Consumer Acceptance, Trust, and Future Use of Self-Driving Vehicles

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Performed in cooperation with the
Frisco Transportation Management Association

August 2019

Disclaimer

This research was supported by and performed in cooperation with the Frisco Transportation Management Association (TMA), including the City of Frisco, Denton County Transportation Authority (DCTA), Frisco Station Partners, Blue Star/The Star, and HALL Group/HALL Park. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Frisco TMA. The research in this report does not constitute a standard, specification, or regulation.

Acknowledgments

This research was supported by and performed in cooperation with the Frisco TMA, including the City of Frisco, DCTA, Frisco Station Partners, Blue Star/The Star, and HALL Group/HALL Park. The authors would like to thank Brian Moen and Kerin Smith of the City of Frisco for their support and valuable discussions throughout this research effort. The authors would also like to acknowledge Texas A&M Transportation Institute (TTI) researchers June Greeman and Brittney Gick for their help in coding the open text questions of the online survey and taking notes during the Frisco focus group, respectively, as well as TTI editor Dawn Herring for her editorial review.

Table of Contents

List of Figures vi

List of Tables vi

Introduction 1

Methodology 3

- Online Survey of Frisco Residents 3
- Focus Group of Frisco Drive.ai Pilot Riders 4

Results 5

- Self-Driving Vehicle Knowledge, Awareness, and Experience 5
- Self-Driving Vehicle Acceptance, Preferences, and Opinions 5
- Behaviors Related to Level 5 Self-Driving Vehicles 12
- Overall Benefits and Concerns of Self-Driving Vehicles 14
- Drive.ai Experience 14

Conclusions 16

References 17

Appendix: Frisco Automated Vehicle Online Survey 18

- Informed Consent 18
- Questionnaire 18

List of Figures

Figure 1. Frisco Drive.ai Pilot Service Area. 1
Figure 2. SAE Levels of Automated Vehicle Technology. 2
Figure 3. Frisco Survey Initial Recruitment Post in the *Focal Point* Newsletter. 3
Figure 4. Reported Ridership in a Level 4 or 5 Vehicle Technology....5
Figure 5. Opinion Toward Level 4/5 Vehicle Technology by Experience Riding in a Self-Driving Vehicle. 6
Figure 6. Preferred AV Level to Own. 6
Figure 7. Preferred AV Level to Own by Age. 7
Figure 8. Preferred AV Level to Own by Technology Adoption. 8
Figure 9. Preferred AV Level to Own by Experience with Ride-Haling. 8
Figure 10. Preferred AV Level to Own by Experience with ADASs....9
Figure 11. Preferred AV Level to Own by Experience Riding in a Self-Driving Vehicle. 9
Figure 12. Most Trusted AV Level to Reduce Crash Likelihood. 10
Figure 13. Most Trusted AV Level to Reduce Crash Likelihood by Experience Riding in Self-Driving Vehicle. 11
Figure 14. Preferred AV Level to Own versus Most Trusted AV Level to Reduce Likelihood of Being in a Crash. 11
Figure 15. Fear of Using a Level 5 AV by Experience Riding in a Self-Driving Vehicle. 12
Figure 16. Preferred Form of Level 5 Self-Driving Vehicle. 13
Figure 17. Preferred Mobility Option of Level 5 Self-Driving Vehicle.... 14

List of Tables

