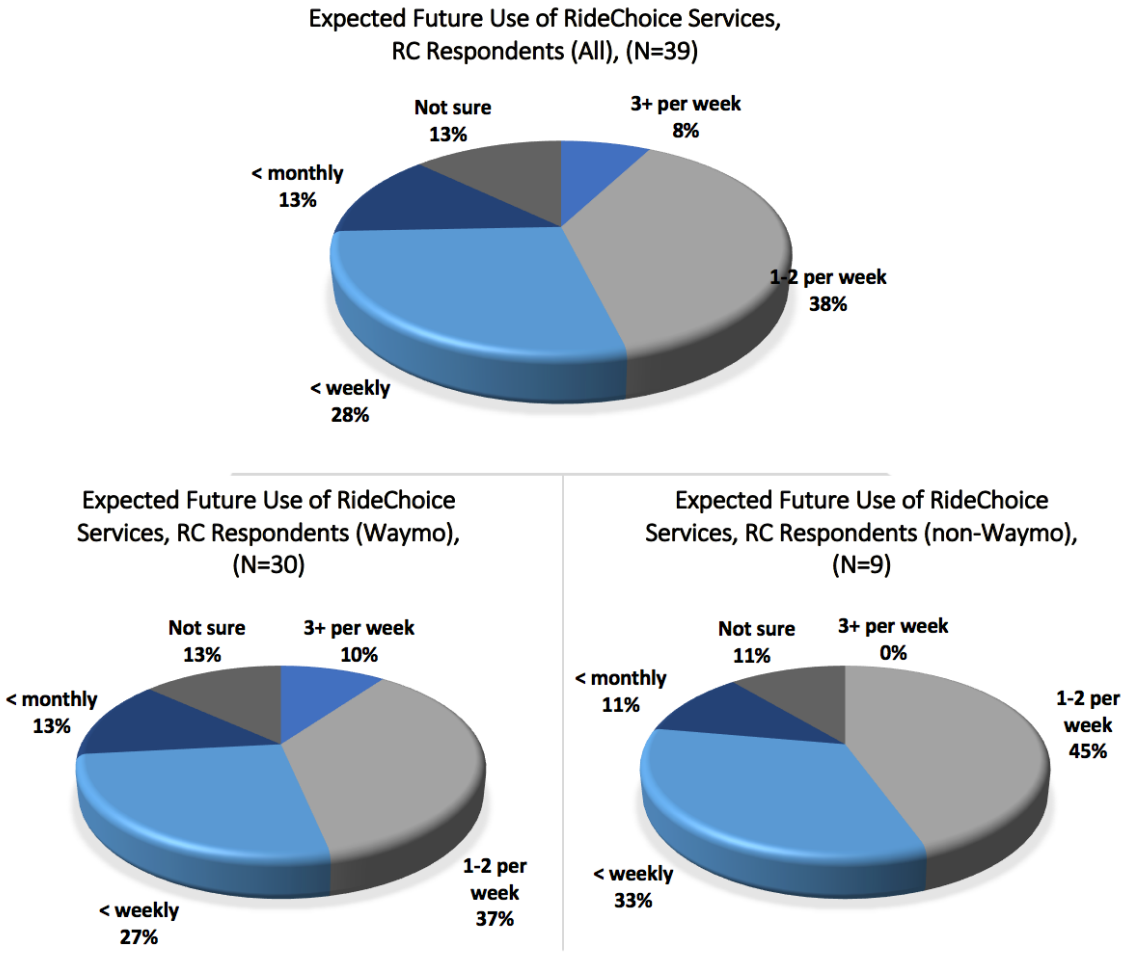


Figure 4-10

Expectations of Future Use of RideChoice Services (Post Survey)

Characteristics of Most Recent Trip

The During Survey collected data from participants for the most recent trip undertaken using Waymo and traditional RideChoice vehicles within the RideChoice program. The intent of this section of the survey was to explore possible differences in trip characteristics of Waymo trips vs. non-Waymo RideChoice trips. A similar "recent trip details" question was included in the Prior Survey; because the Prior Survey was administered prior to the introduction of Waymo as a mobility service option, Prior Survey trip data correspond exclusively to non-Waymo human-driven vehicle trips. This enabled comparisons of trip characteristics between the Prior and During surveys in addition to comparisons between Waymo and non-Waymo trip characteristics in the During Survey.

Figure 4-11 compares the distribution of the month in which the most recent ride occurred between Waymo and non-Waymo RideChoice trips; reported were about 35% for March 2020 and 31% for February 2020 (in accord with the timing of the During Survey). Non-Waymo trips were more evenly distributed by month and year, with slightly larger percentages in the most recent months. This trend was not unexpected, given that Waymo was a more recent addition as a RideChoice service option, so it was reasonable for Waymo trips to occur in larger proportions in the most recent months.

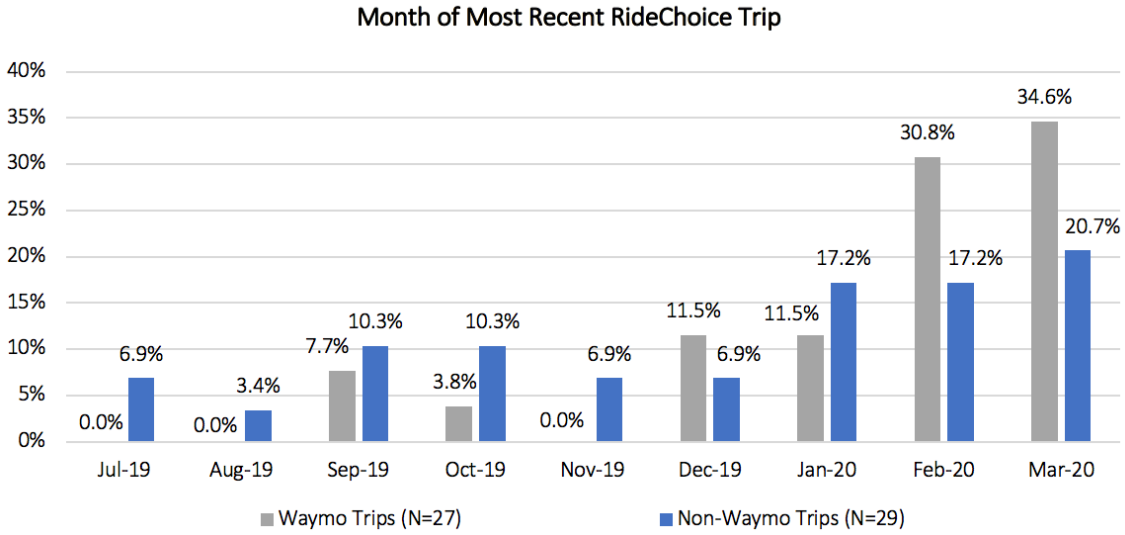


Figure 4-11

Month of Most Recent Waymo and non-Waymo RideChoice Trips (During Survey)[9]

The distribution by day-of-week of the most recent trip, illustrated in Figure 4-12, shows that Waymo trips were a slightly larger proportion on Fridays and slightly lower on Mondays through Thursdays (23% vs. 16% and 65.4% vs. 71%, respectively) . Note that a few respondents did not respond to these questions in the survey at all, suggesting that they may not have taken a RideChoice service trip within a period (prior months). Differences by day of week between traditional (non-Waymo) RideChoice and Waymo trips were not, however, statistically significant.

[9]The Pilot began in September 2019, so there were no Waymo trips reported for July and August 2019.

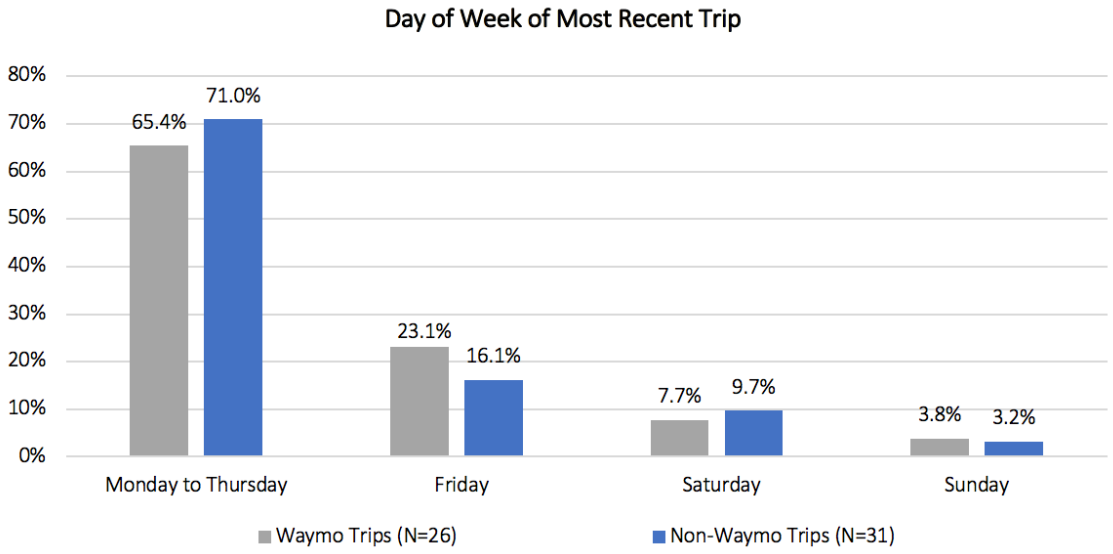


Figure 4-12

Day of Week of Most Recent Waymo and non-Waymo RideChoice Trips (During Survey)

A comparison of the time-of-day distribution of the most recent Waymo and non-Waymo RideChoice trips is depicted in Figure 4-13. It is interesting that only 6.5% of non-Waymo trips took place at night, but 25.9% of Waymo trips were at night. The reason for this is not immediately apparent; it is entirely possible that users of RideChoice Waymo services were younger, employed individuals who may have greater mobility needs at night and found the ability to summon and use Waymo very convenient at night. The convenience afforded by the Waymo app may also have motivated choosing Waymo (over non-Waymo vehicles) for rides at night. This is supported by focus group comments, which indicated that not needing to book ahead and a perception of greater safety at night in a Waymo vehicle led to more trips being requested at night. The difference between traditional non-Waymo RideChoice and Waymo RideChoice trips by time of day was statistically significant at 95% confidence.

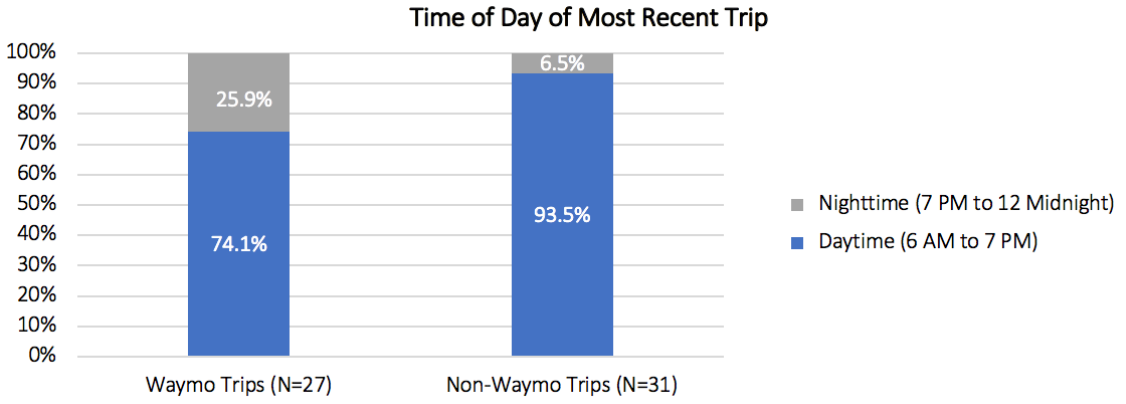


Figure 4-13

Time of Day of Most Recent Waymo and non-Waymo RideChoice Trips (During Survey)

Figure 4-14 compares the distribution of wait times of the most recent trip reported in the Prior Survey with those reported in the During Survey (with a distinction between non-Waymo and Waymo trips). Despite some differences between During Survey non-Waymo trips and Prior Survey trips, especially a much lower percentage in the 16–20-minute category for the Prior Survey sample of trips, the wait time for Waymo trips was the shortest among all three distributions, which confirms that the Waymo option provided trips with a shorter wait time when compared with non-Waymo traditional RideChoice service. The increase in wait times of 16–20 minutes for non-Waymo trips in the During Survey period may have been due to the onset of the pandemic, which may have contributed to a reduction in availability of drivers willing to provide rides.

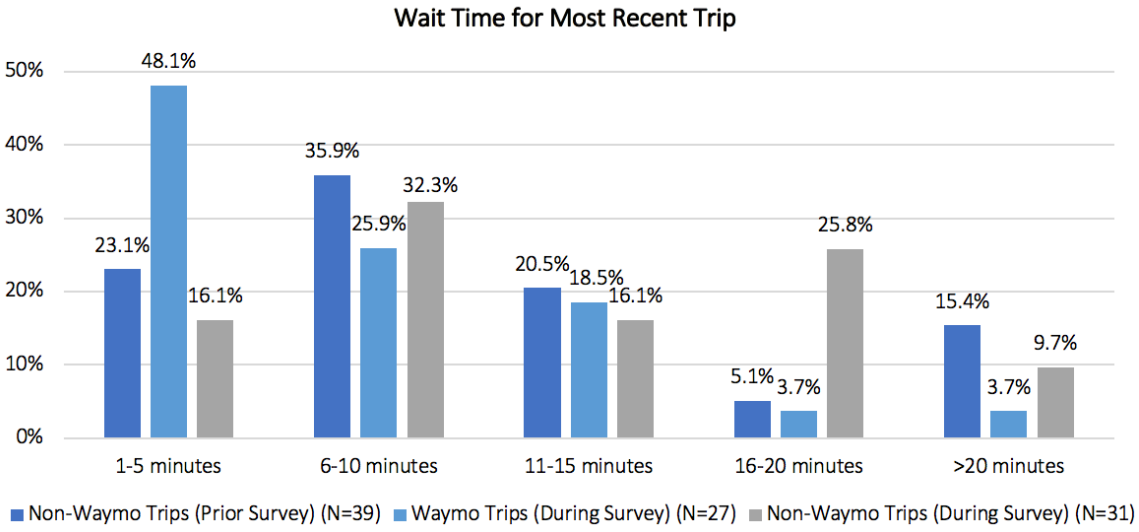


Figure 4-14

Wait Time for Most Recent Trip (Prior and During Surveys)

Travel time distributions for Prior Survey trips, During Survey non-Waymo trips, and During Survey Waymo trips of recent trips are compared in Figure 4-15. As shown, although there were some differences between Prior and During survey non-Waymo trips, with the Prior Survey sample of rides showing a substantially lower percentage in the 16–20-minute category, Waymo trips show a travel time distribution more skewed towards shorter travel times. This finding is consistent with the fact that Waymo operates within a more limited service territory, so lengths of Waymo trips are likely to be shorter. When users needed to travel longer distances, they would have been more likely to choose non-Waymo RideChoice vehicle options because the Waymo vehicles may not have been able to serve their destinations. What is less clear is why RideChoice non-Waymo trips show a much larger presence in the 16–20-minute category in the During Survey when compared to the Prior Survey. The Prior and During Survey distributions for non-Waymo trips were not significantly different; however, in the During Survey, the non-Waymo travel times were very significantly different from the Waymo travel times (at 99% confidence).

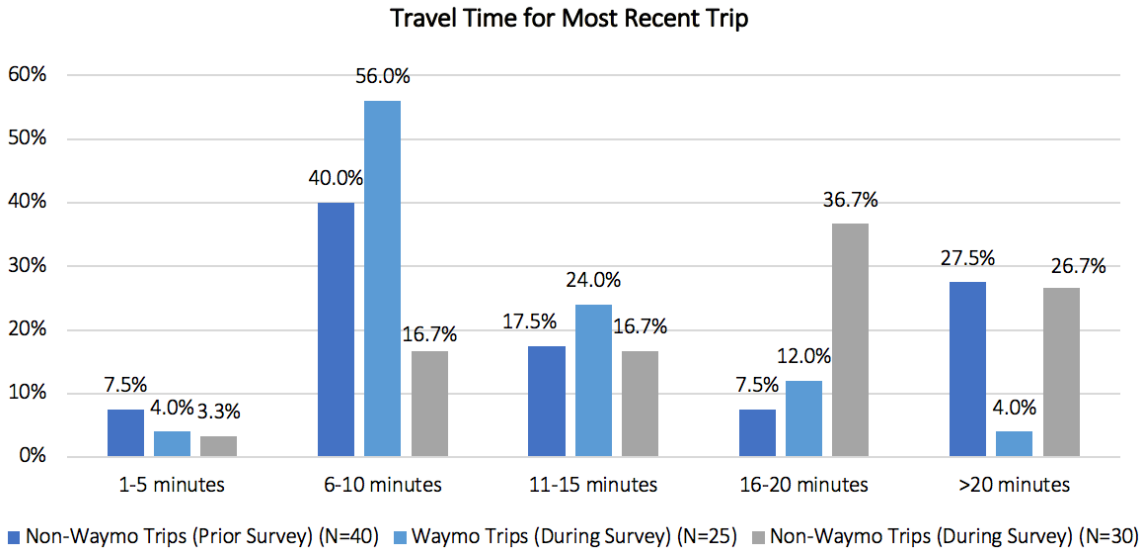


Figure 4-15

Travel Time for Most Recent Trip (Prior and During Surveys)

Figure 4-16 presents a trip purpose comparison for most recent trips among the Prior Survey, During Survey non-Waymo trips, and During Survey Waymo trips. In the Prior Survey sample, a much smaller percentage of trips took place for medical/dental purposes. It is unclear whether the advent of the pandemic may have impacted the percentage of medical/dental trips in the During Survey. It is also likely that the socio-economic differences between the samples (more employed individuals in the Prior Survey sample) contributed to differences in trip purpose distributions across survey samples. The shopping/errands trip

percentage is almost the same between Prior Survey sample and During Survey Waymo trips but much smaller for During Survey non-Waymo trips. It is entirely possible that the Waymo service provided an excellent substitute for non-Waymo vehicles to serve shopping needs, and the same appears to be true for eating/drinking trips. Due to the territory within which Waymo operates, it appears that respondents used non-Waymo vehicles more for social-recreational, work/school, and airport trips (whose destinations may be more likely to fall outside the Waymo service territory). The differences shown in Figure 4-16 were not statistically different, perhaps due to small sample sizes.

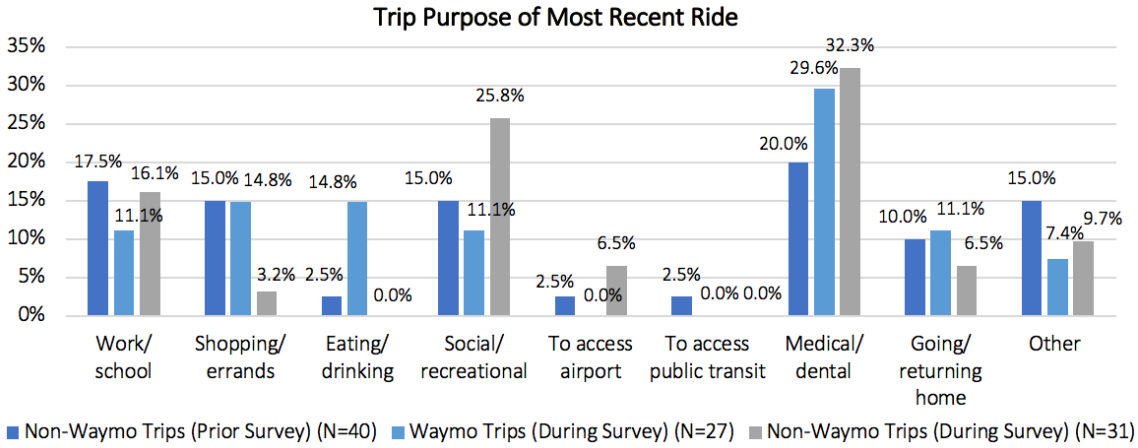


Figure 4-16

Trip Purpose of Most Recent Trip (Prior and During Surveys)

The presence of accompanying passengers was compared across the ride samples (Figure 4-17). In the Prior Survey, about two-thirds of RideChoice trips involved a solo rider. In the During Survey, Waymo trips and non-Waymo traditional RideChoice trips depicted a distinct difference in travel companion presence. Whereas 74% of Waymo trips constituted a solo ride, only 56% of non-Waymo traditional RideChoice trips constituted solo rides. This difference is statistically significant. The reason for this difference is not entirely clear. It was found that Waymo was used more for shorter trips and by a younger demographic (who are less physically challenged and able to adapt to technology more easily). It is possible that trips of this nature were prone to being solo-rider trips without the presence of, or need for, a companion.

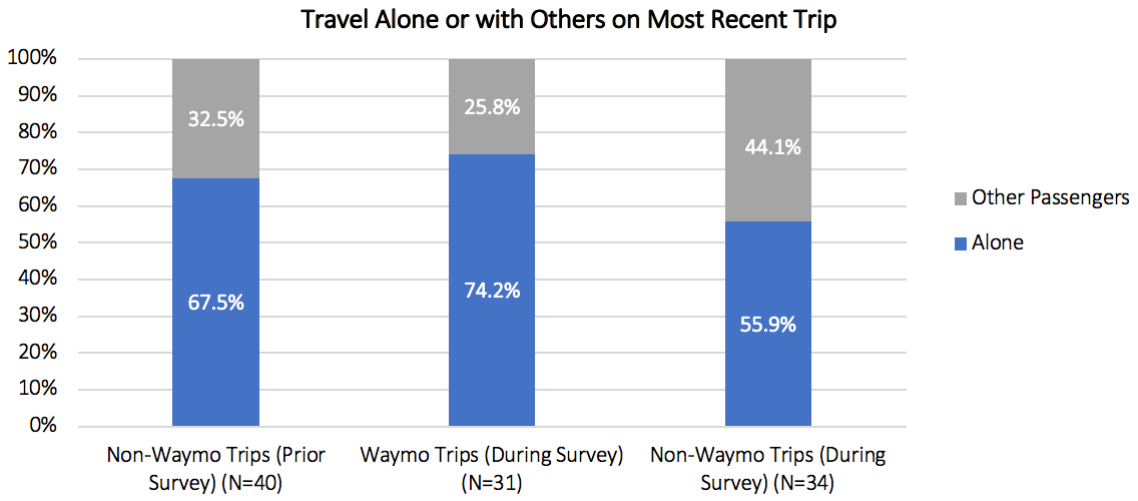


Figure 4-17

Presence of Passengers on Most Recent Trip (Prior and During Survey)

Respondents were asked to identify the mode they would have used if the RideChoice service were unavailable; this was asked in both the Prior and During surveys. Figure 4-18 presents a comparison of alternative travel modes that would have been used if RideChoice service were unavailable. The Prior Survey did not explicitly separate Uber/Lyft from Taxi as an option, but this distinction was made in the During Survey. In the Prior Survey, bus was identified as a likely alternative, but it was not as popular an option in the During Survey. It is possible that the appeal of bus as an alternative dropped due to the pandemic, although the high-quality nature of the Waymo service experience could have also had some impact. Other mobility services such as Uber/Lyft and taxi were seen as key alternatives to RideChoice service, as was getting a ride from a friend or family member. For Waymo trips, Uber/Lyft was identified as the dominant alternative, consistent with the notion that an app-based mobility service would serve as a natural substitute for another app-based mobility service. A substantial percentage indicated they would not make the trip at all in the absence of RideChoice service, suggesting that RideChoice serves as a critical mobility service for this subpopulation. The large percentage for the "Other" category was difficult to interpret because the few comments received were not enough to draw a conclusion. The differences between the three samples and between RC Respondents (Waymo) and RC Respondents (non-Waymo) were not, however, found to be statistically significant.

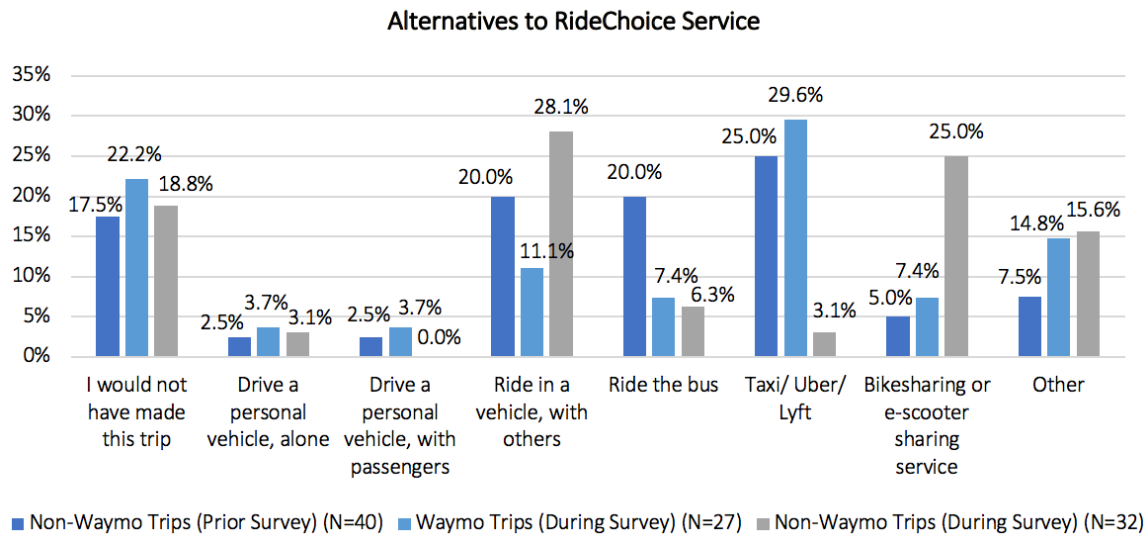


Figure 4-18

Alternatives to RideChoice Service (Prior and During Survey)

Figures 4-19 through 4-22 present comparisons of the subjective evaluations of respondents about their satisfaction with Waymo and non-Waymo RideChoice services with respect to trip wait time, travel time, cost, and comfort level, as captured for the most recent ride in the During Survey. In the During Survey, respondents who had used Waymo were asked about both their satisfaction with their most recent Waymo ride and with their most recent non-Waymo RideChoice ride. Those who had used only non-Waymo RideChoice services were asked only about those services.

Waymo came out ahead when compared with non-Waymo services. In Figures 4-19 through 4-22, RC Respondents (All) refers to the ratings of the entire sample of the During Survey for the most recent RideChoice ride; this group is split between RC Respondents (Waymo) and RC Respondents (non-Waymo). The final bar is the rating by RC Respondents (Waymo) of their most recent Waymo RideChoice ride, referred to as RC Respondents (All)—Trad RC, RC Respondents (Waymo)—Trad RC, RC Respondents (non-Waymo)—Trad RC, and RC Respondents (Waymo)—Waymo RC. Although 92.6% of RC Respondents (Waymo) agreed or strongly agreed that they were satisfied with Waymo wait time, only 65.4% of RC Respondents (Waymo) were satisfied with the wait time for non-Waymo rides. In general, this result was consistent with the finding that the objective (actual/true) wait time for Waymo rides was considerably shorter than the objective wait time for non-Waymo rides. The difference between these two groups was very significant (99% confidence level), although there was not a significant difference between the ratings of RC Respondents (Waymo) and RC Respondents (non-Waymo) for non-Waymo RideChoice rides.

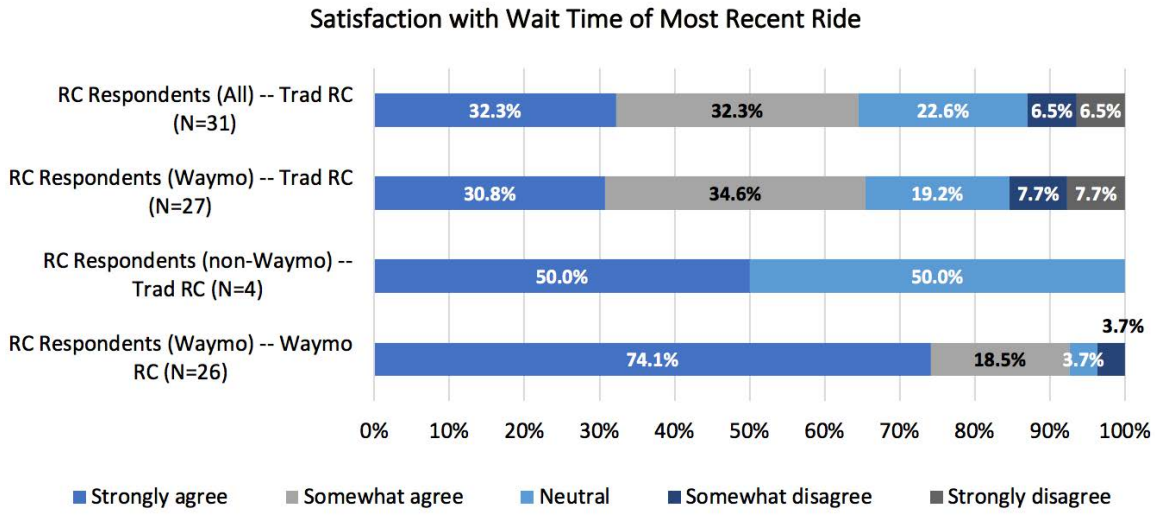


Figure 4-19

Satisfaction with Wait Time for Most Recent Ride (During Survey)

With respect to travel time (Figure 4-20), 92% of Waymo trips were reported as satisfactory, but only 77.4% of non-Waymo trips were reported to be so. It is not entirely clear why travel times by non-Waymo RideChoice services would be viewed less favorably than travel times experienced with Waymo vehicles. The novelty, comfort, and superior condition of the Waymo vehicles may have contributed to a subjective perception that the travel time in Waymo is less onerous and more pleasant. This difference, though appearing numerically to be sizeable, was not statistically significant, and neither were differences between RC Respondents (Waymo) and RC Respondents (non-Waymo) with respect to their assessment of non-Waymo RideChoice services.

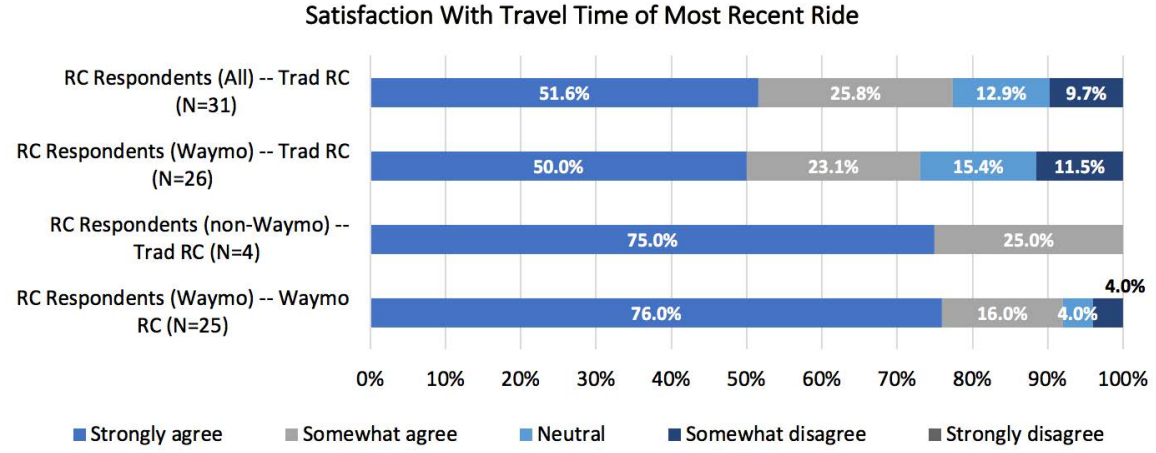


Figure 4-20

Satisfaction with Travel Time of Most Recent Ride (During Survey)

Figure 4-21 shows that 100% of RC Respondents (Waymo) were satisfied with the cost of Waymo rides (with a vast majority of the rides associated with a strong level of satisfaction). Non-Waymo RideChoice rides received only 80.6% approval, and 12.9% disagreed about satisfaction with cost. These differences were highly significant (99% confidence level). It is interesting to note that those who had not used Waymo were overwhelmingly positive about RideChoice rides (75% strongly agreeing and 25% somewhat agreeing), whereas those who had used Waymo were the least satisfied with the cost of their most recent non-Waymo ride in contrast to their rating of the Waymo ride. It should be noted that Waymo rides were capped at the $3.00 out-of-pocket cost to the rider, regardless of distance; this cap did not apply to non-Waymo RideChoice rides, for which the rider had to pay $3.00 for the first eight miles and then a per-mile charge for every mile over eight.

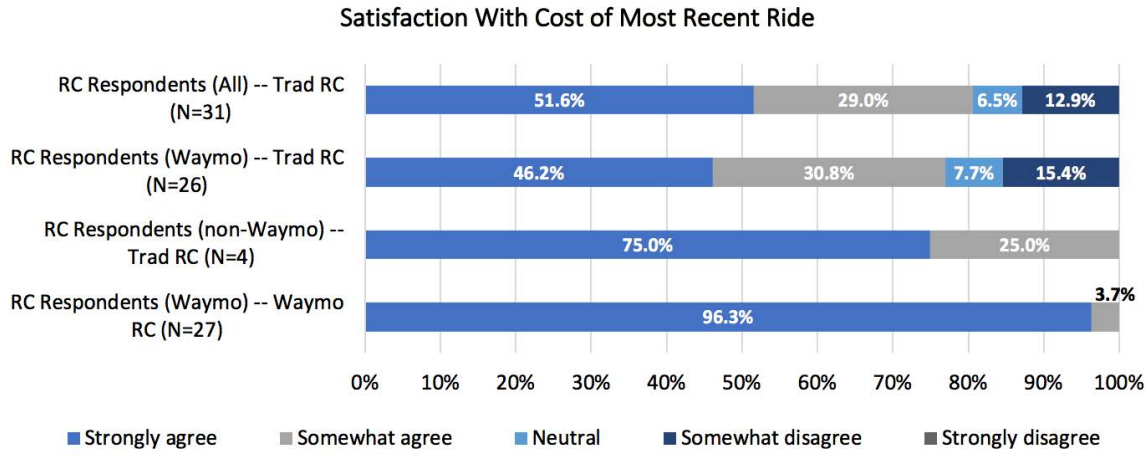


Figure 4-21

Satisfaction with Cost of Most Recent Ride (During Survey)

Figure 4-22 shows that 100% of RC Respondents (Waymo) were satisfied with the comfort of the Waymo ride, with the majority strongly agreeing, and only 77.4% of respondents were satisfied with the comfort of non-Waymo RideChoice rides. These differences were highly significant (99% confidence level); the difference was also statistically significant between RC Respondents (Waymo) and RC Respondents (non-Waymo). This finding is not surprising, given that the Waymo vehicles were new Chrysler Pacifica minivans. Overall, it is clear that Waymo service was viewed more favorably than traditional non-Waymo service with respect to wait time, travel time, cost, and comfort, at least in part because of differences in vehicle type and out-of-pocket cost for Waymo rides.

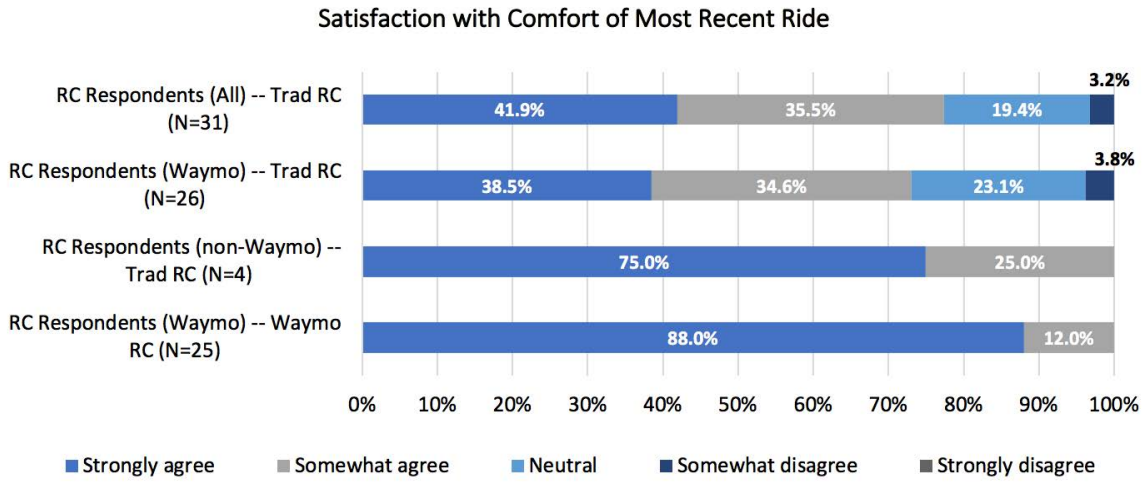


Figure 4-22

Satisfaction with Comfort of Most Recent Ride (During Survey)

In the During Survey, participants were asked to generally evaluate different mobility services with respect to various attributes (not focusing specifically on the most recent trip by each service). The three services presented included taxi, Uber/Lyft, and Waymo, and seven aspects were rated by respondents (Figure 4-23). In terms of average rating scores, Waymo dominated the other services with respect to wait time, ride comfort, cleanliness, ease of getting into and out of the vehicle, and ease of requesting the ride. Uber/Lyft was slightly better with respect to travel time and drop-off/pick-up locations, possibly due to the ability of the human driver to optimize execution of the journey; moreover, the social aspect associated with riding a human-driven vehicle may have helped riders perceive a lower burden of travel time when compared to riding in a self-driving vehicle. As for drop-off/pick-up locations, Waymo vehicles are programmed to follow safety protocols that many human drivers may not follow precisely. Unlike human-driven vehicles, Waymo vehicles target a specific safe location for drop-off and pick-up, which may not necessarily be at the exact location where riders may wish to board and alight. Hence, Waymo scores are slightly lower than Uber/Lyft scores in the drop-off/pick-up location domain. Generally, regular taxi was consistently rated last on every aspect when comparing all three entities.

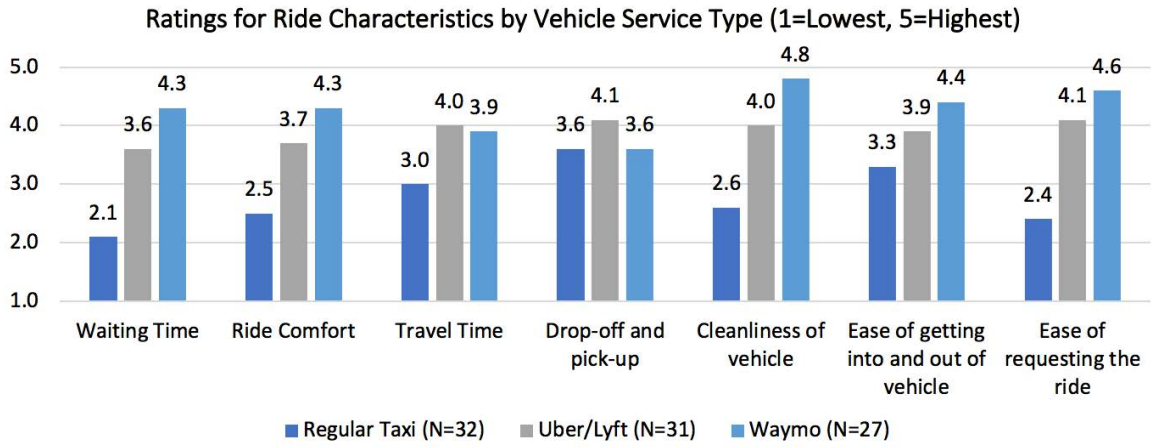


Figure 4-23

Average Ratings for Ride Attributes by Vehicle Service Type (During Survey)

Use of Travel Time

When people ride as passengers in a human-driven vehicle or an AV, they can use the travel time for other activities. In an AV mobility future, travelers may be able to engage in any number of other activities, especially because there is no driver or human operator with whom to converse.

How people spent time during the most recent trip is presented in Figure 4-24 for different examples. There was a slight difference in the presentation of options between the Prior Survey and the During Survey; in the Prior Survey, interaction with the driver or other passengers was presented as a single option, and in the During Survey, interaction with the driver was presented as a separate option from interaction with other passengers. In Figure 4-24, these two options in the During Survey were combined for comparability with the Prior Survey. Interacting with the driver or other passengers and watching the road or enjoying the scenery were popular options selected by a fairly large percentage of respondents. Consistent with the notion that individuals like to multitask during travel, a large percentage of respondents indicated that they talked/texted on the phone while riding in a RideChoice vehicle; this is consistent across all three samples examined in Figure 4-24. RC Respondents (Waymo) differed somewhat from RC Respondents (non-Waymo) with respect to entertainment and the "Other" category (for which additional insights are not available because the few comments received were not enough to draw any conclusions). It is very likely that those riding in Waymo spent considerable time checking out the technology, examining how the vehicle navigated itself, and learning about the fully self-driving vehicle. Hence, RC Respondents

(Waymo) had nobody sleeping or working/studying; the high prevalence of "Other" suggests that users were fascinated by the technology during the ride (as corroborated in subsequent focus group conversations).

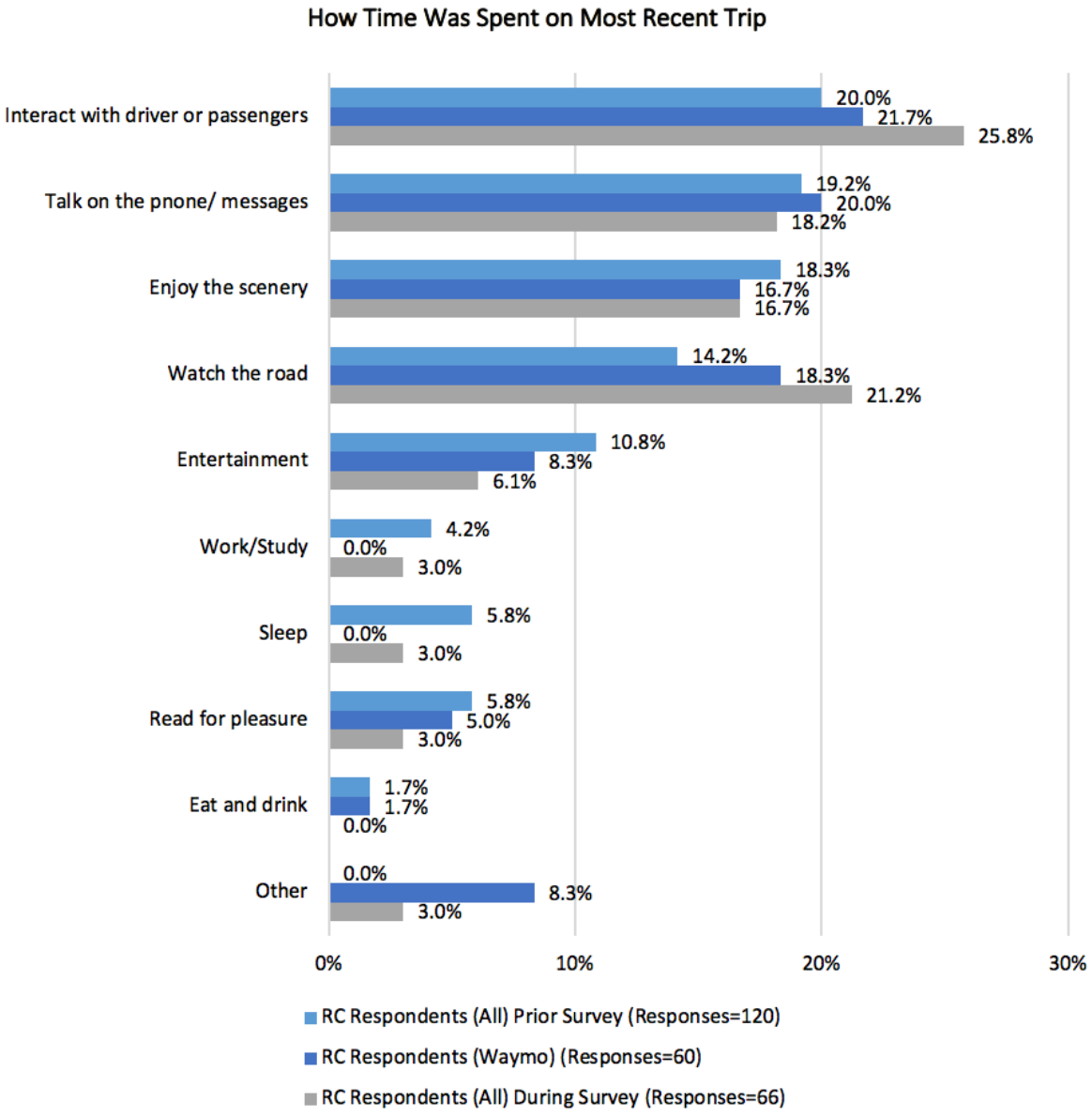


Figure 4-24

Use of Time in Most Recent Trip (Prior and During surveys)

In the Prior Survey, respondents were asked how they expected to use their time in a self-driving vehicle. Figure 4-25 shows these expectations and also subdivides respondents into those who used Waymo and those who did not to allow a comparison to Figure 4-24 (use of travel time corresponding to most recent ride in During Survey). Although there are some similarities in these two figures, it is interesting that interacting with other passengers was one of the most frequently mentioned activities from the actual ride; the expectation was that this would be much lower. When compared to actual levels of participation in work/study and reading as depicted in Figure 4-24, the expected levels (as conveyed in the Prior Survey) were considerably higher.

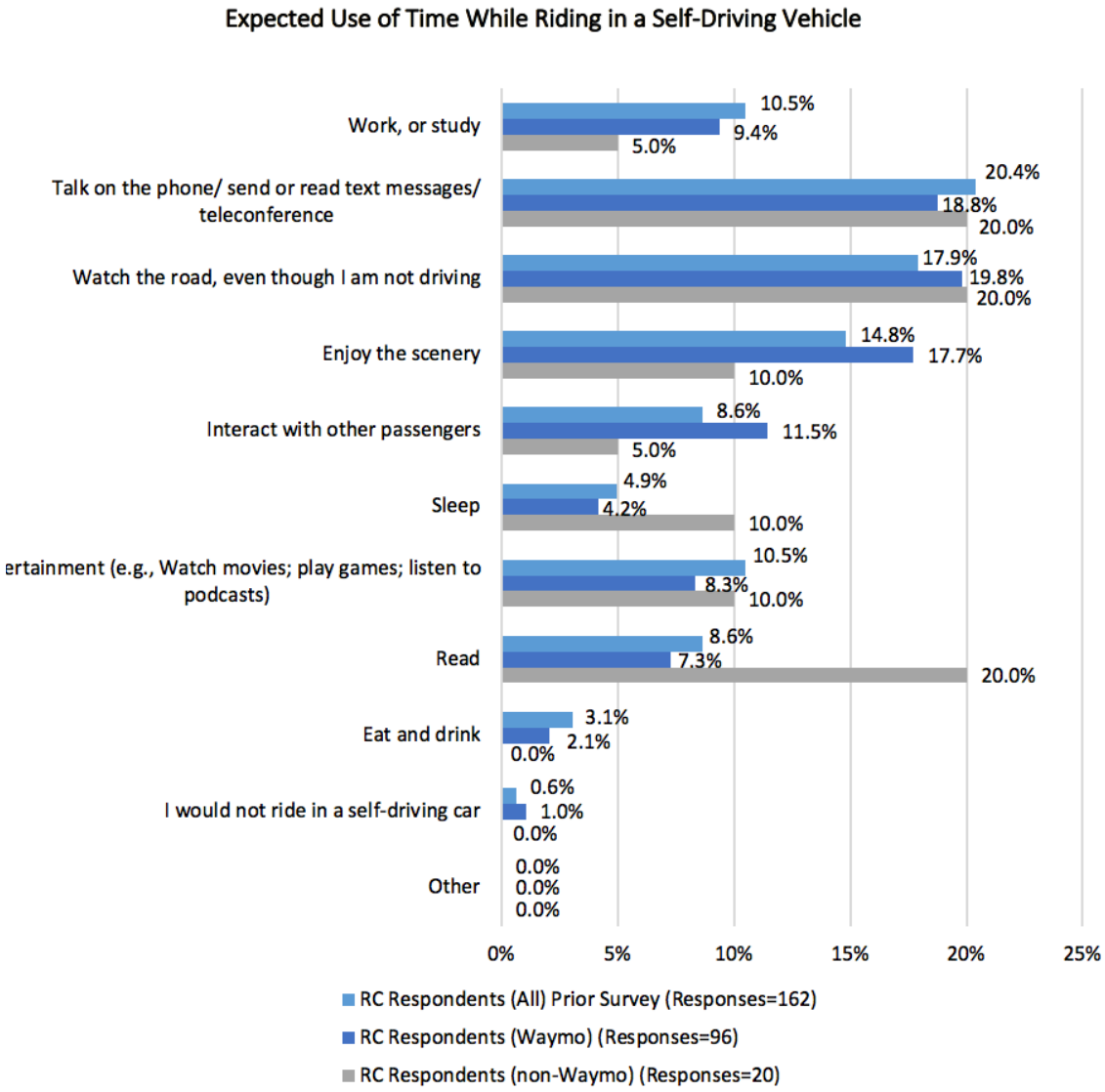


Figure 4-25

Expected Use of Time in a Self-Driving Vehicle (Prior Survey)

Use of Other Modes

As expected, the use of other modes of transportation seemed to be impacted throughout the demonstration pilot. Figure 4-26 shows that before the pilot started, about 27% of respondents rode as a passenger in a car; this number dropped slightly to 24% in the During Survey but went up to 30% in the Post Survey. In the Prior Survey, around 6% of respondents were also driving, either alone or with passengers. More than 20% and 18% of respondents were driving in the During and Post Surveys, respectively, suggesting that the pandemic led to a considerable uptick in the level of driving among this subpopulation.

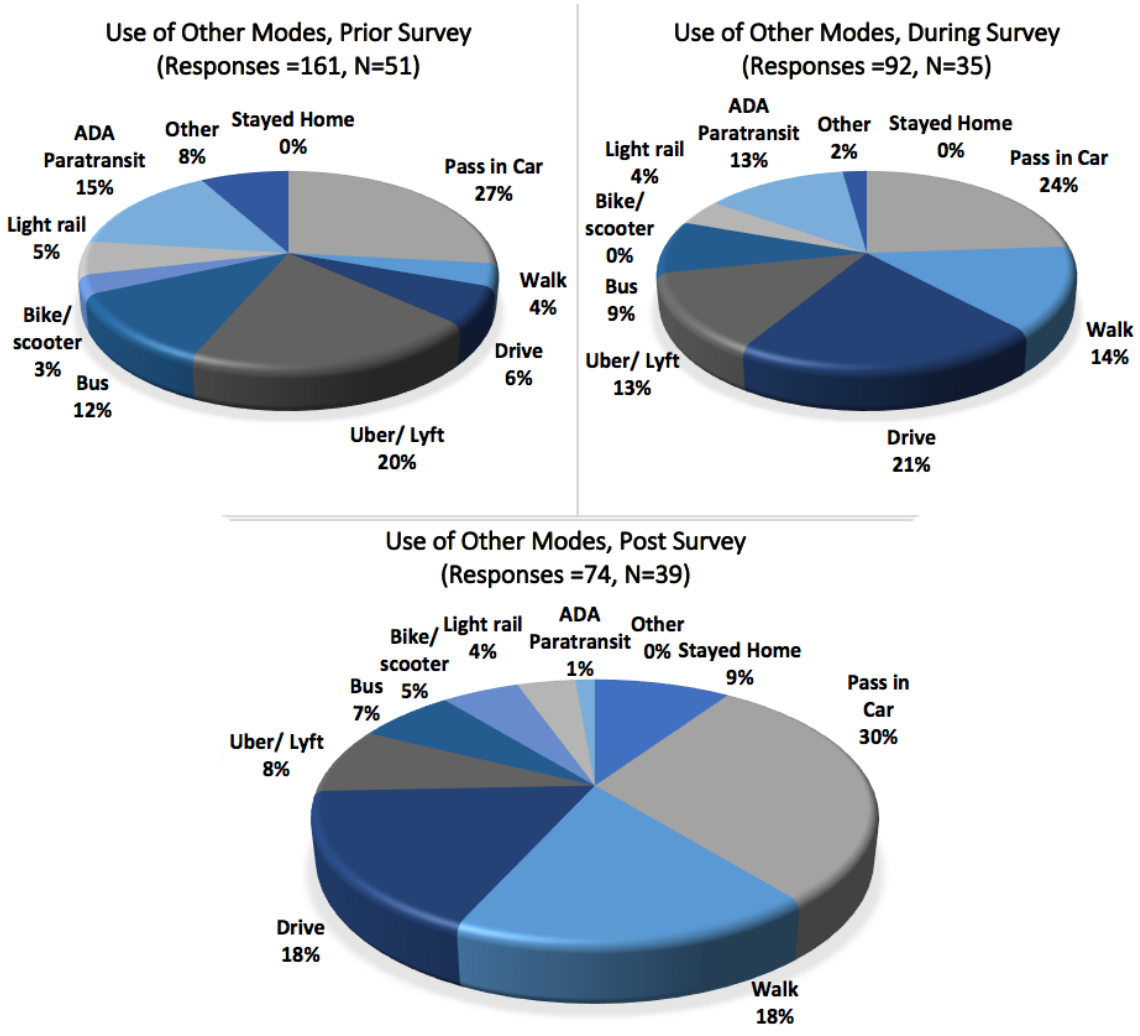


Figure 4-26

Changes in Use of Other Modes of Transportation

Interestingly, there was a decrease in Uber/Lyft use (from 19.8% in the Prior Survey to 13% in the During Survey), possibly due to Waymo availability, which may have contributed to a lower use of ride-hailing services outside the RideChoice program. A decrease in ride-hailing use during the COVID-19 pandemic was also observed in the Post Survey, in which only 8% of respondents reported using such services in the most recent 30 days, most falling into the time period of the pandemic. The same effect of a decrease in use was captured for ADA paratransit services, which decreased from 14.9% in the Prior Survey to 13% in the During Survey and finally to 1.3% in the Post Survey.

Interestingly, use of the walk mode increased from 3.7% in the Prior Survey to 14.1% in the During Survey and 17.3% in the Post Survey. As there is no evidence in the dataset that would suggest usage of Waymo contributed to switching to more active modes of transportation, the likely explanation for that change might be due to weather conditions and the onset of the pandemic. The Prior Survey was conducted in September 2019, when it is very hot in the Phoenix metropolitan area, whereas the During Survey was deployed in March 2020, when the temperature was cooler and more walk friendly.

Finally, Post Survey results showed that 9.3% of respondents did not make any trips in the prior 30 days. As expected, the modes of travel used the most were individual/private, which reflects the severe impact of the COVID-19 pandemic on public and shared modes of transportation. The differences depicted in Figure 4-26 are, however, not statistically significant. It is also interesting to note that respondents used a steadily decreasing number of other modes over the three surveys, although the changes were not statistically significant. In the Prior Survey, an average of three responses was provided to the question on use of other modes; this dropped to an average of about 2.7 in the During Survey and to just under 2.0 in the Post Survey.

In the During Survey, respondents were asked to indicate if their use of non-Waymo modes had increased, decreased, or stayed about the same since introduction of the Waymo option within the RideChoice program; no comparable question was asked in the Post Survey. Figure 4-27 summarizes the results from the During Survey and shows that more than half of respondents indicated no change in their use of driving alone, driving with passengers, riding in a car with others, walking, riding a bicycle or scooter, or using light rail, bike sharing, or e-scooters. At the same time, more than half of respondents showed a decrease in the use of bus, traditional taxi, and Uber/Lyft. Almost none of the respondents indicated an increase in use of any of these modes in absolute terms.

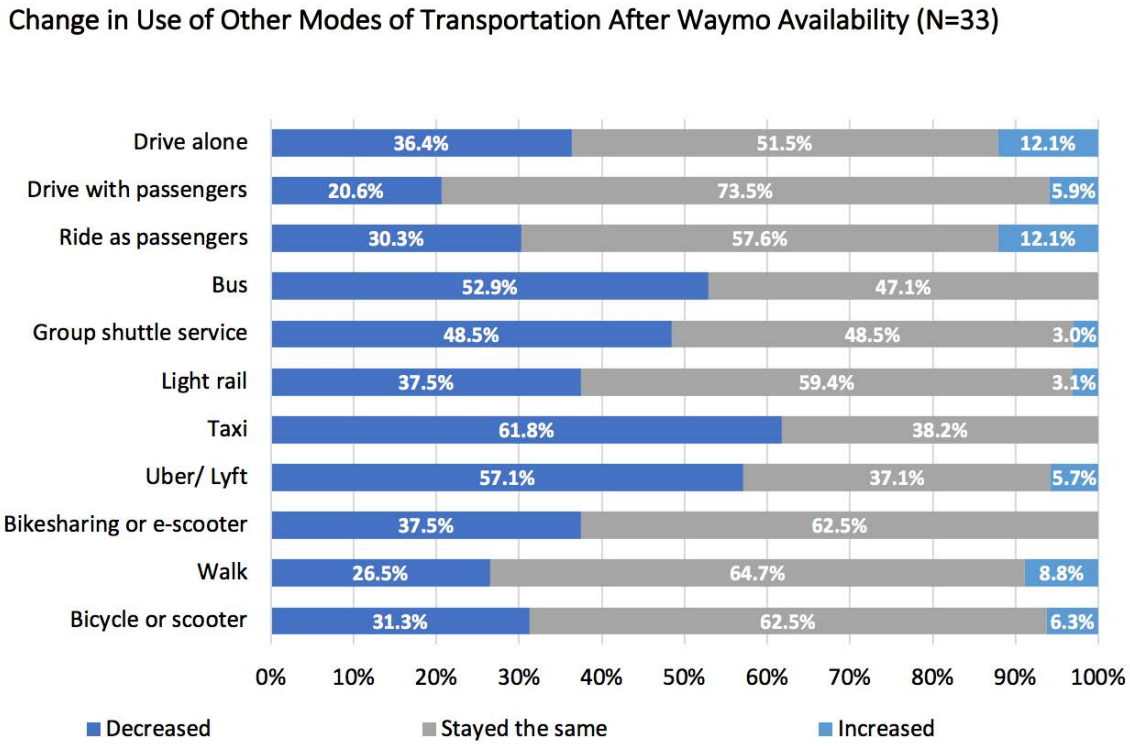


Figure 4-27

Change in Use of Other Modes (During Survey)

SECTION

5

Perceptions of Waymo and non-Waymo RideChoice Services

Perceptions of non-Waymo RideChoice services, also referred to in this section as "traditional RideChoice services,"[10] were asked in all three surveys, and similar questions about Waymo RideChoice services were asked in the During and Post surveys. The largest battery of questions was asked in the During Survey, and fewer questions were asked in the other two surveys. This section presents results from an analysis of the perceptions of Waymo and non-Waymo (traditional) RideChoice services.

Preferences and Perceptions Prior to Waymo Introduction

In the Prior Survey, a number of questions were asked about respondent preferences and perceptions relating to aspects of service that would be provided with an AV service as part of RideChoice and aspects of the RideChoice service that might change with the introduction of such a new vehicle service.

Respondents were asked to indicate their level of agreement that they would be unable to make trips to different places without RideChoice services. Figure 5-1 shows a high degree of dependence on RideChoice services, with agreement by 62.5% of all respondents and 72% by RC Respondents (Waymo). Interestingly, RC Respondents (non-Waymo) show a much stronger disagreement (40%) with this statement. The fact that all non-Waymo respondents had at least one car available in their households could be associated with this higher disagreement rate and may help explain why these respondents did not make use of Waymo when it became available.

[10] "Traditional RideChoice services" are those that were offered through RideChoice prior to introduction of Waymo service, such as rides using Uber or Lyft services or taxi.

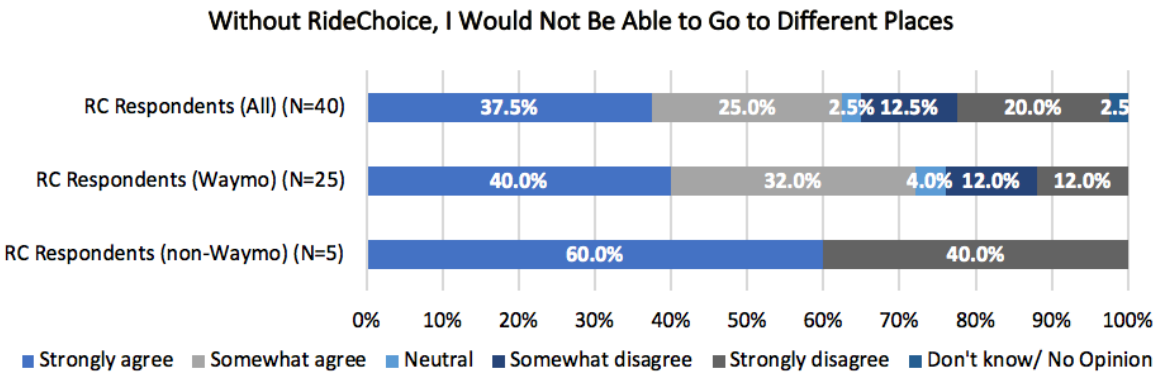


Figure 5-1

Inability to Go to Different Places without RideChoice Services (Prior Survey)

In the Prior Survey, several questions were asked about agreement with statements on RideChoice services. The first was that RideChoice services are affordable; results are shown in Figure 5-2, which shows strong levels of agreement. RC Respondents (non-Waymo) were 100% in strong agreement, and slight disagreement was shown by all respondents to the Prior Survey (RC Respondents [All]) and by RC Respondents [Waymo]). No differences shown Figure 5-2 were statistically significant.

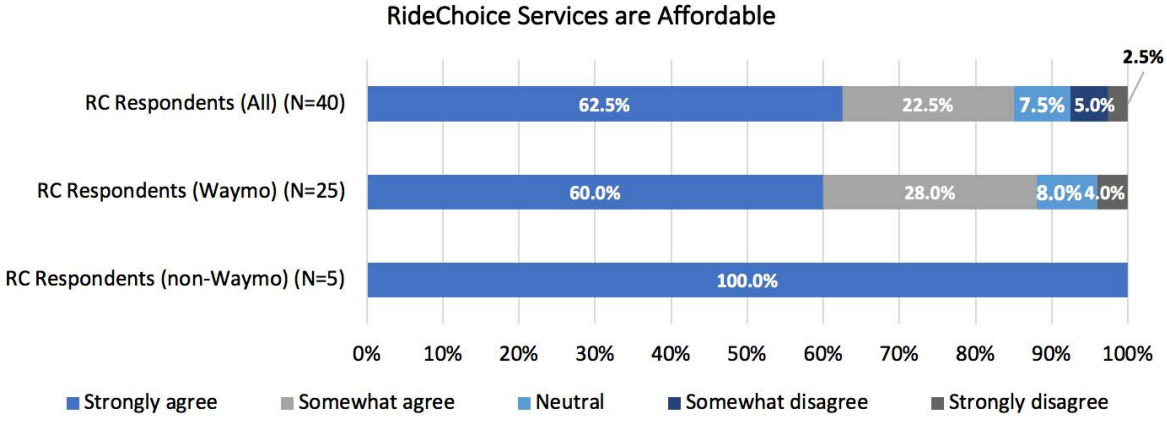


Figure 5-2

Affordability of RideChoice Services (Prior Survey)

The next question related to willingness to share a ride with a stranger if it would lower costs and add only marginally to travel time. In the RideChoice program, rides are not shared, so responses to this question would be helpful to Valley Metro. Figure 5-3 shows that a majority were unwilling to share a ride, at 55% of all respondents and 60% of RC Respondents (Waymo) and RC Respondents (non-Waymo). RC Respondents (non-Waymo) were more strongly in disagreement than the other two groups. No differences were statistically significant.

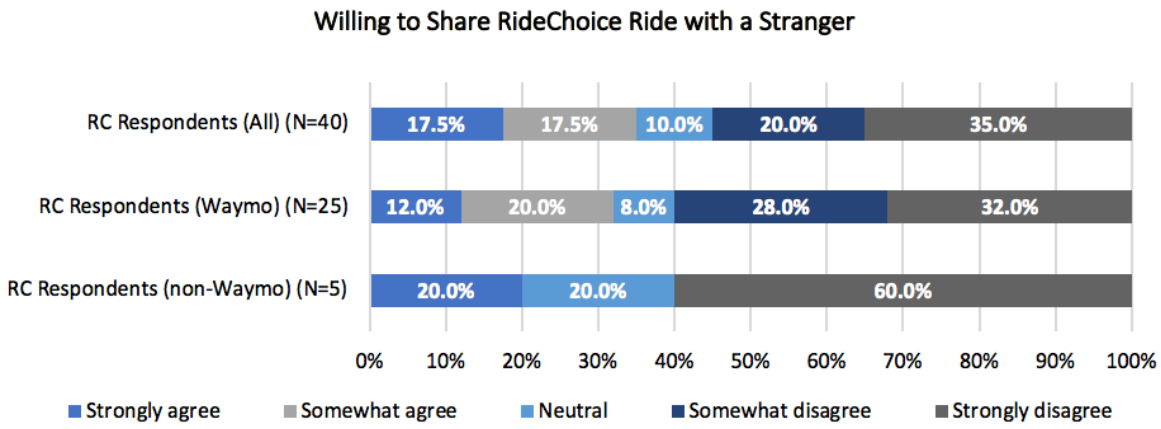


Figure 5-3

Willingness to Share RideChoice Ride with a Stranger (Prior Survey)

Figure 5-4 shows responses to a question about the ability of respondents to find a reasonable substitute for RideChoice service if that service was not available. Interestingly, RC Respondents (non-Waymo) indicated a higher level of disagreement with this statement than the other two groups of respondents, with 60% strongly disagreeing. For RC Respondents (Waymo), 40% disagreed, with only 8% of those disagreeing strongly, and 35% of RC Respondents (All) disagreed. This indicates a moderate level of captivity to RideChoice service. No differences were statistically significant.

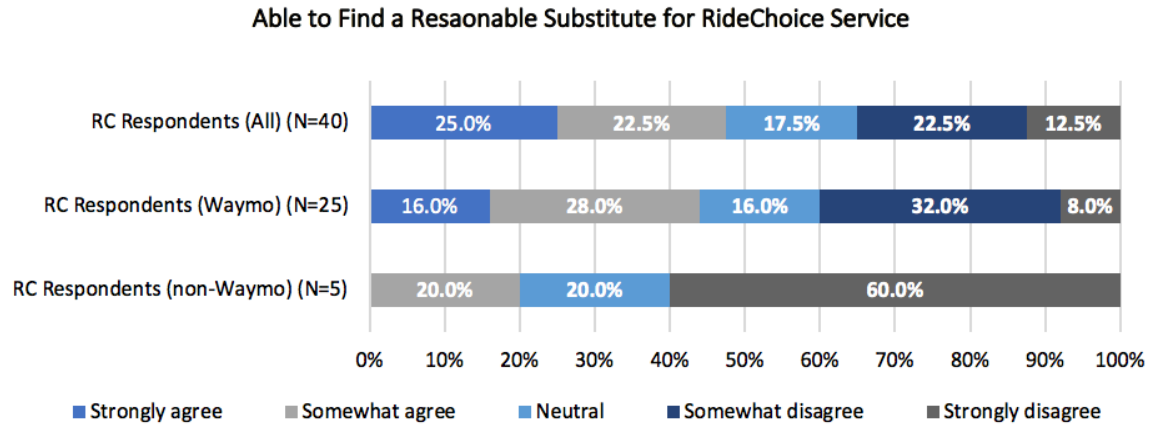


Figure 5-4

Ability to Find Reasonable Substitute for RideChoice Services (Prior Survey)

Respondents were asked about whether it is important for RideChoice services to accommodate the use of mobility aids, such as use of a wheelchair. The results, shown in Figure 5-5, indicate that this was important to less than 50% of RC Respondents (All), with RC Respondents (non-Waymo) showing the lowest level of importance for such a requirement. Again, no differences were statistically significant. It is important to remember that the screening criteria for participation in this pilot resulted in a study sample that was largely ambulatory, with only modest dependence on assistive equipment such as wheelchairs.

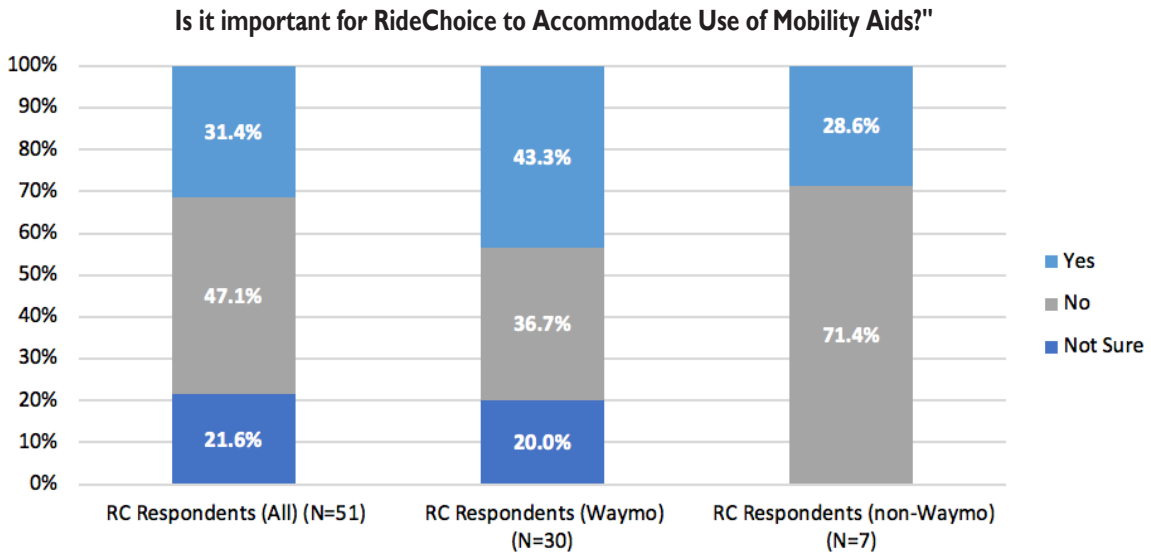


Figure 5-5

Importance That RideChoice Accommodates Use of Mobility Aids (Prior Survey)

Respondents were asked about their level of agreement that they needed assistance from the driver, such as help getting into and out of the vehicle, loading or unloading groceries, etc. Clearly, those who agreed would be less likely to be able to make use of a self-driving vehicle with no driver. As shown in Figure 5-6, the majority of RC Respondents (Waymo) (64.3%) disagreed with this statement, and only one third of RC Respondents (non-Waymo) disagreed. About 22% of RC Respondents (Waymo) agreed or strongly agreed, but only 16.7% of RC Respondents (non-Waymo) agreed.

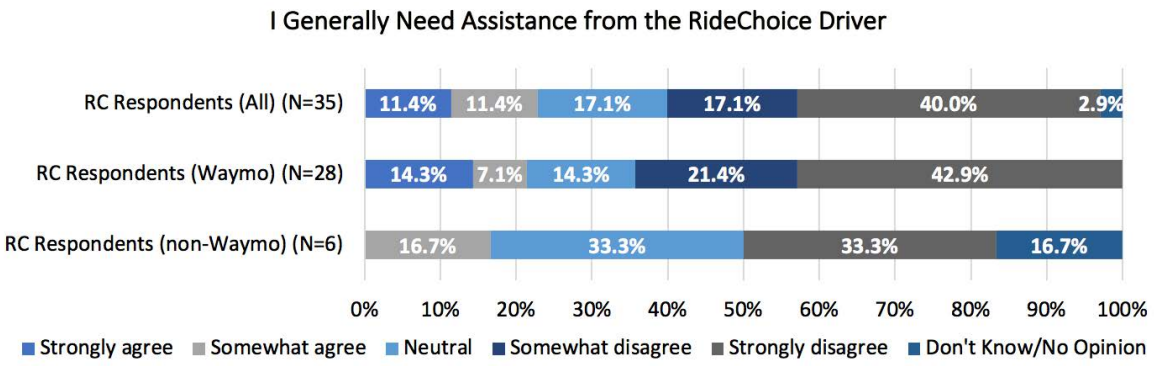


Figure 5-6

Need Assistance from Driver when Using RideChoice Services (During Survey)

Related to this, Prior Survey respondents were asked how important it was to them to have a driver to assist them with boarding, alighting, or carrying packages onto and off the vehicle. Figure 5-7 shows that most respondents were neutral to this (37.3%) or considered it to be unimportant (37.2%) , and RC Respondents (Waymo) were very similar. However, 28.6% of RC Respondents (non-Waymo) considered it to be very important, a similar proportion rated this as very unimportant (28.6%), and 14.3% rated it unimportant. Although to be enrolled in the program participants would need to be able to enter and exit the vehicle by themselves, about one quarter still valued having a driver to assist with getting into and out of the vehicle and helping with packages, suggesting that some level of immobility may exist for these participants.

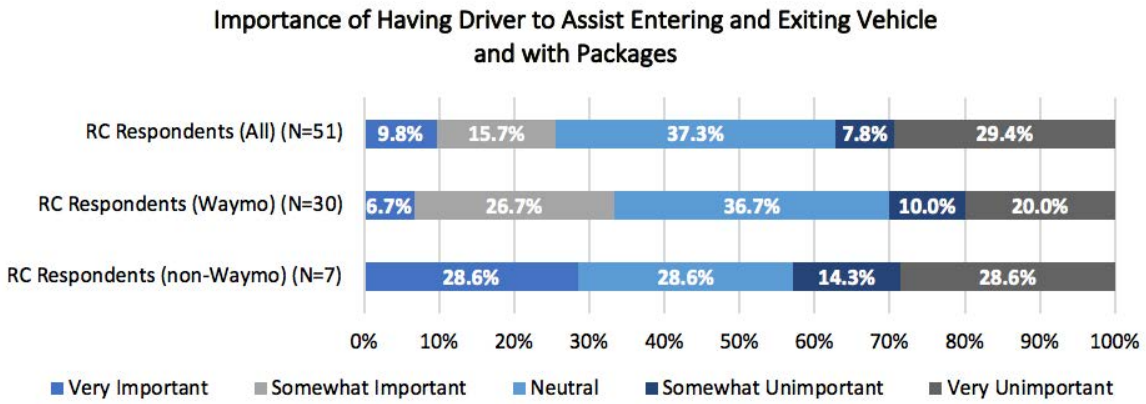


Figure 5-7

Importance of Having a Driver to Assist (Prior Survey)

Safety and Security

Two questions were asked in the During Survey relating to safety and security. The first was about feelings of safety while riding in either the traditional non-Waymo RideChoice vehicles or Waymo vehicles, and the second was about the expectation that there would be no problems while using either service. In the Prior Survey, the question on safety was combined with quality of the ride, comfort, and smoothness, so it could not be compared directly to the During Survey question on safety.

Figure 5-8 shows the levels of agreement about feeling safe while riding in either a traditional or a Waymo RideChoice vehicle. Figure 5-8 shows that RC Respondents (Waymo) rated safety in a Waymo vehicle higher than in traditional RideChoice vehicles; 92.6% agreed about Waymo vehicles, with 70.4% agreeing strongly. In comparison, 82.2% of these users rated traditional RideChoice vehicles as feeling safe, with only 28.6% agreeing strongly. These differences were statistically significant at 95% confidence. Non-Waymo users were more favorable toward traditional vehicles than RC Respondents (Waymo), also statistically significant at 95% confidence. However, the difference between RC Respondents (Waymo) and all users about traditional RideChoice rides was not statistically significant.

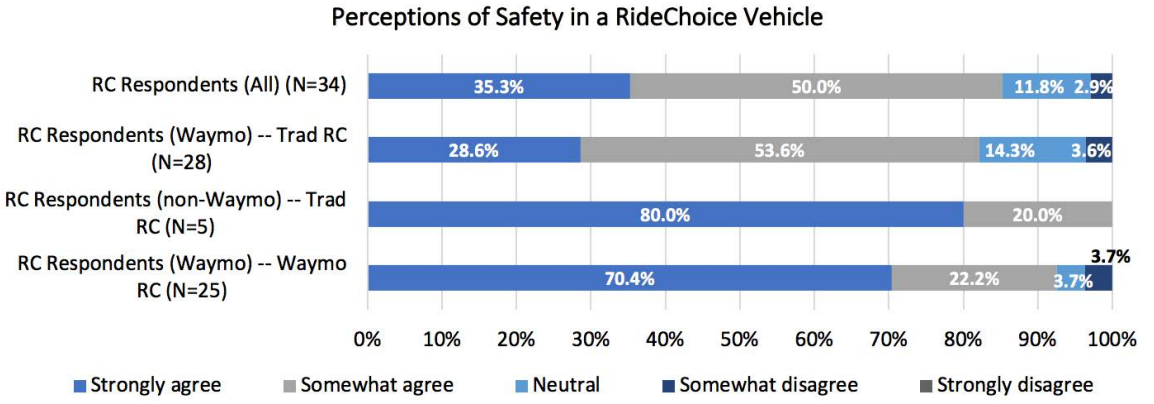


Figure 5-8

Agreement with Feelings of Safety in a RideChoice Vehicle (During Survey)

Figure 5-9 shows the responses to questions about expectation of problems during the ride. RC Respondents (All) and RC Respondents (Waymo)—Trad RC had nearly identical levels of agreement, at 84.8% and 81.5%, respectively. These two groups showed almost identical levels of agreeing strongly and agreeing somewhat. On the other hand, for RC Respondents (Waymo)—Waymo RC, the overall level of agreement was still similar at 88.9%, but twice as many respondents agreed strongly compared to traditional RideChoice services. No differences among these groups were statistically significant.

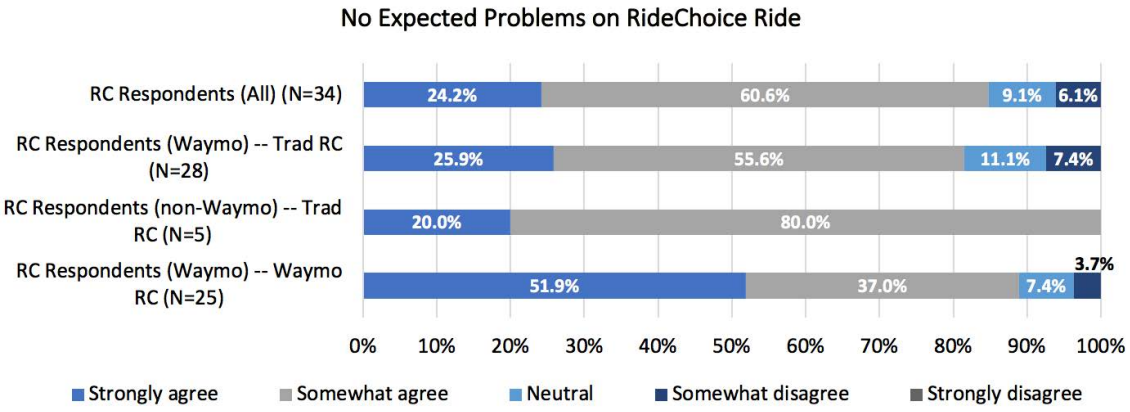


Figure 5-9

Agreement that No Problems Expected on RideChoice Ride (During Survey)

In summary, users of Waymo RideChoice services considered that they were somewhat safer and less likely to encounter problems than users of traditional RideChoice services.

Measures of Impedance (Travel Time, Wait Time, and Cost)

Participant satisfaction with wait time for Waymo rides did not change from the During Survey to the Post Survey. In the During Survey, although they evaluated this ride attribute for their most recent Waymo ride, it is fair to compare it with the Post Survey in which they evaluated it for their Waymo rides in general. In both surveys, over 90% of respondents believed the wait time was acceptable and they were satisfied with it, which reinforces that the quality of Waymo remained positively appraised over time. Differences between the During and Post surveys on this question were not statistically significant.

It is also interesting to look at the difference between RC Respondents (Waymo) and RC Respondents (non-Waymo) on their evaluation of wait time, as shown in Figure 5-10. Although no differences were statistically significant, it is interesting to note that the RC Respondents (non-Waymo) became more satisfied with wait times as the study proceeded, and RC Respondents (Waymo) stayed nearly the same over the three surveys.

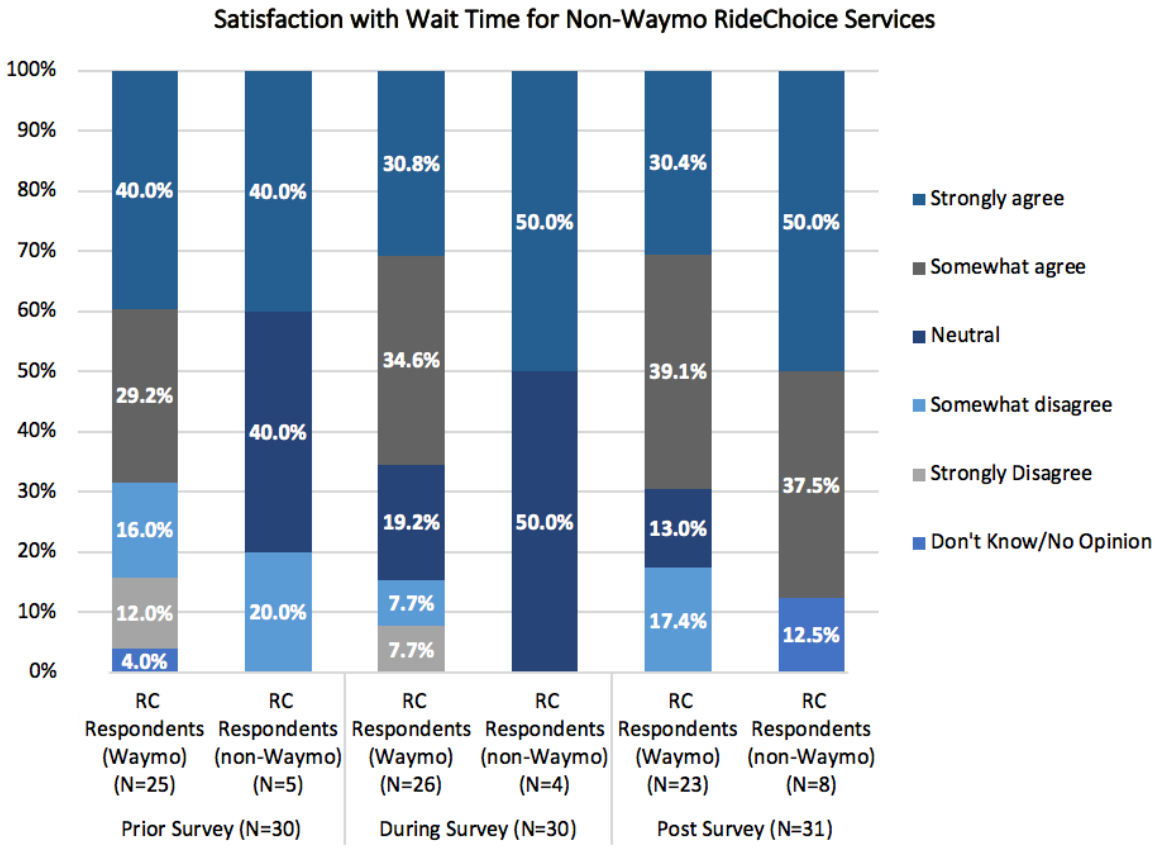


Figure 5-10

Comparison of Waymo and non-Waymo User Satisfaction with Wait Time for non-Waymo RideChoice Services (All Surveys)

Satisfaction with travel time was asked only in the During Survey. The results are shown in Figure 5-11, divided between non-Waymo RideChoice services and Waymo RideChoice Services, with the former subdivided between RC Respondents (Waymo) and RC Respondents (non-Waymo). The pattern is similar to that for wait times, although the level of strong agreement was higher in all cases, and highest for those using Waymo services. No differences were statistically significant.

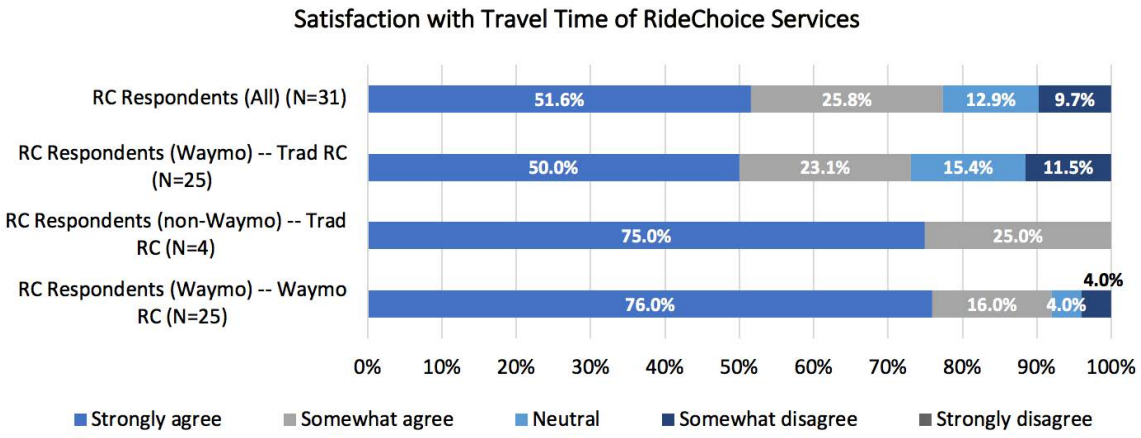


Figure 5-11

Satisfaction with Travel Time of RideChoice Services (During Survey)

Satisfaction with the cost of the RideChoice ride was asked only in the During Survey. Figure 5-12 shows the results grouped the same as for travel time. There was no statistically significant difference between the ratings of all respondents and RC Respondents (Waymo) on the cost of traditional RideChoice services, at 80.6% and 77%, respectively, who were somewhat or strongly satisfied with the costs of these services. The divisions between strong agreement and somewhat agreement also were very similar. RC Respondents (non-Waymo) were not significantly different from RC Respondents (Waymo)—Trad RC. However, satisfaction with cost was much more positive for RC Respondents (Waymo)—Waymo RC and was statistically very significant (99% confidence) in comparison to the ratings of RC Respondents (Waymo)—Trad RC and the ratings of RC Respondents (All)—Trad RC. For cost, the conclusion is that Waymo provided significantly greater satisfaction than traditional RideChoice services.

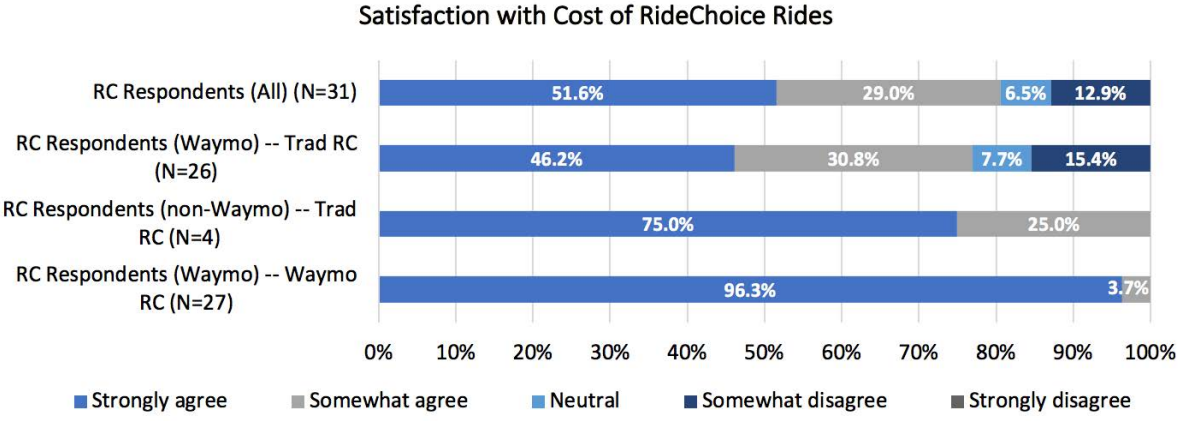


Figure 5-12

Satisfaction with Cost of RideChoice Services (During Survey)

The RideChoice Program in general was also evaluated in the surveys. In the Prior Survey, for example, 75% of respondents agreed that RideChoice was a reliable and dependable means of transportation for them. About the same percentage who had taken a non-Waymo RideChoice ride in the Post Survey agreed that non-Waymo RideChoice services served was a reliable means of transportation, and in both surveys about 10% of respondents disagreed.

In summary, on measures of impedance—wait time, travel time, and cost—Waymo rides were rated as providing greater satisfaction than traditional RideChoice services.

Accessibility, Convenience, and Comfort

In the During Survey, respondents were asked how satisfied they were with the ease of ordering and using RideChoice services, specifically with ordering and using Waymo RideChoice services. Results are shown in Figure 5-13. Although a few RC Respondents (non-Waymo) indicated that they were very satisfied with the ease of ordering and using RideChoice services, RC Respondents (Waymo) were much less satisfied with requesting RideChoice non-Waymo rides. There was no significant difference between the responses of RC Respondents (Waymo) and RC Respondents (All); however, the difference between RC Respondents (Waymo) and RC Respondents (non-Waymo) was very significant (99% confidence), as was the difference between the ratings of RC Respondents (Waymo) on traditional RideChoice services compared to Waymo RideChoice services. RC Respondents (Waymo) found ease of ordering and using Waymo services to be much more satisfactory (85.2% strong agreement or somewhat in agreement), compared to 60.7% for traditional services, with strong agreement going from 7.1% for traditional RideChoice services to 63% for Waymo.

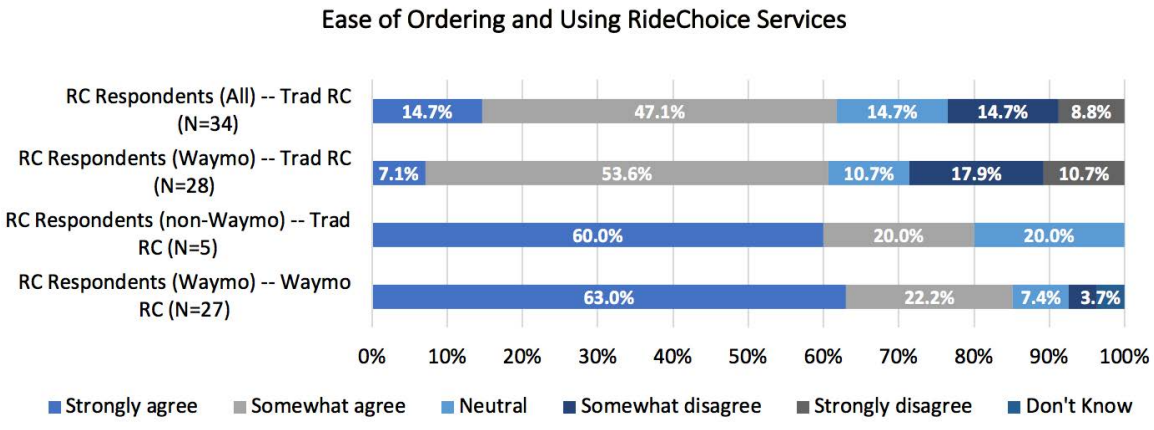


Figure 5-13

Agreement with Ease of Ordering and Using RideChoice Services (During Survey)

Respondent were asked for level of agreement that there was no difficulty getting into and out of the vehicle; results are shown in Figure 5-14. There was agreement by the majority, whether traditional RideChoice or Waymo. No differences were statistically significant. Overall, 85.3% of all respondents agreed that there was no difficulty getting into and out of traditional vehicles, and 88% of RC Respondents (Waymo) agreed that there is no difficulty with Waymo vehicles.

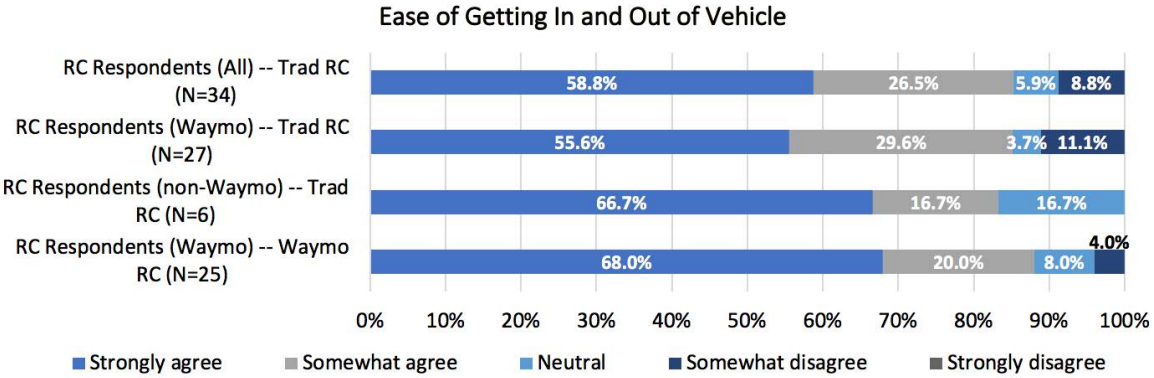


Figure 5-14

Agreement with Ease of Getting Into and Out of Vehicle (During Survey)

In both the Prior and During surveys, respondents were asked about whether traditional RideChoice services allowed them to get where they wanted to go. In the During Survey, this question was also asked about Waymo RideChoice services. Results are shown in Figure 5-15. Most notable is the difference between traditional RideChoice services and Waymo RideChoice services—a majority of RC Respondents (Waymo) strongly agreed (80%), and only 46.4% strongly agreed for Waymo services. This difference was very significant (99% confidence), whereas no other differences were statistically significant. The much lower agreement with this statement for Waymo services is reflective of the service territory in which the Waymo vehicles operated.

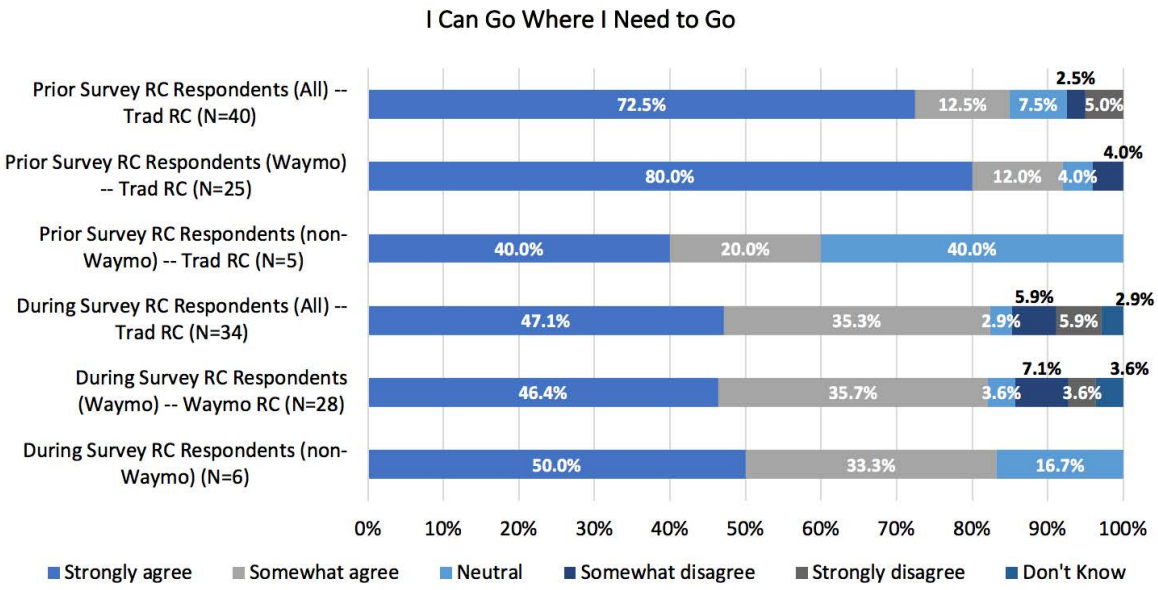


Figure 5-15

Agreement that RideChoice Services Allow Users to Go Where They Need to Go (Prior and During Surveys)

In the During Survey, respondents were asked if they expected that fully self-driving vehicles would make it easier to access bus and rail services; results are shown in Figure 5-16. A majority of RC Respondents (All) (55.9%) and RC Respondents (Waymo) (60.7%) agreed or strongly agreed; only 40% of RC Respondents (non-Waymo) agreed. A rather small proportion of each group disagreed somewhat or disagreed strongly.

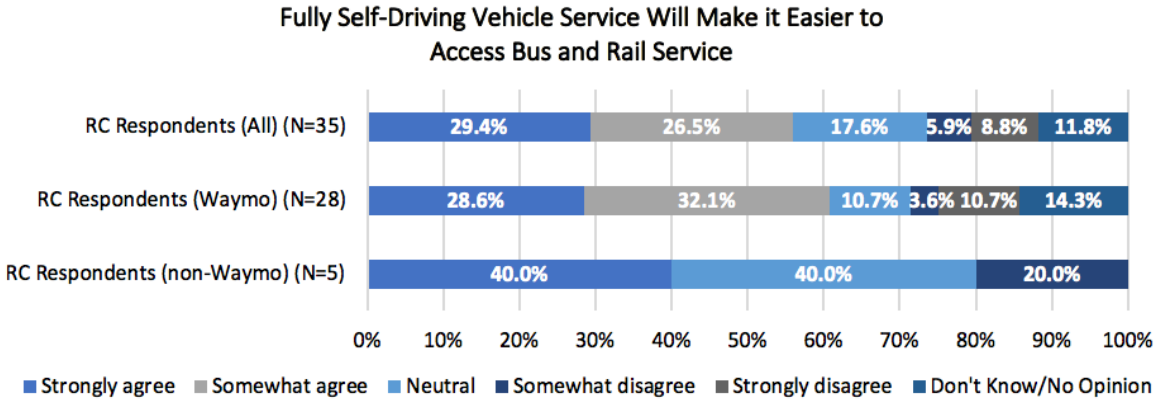


Figure 5-16

Fully Autonomous Vehicles Will Make It Easier to Access Bus and Rail (During Survey)

Similarly, respondents to the During Survey were asked if they agreed that travel would be made easier and more convenient with self-driving vehicles. Figure 5-17 shows that a large majority of respondents (60–78.6%) agreed somewhat or strongly, irrespective of whether or not they were RC Respondents (Waymo). Only a few respondents (5.8%) and only two RC Respondents (Waymo) (7.2%) disagreed somewhat or disagreed strongly.

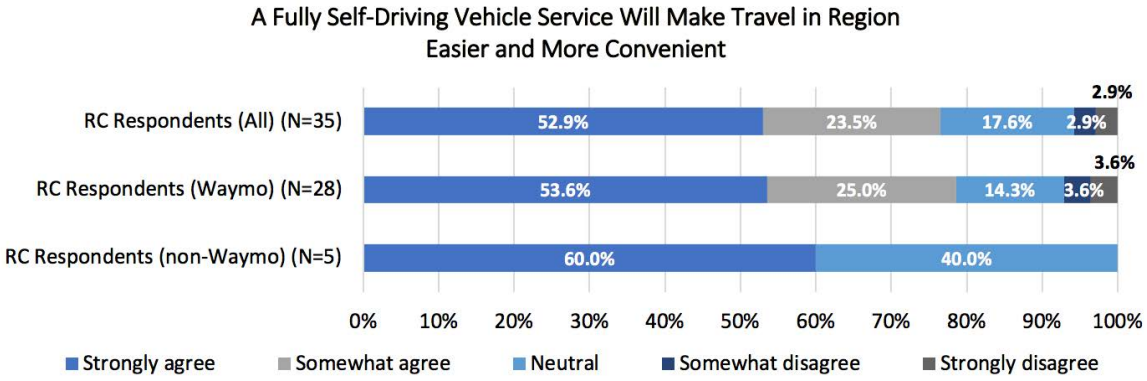


Figure 5-17

Fully Self-Driving Vehicle Service Will Make Travel Easier and More Convenient (During Survey)

A question about the quality of the Waymo ride was asked in both the During and Post surveys, and the results were not materially different—in both, all respondents except one who had experienced Waymo reported that the ride was smooth and comfortable. The differences across the During and Post surveys were not statistically significantly different. In the Prior Survey, respondents were asked to rate the importance of a comfortable and smooth ride. As shown in Figure 5-18, 96.1% of RC Respondents (All) considered a high-quality, comfortable, and smooth ride to be important or very important, all RC Respondents (Waymo) considered it to be very important or somewhat important, and 85.7% of RC Respondents (non-Waymo) considered it to be important or very important.

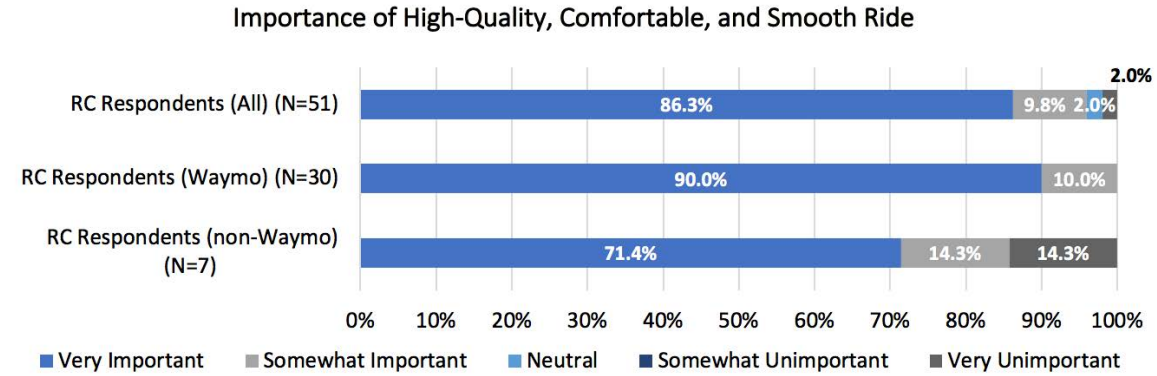


Figure 5-18

Importance of High-Quality, Comfortable, and Smooth Ride (Prior Survey)

Respondents were asked about reliability of service; results are shown in Figure 5-19. The question was asked only in the Post Survey. RC Respondents (Waymo) rated the reliability of traditional RideChoice services more positively than Waymo RideChoice services, with 93.3% agreeing or strongly agreeing that traditional RideChoice services were reliable, and only 79.2% giving a similar response for Waymo services. However, no differences were statistically significant.

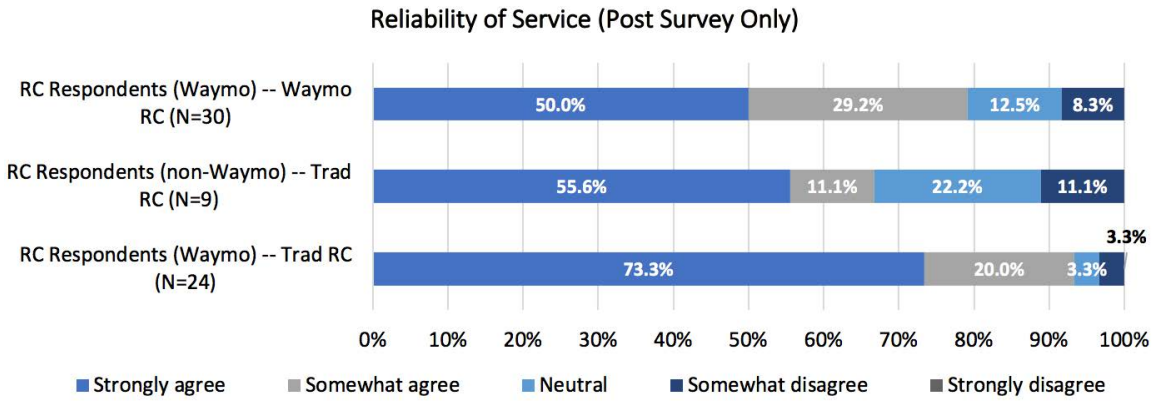


Figure 5-19

Reliability of Service (Post Survey)

SECTION

6

Attitudes and Perceptions Towards Self-Driving Vehicles and On-Demand Mobility Services

In Section 5, it was found that Waymo RideChoice services were considered as providing good accessibility, convenience, comfort, and convenience, although users recognized the limited geographical reach of Waymo service within the designated service territory. To capture a broader set of attitudes and perceptions towards emerging transportation technologies, all three surveys also included questions and statements aimed at better understanding general attitudes and perceptions towards self-driving vehicles and MOD services. This section provides a summary of results for this set of survey questions.

Awareness of and Willingness to Use Self-Driving Ride-Sharing Services

A key question addressed familiarity with self-driving vehicles and was asked only in the Prior and During surveys. In the Prior Survey, only one respondent reported not having heard of self-driving vehicles prior to the study. The option of "never heard of" was not provided in the During Survey because it was assumed that all respondents would now have heard of self-driving vehicles. The results in Figure 6 1 show that, as expected, familiarity increased among all respondents and among RC Respondents (Waymo) and RC Respondents (non-Waymo). As expected, RC Respondents (non-Waymo) showed less familiarity than RC Respondents (Waymo) in both surveys. The difference between RC Respondents (Waymo) from the Prior Survey to the During Survey was highly significant (99% confidence), and all other changes were not statistically significant.

In the Prior Survey, respondents were also asked if they had experienced riding in a self-driving vehicle. For all respondents, 27.5% had previously ridden in a self-driving vehicle. Among RC Respondents (Waymo), this was 20%, and among RC Respondents (non-Waymo) it was 0%. Therefore, although the previous question showed a fairly high level of familiarity with self-driving vehicles, only a few respondents actually had experience of riding in such a vehicle.

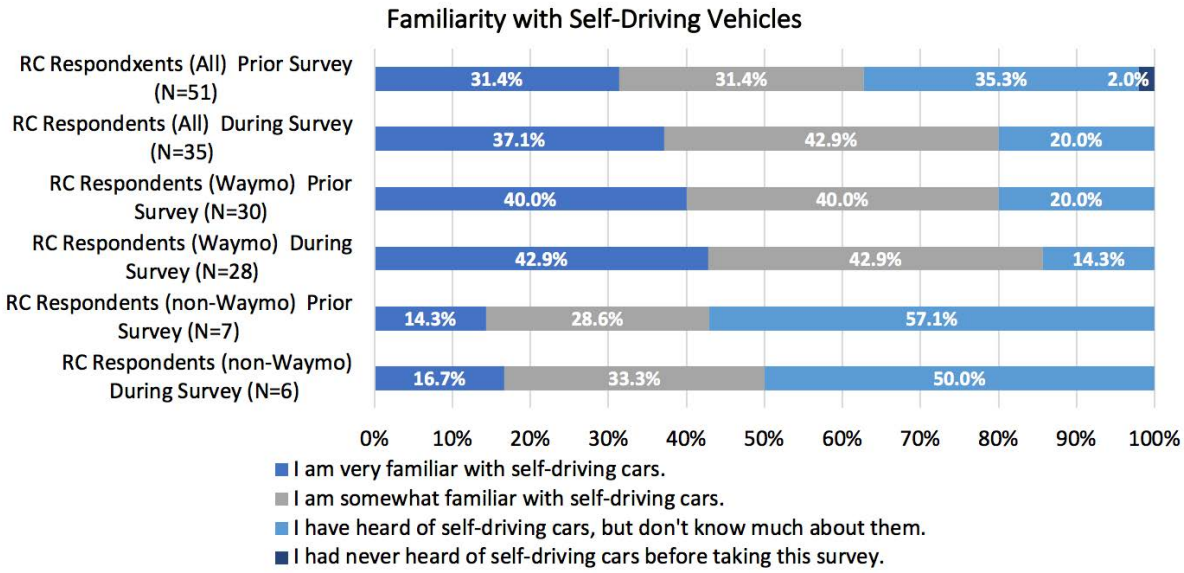


Figure 6-1

Degree of Familiarity with Self-Driving Vehicles (Prior and During Surveys)

When asked about riding in a fully self-driving vehicle with no human safety operator, the survey design was slightly different in the Prior Survey, which asked about willingness to ride in a self-driving car with no backup driver/operator present, whereas in the During and Post surveys they were asked simply if they would ride in a fully self-driving vehicle. Although the effect being captured was virtually the same, it is important to distinguish the survey designs before drawing conclusions. These attitudes were measured in the three surveys for the same three scenarios—riding alone, riding with a known passenger such as a family member or friend, or riding with strangers. The results are presented in a figure for each scenario the first for RC Respondents (All), the second for RC Respondents (Waymo), and the third for RC Respondents (non-Waymo) during the demonstration.

Reactions to the first scenario are shown in Figure 6-2; willingness to ride in a fully self- driving vehicle alone, as expressed in the Prior Survey, did not change when asked in the During and Post surveys; over 12% of respondents, although familiar with such technologies, were still hesitant. Looking separately at those who experienced Waymo and those who did not, in Figures 6-3 and 6-4, RC Respondents (Waymo) show about the same level of unwillingness through the three surveys. Apparently, the experience of using Waymo did not change this attitude, which is probably not surprising because they did not experience a self-driving vehicle with no safety operator on board. Non-Waymo users showed inconsistent attitudes over the three surveys but ended up seemingly more willing to use a self-driving vehicle alone according to the Post Survey than in either of the previous surveys. No differences were statistically significant.

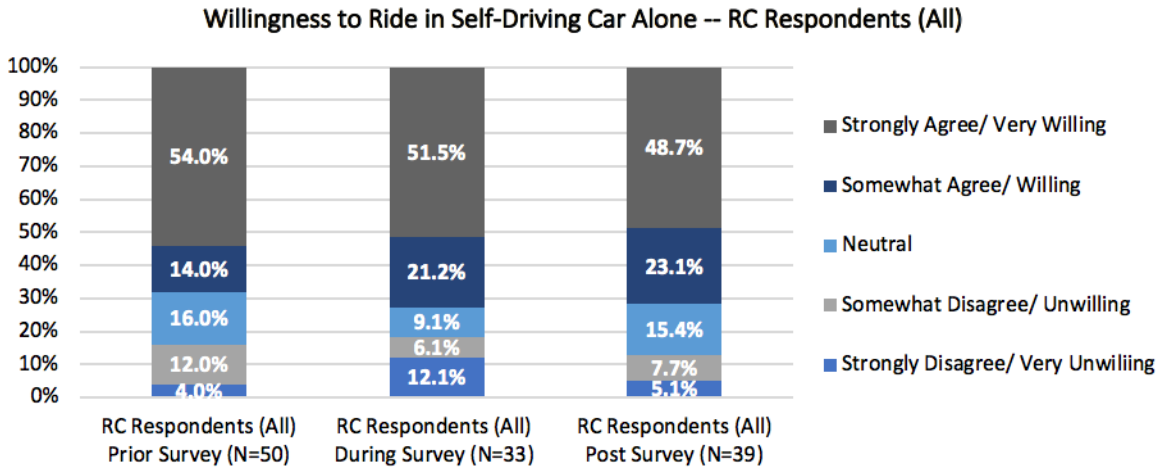


Figure 6-2

Willingness to Ride in Fully Self-Driving Vehicle Alone (All Surveys)

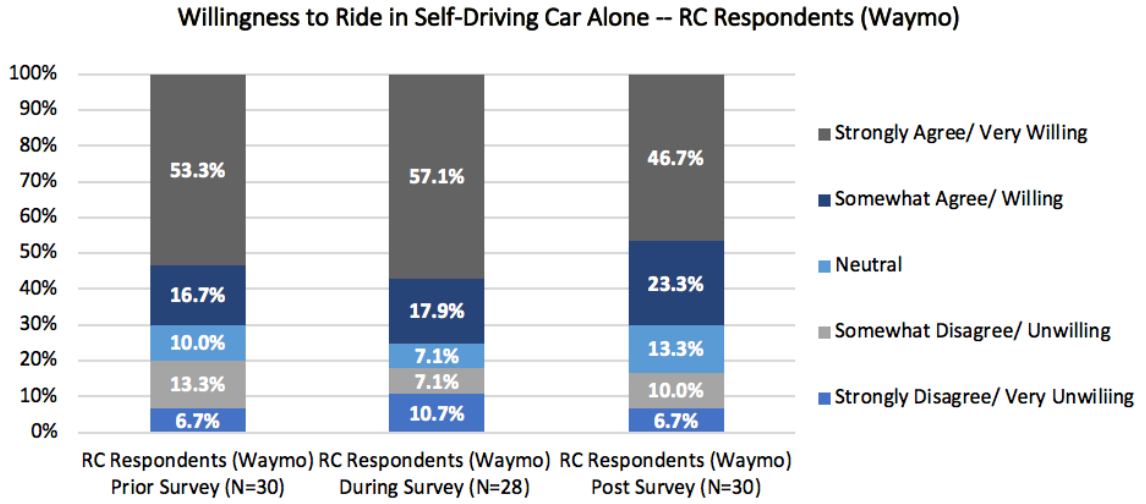


Figure 6-3

Willingness to Ride in Fully Self-Driving Vehicle Alone—RC Respondents (Waymo) (All Surveys)

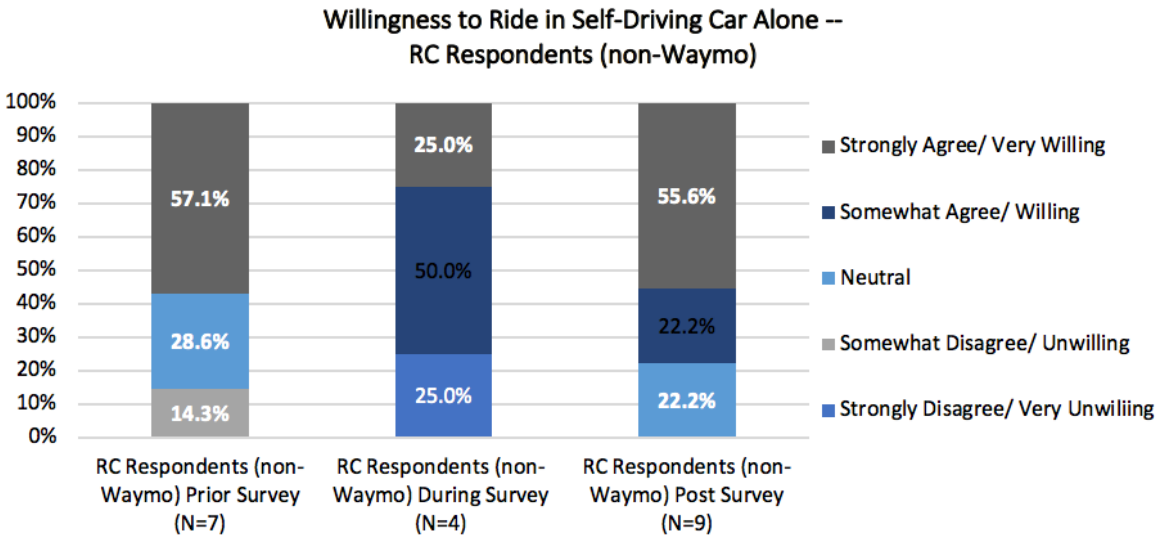


Figure 6-4

Willingness to Ride in Fully Self-Driving Vehicle Alone—RC Respondents (non-Waymo) (All Surveys)

Sharing a ride in a fully self-driving vehicle with friends and family was the most agreeable scenario in all three surveys, as shown in Figures 6-5 through 6-7. Over time, respondents were increasingly comfortable with the idea of sharing a ride in a self-driving vehicle with a family member or a friend; results increased from 78.4% willing to ride in such a scenario in the Prior Survey to 82.3% in the During Survey and to 92.3% in the Post Survey. A similar pattern is seen for RC Respondents (Waymo) in Figure 6-6; although there was a slight drop in the During Survey, the Prior Survey shows 80% willing, and the Post Survey showed 90% willing.

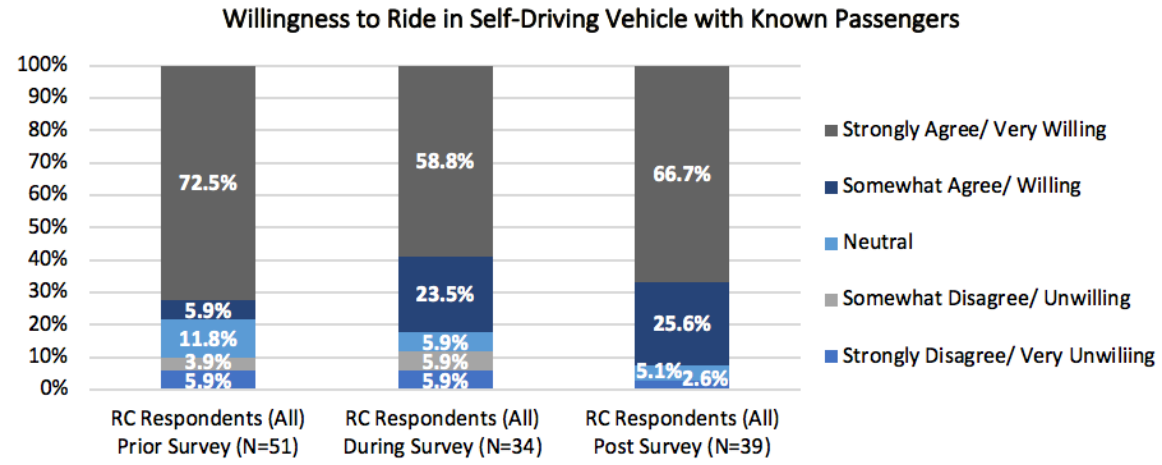


Figure 6-5

Willingness to Ride in Fully Self-Driving Vehicle with Known Passengers (All Surveys)

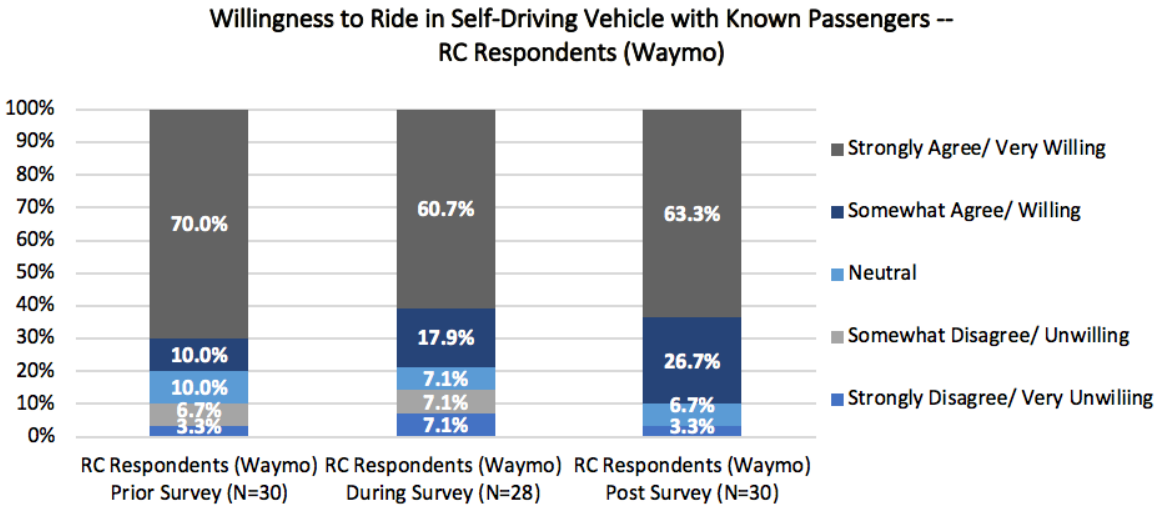


Figure 6-6

Willingness to Ride in Fully Self-Driving Vehicle with Known Passengers—RC Respondents (Waymo) (All Surveys)

RC Respondents (non-Waymo) showed 100% willingness to ride (Figure 6-7). No differences in these three were statistically significant, except between RC Respondents (Waymo) and RC Respondents (non-Waymo) in the Prior Survey, for which the difference was statistically significant at 95% confidence.

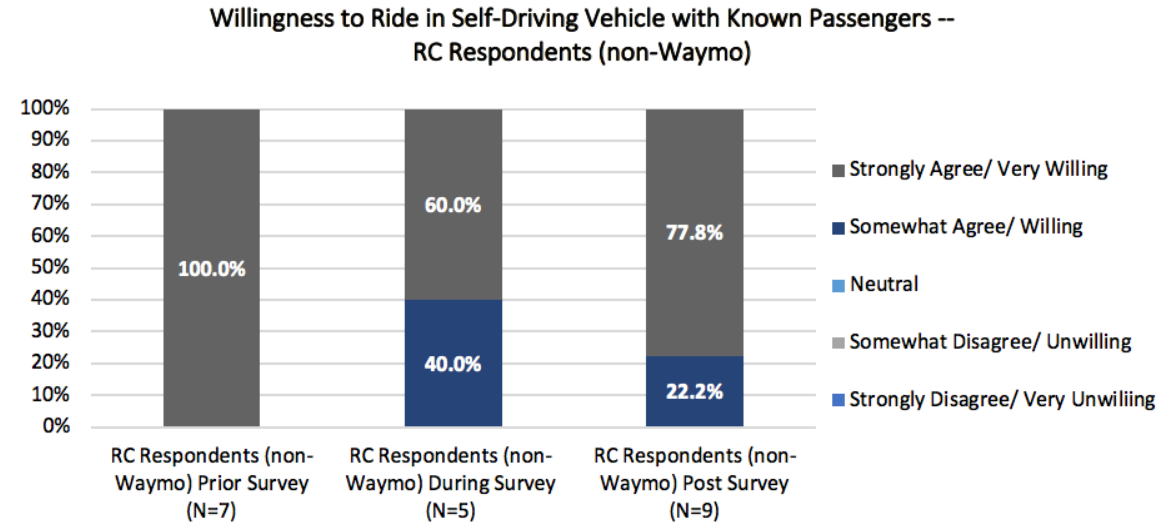


Figure 6-7

Willingness to Ride in a Fully Self-Driving Vehicle with Known Passengers—RC Respondents (non-Waymo) (All Surveys)

Willingness to share a self-driving vehicle ride with strangers changed over time, from 44% in the Prior Survey to 42.5% in the During Survey to 48.8% in Post Survey (Figure 6-8). This remained about the same across the three surveys, but those who were neutral increased in the During Survey and decreased somewhat in the Post Survey. No differences were statistically significant.

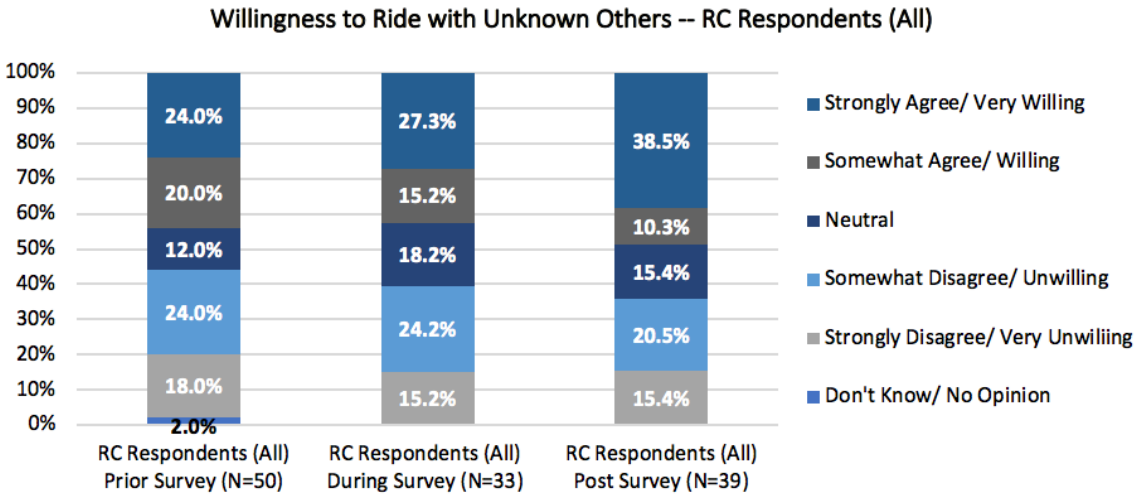


Figure 6-8

Willingness to Ride in Fully Self-Driving Vehicle with Strangers (All Surveys)

The results of the question on willingness to ride with strangers for RC Respondents (Waymo) are shown in Figure 6-9 and show a steadily increased willingness, perhaps as a result of their experience with Waymo. The percentage of respondents who were neutral increased across the three surveys, and the percentage who were unwilling declined from 46.7% in the Prior Survey to 39.3% in the During Survey and then to 33.3% in the Post Survey. The changes were not statistically significant.

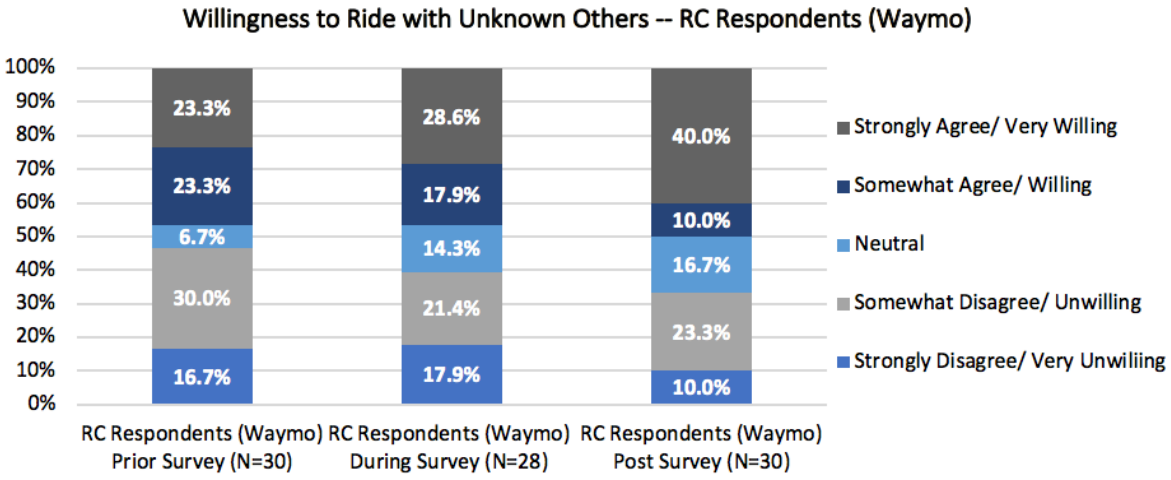


Figure 6-9

Willingness to Ride in Fully Self-Driving Vehicle with Strangers—RC Respondents (Waymo) (All Surveys)

For RC Respondents (non-Waymo), a different change is noted in Figure 6-10. The proportion of RideChoice users who would be willing to ride with strangers declined initially from the Prior to the During surveys but then increased in the Post Survey. The proportion of respondents who were neutral declined across the three surveys, and almost 50% of these respondents were unwilling to ride with a stranger.

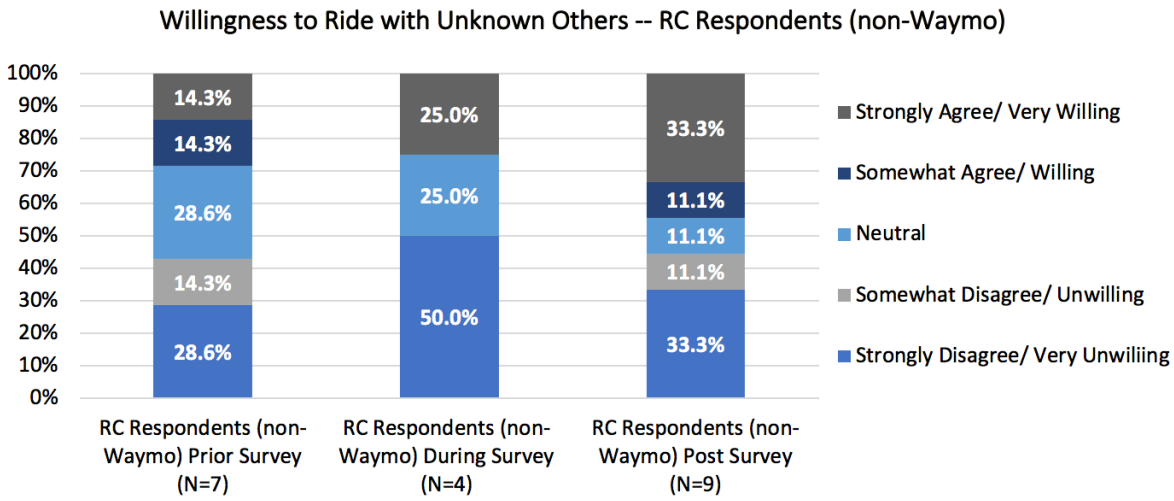


Figure 6-10

Willingness to Ride in Fully Self-Driving Vehicle with Strangers—RC Respondents (non-Waymo) (All Surveys)

Potential Use of Autonomous Vehicles

A question asked in the Prior Survey was about the level of agreement that human-driven vehicles should still be available even after self-driving vehicles are found to be safer than human-driven vehicles. A majority of RC Respondents (All) and RC Respondents (Waymo), as shown in Figure 6-11, agreed or strongly agreed; RC Respondents (non-Waymo) showed only 42.9% agreement or strong agreement, with equal proportions (28.6%) who were neutral and somewhat disagreed. Differences were not statistically significant.

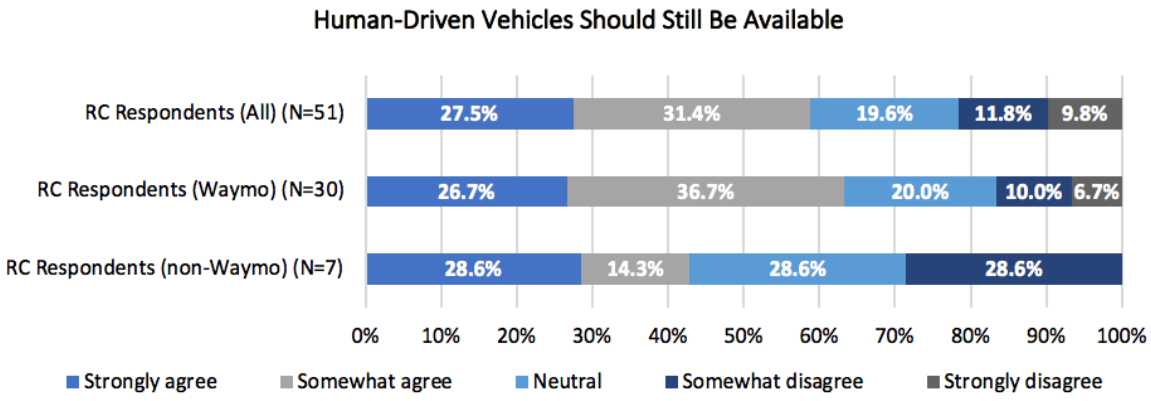


Figure 6-11

Human-Driven Vehicles Should be Available Even After Self-Driven Vehicles are Shown to be Safer (Prior Survey)

In the Prior Survey, respondents were asked to indicate their expectations that their travel would change with the availability of self-driving vehicles. First, they were asked to indicate whether they would travel farther with self-driving vehicles. Figure 6-12 shows that half of RC Respondents (All) (51.3%) agreed that they would expect to travel longer distances with self-driving vehicles available, only 46.7% of RC Respondents (Waymo) expected to do so, and 42.9% of RC Respondents (non-Waymo) expected to do so (when they answered the Prior Survey). In no group did a majority of respondents disagree with the statement, however. Again, no differences were statistically significant.

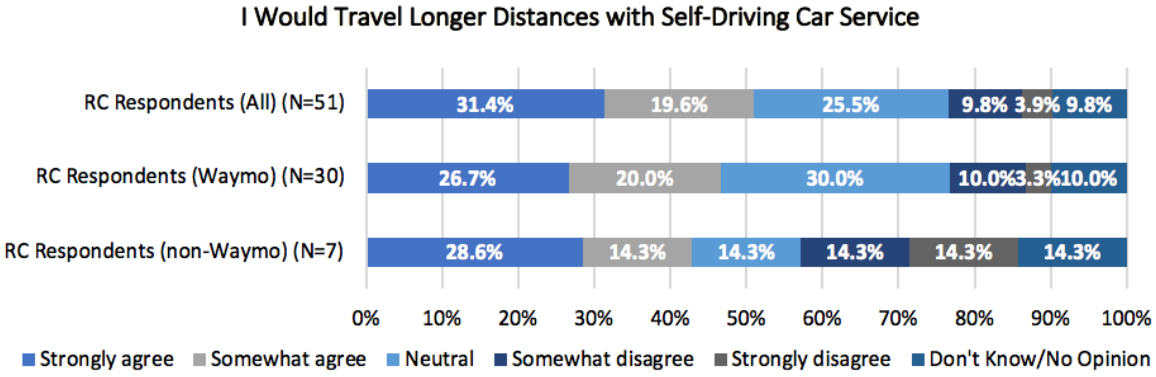


Figure 6-12

Expectation of Traveling Longer Distances with Self-Driving Car Service (Prior Survey)

Respondents were asked if they would make additional trips if self-driving car service was available. Figure 6-13 shows that a majority of all three groups of respondents would expect to make additional trips if self-driving vehicles became available through RideChoice. The smallest majority was among RC Respondents (Waymo). As shown in the data reported, additional trips were made by Waymo users—more trips were made by RC Respondents (Waymo) than regular RideChoice users in December 2019–February 2020. The differences between groups were not statistically significant.

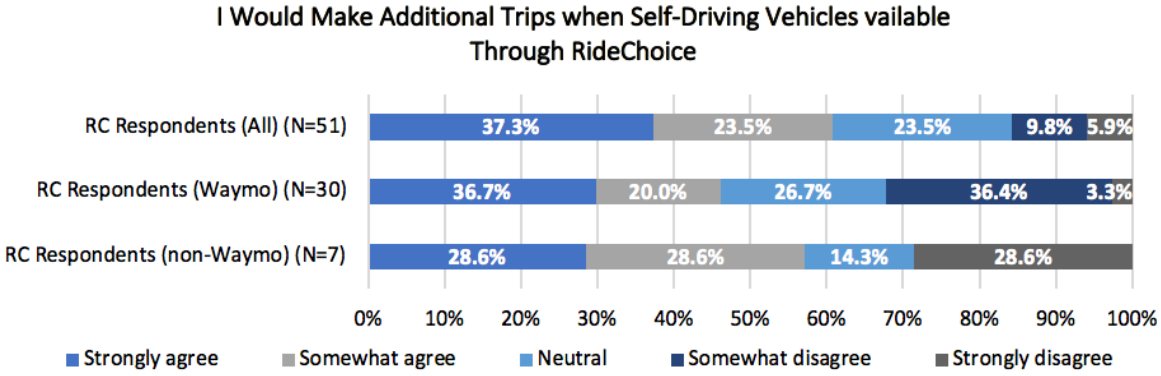


Figure 6-13

Expectation of Making Additional Trips When Self-Driving Vehicles Available Through RideChoice (Prior Survey)

In Figure 6-14, the bars are arranged so the top three bars compare all respondents to each of the three surveys, the middle three bars compare RC Respondents (Waymo) across the three surveys, and the bottom three bars compare RC Respondents (non-Waymo) across the three surveys. This facilitates comparing change over time while still allowing comparison within an individual survey.

Figure 6-14 shows the comparison before, during, and after the Waymo experiment of the expected level of switching to fully self-driving vehicles for RideChoice trips once the service is available on a permanent basis across the entire Phoenix metropolitan area. These levels were close to each other in all three surveys, with most respondents (about 80%) expecting to switch to using fully self-driving vehicles for half or more of their RideChoice trips. In contrast, 43.1% said they expected to use a fully self-driving vehicle for most of their RideChoice trips before the experiment, which changed to 41.2% during the experiment and 33.3% after the experiment. On the other hand, although 17.6% stated that they would use it for a few trips prior to the experiment, only 8.8% stated this in the During Survey and 12.5% in the Post Survey. Overall, 0%, 5.9%, and 10.3% stated that they would not use it for any trips before, during, and after the demonstration, respectively. It seems that the completion of the

demonstration modestly reduced the expected level of switching to fully self-driving vehicles, possibly due to some of the service constraints (pick-up/drop-off locations and geographic coverage of service area). The slight shift toward not using self-driving vehicles is also apparent when the respondents were split between those who used Waymo and those who did not, with the largest shift for the non-Waymo group. However, no differences between surveys and between the Waymo and non-Waymo groups (both within and between groups) were statistically significant.

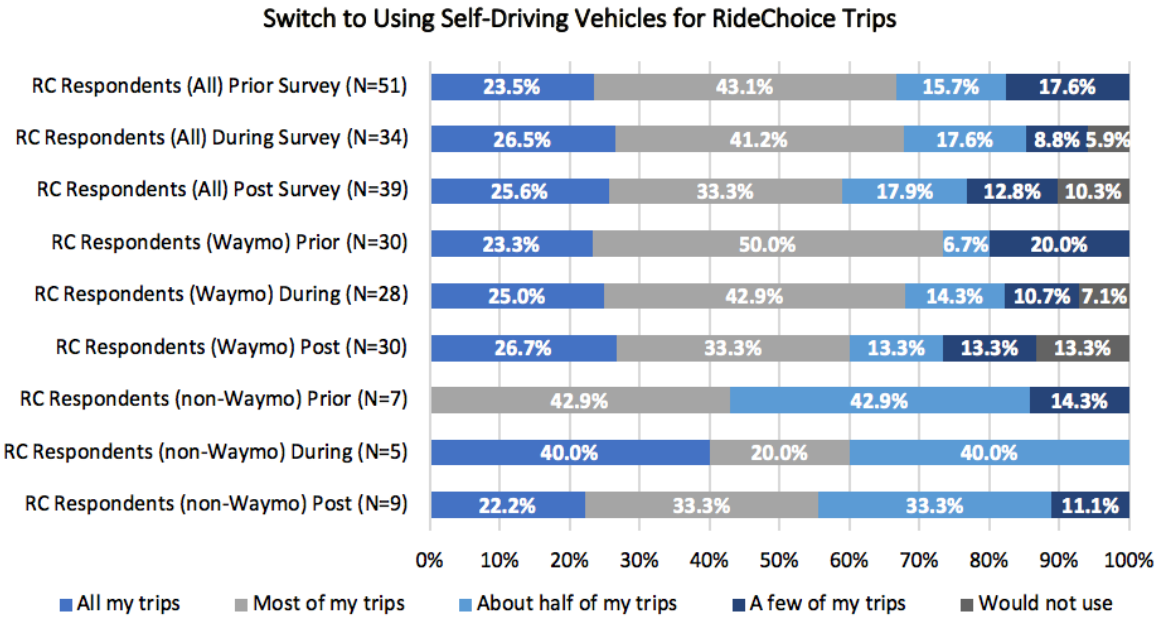


Figure 6-14

Expectation of Switching to Self-Driving Vehicles for RideChoice Service (All Surveys)

Safety Perceptions

In the Prior and During surveys, respondents were asked questions about expected safety in a future when most vehicles were self-driving; results are shown in Figure 6-15. In each group, respondents who offered no opinion disappeared in the During Survey. The strength of agreement with this idea increased significantly (95% confidence) from the Prior Survey to the During Survey for all respondents and RC Respondents (Waymo), with the percentage in agreement increasing from 49% of all respondents (46.7% of RC Respondents [Waymo]) to 61.8% of all respondents (64.3% of RC Respondents [Waymo]). Among those indicating agreement, the proportion indicating strong agreement nearly doubled from the Prior Survey to the During Survey. The change in RC Respondents (non-Waymo) was insignificant.

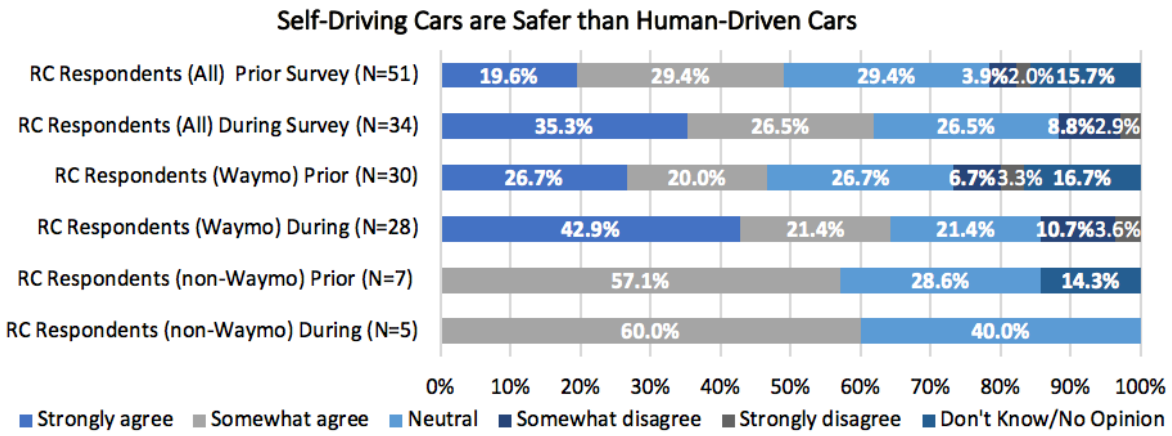


Figure 6-15

Agreement that Self-Driving Cars Are Safer than Human-Driven Cars (Prior and During Surveys)

Results regarding safety for pedestrians, bicyclists and other road users are shown in Figure 6-16. For all groups (RC Respondents [All], RC Respondents [Waymo], RC Respondents [non-Waymo]), their agreement increased from the Prior Survey to the During Survey. The differences between the Prior and During surveys for all respondents and RC Respondents (Waymo) were statistically significant, indicating that there was a real increase in agreement that self-driving vehicles will make roads safer.

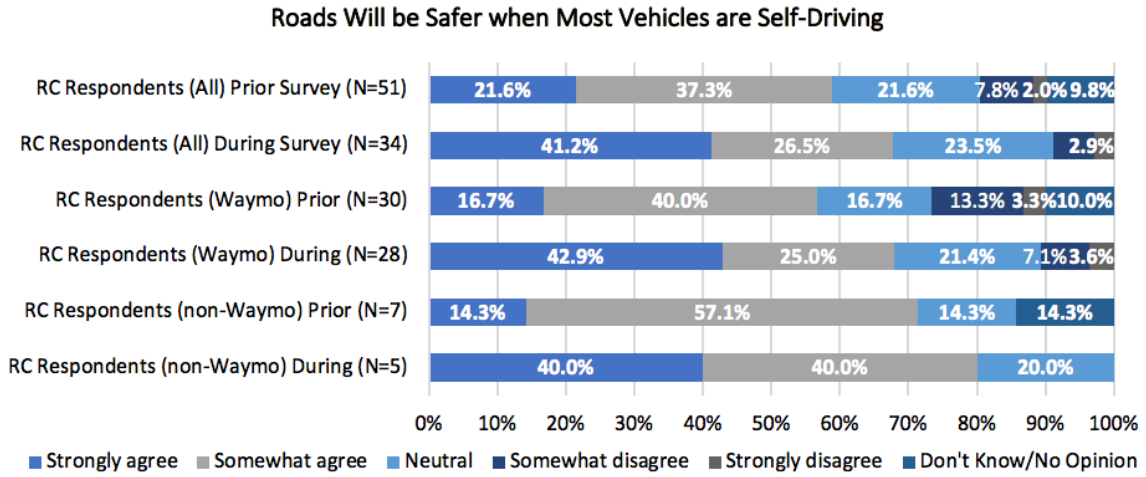


Figure 6-16

Expectation that Roads Will Be Safer When Most Vehicles are Self-Driving (Prior and During Surveys)

Based on these two questions, it appears that the experience of using Waymo significantly influenced survey respondents to look more favorably on the safety aspects of self-driving vehicles than they did before the demonstration. This is reflected further in the focus group results described in Section 8.

Mobility Perceptions

In the Post Survey, respondents were asked if they agreed that self-driving vehicles could enhance mobility for all travelers, including people with mobility limitations. Figure 6-17 shows that there was agreement by more than three-quarters of respondents, although RC Respondents (non-Waymo) showed a higher level of agreement than RC Respondents (Waymo) (88.9% vs. 72.4%) . There was, however, no significant difference between the three groups on this question.

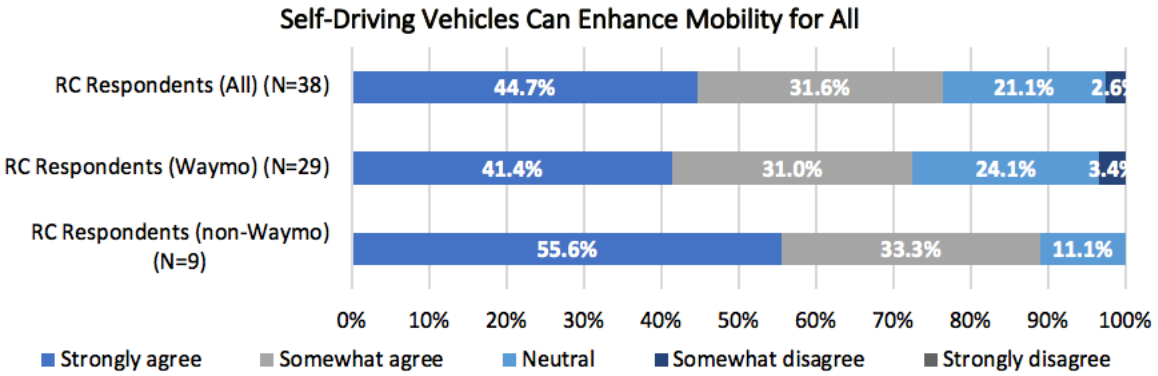


Figure 6-17

Potential of Self-Driving Vehicles to Enhance Mobility for All Travelers (Post Survey)

Figure 6-18 shows the results from the question about self-driving vehicles enhancing the mobility of people with disabilities. Although the majority of RC Respondents (Waymo) agreed, they felt less strongly relative to other mobility options, with 10.3% of RC Respondents (Waymo) disagreeing or disagreeing strongly, which is higher than for the previous question. There was no significant difference between the three groups.

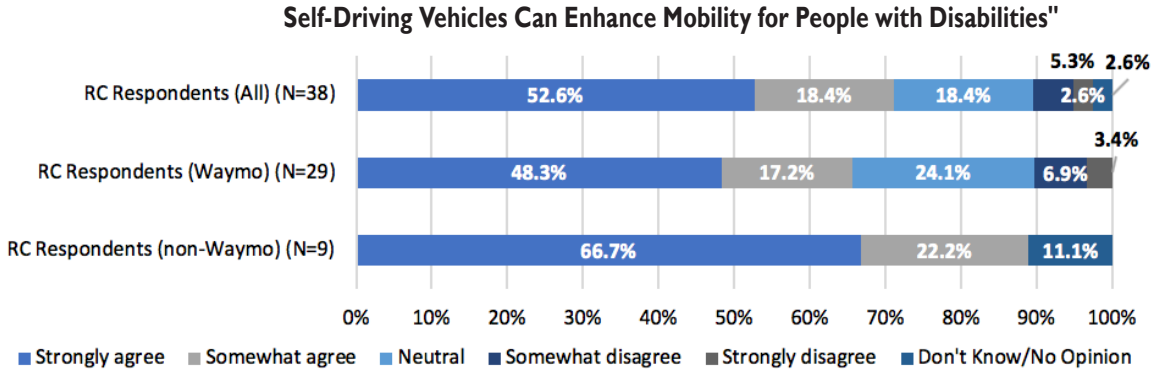


Figure 6-18

Potential of Self-Driving Vehicles to Enhance Mobility for Persons with Disabilities (Post Survey)

Embracing a Self-Driving Future

Respondents were asked if they felt that using self-driving vehicles would be less stressful; Figure 6-19 shows that most respondents agreed or strongly agreed. Interestingly, RC Respondents (non-Waymo) did not disagree, and a few RC Respondents (Waymo) disagreed, some strongly. There was no statistically significant difference among these responses.

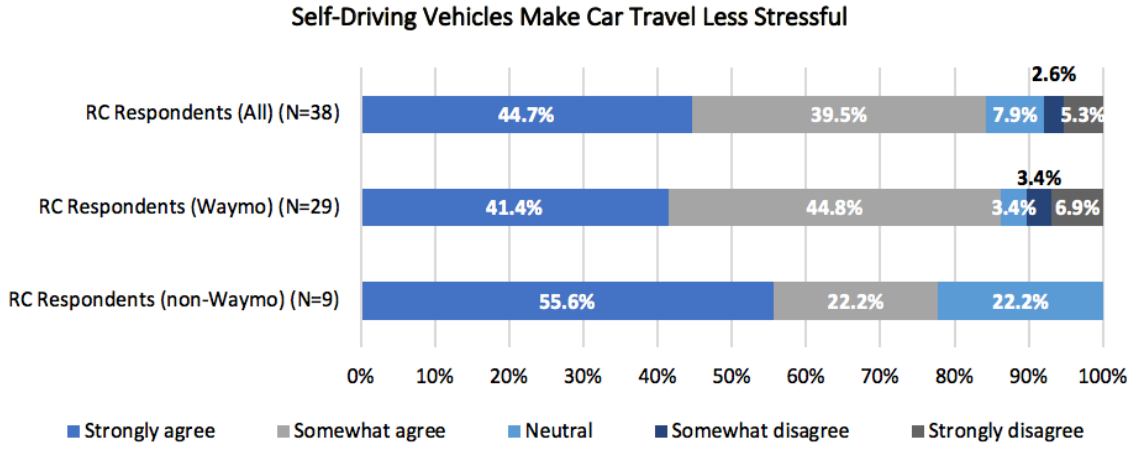


Figure 6-19

Self-Driving Vehicles Make Car Travel Less Stressful (Post Survey)

The last of these questions was about if respondents would like to see self-driving vehicles become common on roadways. Figure 6-20 indicates strong agreement by more than half of respondents. Again, it is interesting that only those who had experience with the self-driving vehicles in this pilot demonstration indicated disagreement. There was no statistically significant difference between the groups on this question.

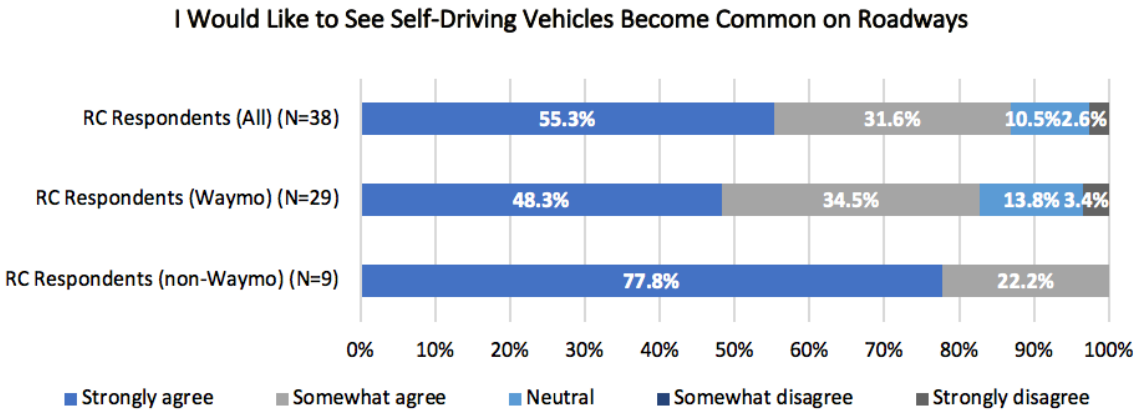


Figure 6-20

Would Like to See Self-Driving Vehicles Become Common (Post Survey)

Respondents were asked in the Prior and During surveys if they would routinely request a self-driving service in preference to a human-driven service for their RideChoice travel. Figure 6-21 shows that RC Respondents (non-Waymo) increased their agreement from the Prior to the During surveys, and RC Respondents (Waymo) and RC Respondents (All)) showed a slight decrease in their agreement. This decrease affected strong agreement in particular but resulted in a decrease overall in the level of agreement. The changes were not statistically significant.

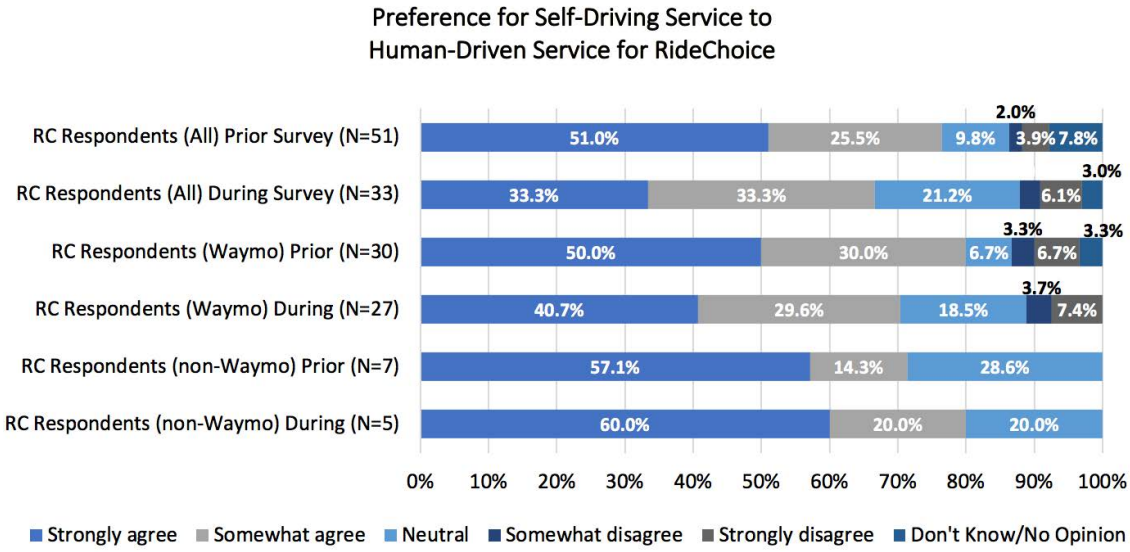


Figure 6-21

Preference for Self-Driving Service for RideChoice Travel (Prior and During Surveys)

In the Post Survey, respondents were asked if they were excited to see technology innovations in transportation. As shown in Figure 6-22, there was nearly unanimous agreement. Among RC Respondents (non-Waymo), 100% strongly agreed; RC Respondents (Waymo) were slightly more cautious, with over three-quarters agreeing strongly and 13.8% somewhat agreeing. There were no significant differences between the results.

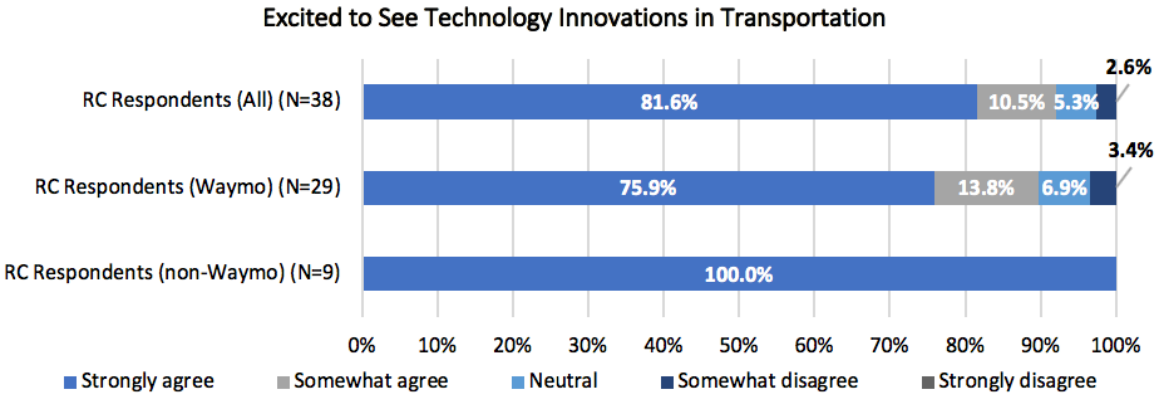


Figure 6-22

Excited to See Technology Innovations in Transportation (Post Survey)

SECTION

7

Aggregate Trip Profiles: Traditional RideChoice vs. Waymo

Trip roster data were received from Valley Metro and Waymo. Valley Metro provided a list of rides for two time periods—during the pilot demonstration and about one year prior to the pilot demonstration—to facilitate comparison of travel characteristics of RideChoice trips before and during the experiment. Waymo provided RideChoice trip data for the period of the pilot experiment, which allowed comparison of traditional RideChoice trip attributes (obtained from Valley Metro) and Waymo RideChoice trip attributes (based on data provided by Waymo).

Trip Roster Data Sets

Table 7-1 summarizes the information contained in the various trip roster datasets obtained by the study team. Valley Metro provided RideChoice trip data from participants in the demonstration during two periods— December 2018–May 2019 and September 2019–March 2020 (non-Waymo RideChoice rides that occurred during the demonstration, when the Waymo option was also available). Waymo provided trip data for the same periods and the same group of participants (enrolled in the demonstration). Therefore, trip characteristics could be compared to alternative RideChoice transportation options (taxi, Uber/Lyft RideChoice rides) as well as to previous travel attributes (before the demonstration). It is important to note that the RideChoice program went through changes in pricing policies in November 2018, which may have impacted travel patterns observed right after these changes in the first dataset provided by Valley Metro.

Table 7-1

Summary of Trip Datasets

	RideChoice 2018/2019	RideChoice non-Waymo 2019/2020	RideChoice Waymo 2019/2020
	Dec 2018–May 2019	*Sep 2019–March 2020*	*Sep 2019–March 2020*
Number of trips	551	501	1,131
Number of users	14	21	30
Included variables:			
Date and time of day	✔	✔	✔
Travel distance	✔	✔	✔
Travel time	✔	✔	✔
Total travel cost	✔		✔
Pick-up/drop-off locations	✔	✔	✔
User ID	✔	✔	

The first dataset, named RideChoice 2018/2019, covered 551 trip records from 14 users in the pilot demonstration from December 2018–May 2019. During the demonstration, from September 2019 to March 2020, participants could use both Waymo and non-Waymo options through the RideChoice program. Valley Metro provided the second dataset, named RideChoice non-Waymo 2019/2020, which contained information for 501 trips made by 21 participants during the pilot demonstration. Finally, the third dataset at the trip level was provided by RideChoice Waymo for the same period (September 2019–March 2020), covering 1,131 Waymo rides from 30 users in the demonstration.

Because these samples were a subsample of the 51 participants enrolled in the project, overlap of samples was expected when comparing these datasets. Identifying sample overlaps among the datasets allowed drawing more accurate conclusions from the analyzed data. Of the 14 users in the RideChoice 2018/2019 sample, 13 also appeared in the RideChoice non-Waymo dataset and 8 took Waymo rides and thus were part of the Waymo dataset. Additionally, 11 of the 21 users in the RideChoice non-Waymo dataset were also present in the Waymo trip records. Unfortunately, datasets did not match perfectly in terms of available variables.

Temporal Characteristics

During the demonstration, the frequency of rides differed between RideChoice non-Waymo and RideChoice Waymo options—although the frequency of non-Waymo rides seemed to be somewhat stable over the course of the six-month period (mid-September 2019 to mid-March 2020), Waymo rides appeared to have spiked in the first half of the program, especially in November and December 2020, followed by a decline in use during the subsequent months (Figure 7-1). The reason for such different patterns in use is possibly the initial excitement to use Waymo, which might have encouraged participants to use Waymo more frequently. RideChoice 2018/2019 rides are not included in Figure 7-1 to facilitate comparison between Waymo and non-Waymo RideChoice in the same months.

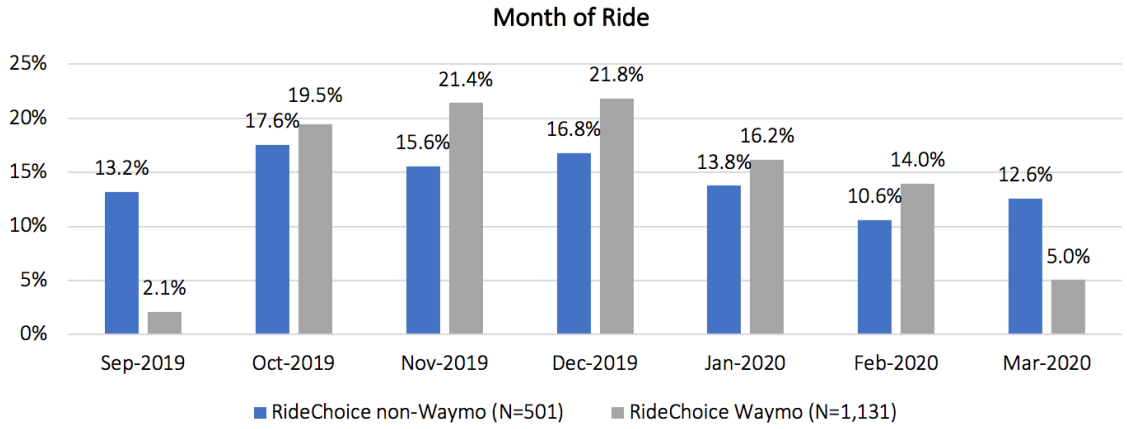


Figure 7-1

Month of RideChoice non-Waymo and RideChoice Waymo Rides

Although the frequency of Waymo rides declined in 2020, that pattern was not observed in terms of active users (participants who rode Waymo at least once in a given month) each month. Figure 7-2 shows that from January to March 2020, the number of active RC Respondents (Waymo) did not change substantially, even considering the effect of the COVID-19 pandemic in March, suggesting that Waymo remained a consistent travel mode for about 17 of the 30 participants who experienced Waymo. This supports the previous hypothesis of initial enthusiasm about riding Waymo, which eventually settled down to a steadier frequency.

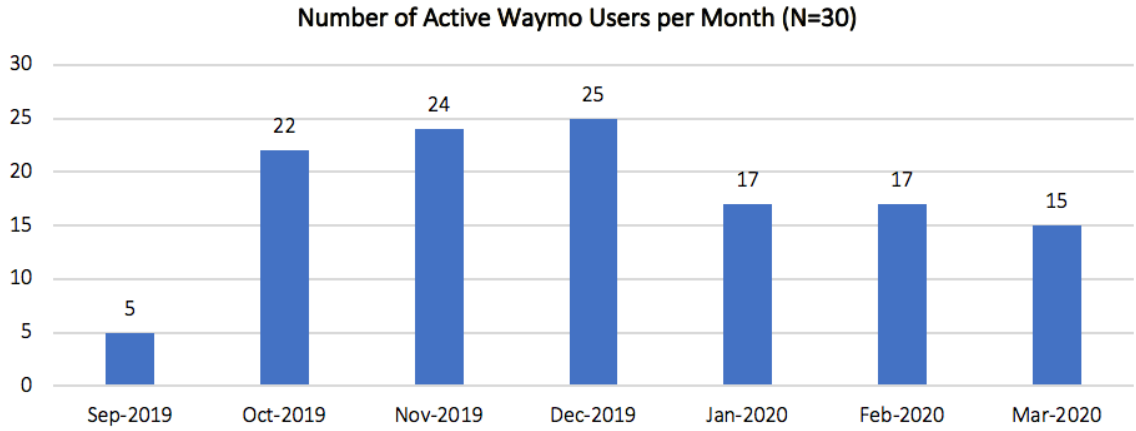


Figure 7-2

Monthly Number of Active Waymo Users

Although about 80% of the trips occurred during daytime (6:00 AM–7:00 PM), it was important to determine how frequently participants used different services in particular periods of the day. Figure 7-3 shows the hourly distribution of trips for each dataset. Interestingly, Waymo showed higher proportions of rides in the late-night to early-morning period (9:00 PM–8:00 AM) and exhibited peaks in the traditional AM and PM peak periods. This suggests that Waymo may have been used to a greater degree for work purposes (including night shifts). During the regular midday period, from 9:00 AM–3:00 PM, non-Waymo RideChoice options were used more frequently in both 2018/2019 and 2019/2020 periods of the study, suggesting that non-mandatory errands and personal business, social, and shopping trips were being taken through the non-Waymo services (possibly due to the need to reach destinations outside the Waymo service territory). Additional data, such as trip purpose, could provide more certainty about these hypotheses. Results from the focus groups, discussed in Section 8, provided some basis to suggest that these hypotheses are not without merit.

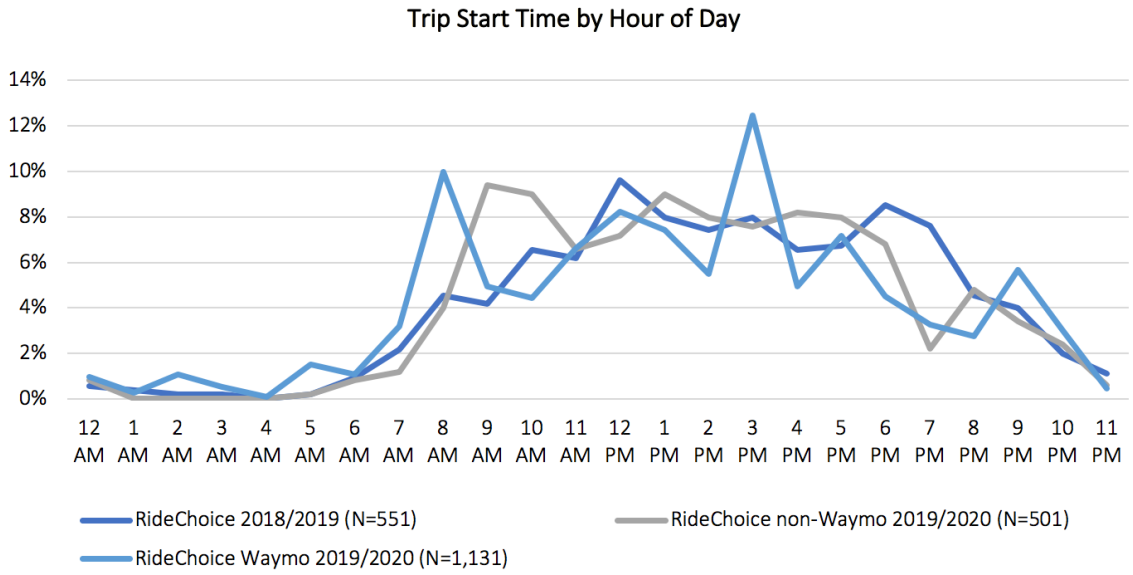


Figure 7-3

Distribution of RideChoice non-Waymo and RideChoice Waymo Trips

Level of Usage

Travel patterns were compared in terms of frequency of trips by users. Figure 7-4 shows that although participants in the RideChoice 2018/2019 and RideChoice Waymo datasets showed similar averages (39 and 38, respectively), the distribution of frequency of trips made by users was slightly different—the percentage of RideChoice Waymo rides was more spread out across frequency categories, with the plurality (30%) taking 1–5 rides. RideChoice non-Waymo rides in both 2018/2019 and 2019/2020 were more skewed in the first two categories, especially in the 6–30 rides category, in which both non-Waymo RideChoice datasets showed 42.9% of participants making 6–30 one-way trips.

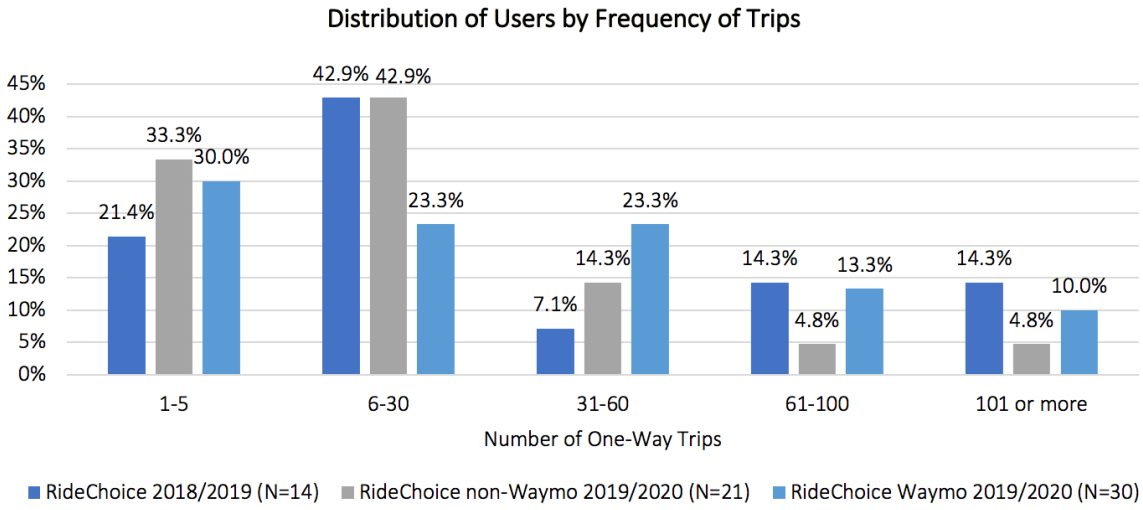


Figure 7-4

Frequency of RideChoice non-Waymo and RideChoice Waymo Trips

Measures of Impedance

Travel time was another attribute compared between datasets (Figure 7-5). RideChoice 2018/2019 showed shorter trips, at an average travel time of 8.5 minutes. During the demonstration, the averages for RideChoice non-Waymo and RideChoice Waymo travel times were 12.8 and 10.0 minutes, respectively. Additionally, it appears that Waymo was preferred over non-Waymo RideChoice alternatives for short rides—17.2% of RideChoice Waymo rides were shorter than five minutes, whereas only 6.2% of RideChoice non-Waymo rides were up to five minutes. Given Waymo territory limitations, such a low proportion of RideChoice Waymo rides being over 20 minutes was expected (only 1.7% of RideChoice Waymo rides).

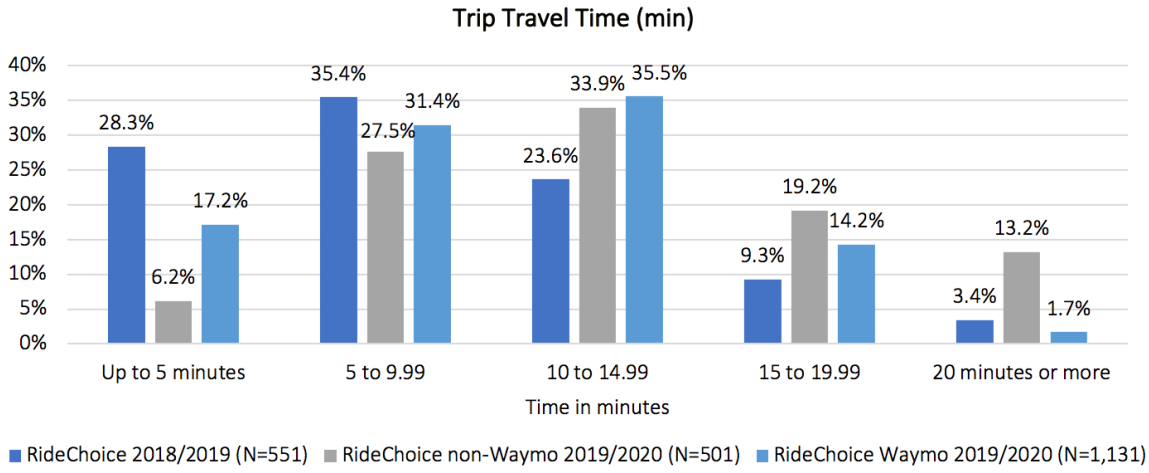


Figure 7-5

Travel Time Distribution of RideChoice non-Waymo and RideChoice Waymo Trips

Similarly, trip distances were analyzed in all three datasets. Figure 7-6 reinforces the previous patterns observed in travel time. RideChoice 2018/2019 rides were noticeably shorter—almost one third (32.1%) were up to one mile, whereas RideChoice non-Waymo and RideChoice Waymo had, respectively, 6.2 and 8.7% of their rides up to one mile. These trip distance averages support the hypothesis that rides in 2019/2020 were longer, as RideChoice 2018/2019, RideChoice non-Waymo, and RideChoice Waymo had averages of 3.3, 5.0, and 4.6 miles, respectively.

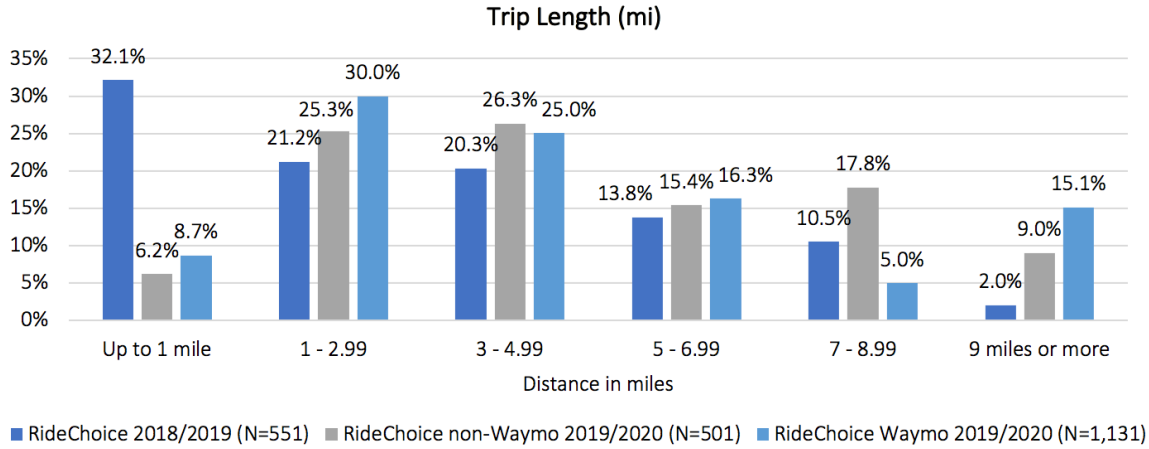


Figure 7-6

Trip Length Distribution of RideChoice non-Waymo and RideChoice Waymo Trips

Spatial Pattern of Origins and Destinations

Because all datasets provided spatial information for trip origins and destinations (with appropriate anonymization for privacy protection), the data were plotted on a map for a geographical visualization, as depicted in Figures 7-7 and 7-8. All three datasets showed that most trips were concentrated in Chandler; however, Tempe, Mesa, and Gilbert, for example, were also origins and destinations for a few trips. As predicted, RideChoice Waymo rides were constrained to the territory within which Waymo vehicles operated. Note that Waymo's trip origin/destination latitude and longitude information was snapped to the nearest intersection for anonymization purposes.

In the RideChoice program, participants pay a fixed fare of $3.00 for a ride up to eight miles. After this threshold, participants are charged extra for each additional mile. Because participants are aware of such policies, it is worth examining the patterns of those RideChoice Waymo rides over eight miles over the course of the demonstration. The number of rides over eight miles was substantial—187 of the 1,131 trip records provided by Waymo (16.5%). Of the 30 participants who experienced Waymo in the RideChoice program, 14 took at least one ride over eight miles. On average, the full unsubsidized cost for these rides was $17.50; however, participants paid only $3.00. The pilot project did not charge participants extra for additional miles, although they continued to pay the per-mile surcharge for non-Waymo RideChoice alternative service providers. Although all RideChoice Waymo rides had 10 minutes and 4.6 miles as average travel time and distance, respectively, the subset of rides over 8 miles showed 17 minutes and 10.9 miles as average travel time and distance, respectively.

Because the first dataset covered a different period from the other two, seasonality bias may have occurred when comparing them and drawing conclusions. To provide a more appropriate comparison, a subsample containing only the months of December, January, and February (common to all three datasets) were selected to control for seasonal variations. The results of this seasonality-controlled comparative analysis are provided in Appendix J.

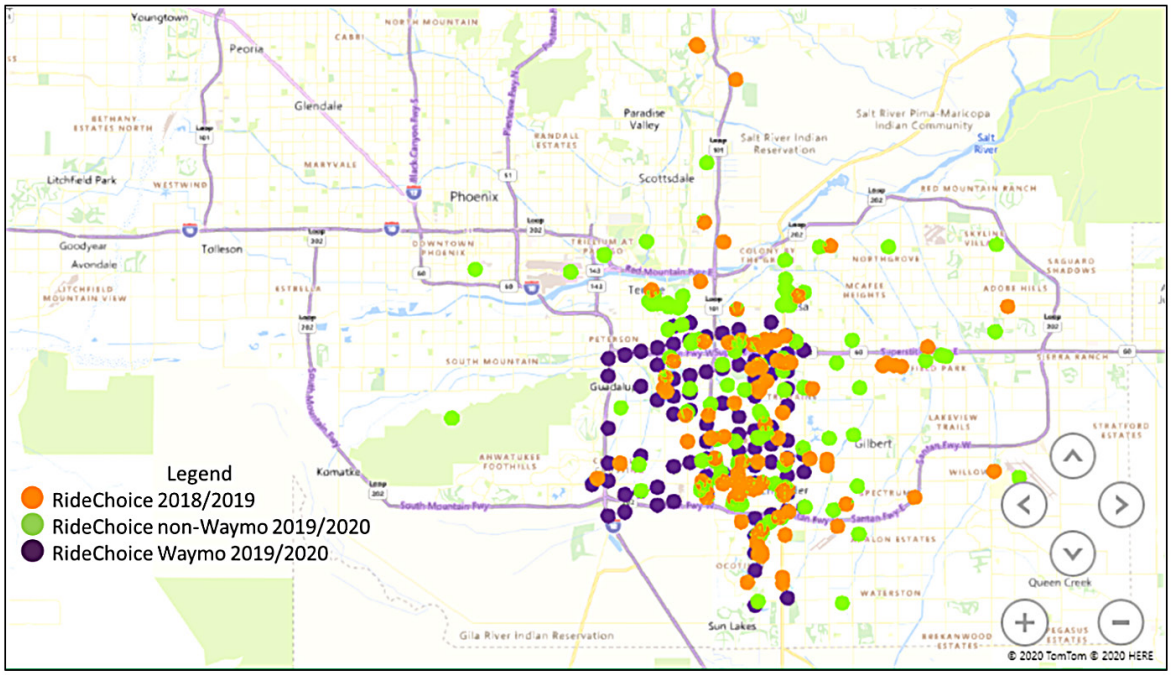


Figure 7-7

Origins of RideChoice non-Waymo and RideChoice Waymo Trips

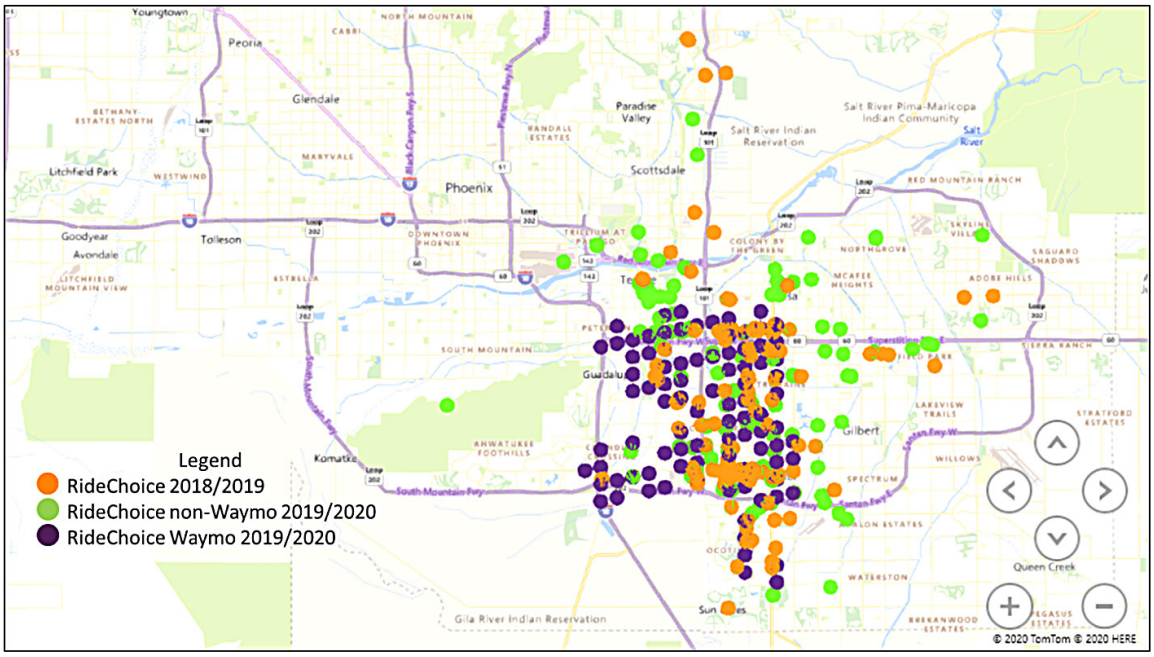


Figure 7-8

Destinations of RideChoice non-Waymo and RideChoice Waymo Trips

SECTION

8

Focus Group Results

In conjunction with the surveys noted in the previous sections of this report, researchers at the ASU Center for Smart Cities and Regions conducted a series of focus groups with users to capture a more in-depth qualitative analysis of user attitudes toward AV technology, experiences with the Waymo MOD service, and changes in travel behavior. These focus groups were conducted with both RideChoice users and Valley Metro employees who participated in an earlier phase of the study that allowed Valley Metro employees to use Waymo as a first/last mile transit solution.

Focus groups were also conducted with urban and transportation planners in jurisdictions around the Phoenix metropolitan area to understand better how cities are planning for AVs in their communities, the challenges and opportunities they face, what they can learn from the Valley Metro Waymo MOD pilot project, and what types of projects and partnerships would be helpful moving forward. In addition, a policymaker roundtable event was held with elected leaders in the Phoenix area who discussed the main issues and implications of the Valley Metro Waymo MOD pilot project on transportation policy in the region and identified possible future projects and pilot projects and next steps for Valley Metro and the region.

This section summarizes the results of these focus groups and the policy roundtable event. The subsections that follow include separate analyses for the rider focus groups, the urban and transportation planners or subject matter expert (SME) focus groups, and the policymaker roundtable. The final subsection concludes with a summary of key findings across all three components of the research (two focus groups and one roundtable) conducted by the ASU Center for Smart Cities and Regions on the Valley Metro Waymo MOD pilot project and provides some possible next steps.

Rider Focus Groups

The rider focus groups provided a qualitative analysis of rider experiences with AVs, their attitudes about this emerging technology, and how it changed their behavior. These focus groups supplemented the surveys conducted throughout the pilot project (Prior, During, and Post), which are the subject of the preceding sections of this report. Like the rider surveys, the focus groups were asked questions to encourage study participants to detail their experiences using the Waymo MOD service, how their attitudes about AV technology had evolved during the pilot project period, and how the MOD service and AV technology affected their travel behavior during the pilot project. The focus groups provided qualitative data that could not be collected through surveys alone.

Background

The rider focus groups comprised two main groups of users. The first group consisted of those in the RideChoice program who had previously been selected as participants in the pilot program. Participants enrolled in the MOD pilot were able to use the Waymo service as they would any other RideChoice option available in the Chandler/Tempe/Mesa/Phoenix service area and paid a flat $3.00 fare.[11] The 46 RideChoice users were contacted in April 2020 to gauge their interest in participating in a virtual focus group virtually via Zoom;[12] 20 users expressed interest. In May 2020, these participants were contacted again and invited to participate in one of two focus group sessions on May 27 and May 29, 2020, with 10 participants taking part—6 on May 27 and 4 on May 28—and each was compensated with a gift card for participation. Of the 10 participants, 2 were blind, 1 was partially blind, 1 was autistic, and 4 had a mobility limitation, including using a manual wheelchair and an electric wheelchair.

The second group included Valley Metro employees. An earlier phase of the partnership between Valley Metro and Waymo allowed employees of Valley Metro to use the Waymo MOD service to provide a first/last mile connection to public transit, which employees can use with their regular monthly transit pass.[13] This focus group explored the same general topics as the RideChoice focus group, but without focusing specifically on the RideChoice service component. Three Valley Metro employees participated in this focus group on May 20, 2020; they did not receive an incentive for their participation.

Focus Group Format

All focus groups were conducted via Zoom, which allowed participants to see and hear each other as in an in-person setting. This format generally worked well for each focus group with no major issues. The focus groups were scheduled for 90 minutes and consisted of three main sections and introduction and concluding sections. Each session had three researchers present—two moderators who alternated between sections and one notetaker. The three main sections each covered how a different dimension of the Valley Metro Waymo MOD pilot affected riders and closely mirrored the questions asked in the surveys (full focus group protocol in Appendix F):

- *Section 1 – Technology, Attitudes and Perceptions* asked questions about user thoughts, feelings, and perceptions about AVs, how these changed during the course of the pilot, what they liked and disliked about the technology based

[11] RideChoice normally has a base fare of $3.00 per ride and $2.00 per mile over 8 miles, but given Waymo's service area, a majority of trips would naturally fall within the 8 miles, so the pilot program used a flat fare for Waymo rides.

[12] The focus groups were initially intended to take place in person, but rather than delaying them during COVID-19, it was decided to hold them virtually.

[13] The first phase with Valley Metro employees served as a feasibility study before expanding to RideChoice riders; as a result, all rides taken by Valley Metro employees were covered by Valley Metro, not the individual rider.

on their experiences, and their thoughts about riding a fully driverless car without a Waymo-trained human safety operator.

- *Section 2 – User Experience of the Waymo MOD Service* asked users about their experiences using the Waymo MOD service. Riders were asked to talk specifically about their experience with Waymo and how it compared to previously-used transportation options available through RideChoice and other transportation options more broadly. Riders were also asked what they liked the most and the least about the Waymo MOD service and what would make them take Waymo rides more frequently. In the introductory section, riders were asked about one of their most memorable Waymo trips, which offered more insight into their experiences using the Waymo MOD service.
- *Section 3 – Rider Choice and Travel Behavior* explored how the Waymo MOD service affected riders ability to travel and how their travel behavior changed during the pilot. Questions were asked about how well Waymo met their mobility needs, why they chose to use Waymo over other options available, and how they anticipate using AVs in the future. In the conclusion, riders were also asked if they would continue to use Waymo if it was part of the Valley Metro RideChoice program.

Findings

Overall, riders had very positive attitudes toward self-driving technology and very positive experiences using the Waymo MOD service. This was fueled by a number of factors, discussed further below, and include an increased sense of safety, higher rider satisfaction resulting from more reliable rides and superior customer service, and increased mobility, in part stemming from an increased sense of independence. Similar findings were obtained from the surveys discussed in previously. Despite issues raised, users were eager to continue to use the Waymo MOD service.

Attitudes about Self-Driving Technology

Overall, users had generally positive opinions of AV technology, both before and throughout the pilot project period. Several were very aware of the advancements in AV technology and a few had signed up for the Waymo One[14] early rider program at their earliest opportunity. Some participants cited apprehension when they first saw Waymo AVs on public roads, being uncertain about whether they were safe to ride in or safe to drive next to. Similarly, some participants did not have complete trust in a computer doing the driving. Once they experienced the technology and had the opportunity to learn more about it, their perspectives changed completely. At the conclusion of the pilot, all participants missed the Waymo MOD service and hoped it would start again soon.

[14]Waymo One is a ride-hailing service powered by Waymo's self-driving technology and includes its commercial public service and an Early Rider Program, a confidential research group within Waymo One in which new features are tested and feedback is obtained that helps them learn and improve. https://support.google.com/waymo/answer/9207432?hl=en.

- "The first time I ever saw Waymo in Chandler I was like 'oh yeah, those are those driverless Google cars.' … It scared me to be in a regular car with those things running around the streets.… But then when I could no longer drive, and I was dependent on other types of transportation, … when I got the opportunity to do it through RideChoice … I was like 'Oh wow, this is fantastic!' When I started taking them, my whole perspective changed … and it kept getting better and better." *(RideChoice rider)*
- "I know that when it started, talking about a self-driving car, I was thinking … there'd be more accidents.… I know computers do great things, but they also have glitches. But dealing with Waymo has built my confidence because I have confidence in Waymo over other rideshare services. I look forward to this opportunity [of a driverless ride], to the point where I thought 'shoot, I have a driver again' but I really am excited to have my first true driverless experience." *(RideChoice rider)*

Riders also noted how significantly the technology improved during the course of the pilot program. Many participants noted that when they first started using Waymo, it drove like a teenager, but later they could not tell the difference between the Waymo vehicle and someone who had been driving for decades.

- "The technology and smoothness of the ride has gotten so much better. The very first time I rode [in] a Waymo vehicle, I would liken it to somebody who [is] an experienced driver but making very deliberate stops, as opposed to when it's a very smooth transition like it is now. It feels like you're riding with someone who's been driving for 20 or 30 years, whereas before it felt more like a newbie driver—very deliberate in its nature. But now I really couldn't tell the difference. If my eyes were closed, I wouldn't be able to tell it wasn't a human driver." *(Valley Metro employee rider)*

Waymo Service Experiences

All participants agreed that they felt safe using Waymo, both the safety of self-driving cars and of the service itself. As noted, all participants had positive attitudes toward self-driving technology and felt confident in its safe. The fact that over 90% of crashes are caused by human error was cited multiple times, and any initial unease with the safety aspect of the technology disappeared with continued use of it. A comparison was made in both RideChoice focus groups about not needing to worry about a ride-hailing or taxi driver not being a safe driver. Knowing this was not an issue when riding a Waymo made passengers feel safe. In one instance, a participant noted how he would constantly watch the driver and stress about being a passenger in a stranger's car, but with Waymo he was able to relax knowing the computer was doing the driving.

- "I have this feeling of trust that few drivers give me because the [Waymo] vans never tailgate—that's an absolute—and I've been in enough fender-benders to appreciate that. So just the safety and reliability…. Really happy with it…. I could trust not having to keep an eye on the driver the whole time." *(RideChoice rider)*

Multiple participants noted that they felt safe knowing that there was a human safety operator in the vehicle and a very responsive Rider Support service available in the event of any unforeseen issues. Additionally, there was comfort and safety knowing that the service was provided by a single company.

- "It is safer. Some of the features and functions that Waymo gives you that he [my son] likes—it's on an app and he knows when it's going to arrive. But the fact that it's Waymo and it's a company and if I put my son in that car I know where it's going, it's a corporation, it's not some individual, independent contractor, so the safety feature from that perspective is huge. I feel more confident putting him in the vehicle—huge win for us." *(Parent of RideChoice rider)*

Compared to other available options, particularly other RideChoice options that riders had used in the past, participant opinions of the Waymo MOD were extremely positive. Riders all liked that they did not need to schedule the ride in advance (as is the case with paratransit; RideChoice rides from other service providers, such as Uber and Lyft, were not required to be booked ahead). As one rider commented, "I like the spontaneity," meaning they like the fact they can decide to go somewhere without needing to plan hours or even a day in advance. Although other ride-hailing alternatives such as Lyft or Uber offer a similar ability to call up a ride when it is needed, half of the riders commented (and others agreed) that the Waymo vehicles would arrive much faster. As summed up by one rider, "They arrive very fast—there's a lot of coverage in my area, and that makes it very convenient in my area." This shorter wait time and knowing when a vehicle would pick them up and when it would get them to their destination made this service much more reliable for riders than other alternatives.

The ability to call up a ride at any time also added to an increased sense of independence among many riders. Aside from no longer needing to schedule a ride in advance or needing to ride with other passengers getting picked up or dropped off in the same area (as noted for ADA paratransit), Waymo MOD users felt that using the service freed them from feeling like a burden on family and friends. Many riders said that asking family or friends for a ride was their only option aside from paratransit, which put certain limitations on where they would go. As one rider said, "Where I'm at here in Chandler, there are no buses or things like that, so I have to rely on other people. And not having to ask family is the most awesome thing." This same issue was also raised by a Valley Metro employee rider in reference to his mother—"From her perspective, she doesn't like to drive in a lot of traffic. But she also doesn't like to be a burden on anyone."

The ability of this service to make riders feel more independent was one of the most positive aspects discussed in the focus groups.

On the issue of the Waymo human safety operator, riders generally liked not needing to interact with them. Many commented that it took getting accustomed to pretending that the human safety operator was not there, simply because their first instinct was not to ignore them. However, after this initial period of adjustment, many found it convenient to do other activities. Many users talked about how they felt more comfortable not needing to engage in conversation with the vehicle operator or worrying about getting a ride-hailing driver who was overly talkative:

- "Another part I like—there's a camera inside the Waymo car and I feel safe. I don't know the driver and I don't feel too comfortable riding in an Uber or Lyft; those drivers, sometimes they talk too much and that scares me. So, I would rather have Waymo with camera[s] everywhere. I don't need to talk to the driver. It's ok. I just feel safer in Waymo in that way." *(RideChoice rider)*
- "I'm not a big talker, so I liked the fact that I didn't have to talk to anyone." *(RideChoice rider)*

When asked about a fully driverless ride, however, feedback varied. Although many riders were enthusiastic and excited about someday receiving a ride without a Waymo trained vehicle operator (one rider had even already received one), others were less excited. The hesitation arose due to a sense of uncertainty about what they might do if something went wrong, a feeling that was shared by both groups of users (RideChoice users and Valley Metro employees):

- "I'm sure we're all going to have that anxiety the first time around [with a fully driverless ride]. We still have not had one. But then I think of all the times that I've already had drivers, whether it's Lyft or Yellow Cab or any other kind of transportation, who possibly may have been intoxicated while driving me, under the influence of marijuana or some other kind of drug – and that was quite obvious—and then I say I think my chances are still better off in a Waymo. In a nutshell, I love the transportation and I say I'm ready for it [a fully driverless ride]. My fear is that I'm not sure that everybody else out there who has not experienced it is." *(RideChoice rider)*
- "He [my son] wouldn't feel comfortable without an attendant. I think his anxiety and his condition—not that he wants to interact with the attendant, but he would feel awkward without somebody." *(Parent of RideChoice rider)*
- "It depends on the situation. It depends on the geographic area that I would be receiving the ride in. If it's in a metropolitan suburban area I'd feel very comfortable. I think once I would not feel comfortable is if it was a long-distance travel ride.… I would be worried about what happens if the vehicle breaks down? It gets a flat tire.… From a distance perspective I would feel a little more hesitant than if I was in a metropolitan or suburban area." *(Valley Metro employee rider)*

Even with the prevailing positive attitudes about Waymo MOD service, riders pointed out areas for service improvement. Many recognized that, despite giving rides to paying customers, Waymo technology was still in development stages; recognizing this, riders were likely more willing to accept "hiccups" along the way. Participants noted issues around pick-up and drop-off locations, trip routing, accessibility of the app and its usability, and accessibility of vehicles. Additionally, a few riders noted that it seemed that these issues got worse over time.

Riders frequently commented that pick-up and drop-off locations were not always accurate or consistent. For example, there were instances cited of a pick-up or drop-off occurring across the street from a rider's home as opposed to directly on their property curbside. Although this is not necessarily an issue for riders without disabilities, it was a challenge for the riders who are mobility-challenged or are visually impaired.[15] Many riders commented about and liked the app's "honk" feature, where a button can be pushed to make the vehicle honk so riders can find it. This is particularly useful for riders who are visually impaired, but a problem can arise when the vehicle is across the street and the person cannot see traffic that may be approaching.

- "I had one [ride] where I wanted to go to Home Depot, but it dropped me off at the Wendy's in front of the Home Depot—but that's a huge parking lot—so when I got out, I had no idea where I was. Driver support was able to actually call back a whole new vehicle to pick me up and actually take me to the door of the Home Depot." *(Visually-impaired RideChoice rider)*

Many riders also commented on how the routing of many trips did not always appear to be the most efficient path. For the most part, this was a minor inconvenience, but in a couple of more extreme instances, it resulted in what should have been a 10-minute trip taking more than 30 minutes.

A few riders discussed the accessibility of the app itself. Many found it easy to use and easy to simply drop a pin where they wanted to go and be able to track the vehicle as it approached. These features were less useful for visually-impaired riders, who commented about how, over the course of the pilot period, the app seemed to become less accessible.

The accessibility of the vehicle itself was noted by several riders and presented a challenge for riders with mobility limitations. In particular, two riders who sometimes needed to use wheelchairs experienced issues. In one case, when a power wheelchair was needed, the Waymo vans were completely inaccessible. In this instance, Waymo Rider Support would have called a WAV for the rider to ensure access to mobility services. In another instance, the rider was required to put his wheelchair in the main part of the van instead of the rear cargo area,

[15]Waymo does offer an accessibility setting to address this scenario.

which he said would have been much easier. Other riders also experienced some difficulty getting in and out of the Waymo vehicle (Chrysler Pacifica minivan), but similar difficulty with other types of vehicles was not mentioned.

Overall, riders were all happy with the service. Those who needed to use Rider Support for a number of different reasons, including some instances mentioned above, all commented that it was almost always able to address their concerns, which added to their level of satisfaction with the Waymo MOD service.

Rider Mode Choice and Travel Behavior

About half of riders in the demonstration program indicated that they felt that they went more places because the Waymo MOD service was so convenient. This feeling was corroborated by the rider survey, which showed RideChoice riders making more trips after introduction of the Waymo MOD service. Many riders attributed taking more trips to their increased sense of independence, as noted above, even though the Waymo option did not offer any trips that could not have been made by traditional RideChoice options. This increased sense of independence empowered them to go more places than previously simply because they felt they no longer needed to burden friends or family. Additionally, they could use the service within just a few minutes of hailing a ride and, as a result, took more trips.

- "Waymo gives me more choice of time than riding with my teenage daughter. I have my mom that could take me, but I feel like I was imposing. If there was a way that I could do it myself, so I chose to push myself to use a different way—a more independent way—but also a way that I was comfortable with and felt safe and didn't have to worry about having to share a ride with someone." *(RideChoice rider)*
- "Having this opportunity for me does let me go more places. Typically, my day would be if I left home it would be to the doctor. The idea of a day that I don't need to interact with someone – I do go more places. I feel more freedom." *(RideChoice rider)*

Many riders cited cost as being another reason they used it as much as they did. A fixed-cost per ride was a significant benefit. Riders were split on whether they would keep using it as much if Waymo MOD service was no longer part of the RideChoice program; some said they would if it was still affordable, although they did not provide a specific opinion on affordable pricing. Others said they would still pay for it even if it cost more because it was the best option available.

- "I'd probably use it less frequently if it wasn't part of the RideChoice. But no, let's say my dial-a-ride does leave me; it would be awesome to have that option just to hop in the Waymo vs. waiting around for a cab or whatever to pick me up. But I'll probably end up using it with or without RideChoice." *(RideChoice rider)*

Riders discussed how they liked the ride-hailing aspect of the service, and not needing to own a car may be enough to offset costs associated with the service as their sole form of transportation. Riders from the RideChoice and Valley Metro groups speculated about the possibility of giving up car ownership or a second family car if a service such as this was widespread throughout the region and affordable.

The most-cited barrier riders gave for not using Waymo MOD service more was the size of the service area. As all RideChoice riders lived within Waymo's service area, they frequently used it for trips within that area; going outside that area required using a different mode of transportation. Many were hopeful the service area would expand and they would be able to go to more places. This sentiment was also shared by Valley Metro employee riders, several of whom do not live in the service area. Feedback from both groups consistently indicated that if it was in their area and went to more places, they would use Waymo MOD service more frequently than they currently do.

Key Takeaways

RideChoice riders experienced an increased sense of safety and independence. All riders felt that the AVs were safer than other drivers, especially drivers of other rideshare services. Riders felt safe knowing that they were dealing with a company's fleet and trained vehicle operators, as opposed to individuals with their own cars. RideChoice users experienced an increased sense of independence with Waymo MOD service, stating that they no longer needed to rely on family or friends to give them rides. This resulted in their use of Waymo MOD service more frequently and going places they might otherwise not have. Related to this sense of independence, riders liked the ability to hail a ride from Waymo MOD service whenever they wanted instead of needing to schedule rides hours or even days in advance.

Waymo MOD provided better service than existing RideChoice options. There was general agreement among RideChoice riders that Waymo MOD service provided far better service than other modes of transportation that participants previously had available to them, including bus, paratransit, taxi, or other ride-hailing services. Wait times were shorter, vehicles were cleaner, and there was no need to book a vehicle hours or days in advance. Using Waymo's app, riders could see where the vehicle was and know exactly when it would arrive. Riders mentioned several recurring issues, such as with pick-up and drop-off locations, accessibility of the app and Waymo vans, and inefficient routing. Despite these issues, riders were still very satisfied with the service and commented frequently that Rider Support was always available to address any problems they had, which added to the high quality of service.

Riders liked ride-hailing, but not necessarily the idea of sharing a ride with strangers. A majority of riders from the RideChoice and Valley Metro employee groups preferred the ride-hailing model of transportation that Waymo

MOD service offered. Many liked the ability to hail a ride and the possibility that this type of service may allow them to give up personal car ownership or provide a service they can use if they are unable to drive due to age-related causes. With Waymo MOD service, most riders liked not needing to interact with the driver and said that would be another benefit of the rides being fully driverless.

What was less strong was a preference to share a ride with a stranger, consistent with the findings from the surveys. Many riders had shared rides either with paratransit or ride-hailing service. In some cases, this made the service less convenient, as they would pick up and drop off other passengers along the way, making a trip take longer. In other instances, it was simply a preference for not wanting to share a ride, which was related to the preference for not talking to other people, whether it be the driver or other passengers.

Riders were eager to use Waymo to go more places and to do so without a human safety operator. All participants were eager for Waymo MOD service to start up again after it paused its service in March 2020 during the COVID-19 pandemic. Many riders looked forward to continuing to use the service and planned to use it more as the service area expanded. This was one of the only limitations as to why riders were not using the service more frequently. Likewise, riders were in general agreement in their excitement to ride in a Waymo vehicle with no trained vehicle operator. Some hesitation was cited, but many felt that, just as they became comfortable with the AV technology with a trained vehicle operator who was there only as back-up, they felt that they would similarly adjust to riding in fully driverless vehicles and looked forward to the opportunity to do so.

Subject Matter Expert Focus Groups

Early in the development of the Valley Metro Waymo MOD pilot project, the project team decided that in addition to understanding how the MOD service and AV technology affected Valley Metro transit users and what the potential long-term benefits of AV technology might be for Valley Metro, it would be useful to understand the implications of the MOD pilot project, and AV technology more broadly, in Phoenix area cities. In particular, the goal was to understand better how Phoenix area cities were able to learn from the Valley Metro pilot project and what insights they offered as the region plans for this emerging technology together. To do this, two focus groups were conducted with urban and transportation planners (subject matter experts, SMEs) in Phoenix area municipalities, and a policymaker roundtable was also held.

Background

The research team conducted the SME focus groups on July 6 and 7, 2020. Representatives from each City and Town that are part of the Valley Metro service area (17 plus Maricopa County) were contacted. In total, between the

two sessions, participants from 12 of the 18 jurisdictions joined, with a total of 27 participants. On July 6, 12 participants joined from Mesa (4), Chandler (1), Glendale (1), Tempe (2), Peoria (2), and Buckeye (2). On July 7, 15 participants joined from Phoenix (4), Surprise (2), Avondale (2), Goodyear (3), El Mirage (2), and Maricopa County (2).

Focus Group Format

Each focus group lasted 90 minutes and took place virtually on Zoom. As with the rider focus groups, the SME focus groups were broken into three main sections and introductory and concluding sections. These sections were determined in collaboration among the ASU research team, Valley Metro and Waymo to understand how cities are planning for AVs and the benefits of pilot projects and mobility partnerships as tools for planning for AVs. The focus group protocol is provided in Appendix G. The three sections were as follows:

- *Section 1 – Transportation, Mobility and Autonomous Vehicles* asked participants to discuss how their local jurisdictions were planning for AVs and how AVs fit broadly into their plans for public transportation and mobility. Local jurisdictions were asked to talk about what efforts they have taken to date (if any) to plan for AVs, about opportunities and challenges their communities face in planning for AVs, and how they have or might engage the public in regard to AVs.
- *Section 2 – Pilot Projects* dealt with how pilot projects might help local jurisdictions plan for AVs. It was developed with the idea that priorities for and approaches to pilot projects may vary between local jurisdictions and regional agencies such as Valley Metro. Questions were asked specifically about the Valley Metro Waymo pilot project and what elements of this pilot were most useful to local jurisdictions. Participants also were asked about other types of pilot projects that jurisdictions may be interested in seeing in the region or developing themselves and if any barriers to developing pilot projects exist in their communities.
- *Section 3 – Mobility Partnerships* explored the role of partnerships in planning for AVs. This was included because the partnership between Valley Metro and Waymo was a key component of the current project and the project team felt it was useful to understand better how local jurisdictions were thinking about what their relationships with AV companies would be as the technology continues to be tested and deployed. Participants were asked what partnerships with AV companies might look like in local jurisdictions and what barriers, if any, exist in developing these partnerships.

The focus group concluded by asking each jurisdiction what types of information would be most useful to their community to advance their efforts in planning for AVs in the Phoenix region.

Findings

Transportation, Mobility, and AVs

Participants identified several key transportation issues that were important and relevant for thinking about the future of AVs in the Phoenix region.

First was an overarching perspective that the region needs better public transportation and should be thinking about how AVs might be able to help communities improve existing transit service. The two groups discussed key points around how AVs might lower the costs associated with providing transit service and were keen to understand from the Valley Metro Waymo MOD demonstration if this service achieved that, particularly within the context of paratransit. The MOD pilot project was considered by many participants to be a great example of how to use this new technology to meet existing transportation challenges, and participants were eager for more detailed results from the pilot project.

The discussions also touched on how to use AVs to address first/last mile challenges in many communities; some that have invested in light rail and other high-capacity corridors were particularly interested in this.

Participants also thought about how AVs might help with the challenges communities face in providing transit service to lower-density areas of their cities. Many participants commented how transit was good in parts of their cities, particularly in downtowns and other more built-up areas, but that they struggled to provide affordable service in lower-density areas and outlying neighborhoods farther from the center of town. Many participants commented that investment in light rail does not make sense in these areas, and expanded bus service is not always cost-effective, but a lower-cost alternative and smaller capacity AV potentially could fill this need.

These points indicate that there was a lot of interest, generally, in AVs and about how the technology may help local communities improve transit and mobility. However, many participants cited not knowing enough about the technology, uncertainty about infrastructure needs, and what types of investments might be required by cities. A couple of participants also showed a strong desire to wait for further State or federal guidance on AVs before undertaking their own planning efforts, citing that they think there are many unknowns at this time.

Pilot Projects and Mobility Partnerships

A number of ideas for pilot projects in the Phoenix area emerged from the focus groups. Generally, pilot projects were seen as a good way to engage the public in the topic of AVs, get feedback about particular use cases, and enable people to begin to feel more comfortable with the technology throughout the region. Given the general interest in expanding public transportation opportunities in many communities, many participants showed interest in AV shuttle pilots to serve residents and connect them to activity centers such as downtowns, the

ASU main campus in Tempe, and sports complexes (Mesa and Peoria). This was spurred by an interest in an unrelated Peoria AV shuttle pilot (Robo Ride) that was operating in early March 2020. Several other communities mentioned that they had looked into developing AV pilots; many indicated that the capacity of those shuttle vehicles (8–12 people) may be a good size for addressing the high cost of transit in low-density parts of their cities and could be an opportunity for a pilot project.

Several communities showed interest in expanding the RideChoice pilot conducted in Waymo's service area, which encompasses parts of Chandler, Mesa, Phoenix, and Tempe. In regard to public transit, many participants discussed the high cost to provide paratransit service in their communities and interest in whether expanding Waymo's service to other communities was in the works and if that or something similar could help communities lower the costs associated with paratransit, especially if it meant providing a superior service option to their residents. To this end, a couple cities mentioned they had partnerships or were exploring partnerships with other ride-hailing services such as Lyft or Uber, but that AV ride-hailing would be considered if it was available.

There was also interest in pilot projects that specifically looked at understanding better what the infrastructure needs of AVs might be (e.g., sensors, roadway configurations, facilities for charging electric vehicles or vehicle service and maintenance). It was widely agreed that cities will be required to invest in providing infrastructure for AVs, but that there is too much uncertainty about the overall direction of the technology to make sound investments at present. Small-scale pilots designed to find low-cost infrastructure requirements could be a useful approach for any AV pilots carried out in the region.

Participants identified several barriers that were useful starting point for what a successful pilot project might offer and what unknowns need to be addressed. These included uncertainty about costs and who would pay for pilot projects, uncertainty about how multi-jurisdictional pilot projects might work, uncertainty about how to work with private companies, particularly on issues involving proprietary technology and/or data, uncertainty about the rules and regulations for procurement of AV transportation services, and logistically being able to identify areas best-suited for AV pilot projects based on the current level of technology (i.e., low-speed shuttle vs. ride-hailing) or on need and what populations or areas of the city may be best-served by this emerging technology and truly benefit from a pilot project.

On the topic of partnerships, there was a lot less clarity on how these might work in a way that is advantageous for all partners while providing a meaningful service. There was some concern over high turnover of companies in the broader mobility and technology space (not just AVs) and if cities partnering with the AV industry could help ensure more consistent service to their residents. The discussion also included infrastructure, both in terms of what industry might need from cities and how the AV industry might be able to help cities that are already

struggling to keep up with maintaining their existing roadway infrastructure. Although partnerships with major employment or activity centers were discussed as a possibility, there were unknowns around partnering with AV companies to deliver mobility services.

Key Takeaways

Develop pilot projects that explore ways to enhance public transit service and identify infrastructure needs. Both SME focus groups discussed how to use AVs to enhance public transit service, recognizing that they face numerous challenges in expanding current systems (both bus and light rail) as well as circulator systems that many Valley cities operate independent of Valley Metro. Participants were particularly interested in exploring how AVs may enable them to connect lower-density areas of their cities that are farther away from their downtowns and other activity centers to the rest of the city. There was a lot of interest in the possibility of AV shuttles possibly filling this need. They were also seen as a way to expand the availability of AVs beyond Waymo's existing service in the East Valley. There was equal interest in whether Waymo could expand to other areas of the Valley and expand its current MOD pilot project to other communities, either by expanding its current service area or leapfrogging to other areas of the Valley such as the West Valley.

There was also a lot of interest in making sure that AV pilot projects helped communities understand better the infrastructure needs that would be required. This would help them consider the types of projects they could fund based on current and future levels of funding. Participants also discussed the benefits of using pilot projects to engage the public on AVs. A public meeting can only achieve so much, but giving people the opportunity to experience the technology first-hand was of interest, as was finding more ways the AV industry and the public sector could share responsibility for engaging the public.

Address uncertainty at a regional level. One of the key barriers that emerged from these two roundtables for planning for AVs was that there remains a lot of uncertainty about the technology and deployment that needs to be addressed in a more robust and regional way. Barriers discussed included uncertainty about how and when the technology would be deployed across the region; costs to cities related to conducting pilot projects, providing service, or investing in infrastructure; uncertainty about what the state or federal government might do in terms of regulation; and numerous obstacles about how local communities might work with industry partners to provide meaningful transportation improvements to their residents.

Policymaker Roundtable

The final component of the work conducted by the ASU research team at the Center for Smart Cities and Regions was a policymaker roundtable. ASU researchers convened Valley Metro Board members with two goals in mind—to

share some of the preliminary findings of the MOD pilot program and to engage them in a conversation about the implications of the Valley Metro Waymo pilot project and possible next steps that could be taken by Valley Metro, local jurisdictions, and industry partners. Participants for the roundtable were identified by Valley Metro and were members of the Valley Metro Board of Directors. Seven Board members participated, representing both large and small jurisdictions throughout the region. There were also numerous participants from ASU, Valley Metro, and Waymo that joined the roundtable as observers.

Roundtable Format and Agenda

The policymaker roundtable was held on July 8, 2020, and took place virtually on Zoom for 90 minutes. The roundtable was divided into four parts—an introduction and overview of the MOD pilot project and the partnership between Valley Metro and Waymo, a presentation of results from the rider surveys and the rider focus groups, a discussion about the Valley Metro Waymo MOD pilot project and AV planning more generally, and closing comments where questions were asked about possible next steps. The roundtable protocol is provided in Appendix H. The discussion component of the roundtable was divided into three sections:

- *Section 1 – Implications of the Valley Metro Waymo MOD Pilot Project* asked participants to consider what the pilot project meant for Valley Metro and for transportation policy in the region more generally and some of the main issues it raised for them.
- *Section 2 – AVs in Public Transit* asked participants to discuss how they envision AVs interacting with public transit in the future and what types of pilot projects they may be interested in seeing developed in the Phoenix region.
- *Section 3 – AVs in Phoenix Area Jurisdictions* asked participants to discuss their jurisdiction's thinking about AVs and how local planning for AVs can align with regional efforts. They were also asked broadly about the types of transportation issues they would be interested in seeing AVs address.

The roundtable concluded by asking about possible next steps that Valley Metro and the region could take in their efforts to plan for AVs and what type of information would be most useful for them in their role as decision makers.

Key Takeaways

Several key issues emerged from the roundtable discussion that will help the region think in greater detail about how best to plan for AVs. Generally, there was a lot of interest in the Valley Metro Waymo MOD pilot project and in seeing how it could be expanded. There was also a lot of interest in exploring other use cases for AVs, and several important issues were raised.

Explore additional use cases. A key point in the roundtable discussion was a desire to explore other demonstration projects for AVs in the Phoenix

area. Participants were generally pleased with the Valley Metro Waymo MOD pilot program and wondered how easily this service could be expanded. It was pointed out that on-demand transportation requires extensive mapping of a neighborhood before service can start. It was discussed whether this was the right fit for every community in the near-term, although there was uncertainty about how quickly Waymo might expand its service area.

AV shuttles were brought up as a possible alternative due to their larger size. Several participants commented that for transit, a 4–5-person AV might not make the most sense in a lot of places, but also recognized that a full-size bus might not make the most sense either in many parts of the Phoenix area. Medium-size shuttles, similar to circulator buses or trolleys that many cities currently operate, could be an alternative use for AVs. An example of this is the AV shuttle that operated briefly in Peoria (Robo Ride) (see https://www.peoriaaz.gov/government/departments/public-works/transportation/autonomous-shuttle). These types of vehicles offer a mid-size vehicle that seats 8–12 passengers, which could make it a good option to explore in the future. One participant mentioned how his community was having conversations about their circulator system and that AV shuttles could be part of that conversation moving forward. There was a particular interest in these types of projects, as they could be deployed on existing fixed-route circulator routes and be less dependent on Waymo to expand its service area before deploying AVs for this use.

In general, the conversation was supportive of exploring a variety of other demonstration projects as long as they met two criteria—1) the goal should not be to replace existing transit, but to find ways to complement it with new uses, and 2) within the context of transit, AV technology should enable first/last mile connections to existing transit, particularly to high-capacity transit corridors. It was pointed out that as the region continues to grow, improving the first/last mile connections will be a critical goal that will help ensure that transit remains a viable mode of transportation for the region. Also raised was the overall benefit of deploying AV technologies around the Valley as a way of people getting familiar with the technology and experiencing it, which was identified as a critical component of these early planning efforts.

Who pays for AV projects? A second key discussion point related to funding of AV projects. This was raised within the context of the next regional transportation plan and the potential need to allocate money for AV projects and to identify corresponding projects within that framework. Valley Metro staff noted that funding was critical and that it should not take funds away from existing service to fund AV pilot projects; Valley Metro would instead pursue grant opportunities, either on its own or with local jurisdictions as opportunities became available. Valley Metro has also been advocating with Maricopa Association of Governments (MAG) to explore opportunities to create a dedicated regional fund for local jurisdictions to conduct pilot projects, possibly as part of the next regional transportation plan funding.

Data-sharing. The issue of data-sharing came up within the context of transportation issues and whether efforts were being made to develop an app that would enable residents to access multiple modes (light rail, bus, Waymo, rideshare, e-scooters, etc.) in one platform instead of multiple apps. Although there is no regional effort to do this, the City of Phoenix is leading this effort, and the technology will be used regionally. For Valley Metro's part, they make all their bus location data available and have an application programming interface (API) so a third party can access and use those data. This expanded into a discussion about ensuring that future pilot projects and partnerships develop data-sharing agreements that facilitate the collection, sharing, and use of data among Valley Metro, Cities, AV service providers, and other potential partners.

Collaboration and coordination among jurisdictions. The final key discussion point in the roundtable was on coordinating and collaborating on planning efforts for AVs throughout the region. Over the next few years, MAG is developing the next regional transportation plan, and there is a need to engage with MAG to ensure that local issues and priorities for AVs are leveraged at the regional level. The need to engage with MAG was seen as beneficial in the future to address efforts around both project planning and as a possible funding source for AV pilot projects.

The need for collaboration and more regional conversations emerged out of an acknowledgement that current efforts are not highly coordinated, and knowledge about different projects is not necessarily widely known. Although efforts to do this are being made, such as through the Institute of Automated Mobility, a State-level initiative to advance planning for AVs statewide, many different actors are working in this space. For example, at ASU, numerous faculty are working on different aspects of AVs, but there is no single person or entity to go to learn about all these efforts. The need for a more effective platform of information-sharing was made more apparent by the lack of knowledge by roundtable participants of the Peoria AV shuttle pilot that operated for about three weeks prior to being stopped early due to COVID-19 considerations.

One suggestion to advance further regional collaboration was to expand on the smart region efforts being led by ASU by creating a smart region subgroup on transportation. Whatever the forum, it was agreed that conversations such as the roundtable were useful for participants in the public and private sectors and that it is important to have active and continuing dialogues so the region can best advance its planning around AV mobility.

SECTION

9

Conclusions

This report documents the results of a six-month demonstration project, with the evaluation funded by FTA, to provide self-driving vehicles within a program of transportation services provided for ADA paratransit-certified people with disabilities and older adults age 65 and over who reside in participating communities in the Phoenix metropolitan area (Valley Metro RideChoice program). The self-driving vehicles (Fiat Chrysler Pacifica hybrid minivans) were provided and operated by Waymo as part of Valley Metro's RideChoice program and were operated in an area of about 100 square miles during the demonstration project. As part of the MOD grant, Valley Metro and Waymo agreed to have Waymo added as a certified mobility provider in the RideChoice program for RideChoice participants living within the Waymo territory.

The project team partners worked collaboratively to define research questions stemming from shared project goals to guide the research evaluation methods and project outcomes. The research questions helped to identify data needs and guided the collection of data. The ASU TOMNET Transportation Center assisted this effort by deploying surveys on three occasions—one before the AV MOD service began and two during and after AV MOD service was provided. Before the first of these surveys, an Expression of Interest survey was conducted to recruit a sample for the following three surveys; it was hoped that those identified in the Expression of Interest survey would respond to all three subsequent surveys. The latter two surveys were conducted using subsets of respondents to the Prior Survey. The Prior Survey was deployed in September 2019 and 51 valid responses were collected. The During Survey was deployed in March–April 2020 and 35 valid responses were recorded. The Post Survey was conducted in May–June 2020 several weeks after the Waymo pilot ended and had 39 valid responses. It is important to note that the samples for these surveys were not random samples; the initial sample obtained for the Prior Survey was a self-selected sample of people determined to be eligible for Waymo service and who responded to the Expression of Interest. The samples for the During Survey and the Post Survey were subsamples of the Prior Survey sample.

In addition to these surveys, the project team conducted two focus groups and a policymaker roundtable to provide further insights into the project.

Conclusions are presented in two ways—conclusions that are directed, as far as possible, at the research questions posed in the beginning of this work, and conclusions based on the surveys conducted.

The following conclusions were drawn from the data described in this report. Again, it must be kept in mind that the samples are not representative, so the

findings apply only to those who participated in the various data collection efforts. Additionally, other limitations were observed in this demonstration, such as small sample sizes in some analyses; the nature of self-selected participants, which could result in biases when answering some questions; the understanding that the study would last six months only, potentially impacting user usual travel patterns; and the unprecedented COVID-19 pandemic impacts at the end of the study.

Conclusions on Research Questions

Research Question 1

How can Valley Metro reduce costs to serve ADA paratransit customers but improve convenience and service to the paratransit customers?

- Evaluate impact of subsidizing AV MOD service.
- Evaluate AV MOD trip lengths and costs within the RideChoice program.
- Evaluate how AV MOD trip costs compare to competing modes or service providers (TNCs, taxis) within the RideChoice program.

With respect to these questions, the surveys did not provide any answers from the viewpoint of Valley Metro. In general, users of the AV MOD service were satisfied with the convenience and service offered and indicated that it was generally considered better than the traditional choices available to them. From the viewpoint of the respondents, most felt that Valley Metro's RideChoice was affordable, and most expected to pay within $3.00 of the cost of traditional RideChoice services for using the AV MOD service. Trip lengths for users were somewhat longer on Waymo, although this may have been a result of the lower cost of these trips to the user, because the additional charges for trips over eight miles were not imposed on Waymo users.

Research Question 2

For RideChoice customers, does having access to on-demand, self-driving cars alter transit (i.e., bus, light rail) usage?

- Identify changes in travel demand for transit and MOD AV service
- Identify rates of adoption, active use, and occasional users for transit and MOD AV service.

Use of light rail was almost unchanged at around 4–5%. Use of bus declined from around 12% to 7%, but part of this decline could be attributed to the COVID-19 pandemic. Use of the AV MOD service was higher than for traditional RideChoice travel options, which, again, may have been due to the lack of a limit on the number of rides that could be taken on the AV MOD services compared to traditional services.

Research Question 3

What value can on-demand, self-driving car service provide to people who currently do not have access to or may not have the ability to use transit?

- Document RideChoice customers' perception of value added by MOD AV service.

This question was not addressed by the surveys, so no conclusion can be drawn.

Research Question 4

Can adding on-demand, self-driving cars to the RideChoice program help Valley Metro make progress on project goals?

- Evaluate the changes in attitudes and awareness of AV technology and MOD services before and after use of MOD AV service.
- Evaluate the change in individual use of RideChoice and paratransit.

Noting that the AV MOD service was offered with a safety operator on board, only limited conclusions can be drawn on this question. Awareness of AV technology appeared to be impacted somewhat by the demonstration project. The very small percentage of respondents who had never heard of AVs was not present after the Prior survey, and those who had heard of AVs but were not familiar with them declined somewhat. Respondents who used Waymo services showed only slight changes in their perceptions and attitudes to AV service (as discussed in Section 7), and respondents who did not use the Waymo services showed somewhat larger increases in favorable attitudes to AV MOD services. There was no increase in expectations to use AV MOD service in the future by those who used Waymo services.

Research Question 5

Does having access to on-demand, self-driving cars improve RideChoice customer perceptions of safety and/or the overall customer experience?

- Identify concerns or barriers before and after use of MOD AV service.
- Identify the attributes of MOD AV service and technology that improve travel experience, access, and convenience for a subset of eligible ADA paratransit customers.
- Evaluate MOD AV service effectiveness and attractiveness compared to other modes and service providers serving RideChoice customers (e.g., taxis, TNCs).

Perceptions of the safety of AV MOD services showed a marked improvement for users of Waymo service, who also considered AV MOD services to be much safer than traditional RideChoice services. The surveys identified some barriers in the Prior Survey, but these were not queried in the During or Post surveys. Overall, 65–85% of respondents who used Waymo agreed that AV MOD service

would make travel easier and less stressful. However, a barrier identified was the need for assistance in boarding and alighting and in loading and unloading packages, which services with no human present would be unable to assist. On the positive side, the ability to book AV MOD rides through a phone app was considered to be a major advantage, as was the fact that there was not a need to book in advance as with traditional RideChoice options. Overall, respondents who used Waymo rated the service as better than any of the other modes and service providers.

Research Question 6

How does on-demand, self-driving car service improve access and mobility options for older adults in the low-demand or hard-to-serve transit markets?

- Identify changes in trip generation, mode choice, and time of day travel for transit and MOD AV service.
- Document rider accessibility needs and level of accommodation offered by AV MOD service by tracking accessibility feature use (e.g., screen reader, screen magnification, cane, seeing-eye dog).
- Evaluate trips taken in areas served and not served by transit or ADA paratransit services.
- Document activity centers or areas of interest currently not served by transit, paratransit, RideChoice, and/or MOD AV services.

In terms of trip generation, respondents who used Waymo made more trips on Waymo vehicles than those who used other RideChoice options such as Uber/Lyft and taxi. Respondents also reported an expectation of making more trips when AV MOD services become a permanent part of RideChoice options. Regarding time of day, respondents who used Waymo made more trips in the evening and overnight than those using traditional RideChoice options, and respondents reported that they felt greater personal safety using Waymo than traditional RideChoice options. The other sub-questions in this research question were not addressed by the research, partly as a result of the limited territory in which Waymo rides were offered.

Demographics

- Survey respondents tended to be younger than general participants in the Valley Metro RideChoice program.
- Respondents who answered the During and Post surveys showed differences between respondents and non-respondents based on the Prior Survey, particularly related to employment status, student status, and occupation.
- Those who did not use Waymo during the demonstration project (RC Respondents [non-Waymo]) were generally older than the RC Respondents (Waymo), predominantly male, came from larger households with more

vehicles, were more likely to live in a stand-alone home, were more likely to live in a gated community, were not currently working, had a higher proportion of students, had a higher income level, and were better educated.

- It was not appropriate to compare the demographics of the samples in this report to the general population, as only those who were eligible to use the RideChoice program were affected and could be included in the samples.

Current and Recent Travel Behavior

- In the During and Post surveys, 23% of respondents did not use Waymo RideChoice at all. The main reason appeared to be the limits of its geographical service area.
- In the past 12 months (May 2019–May 2020), 80% of RC Respondents (Waymo) and 100% of RC Respondents (non-Waymo) had used non-Waymo RideChoice services. However, in the period since March 15, 2020 (COVID-19 restrictions), most respondents (51.3%) had not used any non-Waymo RideChoice services.
- Almost half of both RC Respondents (Waymo) and RC Respondents (non-Waymo) expected to use RideChoice services at least once or twice per week after the COVID-19 pandemic.
- The proportion of users (both Waymo and non-Waymo) using ride-hailing services outside the RideChoice program dropped significantly after the introduction of Waymo service.
- In rating the various ride characteristics of regular taxi, Uber/Lyft, and Waymo, Waymo was rated highest on all attributes except pick-up and drop-off locations and travel time. Regular taxi was rated the lowest on all attributes.

Comparison of Trip Characteristics

- Waymo was used significantly more for travel for 12:00–6:00 AM than other RideChoice services.
- Waymo riders also were accompanied by others significantly less frequently than other RideChoice services.
- Waymo riders were overwhelmingly satisfied with the wait time, travel time, cost, and comfort of their most recent Waymo ride.
- Most RC Respondents (Waymo) had taken 6–30 rides on Waymo in the December–February period.

Perceptions of Waymo and Non-Waymo RideChoice Services

- In the Prior Survey, respondents indicated that they relied on the RideChoice program to go different places and found the program affordable, and a majority felt they would be unable to find a reasonable alternative to RideChoice.
- In evaluating safety and security of the RideChoice Waymo services, respondents who used Waymo were more satisfied with the safety and security of RideChoice Waymo services than of traditional RideChoice options.
- Respondents were generally more satisfied with the travel times and costs for RideChoice Waymo services than for traditional RideChoice services.
- Respondents were more satisfied with the ease of ordering RideChoice Waymo services than traditional RideChoice services but found little difference in the ease of getting in and out of the vehicles.
- Respondents were more satisfied with the reliability of RideChoice Waymo services than with traditional RideChoice services.

Attitudes and Perceptions Towards Self-Driving Vehicles and On-Demand Mobility Services

- Of three scenarios—riding alone, riding with friends or relatives, and riding with strangers—riding with friends or relatives was preferred to either of the other options.
- Waymo riders became more comfortable with riding with friends or relatives and riding with strangers after experiencing Waymo rides but less comfortable with riding alone.
- Non-Waymo riders showed increasing comfort with all three scenarios, progressing from the Prior to the Post survey.
- All survey participants felt that AVs would improve safety on the roads and would meet the mobility needs of all people, including people with disabilities, and agreed that it would be good to see more such vehicles on the roads.
- Most survey participants agreed that they would switch to requesting self-driving vehicles when available as part of RideChoice and that they would like to be among the first to use such vehicles when they become widely available.

Focus Groups

- The rider focus groups tended to confirm the findings of the surveys.
- Waymo riders found that Waymo service gave them a greater sense of safety and independence.
- Waymo riders felt that Waymo service was better than other RideChoice options.
- Waymo riders liked the idea of a ride-hailing AV service but were somewhat less comfortable with ridesharing with strangers.
- Waymo riders were eager to use Waymo to go more places and to do so without a vehicle operator.
- The SME focus group was keen to see pilot projects that would point the way to enhancing transit service and identify infrastructure needs.
- The SME focus group also felt that there was a need to address the uncertainties of the technology at a regional level.
- The Policymaker Roundtable felt there was a need to explore more use cases within the region and raised the issues of who pays for such use cases and data sharing, particularly with private companies that may be offering the AV services, and emphasized the need for collaboration and coordination among the various jurisdictions.

Overall, the demonstration project was successful in helping people understand and perceive the benefits of AVs and overcome some of their initial misgivings about such technology. The Waymo services were well received by the sampled RideChoice users and were rated as providing better service than other RideChoice options.

APPENDIX

A

Waymo Vehicle Accessibility Features

The Waymo app and service used by RideChoice users included access to several accessibility features, including the following:

- An in-app button that enables the user to "honk" the vehicle's horn from nearby when the vehicle was ready for boarding, helping blind and low-vision users find their way to the vehicle.
- In-vehicle audio cues describing vehicle maneuvers (e.g., "turning left onto Shoreline Boulevard") to keep blind and low-vision users informed on their journey. These audio cues supplement default audio cues provided in the vehicle and give blind and low-vision users access to information that is also displayed on the second-row video screens. Users may turn on this in-vehicle audio cues feature in the app.
- A setting that, when activated, minimizes walking at pick-ups and drop-offs, including preventing the vehicle from considering a pick-up or drop-off point on the opposite side of the street from the rider's selected location.
- The option to communicate with the Waymo Rider Support team through text in the app, instead of, or in addition to, communicating through the in-vehicle audio system.
- In-vehicle displays that show text to accompany standard in-vehicle audio announcements (e.g., the vehicle will announce when the vehicle is approaching the rider's destination, and that message will also appear on the in-vehicle video displays).
- Ride buttons in Waymo self-driving vehicles that have Braille labels that allow users to start the ride, pull over the vehicle, or call to speak to a member of the Waymo Rider Support team who can provide further assistance and information. These commands can also be made through the app.

APPENDIX

B

Expression of Interest Form

Expression of Interest Form

1. Your name:
   First name: _____
   Last name: _____

2. Your home address:
   Complete street address _____
   City _____
   State _____
   ZIP code _____

3. Your phone number (area code + number): _____

4. Your e-mail address:
   - E-mail: _____ OR
   - I do not have an e-mail address

5. Do you have a smartphone purchased within the last 4 years?
   - Yes
   - No
   - Not sure

6. On average, how many one-way trips do you make using RideChoice services?
   - More than 3 trips per week
   - About 1-3 trips per week
   - Less than 1 trip per week
   - Other: _____

7. Do you currently use Waymo service for any of your trips?
   - Yes
   - No

8. Are you willing to participate in the Valley Metro–Waymo self-driving research study? Please note that Waymo vehicles do not currently accommodate people who use certain mobility devices or people who cannot safely enter and exit a standard minivan that is not equipped with a lift or ramp.
   - Yes
   - No
   - Not sure

9. Please check all of the activities in the list below that you can do on your own or with the assistance of a Personal Care Attendant (PCA).
   - Download and install a mobile app on to a smartphone.
   - Use a mobile app to book, check on, cancel, and pay for trips.
   - Navigate to or from a self-driving vehicle, recognizing that the vehicle may be located up to 300 yards from my location, depending on traffic conditions and the availability of parking in the area where I will begin or end my trip.
   - Board, secure myself, and ride in a self-driving vehicle (standard minivan).
   - Carry and secure my own possessions within the vehicle.
   - Speak and understand English sufficiently to communicate with support staff if necessary, either by phone or in person.
   - Speak, write, and understand English sufficiently to complete surveys documenting my experience as a participant in this pilot project.
   - I cannot perform any of the above activities. Exclusive alternative, if this option is selected, all other options cannot be selected. *Display if Q7=No or Q7=Not sure*

10. Please tell us why you are not interested in participating in the Valley Metro-Waymo self-driving ride service (so that we can plan for the future). *Display if Q8=No*

11. Would you like a member of the study team to call you to discuss the Valley Metro-Waymo self-driving ride service further? *Display if Q8=Yes or Q8=Not sure*
    - ○ Yes
    - ○ No

APPENDIX

C

Prior Survey Form

Prior Survey Form

Section A: Your Use of RideChoice Service

This section asks questions about your current use of and opinions about Valley Metro's RideChoice service.

1. About how often do you use RideChoice service?
   - ○ Every day
   - ○ Weekly (not every day, but at least one day per week)
   - ○ Monthly (not every week, but one or more days per month)
   - ○ Less than once a month
   - ○ I have never used RideChoice service

2. Considering the **last trip** you recall using RideChoice, please answer the following questions. If you don't remember all of the information precisely, your best guess is fine. *Display if Q1=Every day, Weekly, Monthly, or Less than once a month*

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 you **pay for the trip**?	_____*OR* ○ I don't know.
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, personal care attendants, etc.

What would you have done if the RideChoice were not available? *Choose the most likely option.*	○ Drive a personal vehicle, alone ○ Drive a personal vehicle, with passengers ○ Ride in a vehicle, with others ○ Ride the bus ○ Ride the light rail ○ Use taxi ○ Group shuttle service (e.g., senior center group ride to grocery store) ○ Volunteer driver program (e.g., Give A Lift in Fountain Hills) ○ Use a bikesharing or e-scooter sharing service ○ Walk ○ Ride a bicycle or scooter ○ I would not have made this trip ○ Other (please, specify): _____

3. In the **last month**, about how much did you spend out-of-pocket on RideChoice service? *Display if Q1=Every day, Weekly, Monthly, or Less than once a month*
   - ○ $0
   - ○ $1 - $9
   - ○ $10 – $29
   - ○ $30 - $ 49
   - ○ $50 - $74
   - ○ $75 - $100
   - ○ I do not know

4. In the **last month**, how much time did you spend, on average, **waiting** for the RideChoice vehicle to arrive after you placed a request for a ride? If you book rides in advance for a specific pick-up time, indicate how long you waited (on average) for the vehicle to arrive after the requested pick-up time. *Display if Q1=Every day, Weekly, Monthly, or Less than once a month*
   - ○ Less than 3 minutes
   - ○ 3-5 minutes
   - ○ 6-10 minutes
   - ○ 11-20 minutes
   - ○ 21-30 minutes
   - ○ 31-60 minutes
   - ○ More than 60 minutes
   - ○ I do not know

5. Please rate your level of agreement with each of the following statements about current RideChoice service. *Display if Q1=Every day, Weekly, Monthly, or Less than once a month*

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*	*Don't know/ No Opinion*
RideChoice service allows me to get to places where I need to go.	○	○	○	○	○	○
If RideChoice service were not available, I would not be able to make trips to different places.	○	○	○	○	○	○
The RideChoice service is a reliable and dependable means of transportation for me.	○	○	○	○	○	○
RideChoice service is an affordable means of transportation.	○	○	○	○	○	○
The time spent waiting for the RideChoice vehicle is acceptable.	○	○	○	○	○	○
Having a human driver present during a RideChoice trip is important to me.	○	○	○	○	○	○

I would be willing to share my RideChoice trip with a stranger, if it would lower costs and add only a small amount of additional travel time.	○	○	○	○	○	○
I would be able to find reasonable substitute transportation if RideChoice service were not available.	○	○	○	○	○	○
I have generally found RideChoice drivers to drive safely and provide a good quality, comfortable, and smooth ride.	○	○	○	○	○	○
I have generally found RideChoice drivers to know their way around and get me where I need to go without any difficulty.	○	○	○	○	○	○
I have generally found RideChoice customer service to be of high quality.	○	○	○	○	○	○

6. Is the ability of a RideChoice service provider to accommodate special needs (e.g., wheelchair) important to you?
   - o Yes, please specify: _____
   - o No
   - o Not Sure

7. How do you spend your time when riding in a RideChoice vehicle? *Select **up to four** activities.*
   Display if Q1=Every day, Weekly, Monthly, or Less than once a month
   - o Work, or study
   - o Talk on the phone/ send or read text messages/ teleconference
   - o Read for pleasure
   - o Sleep
   - o Entertainment (e.g., Watch movies; play games; listen to podcasts)
   - o Eat and drink
   - o Interact with the driver or other passengers
   - o Enjoy the scenery
   - o Watch the road
   - o Other (please, specify): _____

8. What are the main purposes for which you use RideChoice service? *Select **up to four** purposes*.
   Display if Q1=Every day, Weekly, Monthly, or Less than once a month
   - o Work/school
   - o Shopping/errands
   - o Eating/drinking
   - o Social/recreational
   - o To access airport
   - o To access public transit
   - o Medical/dental
   - o Just to enjoy a ride/outing
   - o Other (please, specify): _____

9. What other means of transportation do you use to get around? *Select **up to four** options*.
   - o Drive myself
   - o Ride as passenger with friend or family
   - o Carsharing services (*e.g.*, Zipcar)
   - o Volunteer driver program
   - o Bus
   - o ADA Paratransit service
   - o Group/Community Shuttle service
   - o Light rail
   - o Taxi
   - o Uber/Lyft
   - o Bike or scooter (including shared services)
   - o Walk
   - o Other (please, specify): _____

Section B: Your Thoughts About Self-driving and On-Demand Mobility Services

A **self-driving car** is a vehicle that can transport people, including those who do not drive, on its own without a human driver. When self-driving cars become available, people may purchase them for personal use or transportation providers could provide on-demand transportation in self-driving cars. A self-driving car ride may have a backup safety driver present in the vehicle; if one is not present, then the ride will be monitored remotely to handle any emergencies. Self-driving cars can provide on-demand transportation service, similar to current services (e.g., RideChoice, Uber, Lyft).

1. Which of the following statements best describes your **familiarity with self-driving cars**?
   - ○ I had never heard of self-driving cars before taking this survey.
   - ○ I have heard of self-driving cars, but don't know much about them.
   - ○ I am somewhat familiar with self-driving cars.
   - ○ I am very familiar with self-driving cars.

2. Have you ever taken a ride in a self-driving vehicle (e.g., Waymo)? Do **not** include riding in vehicles with advanced driver-assist features (such as the Tesla).
   - ○ Yes, please specify_____
   - ○ No
   - ○ Not Sure

3. To what extent are you willing to ride in a self-driving car in each of the following ways when **a backup driver/operator is not present** in the vehicle? Assume that the vehicle is being monitored remotely to handle emergencies.

	Not at all Willing	*Somewhat Unwilling*	*Neutral*	*Somewhat Willing*	*Very Willing*	*Don't Know/No Opinion*
Riding a self-driving car alone	○	○	○	○	○	○
Riding a self-driving car with someone I know (*e.g.,* family, friends)	○	○	○	○	○	○
Riding a self-driving car with passengers who are unknown to me	○	○	○	○	○	○

4. Please rate your level of agreement with each of the following statements about self-driving cars?

	Strongly disagree	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Strongly agree*	*Don't Know/No Opinion*
Self-driving cars operate more safely on the roadways than human-driven vehicles.	○	○	○	○	○	○
Pedestrians, cyclists, and other road users will be safer in a future when most vehicles are self-driving.	○	○	○	○	○	○
Any self-driving car ride should have a human backup driver present in the vehicle to handle vehicle operation emergencies.	○	○	○	○	○	○
Human-driven vehicles should still be available even after self-driving vehicles are shown to be safer than human-driven vehicles.	○	○	○	○	○	○

5. Please rate your level of agreement with each of the following statements about your potential use of on-demand, self-driving car service?

If an on-demand, self-driving car service is available, I will routinely request it rather than the human-driven vehicle option for my RideChoice trips.	○	○	○	○	○	○
I would travel farther (longer distances) when on-demand, self-driving car service is available through RideChoice. *Assume you have to pay and wait for self-driving car service exactly as you do now for your RideChoice service.*	○	○	○	○	○	○
I would make additional trips (that I don't make at this time) when on-demand self-driving car service is available through RideChoice. *Assume you have to pay and wait for self-driving car service exactly as you do now for your RideChoice service.*	○	○	○	○	○	○
I would like to be one of the first to use a self-driving car service (as soon as it is available).	○	○	○	○	○	○

6. Think about your current RideChoice trips. How do you think you would spend your time on those trips if you were riding in a self-driving car **with no human operator/driver**? *Select **up to four** activities.*
   - ○ Work, or study
   - ○ Talk on the phone/ send or read text messages/ teleconference
   - ○ Read
   - ○ Sleep
   - ○ Entertainment (e.g., Watch movies; play games; listen to podcasts)
   - ○ Eat and drink
   - ○ Interact with other passengers
   - ○ Enjoy the scenery
   - ○ Watch the road
   - ○ I would not ride in a self-driving car
   - ○ Other (please, specify): _____

7. To what extent will you switch to using self-driving car service for your RideChoice trips once they are available?
   - ○ I would use self-driving cars for **all** my trips
   - ○ I would use self-driving cars for **most** of my trips
   - ○ I would use self-driving cars for **about half** of my trips
   - ○ I would use self-driving cars for **a few** of my trips
   - ○ I would **not** use self-driving cars for any of my trips

8. How much would you expect to pay for a RideChoice ride in a self-driving car?
   - ○ $1 to $3 **less** than what I pay now *per trip*
   - ○ Up to $1 **less** than what I pay now *per trip*
   - ○ I would not expect to pay any more or any less than what I pay now for RideChoice trips
   - ○ Up to $1 **more** than what I pay now *per trip*
   - ○ $1 to $3 **more** than what I pay now *per trip*
   - ○ I am not sure

9. How long are you willing to wait for a RideChoice vehicle pick-up after you have placed the request? *If you book rides in advance for a specific pick-up time, then indicate how long you are willing to wait for the vehicle to arrive after the requested pick-up time.*

- ○ Up to 5 minutes
- ○ Up to 10 minutes
- ○ Up to 20 minutes
- ○ Up to 30 minutes
- ○ Up to 60 minutes
- ○ Not sure

10. How important are the following features of a RideChoice trip service provider?

	Very Unimportant	*Somewhat unimportant*	*Neutral*	*Somewhat Important*	*Very Important*	*Don't Know/No Opinion*
Having to wait only a short time (less than 5 minutes) for my ride to arrive.	○	○	○	○	○	○
Having a high quality, comfortable, and smooth ride, where the vehicle operates on the roadways safely without incident.	○	○	○	○	○	○
Having a driver willing and able to provide some assistance with entering/exiting the vehicle, loading/unloading bags, or walking to/from the door.	○	○	○	○	○	○
Being picked-up and dropped off as close to the door as possible.	○	○	○	○	○	○
Having a mobile app to book, track, and pay for rides.	○	○	○	○	○	○

Section C: Background Information

To help us better understand the transportation needs of the community, we would like to ask you a few background questions. Your privacy is guaranteed.

1. How old are you? _____ years old

2. What is your gender?
   - ○ Male
   - ○ Female
   - ○ Other
   - ○ Prefer not to answer

3. At this time, are you:
   - ○ Employed full-time
   - ○ Employed part-time
   - ○ Self-employed
   - ○ Retired
   - ○ Homemaker
   - ○ Unable to work
   - ○ Not employed and currently looking for work
   - ○ Not employed and **not** currently looking for work
   - ○ Other (please, specify): _____

4. At this time, are you:
   - ○ A full-time student
   - ○ A part-time student
   - ○ Not a student

5. What is your occupation? *Display if Q3=Employed full-time, Employed part-time, or Self-employed*
   - ○ Sales or service
   - ○ Clerical or administrative support
   - ○ Manufacturing, construction, maintenance, or farming
   - ○ Professional, managerial, or technical
   - ○ Education, training, and library occupations
   - ○ Arts, design, entertainment, sports, and media occupations
   - ○ Military specific occupations
   - ○ Other (please, specify): _____

6. Knowing more about your **work** location will help us understand the transportation options available to you. Please give the address or, if you prefer, major cross streets closest to your main workplace location. *If you travel to more than one work location on a regular basis, enter the location to which you travel most often. Display if Q3=Employed full-time, Employed part-time, or Self-employed*

   _____ City: _____ State: _____ ZIP code: _____

7. Knowing more about your **school** location will help us understand the transportation options available to you. Please give the address or, if you prefer, major cross streets closest to your main school location. *If you travel to more than one school location on a regular basis, enter the location to which you travel most often. Display if Q4=A full-time Student or a part-time student*

   _____City: _____ State: _____ ZIP code: _____

8. Please provide the address of up to **five** (other) **locations** that you visit most frequently. These may be locations such as a grocery store, a movie theater, a favorite restaurant, a friend's house, a place of worship, a doctor's office, or a place where you volunteer your time. *This information will be used to determine if the self-driving car service can meet most of your transportation needs*. *Your privacy is guaranteed.*

   a_____ City: _____ State: _____ ZIP code: _____

   b_____ City: _____ State: _____ ZIP code: _____

   c_____ City: _____ State: _____ ZIP code: _____

   d_____ City: _____ State: _____ ZIP code: _____

   e_____ City: _____ State: _____ ZIP code: _____

9. 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)

10. Do you have any disabilities or health-related conditions that prevent or limit you from … (If needed, feel free to add more details into the last column.)

	No	*To some extent*	*Yes*	*Please explain (optional)*
Driving a personal vehicle	○	○	○	
Using public transit (bus or light rail)	○	○	○	
Riding a bike	○	○	○	
Walking up to three city blocks	○	○	○	

11. Do you use any of the following way-finding, mobility assistance systems, or tools? Please check all that apply.
    - ○ None
    - ○ Screen reader / text to speech
    - ○ Magnification / zoom / large font
    - ○ Keyboard only
    - ○ Color modifications
    - ○ Closed captions
    - ○ Voice control
    - ○ Switch device
    - ○ Other (please, specify): _____

12. What best describes the home you **currently** live in?
    - ○ Stand-alone home
    - ○ Condo/apartment
    - ○ Mobile home
    - ○ Attached home/townhome
    - ○ Other (please, specify): _____

13. Do you live in a **gated** community or apartment complex?
    - ○ Yes
    - ○ No

14. **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.*

15. How many personal vehicles (automobiles) and/or motorcycles does your household own, lease, or have available for personal use at any time? _____

16. Do you have a ride-hailing service app (*e.g*., Uber, Lyft) on your phone?
    - ○ Yes
    - ○ No
    - ○ Not Sure

17. Have you taken a ride through a ride-hailing service (*e.g*., Uber, Lyft) at any time in the past six months (outside of the RideChoice program)?
    - ○ Yes
    - ○ No
    - ○ Not sure

18. About how frequently do you take a ride through a ride-hailing service (*e.g*., Uber, Lyft) outside of the RideChoice program? *Display if Q17=Yes*
    - ○ Rarely (less than once a month)
    - ○ At least once a month, but less than weekly
    - ○ At least once a week, but less than daily
    - ○ About every day
    - ○ Not sure

19. What type of smartphone do you have?
    - ○ iPhone/ iOS (Apple)
    - ○ Android
    - ○ Other (please, specify): _____

20. We will be sending you a $100 gift card as a token of appreciation for your response to this survey. Have you received or are you receiving any other payments or incentives from Arizona State University (ASU) during the 2019 calendar year?
    - ○ Yes
    - ○ No

21. 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 have any additional comments about your current travel, and new transportation options such as self-driving vehicles, you are welcome to share them in the space below.

Thank you for your valuable participation in this survey!

All of your responses have been successfully recorded.

APPENDIX

D

During Survey Form

During Survey Form

Section A: Your Transportation Choices

This section asks questions about your recent transportation choices. Please think about the RideChoice rides that you have taken when answering questions in this section.

1. About how many **Waymo rides** have you taken in total since the beginning of this study (include **all Waymo rides**, even if the Waymo ride was not officially part of this study or taken under the RideChoice program)? Note: A one-way trip is counted as a ride.
   _____ rides

2. Please rate your level of agreement with each of the following statements about how you use **RideChoice** and the needs that you have when going places.

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I use RideChoice to travel within the city of Chandler.	○	○	○	○	○	○
I generally need assistance from the driver when using RideChoice services (*e.g.*, help getting in and out of vehicle; loading and unloading groceries)	○	○	○	○	○	○
I enjoy the social aspect of RideChoice and often talk with the driver.	○	○	○	○	○	○

3. Please rate your level of agreement with each of the following statements about your experience riding in **Waymo vehicles**. *Display if Q1>0*

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
Waymo vehicles serviced all of the locations that I needed to go.	○	○	○	○	○	○
I had no trouble getting into and out of the Waymo vehicle.	○	○	○	○	○	○
Waymo vehicles provided a social aspect that fulfilled my desire to talk to other people.	○	○	○	○	○	○

4. Now consider your rides in traditional RideChoice vehicles (**not Waymo vehicles)**. Please rate your level of agreement with each of the following statements about your experience riding in **traditional RideChoice vehicles**.

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
RideChoice vehicles serviced all of the locations that I needed to go.	○	○	○	○	○	○
I had no trouble getting into and out of the traditional (non-Waymo) RideChoice vehicles.	○	○	○	○	○	○
Riding in traditional (non-Waymo) RideChoice vehicles provided a social aspect that fulfilled my desire to talk to other people.	○	○	○	○	○	○

5. Consider the most recent ride that you took **using Waymo service**. *For this specific ride, please answer the following questions. If you don't remember all of the information precisely, your best guess is fine. Display if Q1>0*

What is the month and year when the ride for which you are reporting information was taken?	Month: (September-March) _____ Year: (2019-2020_____
Where did you travel using this service? *Provide address or major cross-streets and city*.	From: _____ To: _____
What was the day of week when the ride was taken?	o Monday, Tuesday, Wednesday, or Thursday o Friday o Saturday o Sunday
What time of day was this ride?	o Daytime (6 AM to 7 PM) o Nighttime (7 PM to 12 Midnight) o Late night (12 midnight to 6 AM)
About how long was the **wait time** for this ride?	_____ minutes
About how long was the **travel time** in the vehicle?	_____ minutes
What was the primary **purpose** of the ride? *Please check the **best answer.***	o Work/school o Shopping/errands o Eating/drinking o Social/recreational o To access airport o To access public transit o Medical/dental o Going/returning home from another location o Other (please, specify): _____
How many other passengers traveled with you?	o I was the only passenger *OR* o Family members/friends (enter a number): _____ o Personal care attendants (enter a number): _____
What would you have done if the RideChoice were **not** available for this trip? *Choose the most likely option.*	o I would not have made this trip o **Drive** a personal vehicle, alone o **Drive** a personal vehicle, with passengers o **Ride** in a vehicle, with others o Ride the bus o Ride the light rail o Use taxi o Use an Uber/Lyft o Group shuttle service (*e.g.*, senior center group ride to grocery store) o Volunteer driver program (*e.g.*, Give A Lift in Fountain Hills) o Use a bikesharing or e-scooter sharing service o Walk o Ride a bicycle or scooter o Other (please, specify): _____

Please rate how satisfied you were with the following aspects of this ride.

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I was satisfied with the wait time for this ride.	○	○	○	○	○	○
I was satisfied with the travel time (*i.e.*, time spent riding in the vehicle) for this ride.	○	○	○	○	○	○
I was satisfied with the cost of this ride.	○	○	○	○	○	○
I was satisfied with the comfort of the vehicle during this ride.	○	○	○	○	○	○

How did you spend your time in the vehicle during this ride? *Select **up to four** activities.*

- ○ Work or study
- ○ Talk on the phone/ send or read text messages/ teleconference
- ○ Read for pleasure
- ○ Sleep
- ○ Entertainment (*e.g.*, Watch movies; play games; listen to podcasts)
- ○ Eat and drink
- ○ Interact with the driver
- ○ Interact with other passengers
- ○ Enjoy the scenery
- ○ Watch the road
- ○ Other (please, specify): _____

6. Please rate your level of agreement with each of the following statements about Waymo service. *Display if Q1>0*

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I feel safe when riding in the Waymo vehicle.	○	○	○	○	○	○
The ride in the Waymo vehicle is smooth and comfortable.	○	○	○	○	○	○
I feel confident that my Waymo ride will not have any problems.	○	○	○	○	○	○
I find it exciting to ride in a Waymo vehicle.	○	○	○	○	○	○
I am making new trips (that I did not make previously) in the RideChoice program after the inclusion of the Waymo option.	○	○	○	○	○	○
I find it easy to use the Waymo ride-hailing app on my smartphone to order service.	○	○	○	○	○	○
I like riding in the Waymo self-driving vehicle more than riding in traditional RideChoice vehicles with a human driver (taxi, Uber/Lyft).	○	○	○	○	○	○

7. In the past 30 days, about how many RideChoice rides have you taken (**include Waymo rides** taken as part of the RideChoice service)?
   _____ rides

8. Consider the most recent ride that you took in a **traditional RideChoice vehicle (that is not a Waymo vehicle)**. *For this specific **non-Waymo** ride, please answer the following questions. If you don't remember all of the information precisely, your best guess is fine. If you have never taken a RideChoice ride in a traditional non-Waymo vehicle, then please skip this question.*

What is the month and year when the ride for which you are reporting information was taken?	Month: (January-December) _____ Year: (2019-2020) _____
Where did you travel using this service? *Provide address or major cross-streets and city*.	From: _____ To: _____
What was the day of week when the ride was taken?	○ Monday, Tuesday, Wednesday, or Thursday ○ Friday ○ Saturday ○ Sunday
What time of day was this ride?	○ Daytime (6 AM to 7 PM) ○ Nighttime (7 PM to 12 Midnight) ○ Late night (12 midnight to 6 AM)
About how long was the **wait time** for this ride?	_____ minutes
About how long was the **travel time** in the vehicle?	_____ minutes
What was the primary **purpose** of the ride? *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 (enter a number): _____ ○ Personal care attendants (enter a number): _____
What would you have done if the RideChoice were **not** available for this trip? *Choose the most likely option.*	○ I would not have made this trip ○ **Drive** a personal vehicle, alone ○ **Drive** a personal vehicle, with passengers ○ **Ride** in a vehicle, with others ○ Ride the bus ○ Ride the light rail ○ Use taxi ○ Use an Uber/Lyft ○ Group shuttle service (*e.g.*, senior center group ride to grocery store) ○ Volunteer driver program (*e.g.*, Give A Lift in Fountain Hills) ○ Use a bikesharing or e-scooter sharing service ○ Walk ○ Ride a bicycle or scooter ○ Other (please, specify): _____

Please rate how satisfied you were with the following aspects of this ride.

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I was satisfied with the wait time for this ride.	○	○	○	○	○	○
I was satisfied with the travel time (*i.e.*, time spent riding in the vehicle) for this ride.	○	○	○	○	○	○
I was satisfied with the cost of this ride.	○	○	○	○	○	○
I was satisfied with the comfort of the vehicle during this ride.	○	○	○	○	○	○

How did you spend your time in the vehicle during this ride? *Select **up to four** activities.*

- ○ Work or study
- ○ Talk on the phone/ send or read text messages/ teleconference
- ○ Read for pleasure
- ○ Sleep
- ○ Entertainment (*e.g.*, Watch movies; play games; listen to podcasts)
- ○ Eat and drink
- ○ Interact with the driver
- ○ Interact with other passengers
- ○ Enjoy the scenery
- ○ Watch the road
- ○ Other (please, specify): _____

9. Please rate your level of agreement with each of the following statements about **traditional RideChoice service** (*i.e.*, **non-Waymo service**).

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I feel safe when riding in the traditional RideChoice vehicle.	○	○	○	○	○	○
The ride in the traditional Ride Choice vehicle is smooth and comfortable.	○	○	○	○	○	○
I feel confident that my traditional RideChoice vehicle ride will not have any problems.	○	○	○	○	○	○
I find it exciting to ride in a traditional RideChoice vehicle.	○	○	○	○	○	○
I find it easy to order and use the traditional RideChoice service.	○	○	○	○	○	○
I like riding in traditional RideChoice vehicles more than in Waymo vehicles.	○	○	○	○	○	○

10. In the past 30 days, what other means of transportation have you used to get around? *Select **up to four** options used most often*.

- ○ Drive alone
- ○ Drive with other passengers in vehicle
- ○ Ride as passenger with friend or family
- ○ Carsharing services (e.g., Zipcar)
- ○ Volunteer driver program
- ○ Bus
- ○ ADA Paratransit service
- ○ Group/Community Shuttle service
- ○ Light rail
- ○ Traditional Taxi
- ○ Uber/Lyft
- ○ Bike or scooter (including shared services)
- ○ Walk
- ○ Other (please, specify): _____

Section B: Your Thoughts About Self-driving and On-demand Mobility Services

This section asks questions about your perceptions of and expectations for new mobility services and technologies. Please think about your transportation needs and experiences in general, and not just about traditional RideChoice or Waymo vehicles.

11. Which of the following statements best describes your **current familiarity with fully self-driving vehicles**?
    - ○ I have heard of fully self-driving vehicles, but don't know much about them.
    - ○ I am somewhat familiar with fully self-driving vehicles.
    - ○ I am very familiar with fully self-driving vehicles.

12. Please rate your level of agreement with each of the following statements about riding in a **fully self-driving vehicle with no driver**.

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I would ride in a fully self-driving vehicle alone.	○	○	○	○	○	○
I would ride in a fully self-driving vehicle with someone I know (*e.g.*, family, friends).	○	○	○	○	○	○
I would ride in a fully self-driving vehicle with passengers who are unknown to me.	○	○	○	○	○	○

13. How much do you agree or disagree with each of the following statements about fully self-driving vehicles?

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I believe that self-driving vehicles are safer than human-driven vehicles and will reduce accidents and fatalities.	○	○	○	○	○	○
I believe that pedestrians, cyclists, and other road users would be safer in a future when most vehicles are fully self-driving.	○	○	○	○	○	○

14. How much do you agree or disagree with each of the following statements about your potential use of an on-demand, fully self-driving vehicle service?

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I would prefer to use a fully self-driving vehicle service over a traditional human-driven vehicle service for my RideChoice trips.	○	○	○	○	○	○
I would like to be one of the first users of a fully self-driving vehicle service for my RideChoice trips once such a service is available on a permanent basis.	○	○	○	○	○	○
I believe that a fully self-driving vehicle service would make it easier for me to access and use bus and rail service.	○	○	○	○	○	○
I believe that a fully self-driving vehicle service will make traveling in the region easier and more convenient.	○	○	○	○	○	○

15. To what extent will you switch to using a fully self-driving vehicle service for your RideChoice trips if the service is available on a permanent basis across the entire Phoenix metropolitan area?
    - ○ I would use fully self-driving vehicles for **all** my trips
    - ○ I would use fully self-driving vehicles for **most** of my trips
    - ○ I would use fully self-driving vehicles for **about half** of my trips
    - ○ I would use fully self-driving vehicles for **a few** of my trips
    - ○ I would **not** use fully self-driving vehicles for any of my trips

16. Rate each of the following modes on a scale of 1 to 5 for the characteristics listed in the first column. **The scale is as follows: 1=poor; 2=fair; 3=good; 4=very good; 5=excellent.** *If you have not used a particular service, or have no opinion on a particular characteristic, enter a ZERO.* ***Do not leave any blanks.***

Characteristic	*Regular Taxi*	*Uber/Lyft*	*Waymo*
Waiting time			
Ride comfort			
Travel time			
Drop-off and pick-up locations			
Cleanliness of vehicle			
Ease of getting into and out of vehicle			
Ease of requesting the ride			

17. How has your use of other modes of transportation changed after the inclusion of Waymo as an option in the RideChoice program?

	Decreased	*Increased*	*Stayed the Same*
Drive a personal vehicle, alone	○	○	○
Drive a personal vehicle, with passengers	○	○	○
Ride in a vehicle, with others	○	○	○
Bus	○	○	○
Group shuttle service (*e.g.*, senior center group ride)	○	○	○
Light rail	○	○	○
Traditional taxi	○	○	○
Uber/Lyft	○	○	○
Bikesharing or e-scooter sharing service	○	○	○
Walk	○	○	○
Ride a bicycle or scooter	○	○	○

Section C: Background Information

To help us better understand the transportation needs of the community, we would like to ask you a few background questions. Please answer these questions even if there is no change from the last survey. Your privacy is guaranteed.

18. At this time, you are:
    - o Employed full-time
    - o Employed part-time
    - o Self-employed
    - o Retired
    - o Homemaker
    - o Unable to work
    - o Not employed and currently looking for work
    - o Not employed and **not** currently looking for work
    - o other (please, specify): _____

19. At this time, you are:
    - o A full-time student
    - o A part-time student
    - o Not a student

20. What is your occupation? *Display if Q18=Employed full-time, Employed part-time, or Self-employed*
    - o Sales or service
    - o Clerical or administrative support
    - o Manufacturing, construction, maintenance, or farming
    - o Professional, managerial, or technical
    - o Education, training, and library occupations
    - o Arts, design, entertainment, sports, and media occupations
    - o Military specific occupations
    - o Other (please, specify): _____

21. Knowing more about your **work** location will help us understand the transportation options available to you. Please give the address or, if you prefer, major cross streets closest to your main workplace location. *If you travel to more than one work location on a regular basis, enter the location to which you travel most often. Display if Q18=Employed full-time, Employed part-time, or Self-employed*
    _____ City: _____ State: _____ ZIP code: _____

22. Knowing more about your **school** location will help us understand the transportation options available to you. Please give the address or, if you prefer, major cross streets closest to your main school location. *If you travel to more than one school location on a regular basis, enter the location to which you travel most often*. Display if Q19=A full-time Student or a part-time student
    _____ City: _____ State: _____ Zip code: _____

23. **Including yourself**, how many people live in your household? (1-10 or more) _____
    *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.*

24. How many personal vehicles (automobiles) and/or motorcycles does your household own, lease, or have available for personal use at any time? (0-6 or more) _____

25. Do you have a ride-hailing service app (*e.g.*, Uber, Lyft) on your phone?
    - o Yes
    - o No
    - o Not Sure

26. Have you taken a ride through a ride-hailing service (*e.g.*, Uber, Lyft) at any time in the past 30 days (outside of the RideChoice program)? Include trips ordered by somebody else (and you rode along).
    - ○ Yes
    - ○ No
    - ○ Not Sure

27. About how frequently do you take a ride through a ride-hailing service (*e.g.*, Uber, Lyft) outside of the RideChoice program? Include rides ordered by somebody else (where you ride along).
    - ○ Rarely (less than once a month)
    - ○ At least once a month, but less than weekly
    - ○ At least once a week, but less than daily
    - ○ About every day
    - ○ Not sure

28. We will be sending you a $100 gift card as a token of appreciation for your response to this survey. Have you received or are you receiving any other payments or incentives from Arizona State University (ASU) during the 2019 or 2020 calendar years (do not include payments or incentives you are receiving as part of this Valley Metro/Waymo study)?
    - ○ Yes
    - ○ No

29. 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

30. If you have any additional comments about your current travel, and new transportation options such as self-driving vehicles, you are welcome to share them in the space below.

Thank you for your valuable participation in this survey!
All of your responses have been successfully recorded.

APPENDIX

E

Post Survey Form

Post Survey Form

Section A: Your Travel Choices and Experiences

This section asks questions about your recent transportation choices and Waymo experience.

1. Have you taken at least one **Waymo ride** over the past 12 months (include **all Waymo rides**, even if the Waymo ride was not officially part of this study or taken under the RideChoice program)? Note: A one-way trip is counted as a ride.
   - ○ Yes
   - ○ No
   - ○ Not sure

2. Do you currently have the **Waymo app** on your smartphone?
   - ○ Yes
   - ○ No
   - ○ Not sure

3. Have you taken at least one ride using any **non-Waymo RideChoice service provider** (*e.g.*, taxi, Uber, Lyft, etc.) in the past 12 months?
   - ○ Yes
   - ○ No
   - ○ Not sure

4. Have you taken at least one ride using any **non-Waymo RideChoice service provider** (*e.g.*, taxi, Uber, Lyft, etc.) after March 15, 2020 (after the Waymo service suspension due to COVID-19)? *Display if Q3=YES*
   - ○ Yes
   - ○ No
   - ○ Not sure

5. Please rate your level of agreement with each of the following statements based on your experience riding in **Waymo vehicles**. *Display if Q1=YES*

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
Waymo served as a reliable means of transportation for me.	○	○	○	○	○	○
Waymo's customer service provided high quality assistance when I needed help. If you didn't need Waymo support, then check *Don't Know/No Opinion.*	○	○	○	○	○	○
Waymo provided a comfortable and smooth ride to my destinations.	○	○	○	○	○	○
The amount of time that I waited for my Waymo rides was acceptable.	○	○	○	○	○	○
I would like to have Waymo service available as a regular and permanent RideChoice option.	○	○	○	○	○	○

6. Please rate your level of agreement with each of the following statements based on your experience using **non-Waymo RideChoice services** (*e.g.*, taxi, Uber, Lyft, etc.) over the past 12 months. *Display if Q3=YES*

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
Non-Waymo RideChoice services served as a reliable means of transportation for me.	○	○	○	○	○	○
Valley Metro's RideChoice customer service provided high quality assistance when I needed help. If you didn't need Valley Metro's RideChoice support, then check *Don't Know/No Opinion.*	○	○	○	○	○	○
non-Waymo RideChoice services provided a comfortable and smooth ride to my destinations.	○	○	○	○	○	○
The amount of time that I waited for my non-Waymo RideChoice rides was acceptable.	○	○	○	○	○	○

7. About how often have you used RideChoice services **in the past 30 days (during the COVID-19 pandemic)**?
   - ○ Never
   - ○ Rarely (less than one day a week)
   - ○ About 1-2 days per week
   - ○ Several days per week (3-7 days per week)

8. After the COVID-19 pandemic is over, how often do you think you will use RideChoice services?
   - ○ Every day
   - ○ Weekly (not every day, but at least one day per week)
   - ○ Monthly (not every week, but one to three days per month)
   - ○ Less than once a month
   - ○ I will not use RideChoice services after the COVID-19 pandemic
   - ○ Not sure

9. In the past 30 days (during the COVID-19 pandemic), what other means of transportation (i.e., other than RideChoice services) have you used to get around? *Select **up to four** options used most often*.
   - ○ I did not make any trips at all (stayed home all the time)
   - ○ Drive alone
   - ○ Drive with other passengers in the vehicle
   - ○ Ride as passenger with friend or family
   - ○ Carsharing services (*e.g.*, Zipcar)
   - ○ Volunteer driver program
   - ○ Bus
   - ○ ADA Paratransit service

   OR CHOOSE UP TO 4 OPTIONS BELOW

   - ○ Group/Community Shuttle service
   - ○ Light rail
   - ○ Traditional Taxi
   - ○ Uber/Lyft)
   - ○ Bike or scooter (including shared services)
   - ○ Walk
   - ○ Other (please, specify): _____

10. **In the past 30 days (during the COVID-19 pandemic)**, about how frequently have you taken a ride through a ride-hailing service (*e.g.*, Uber, Lyft) **outside of the RideChoice program**? Include rides ordered by somebody else (where you ride along).
    - ○ Never
    - ○ Rarely (less than one day a week)
    - ○ About 1-2 days per week
    - ○ Several days per week (3-7 days per week)

11. After the COVID-19 pandemic is over, about how frequently might you take a ride through a ride-hailing service (*e.g.*, Uber, Lyft) **outside of the RideChoice program**? Include rides ordered by somebody else (where you would ride along).
    - ○ Never
    - ○ Rarely (less than once a month)
    - ○ At least once a month, but less than weekly
    - ○ At least once a week, but less than daily
    - ○ About every day
    - ○ Not sure

Section B: Your Thoughts About Self-driving and On-Demand Mobility Services

This section asks questions about your perceptions of and expectations for new mobility services and technologies. Please think about your transportation needs and experiences in general, and not just about RideChoice or Waymo vehicles and services. In answering these questions, assume that the COVID-19 pandemic is over.

12. Please rate your level of agreement with each of the following statements about riding in a **fully self-driving vehicle with no driver.**

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
I would ride in a fully self-driving vehicle alone.	○	○	○	○	○	○
I would ride in a fully self-driving vehicle with someone I know (*e.g.*, family, friends).	○	○	○	○	○	○
I would ride in a fully self-driving vehicle with passengers who are unknown to me.	○	○	○	○	○	○

13. To what extent will you switch to using a fully self-driving vehicle service for your RideChoice rides once the service is available on a permanent basis across the entire Phoenix metropolitan area?
    - ○ I would use fully self-driving vehicles for **all** my RideChoice rides.
    - ○ I would use fully self-driving vehicles for **most** of my RideChoice rides.
    - ○ I would use fully self-driving vehicles for **about half** of my RideChoice rides.
    - ○ I would use fully self-driving vehicles for **a few** of my RideChoice rides.
    - ○ I would **not** use fully self-driving vehicles for any of my RideChoice rides.

14. Please rate your level of agreement with each of the following statements about self-driving vehicles.

	Strongly agree	*Somewhat agree*	*Neutral*	*Somewhat disagree*	*Strongly disagree*	*Don't Know/No Opinion*
Self-driving vehicles can significantly enhance mobility for all people.	○	○	○	○	○	○
Self-driving vehicles will make traveling by car less stressful for me.	○	○	○	○	○	○
I am excited to see technology innovations in transportation.	○	○	○	○	○	○
Self-driving vehicles can especially improve mobility for individuals with special needs or mobility limitations (*e.g.*, senior, disabled).	○	○	○	○	○	○
I would like to see self-driving vehicles become common on our roadways.	○	○	○	○	○	○

Section C: Employment Status and Incentive

15. At this time, you are:
    - ○ Employed full-time
    - ○ Employed part-time
    - ○ Self-employed
    - ○ Retired
    - ○ Homemaker
    - ○ Unable to work
    - ○ Not employed and currently looking for work
    - ○ Not employed and **not** currently looking for work
    - ○ Other (please, specify): _____

16. We will be sending you a $100 gift card as a token of appreciation for your response to this survey. Have you received or are you receiving any other payments or incentives from Arizona State University (ASU) during the 2019 or 2020 calendar years (do not include payments or incentives you are receiving as part of this Valley Metro/Waymo study)?
    - ○ Yes
    - ○ No

17. If you have any additional comments about your current travel, and new transportation options such as self-driving vehicles, you are welcome to share them in the space below.

Thank you for your valuable participation in this survey!
All of your responses have been successfully recorded.

APPENDIX

F

Rider Focus Group Questions

Group 1: RideChoice Users Focus Group
May 27 and 28, 2020

Part I: Introduction

1. Tells us your first name and about one of your most memorable Waymo trips.

Part II: AV Technology Attitudes and Perceptions

2. How does it feel to ride in a self-driving car? What parts do you like and not like?
3. What are your current thoughts, feelings, or perceptions of self-driving cars? Have they changed while using Waymo as a RideChoice option?
4. How would you feel about receiving a driverless ride (i.e., a ride without a Waymo trained driver)?

Part III: User Experience

5. How does Waymo as a RideChoice option with Valley Metro compare to other RideChoice options?
6. What do you like the most about Waymo? What do you like the least?
7. What would make you take Waymo more frequently?

Part IV: Ride Choice and Behavior

8. How well did Waymo meet your transportation and mobility needs for the trips you took with it?
9. On trips where you used Waymo, what other modes did you have available and why did you use Waymo over other transportation options?
10. How do you see yourself using self-driving cars in the future?

Part V: Closing Comments

11. Would you keep using Waymo if it remained a RideChoice option? Would you use Waymo if it was not part of RideChoice?
12. Any final comments, questions, or thoughts about your experiences with Waymo or about self-driving cars?

Group 2: Valley Metro Employee Users Focus Group
May 20, 2020

Part I: Introduction

1. Tells us your first name and about one of your most memorable Waymo trips.

Part II: AV Technology Attitudes and Perceptions

2. How does it feel to ride in a self-driving car? What parts do you like and not like?
3. What are your current thoughts, feelings, or perceptions of self-driving cars? Have they changed while using Waymo?
4. How would you feel about receiving a driverless ride (i.e., a ride without a Waymo trained driver)?

Part III: User Experience

5. How does the Waymo service compare to other mobility options you have available to you?
6. What do you like the most about Waymo? What do you like the least?
7. What would make you take Waymo more frequently?

Part IV: Ride Choice and Behavior

8. How well did Waymo meet your transportation and mobility needs for the trips you took with it?
9. On trips where you used Waymo, what other modes did you have available and why did you use Waymo over other transportation options?
10. How do you see yourself using self-driving cars in the future?

Part V: Closing Comments

11. Would you keep using Waymo if it was not part of Valley Metro service?
12. Any final comments, questions, or thoughts about your experiences with Waymo or about self-driving cars?

APPENDIX

G

Subject Matter Expert Focus Group Questions

Group 3: Subject Matter Expert (SME) Focus Group
July 6 and 7, 2020

Part I: Introduction

1. By jurisdiction, tell us your name and what you hope to get out of or learn from today's event.

Part II: Transportation, Mobility and Autonomous Vehicles

2. Where do AVs fit within your city's goals and plans for (1) public transportation and (2) mobility?
3. What opportunities and challenges do you see in planning for AVs in your community?
4. How has or might your community engage the public about AVs?

Part III: Pilot Projects

5. How familiar are you with the Valley Metro Waymo Pilot Project? What elements of this pilot do you think are most useful to your community and/or to the region?
6. What other types of pilot projects are you interested in seeing and/or developing?
7. What, if any, barriers do you see in developing successful pilot project?

Part IV: Mobility Partnerships

8. What are your thoughts on public private partnerships in the mobility sector? What might partnerships with AV companies look like?
9. Are there barriers in your community to developing public private partnerships with AV companies?

Part V: Closing Comments

10. What additional information about AVs would be most useful to your community?
11. Any final comments, questions, or thoughts?

APPENDIX

H

Policymaker Roundtable Agenda and Questions

Group 4: Policymaker Roundtable

July 8, 2020

Agenda

Part I: Introduction

- Overview and goals for the roundtable
- Introduction to Valley Metro Waymo Mobility-on-Demand Demonstration Program
- Broader ecosystem of AV testing and pilot projects in U.S.

Part II: Presentation of Results for Valley Metro Waymo Mobility-on-Demand Demonstration Program

- Survey results
- Rider focus group results

Part III: Discussion

- Implications of Valley Metro Waymo pilot project
- AVs in public transit
- AVs in Phoenix area jurisdictions
- Next Steps

Part IV: Closing Comments

Discussion Questions, Part III:

Implications of pilot project:

- What are the implications of the Valley Metro Waymo Pilot Project for Valley Metro and transportation policy more generally?
- What are the main issues that the Valley Metro pilot raises for you?

AVs in public transit:

- How do you envision AVs interacting with transit in the future?
- What other types of pilot projects would you like to see in the Phoenix region?

AVs in Phoenix area jurisdictions:

- How is your jurisdiction thinking about AVs?
- How does this align with potential regional opportunities and challenges?
- What types of transportation issues would you like to see AVs address?

Closing Comments Questions, Part IV:

- What are some next steps that Valley Metro and/or the region can take?
- What types of information would be useful to have moving forward that would help with decision making?

APPENDIX

Detailed Demographic Analysis

Testing for Significant Differences

When surveys are being compared, analyzing demographic differences between samples is as important as discussing potential differences in major results. Although the only demographic information collected in the Post Survey was employment, other demographic variables could be matched to respondent IDs based on the answers provided in the previous surveys. Because the During Survey and Post Survey comprised subsamples of the Prior Survey, there was considerable overlap between the survey samples. Differences in demographic characteristics at person- or household-level were not substantial but could still be useful when exploring hypotheses about differences in results.

Statistical tests of differences between the samples were performed.[16] When testing between the Prior Survey and either of the other two surveys, sampling errors were computed using equation (1) for a subsample.

$$s.e.(\overline{x_1} - \overline{x_2}) = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} - \frac{2s_{12}}{n_1}} \quad (1)$$

where x_1 = mean value of characteristic in Prior Survey
x_2 = mean value of characteristic in either During or Post Survey
s_1^2 = variance of characteristic in Prior Survey
x s_1^2 = variance of characteristic in either During or the Post Survey
n_1 = sample size in Prior Survey
n_2 = sample size in either During or Post Survey
n_{12} = covariance of characteristic between Prior Survey and either During or Post Survey

For tests between the During Survey and the Post Survey, sampling errors were computed for overlapping samples, using equation (2).

$$s.e.(\overline{x_1} - \overline{x_2}) = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} - \frac{2n_c s_{12}}{n_1 n_2}} \quad (2)$$

where n_c = size of overlapping sample, i.e., number of respondents common to both During and Post Survey
n_1 = sample size of During Survey
n_2 = sample size of Post Survey

[16]Stopher, Peter R., 2012, Collecting, Managing, and Assessing Data, Cambridge University Press, Cambridge, England, 337-342.

All other symbols are similar in meaning to equation (1) except they refer to either the During Survey (subscript 1) or the Post Survey (subscript 2).

Finally, when comparing Waymo RideChoice users to non-Waymo users, there was no overlap because these are mutually-exclusive categories. In this case, tests for differences between the two rider groups were done using equation (3).

$$s.e.(\overline{x_1} - \overline{x_2}) = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \quad (3)$$

where the symbols have the same meanings as for the previous equations.

Respondent Age and Gender

Figure I-1 shows that the differences in distribution of respondent ages between the surveys do not seem to be substantial. The statistical tests showed no significant differences in the average age of participants in the three surveys; all age groups were reasonably represented in the project. On average, 20% were in the 18–30 age group, and around the same proportions were observed for the 51–60 and 71 and older age groups. The smallest age group in all three surveys was 41–50, which is also one of the two smallest age groups in the RideChoice program, as shown in Figure I-1.

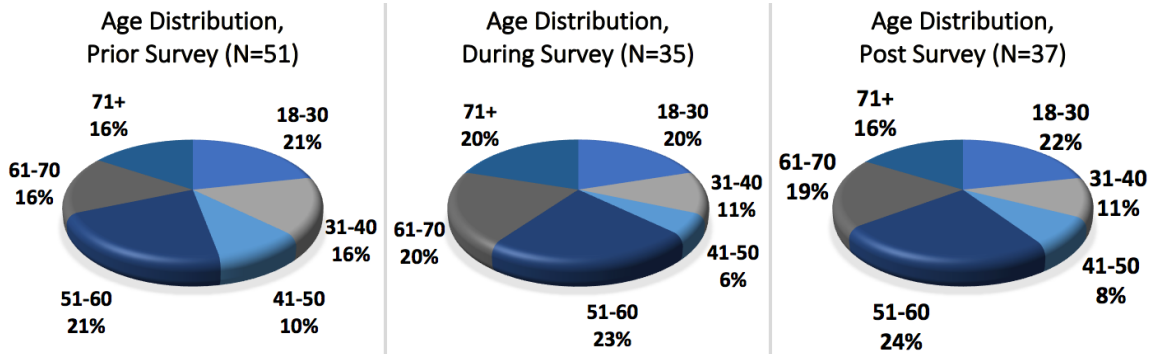


Figure I-1

Comparison of Age Distribution—Prior, During, and Post Surveys

A comparison between the ages of Waymo and non-Waymo users is shown in Figure I-2. Comparing Figure I-1 and Figure I-2, it can be seen that the Waymo RideChoice users had an age distribution very similar to all respondents to the Prior Survey, whereas the non-Waymo users were predominantly older people, with only one younger person (18–30) and no users ages 31–50. There was no statistically significant difference between Waymo and non-Waymo participants, however.[17]

[17]Most statisticians would question whether samples as small as 8 or 10 respondents can permit estimation of a variance. However, variances were estimated and, as expected, usually did not show significant differences.

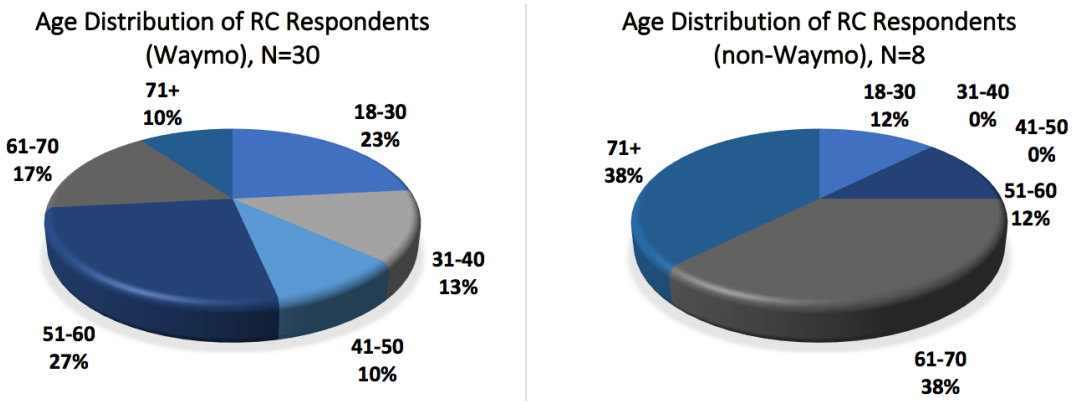


Figure I-2

Comparison of Age Distribution of Waymo and Non-Waymo Users

In the Prior Survey, 59% of respondents were males, 41% were females. The gender distribution was more balanced in the During Survey, in which 48.5% were males and 51.5% were females, and the Post Survey also showed an even distribution, with 51.4% males and 48.6% females. The difference between the Prior Survey and the During Survey was statistically significant. However, between the Prior Survey and the Post Survey and the During and Post Surveys, the differences were not statistically significant. Among Waymo RideChoice users, the gender split was much more even, with 48.3% males and 51.7% females; in contrast, non-Waymo users were predominantly males, at 71.4%; 28.6% were females. However, because of the small sample size of the non-Waymo users, this was not a significant difference.

Household Size, Vehicles, and Income

Figure I-3 shows that the household size distribution of the Post Survey sample was similar to the Prior Survey distribution. Among the three surveys, the Post Survey showed the lowest proportion of single-member households (15.8%) but had the highest proportion of households with three members (34.2%) . Overall, most respondents lived in either a 2- or 3-person household, and meaningful differences were not observed across surveys. The differences between the three surveys were not statistically significant.

Although average household size does not show any significant differences, there were multiple changes within individual households. Results described here are for the 34 respondents who answered all three surveys. In the Prior Survey, five respondents were living in 1-person households, one of whom reported living in a 2-person household in the During Survey. Overall, 12 respondents indicated they lived 2-person households in the Prior Survey. Of these, only seven indicated they

lived in 2-person households in the During Survey, two of whom reported living in a 1-person household in the During Survey, two reported living a 3-person household in the During Survey, and one (possibly in error) indicated living in a 6-person household in the During Survey. Overall, 12 respondents reported living in a 3-person household in the Prior Survey, of which 6 reported being in a 3-person household in the During Survey. In the During Survey, one of these respondents reported being in a 1-person household, one in a 2-person, three in a 4-person, and one in a 5-person household. The three respondents who reported living in a 4-person household in the Prior Survey also reported living in a 4-person household in the During Survey. None of the respondents who completed all three surveys indicated 5 persons in the household in the Prior Survey, and the one person in a 6-person household in the Prior Survey still reported living in a 6-person household in the During Survey.

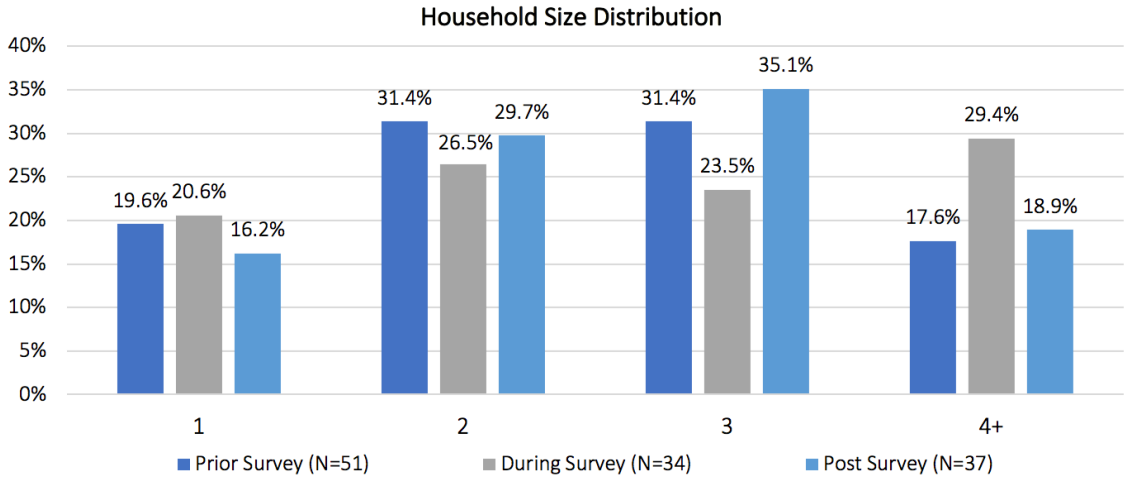


Figure I-3

Comparison of Household Size

Figure I-4 shows the comparison between the household sizes of Waymo and non-Waymo users. As can be seen, Waymo RideChoice users were similar to all respondents to all three surveys, and non-Waymo users were dominated by household sizes of 2 and 4 or more, each of which comprises over one-third of the sample. These differences, however, were not statistically significant.

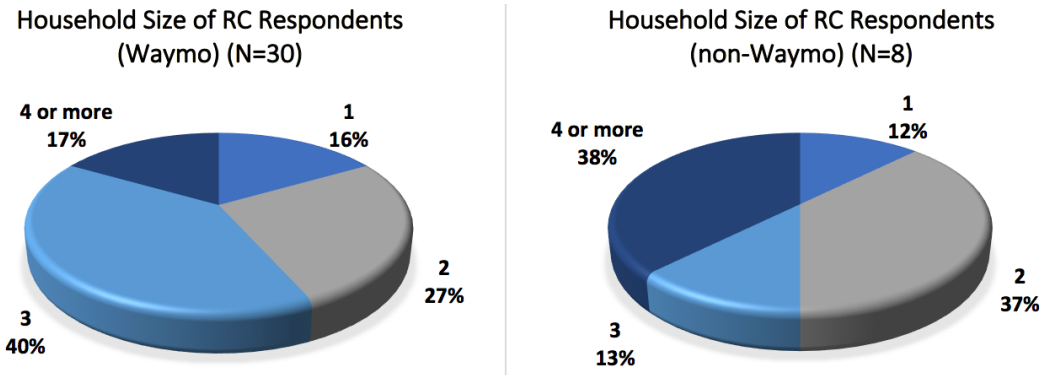


Figure I-4

Comparison of Household Sizes of Waymo and non-Waymo Users

The type of housing unit showed very minor changes across the three surveys, as shown in Figure I-5. Only respondents to the Prior Survey indicated Other as a category. Otherwise, the percentages varied minimally.

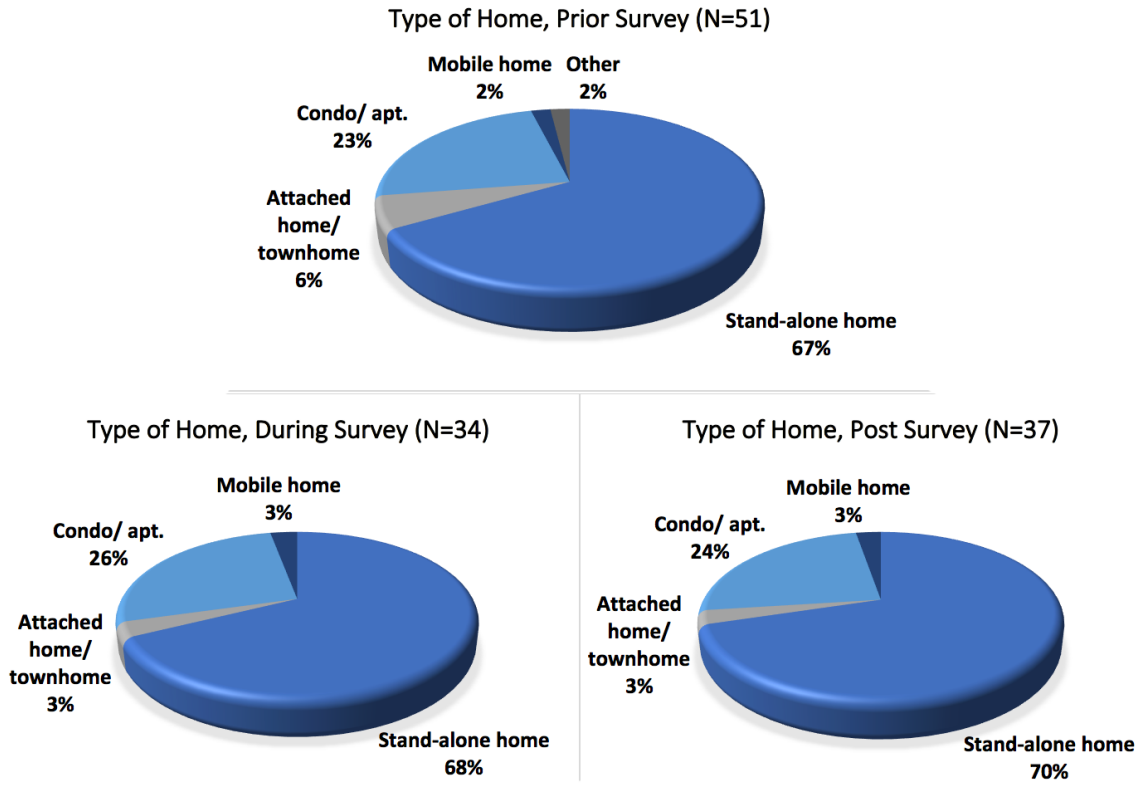


Figure I-5

Comparison of Housing Type

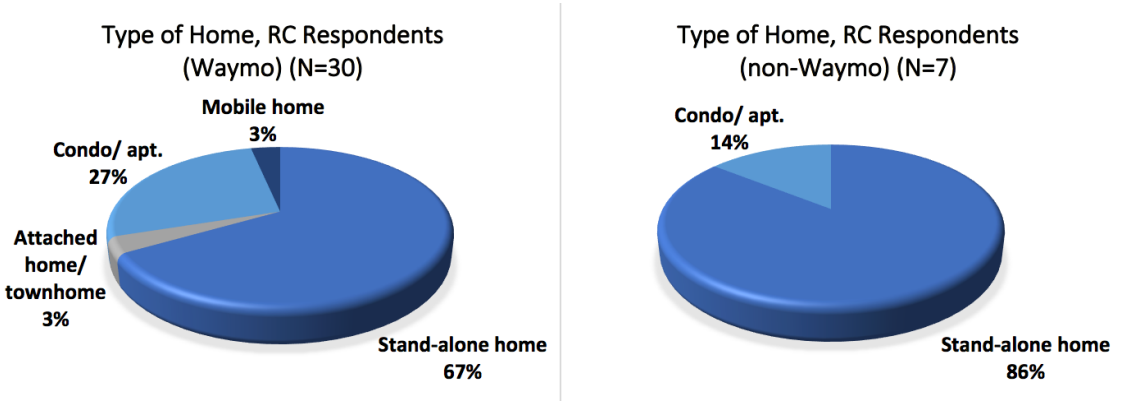


Figure I-6

Comparison of Housing Type for Waymo and non-Waymo Users

Respondents were also asked if they lived in a gated community. Such communities pose more difficulties for RideChoice rides to be provided because taxis, Uber/ Lyft, and Waymo do not have easy access to the interior of the gated community and must be let in by the rider. There was almost no change between the surveys, with overall around 23% of respondents living in a gated community. However, the difference between Waymo and non-Waymo users was quite marked, with 14% of Waymo RideChoice users living in a gated community and 57% of non-Waymo users living in gated communities. This may have contributed to the latter group not using Waymo. The difference between Waymo RideChoice users and all respondents was statistically significant at 95% confidence.

Minor changes were seen across the three surveys in terms of number of vehicles available in the household. The During Survey showed the lowest percentage of respondents having one vehicle available at home (32.4%) , a similar percentage (33.3%) was observed in the Prior Survey, and the highest percentage was seen in the Post Survey sample, which reached 37.8% (Figure I-7). About one quarter of respondents lived in a household with no vehicle available at home. On average, 25–30% of respondents had two vehicles available in their households, and 12-15% had three or more. These numbers might help explain their attitudes towards self-driving technologies and mobility-on-demand services as well as their travel patterns. There were no significant differences between the surveys in terms of vehicle availability.

There was also little variation between the Waymo RideChoice users on this question and similarly little variation among the non-Waymo users. The latter showed no one living in an attached dwelling or a mobile home, as shown in Figure I-6.

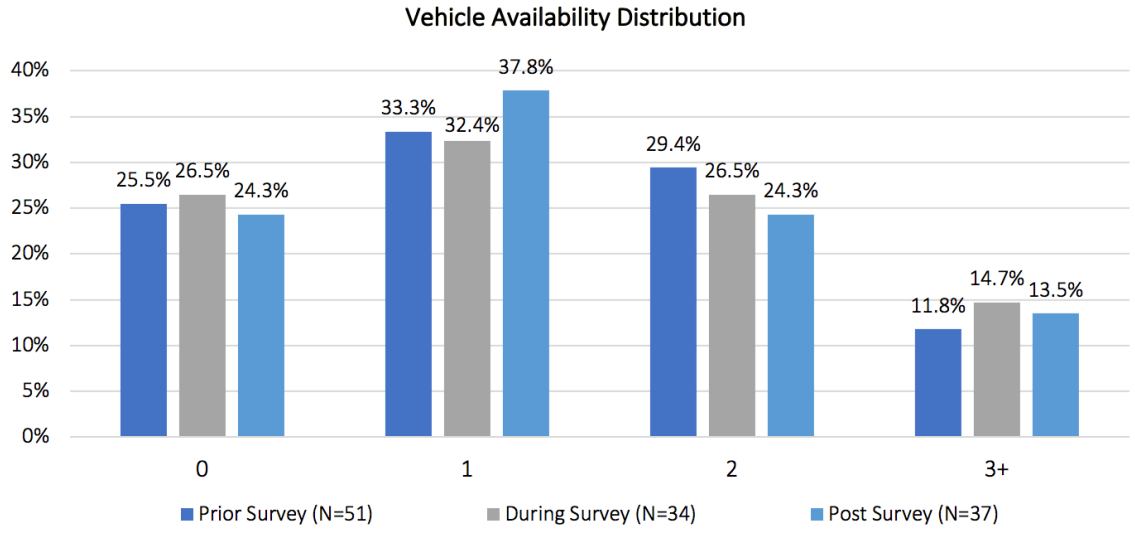


Figure I-7

Comparison of Number of Vehicles Available in Household

As for the previous demographics, the distribution of vehicles for the Waymo RideChoice users was similar to that of all respondents, as shown in Figure I-8. However, non-Waymo users included no respondents with no vehicles available and much higher proportions of one-vehicle and three or more vehicle households. The differences, however, were not statistically significant.

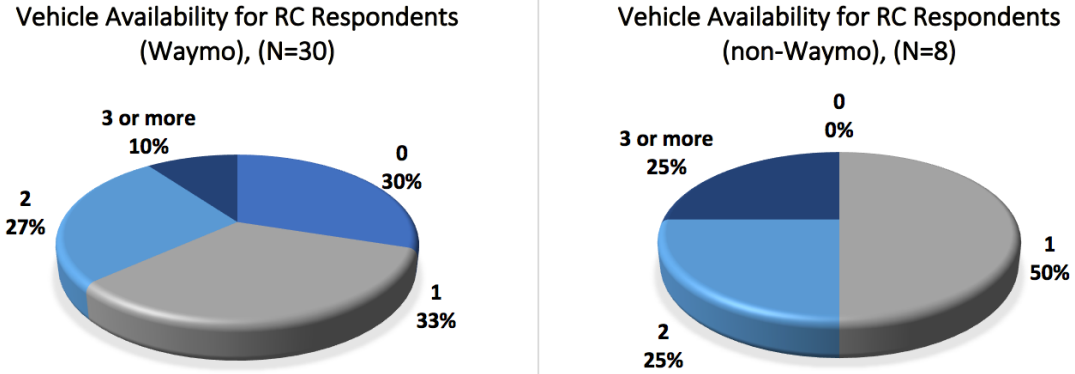


Figure I-8

Comparison of Vehicle Availability Between Waymo and non-Waymo Users

In Figure I-9, a comparison was conducted for household income across the surveys; it appears that the samples were not materially different, although in the Post Survey there was a lower percentage of respondents earning between $75,000 and $99,999 per year and none who earned in excess of $150,000; the other groups seem to be virtually equal. Statistical tests showed that the differences among the three surveys were not statistically significant. It

is interesting to analyze income patterns because there may be a significant relationship between this variable and willingness to pay for RideChoice services or future self-driving vehicle MOD services and also because it might impact people's perceptions of new transportation technologies.

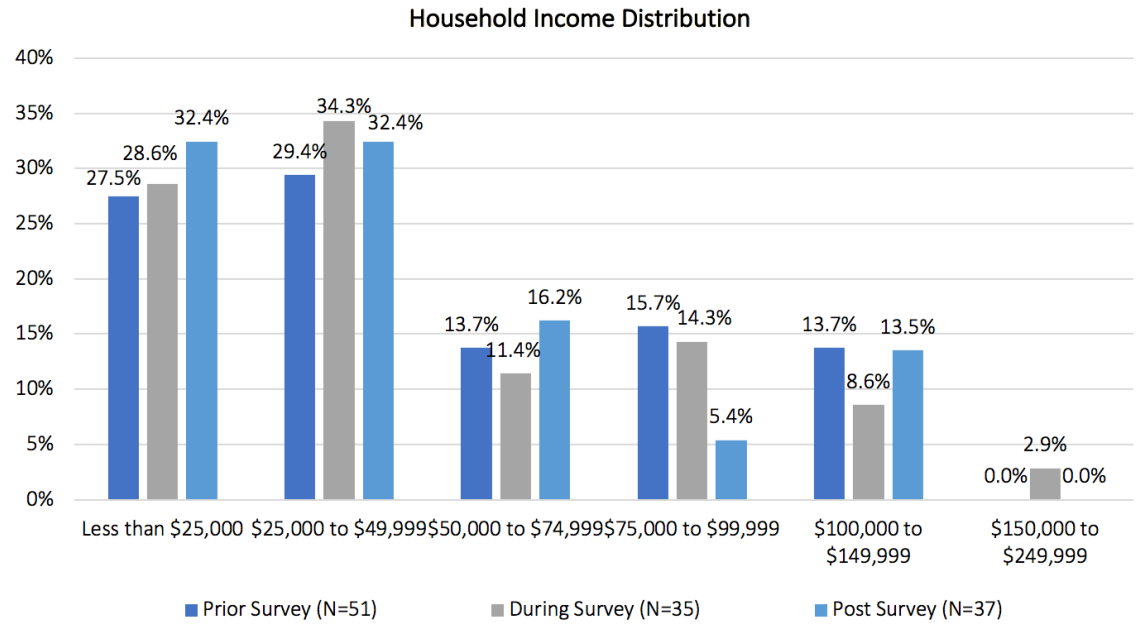


Figure I-9

Comparison of Household Income

Figure I-10 shows that the income distributions are somewhat different for Waymo and non-Waymo users compared to the overall sample. The Waymo RideChoice users showed a higher proportion of respondents in the $25,000 to $49,999 bracket, with fewer respondents in the next two brackets. In contrast, non-Waymo users were predominantly in the $50,000 to $74,999 bracket but with about the same proportion of users in the $100,000 to $149,999 bracket. The only respondent reporting an income above $149,999 did so only to the During Survey and could not be classified as a Waymo or non-Waymo rider based on the Post Survey questions. Again, none of these differences was statistically significant.

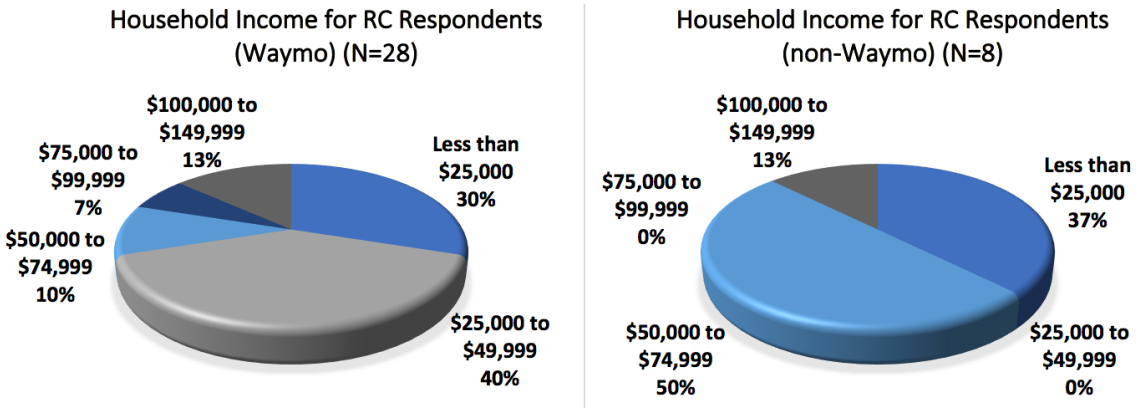


Figure I-10

Comparison of Household Income Between Waymo and non-Waymo Users

Employment, Occupation, Student, Education, and Disability

For employment status, Figure I-11 shows a comparison between the three surveys. This question was asked in all three surveys. A problem with the comparisons of the Prior Survey to the other two surveys was that a disproportionate number of employed people were non-respondents to the other two surveys. The reason for this could be that the incentive to respond was more significant for people who were not employed. This would be expected to result in an increase in the percentages of most, if not all, other categories. Prior Survey and During Survey differences were not significant, nor were the differences between the During and the Post Surveys. However, the Prior Survey results were statistically very significantly different (at 99% confidence) from the Post Survey. It is useful to look at the dynamics of change in employment status, which were quite marked.

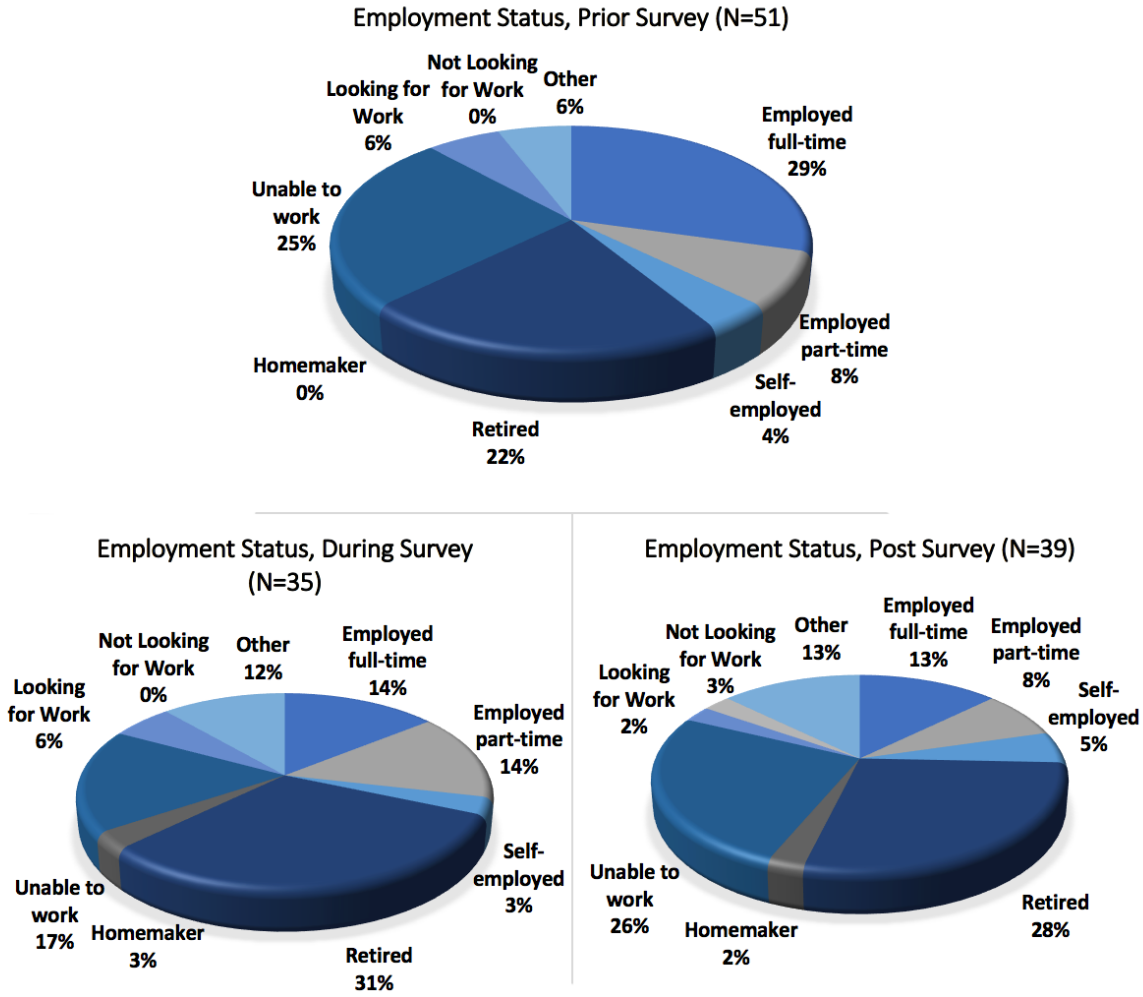


Figure I-11

Comparison of Employment Status

Looking in more detail at employment, which was asked in all three surveys, the following observations were made. Five of the 34 respondents to all three surveys reported working full-time in all three surveys. However, one reported a change from full-time work to part-time and one to "other," with both of these changes taking place between the During and the Post Surveys. Similarly, three respondents reported being employed part-time in all three surveys and one was self-employed in all three surveys. In the During and Post Surveys, nine respondents reported being retired, one of whom reported being unable to work in the During Survey. In the Prior Survey, 10 people indicated that they were unable to work, and 5 reported being unable to work in both the During and Post Surveys; one of these reported being retired in the During and Post Surveys, and one was a homemaker in both surveys. Two of these respondents reported being unable to work in the Post Survey, one of whom had reported being unemployed

and looking for work in the During Survey and one indicated "other." In the Prior Survey, one respondent indicated looking for work, then was employed part-time in the During Survey and unable to work in the Post Survey. It is not clear that these employment status changes were a result of the pandemic, although it may have influenced some of the changes.

Figures I-12, I-13, and I-14 compare the employment status of Waymo and non-Waymo users for each of the surveys, as this question was asked in each survey and answers changed over the course of the project. Employment status was quite different between Waymo RideChoice users and non-Waymo users and also different between the three surveys. Also, employment status changed much more for non-Waymo users than for Waymo RideChoice users. Only in the Prior Survey did any non-Waymo users report being unable to work. This category did not appear in the During and Post Surveys. Similarly, the category of Unemployed and Not Looking for Work appeared only in the Post Survey for non-Waymo users. No non-Waymo user was employed, either in full-time, part-time, or self-employment, which is consistent across all three surveys. No differences between surveys within each group of Waymo RideChoice users and non-Waymo users was significantly different. Likewise, no differences between Waymo RideChoice users and non-Waymo users within each of the three surveys was statistically significantly different, probably due to the very small sample size of the non-Waymo user group.

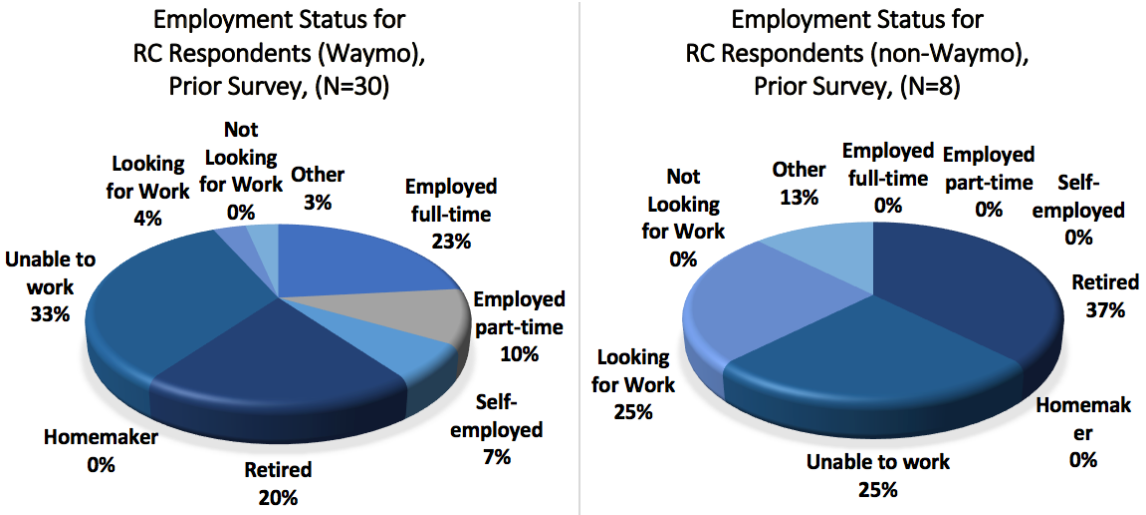


Figure I-12

Comparison of Employment Status for Waymo and non-Waymo Users in Prior Survey

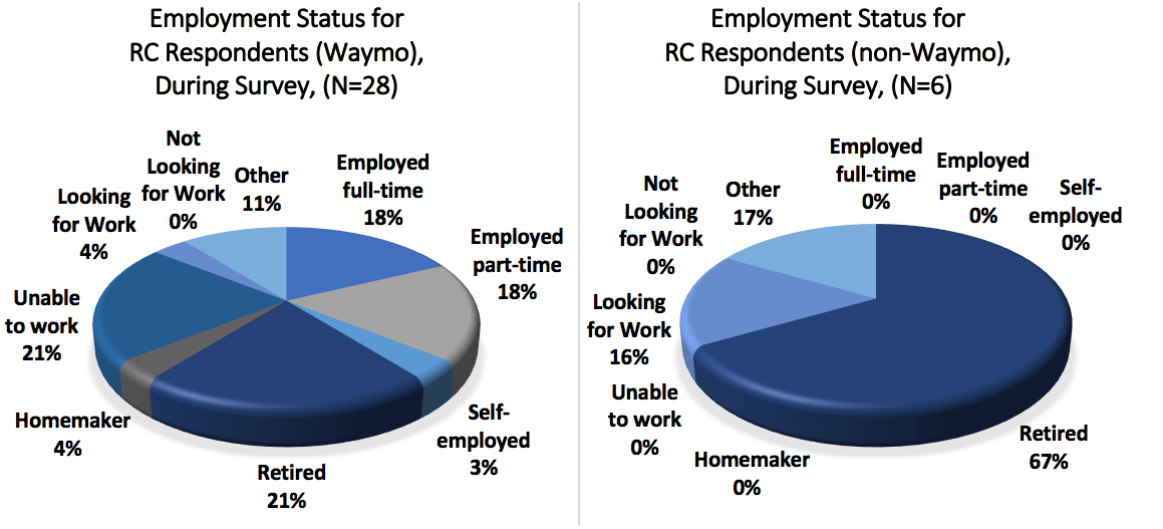


Figure I-13

Comparison of Employment Status for Waymo and non-Waymo Users in During Survey

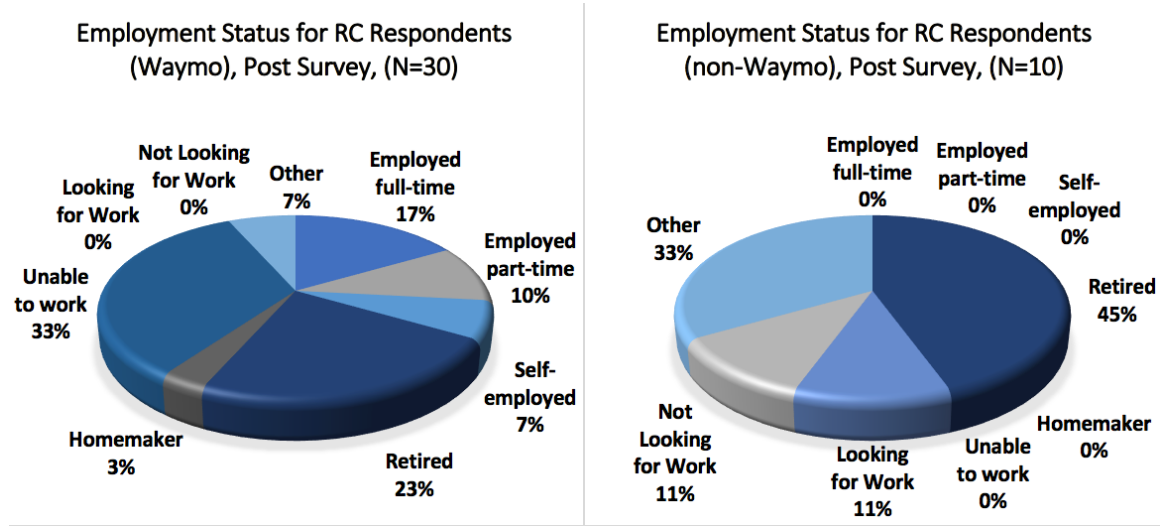


Figure I-14

Comparison of Employment Status for Waymo and non-Waymo Users in Post Survey

Figure I-15 shows the comparison of occupations between the three surveys. Of the 21 respondents who answered the Prior Survey and indicated an occupation, 10 did not respond to the During Survey and 9 did not respond to the Post Survey; only 10 respondents indicated their occupation on all three surveys, and 9 did not respond to either the During or the Post Survey. Statistical tests of the comparison of the three surveys on occupation showed no significant differences, probably as a result of the small number of respondents to the During and Post Surveys. It is also possible that differences between the three surveys in this case are a result of the same person categorizing themselves differently on the different surveys. As the question was not asked in the Post Survey, the category indicated in the most recent completed survey was assigned for the Post Survey. Differences between the surveys were not statistically significant. Because no non-Waymo users were employed, this question was not asked of any non-Waymo user. Results shown in Figure I-15 are all based on Waymo RideChoice users only.

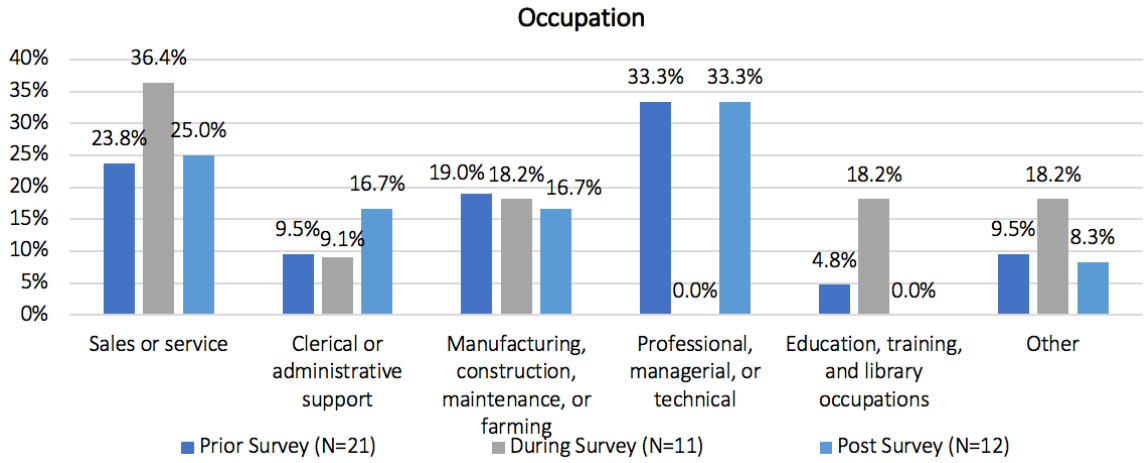


Figure I-15

Comparison of Occupation Between Three Surveys

In the Prior Survey, three respondents indicated being full-time students and five were part-time students. In the During Survey, only one respondent indicated being a part-time student, and there were no full-time students among the respondents. In the Post Survey, there were three part-time students among the respondents and no full-time students. In the During Survey, one of the full-time students and one of the part-time students were no longer students. Because this question was not asked in the Post Survey, it was assumed that the two students were still no longer students at that time. Based on the responses from the Prior and During surveys, two of the non-Waymo users (25%) were students, representing a much higher proportion than for the Waymo RideChoice users, with three of them being students (10%). The difference in responses to the Prior and During surveys was statistically significant, but differences between the Prior and Post Surveys and the During and Post surveys were not significant.

Education level attained showed very little difference across the three surveys, as shown in Figure I-16. There were no statistically significant differences among the three surveys, and the percentages at each level are very similar. This suggests that, unlike the employment status, there was no particular difference among the respondents and non-respondents on the latter two surveys.

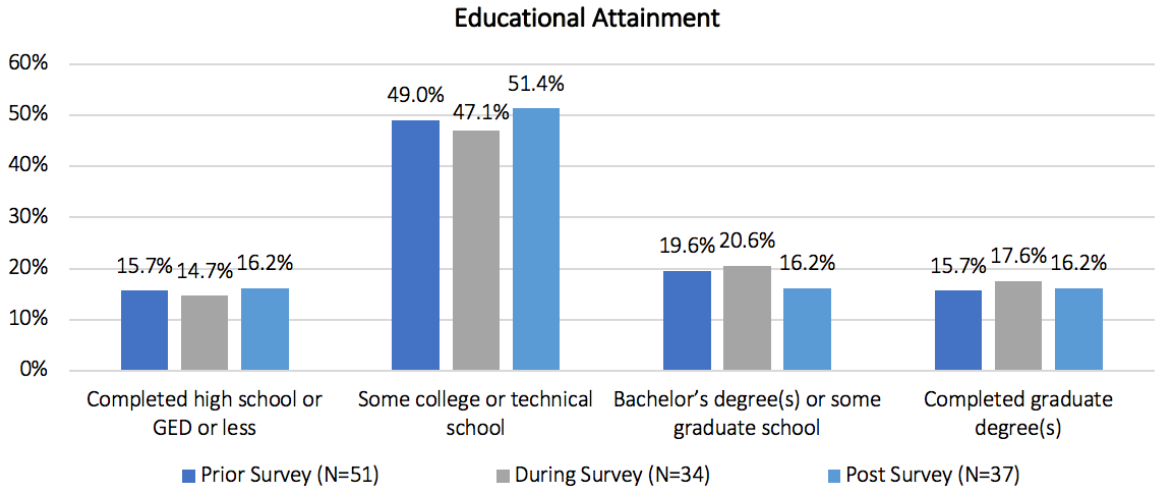


Figure I-16

Comparison of Educational Attainment

RC Respondents (non-Waymo) showed a different distribution from RC Respondents (Waymo), with 62.5% of RC Respondents (non-Waymo) having some college or technical school and 37.5% having completed a graduate degree. None of the RC Respondents (non-Waymo) reported having a GED or less, or a bachelor's degree or some graduate school. Figure I-17 shows the comparison for RC Respondents (Waymo) and RC Respondents (non-Waymo). However, these differences were not significant.

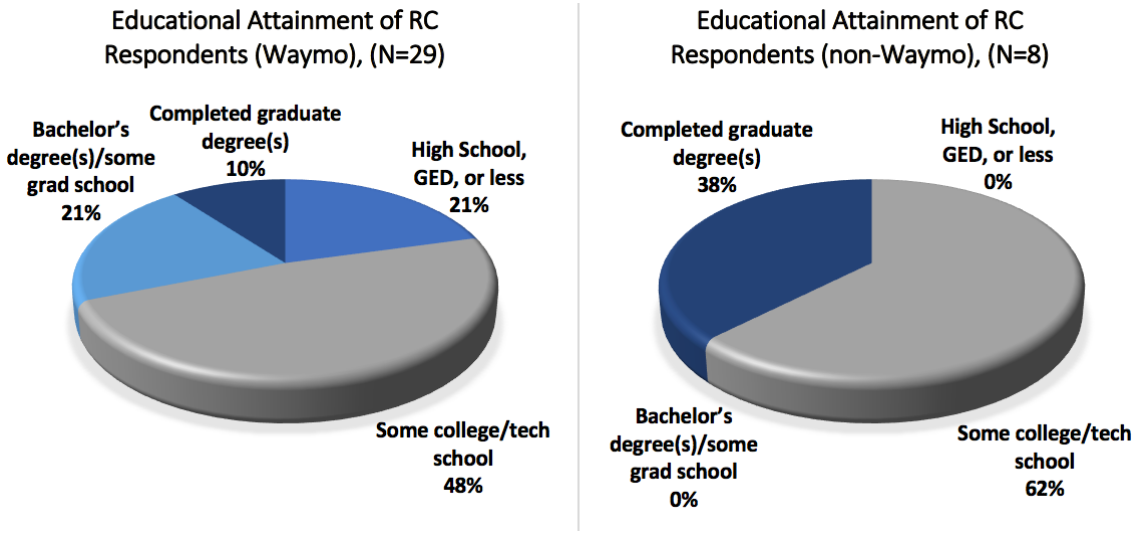


Figure I-17

Comparison of Educational Attainment for Waymo and non-Waymo Users

APPENDIX

J

Analysis of Aggregate Trip Data

In the aggregate trip roster data, because the first dataset covered a different period from the latter two, seasonality bias may have occurred when comparing them and drawing conclusions. To provide a more appropriate comparison, a subsample containing data only for December, January, and February (common to all three datasets) was selected to control for that seasonal effect. Although March data were also present in all datasets, it was believed that the travel patterns of this month could be biased in the RideChoice non-Waymo and Waymo datasets (2019/2020), given the COVID-19 pandemic and travel restrictions put in place. Thus, attributes such as month of ride, trip frequency, travel time, travel distance, and time of day were examined for the restricted period, called the "common period" in the following discussion. Table J-1 provides a summary of the filtered datasets analyzed for the December to February period.

Table J-1

Summary of Trip Datasets for December-February Common Period

	RideChoice 2018/2019	RideChoice non-Waymo	RideChoice Waymo
Period	*Dec 2018 to Feb 2019*	*Dec 2019 to Feb 2020*	*Dec 2019 to Feb 2020*
Number of trips	227	206	588
Number of users	11	16	28
Service provider	Lyft	Uber	Waymo

Regarding the month of ride, Figure J-1 shows that in addition to the drop in Waymo frequency of rides (42.0%, 31.1%, and 26.9% for December, January, and February, respectively), the differences in RideChoice non-Waymo frequency of rides in 2018/2019 and 2019/2020 do not appear to be substantial, as the first went from 30.4% to 38.3%, and then 31.3% from December to February 2018/2019, and in 2019/2020 from 40.8% to 25.7%, then 33.5% for the same three-month period.

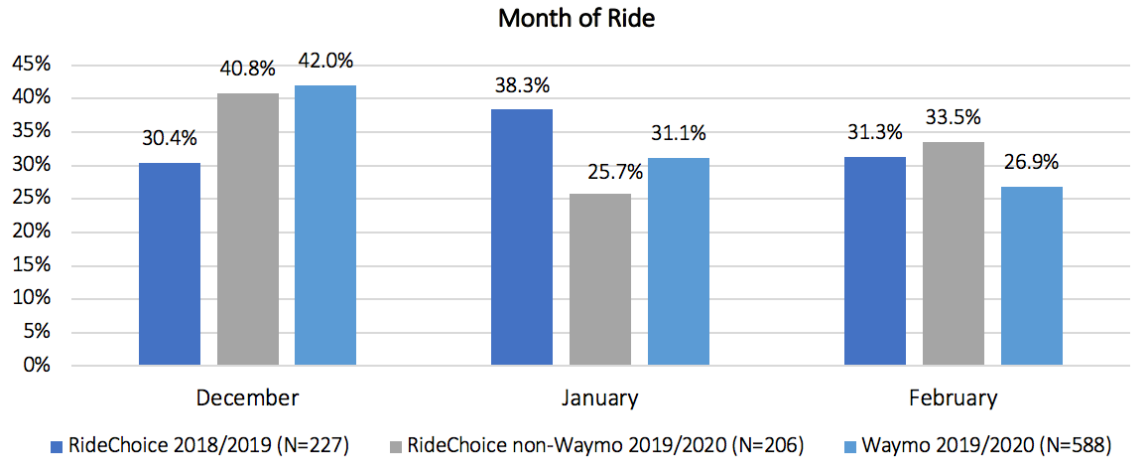


Figure J-1

Month of RideChoice non-Waymo and Waymo Trips in Common Period

On average, RideChoice 2018/2019, RideChoice non-Waymo, and RC Respondents (Waymo) took 21, 13, and 21 rides during the three-month period, respectively. Although 62.5% of RideChoice RC Respondents (non-Waymo) took 1-5 rides, only 36.4% and 35.7% of users in the RideChoice 2018/2019 and Waymo groups made that small number of trips. Additionally, although no participants in both RideChoice 2018/2019 and RideChoice non-Waymo groups took more than 60 rides in the December-February period, four Waymo participants did. The higher trip frequency may also be explained by positive perceptions of Waymo, as evidenced in the survey data. Also, the financial incentives provided to participants riding Waymo consistently may have influenced the high frequency of Waymo rides.[18] Furthermore, most participants had a limit of 20 rides per month for their non-Waymo RideChoice options but no such limit for their Waymo usage, according to Valley Metro RideChoice Program policies.

Trip travel time during the common period depicts how short the rides were for the RideChoice 2018/2019 group, in which a quarter of these rides were less than five minutes long; however, only 1.9% of the RideChoice non-Waymo group in 2019/2020 were that short (Figure J-2). The average travel times were 8.9, 13.2, and 10.0 minutes for RideChoice 2018/2019, RideChoice non-Waymo, and Waymo groups, respectively. Again, only 2.2% of Waymo rides were over 20 minutes, which is consistent with Waymo's operational territory.

[18]Participants were told they would receive a $100 Visa gift card for riding Waymo at least once per week for every 4-week period (or every month), a strategy put in place to incentivize ridership. However, because ASU did not have weekly ridership status information, gift cards were sent to those who rode Waymo at least once per month (Waymo shared monthly ridership status for each participant). Participants were not told this was the method being used to send the gift cards.

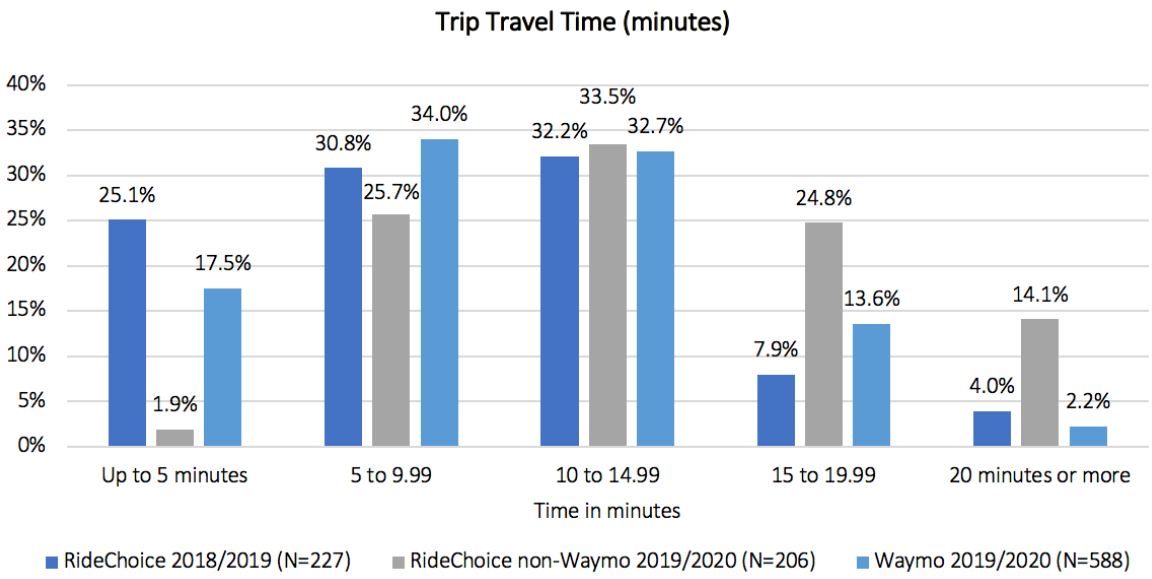


Figure J-2

Travel Duration Distribution of RideChoice non-Waymo and Waymo Trips in Common Period

Trip length patterns were also explored across the different datasets in the December–February period, as shown in Figures J-3 and J-4. Although the shorter rides in the RideChoice 2018/2019 group are obvious, another interesting highlight was the diversity in travel distances in the RideChoice non-Waymo group, which were more evenly distributed than the other two groups. The average trip distances were 3.1, 5.5, and 4.6 miles for RideChoice 2018/2019, RideChoice non-Waymo, and Waymo groups, respectively.

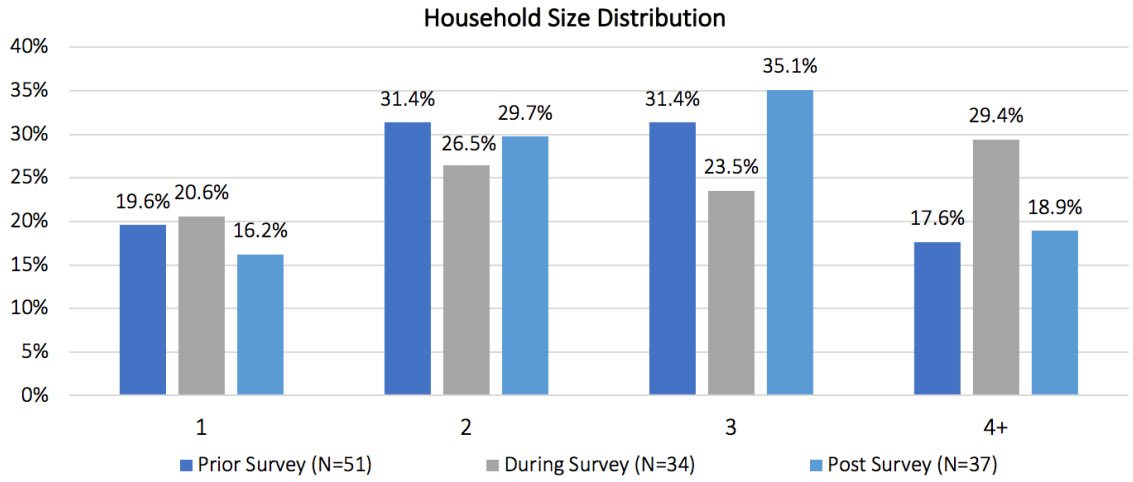


Figure J-3

Trip Length Distribution of RideChoice non-Waymo and Waymo Trips in Common Period

For start times of rides, it is noticeable that RideChoice non-Waymo showed a substantially lower percentage (13.1%) of rides during the midday period (9:00 AM–3:00 PM), whereas RideChoice 2018/2019 and Waymo showed 40.5% and 35.2% of their rides in the same period of the day, respectively (Figure J-4). Despite a low percentage of trips during the midday period, RideChoice non-Waymo rides in 2019/2020 were more frequent (61.2% of rides) during the PM peak period (3 –7:00 PM), whereas RideChoice 2018/2019 and Waymo had 31.7% and 30.6% respectively. Additionally, Waymo rides showed higher proportions in the overnight and early morning periods.

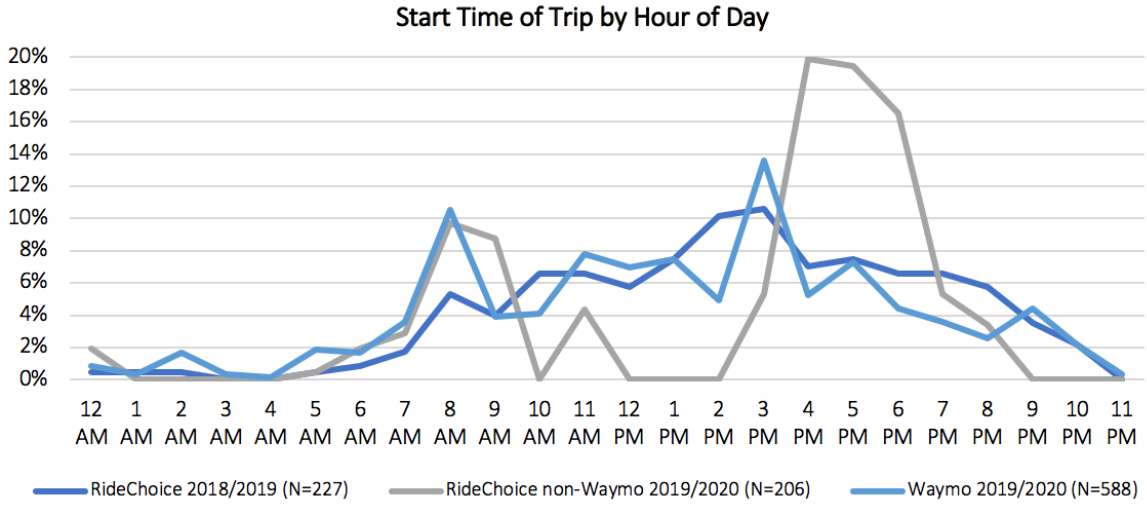


Figure J-4

Distribution of RideChoice non-Waymo and Waymo Trips by Hour of Day in Common Period

Although Waymo rides within the RideChoice Program were longer in 2019/2020 compared to non-Waymo RideChoice rides in 2018/2019, they were substantially less costly. The average total cost (cost that a service provider charges Valley Metro for a ride) for Waymo rides was $9.30, as opposed to $14.60 for RideChoice rides in 2018/2019. It is important to consider that RideChoice pricing policies were changed in December 2018, right before the period analyzed, which may have influenced these results. A summary with the main highlights from a comparison of trip characteristics is provided in Table J-2.

Table J-2

Summary of RideChoice non-Waymo and Waymo Rides in December–February Period

	RideChoice 2018/2019 (N=227)	RideChoice non-Waymo 2019/2020 (N=206)	Waymo 2019/2020 (N=588)
Average travel time (min)	8.9	13.2	10.0
Average travel distance (mi)	3.1	5.5	4.6
Average total cost	$ 14.60	N/A	$ 9.30
Number of users taking at least one ride over 8 mi (% of total)	8/11 (73%)	10/16 (63%)	9/28 (32%)
Number of rides over 8 mi (% of total)	14/227 (6%)	36/206 (17.5%)	94/588 (16%)
Average travel time of rides over 8 mi (min)	18.0	19.0	17.5
Average travel distance of rides over 8 mi (mi)	9.4	10.1	11.1

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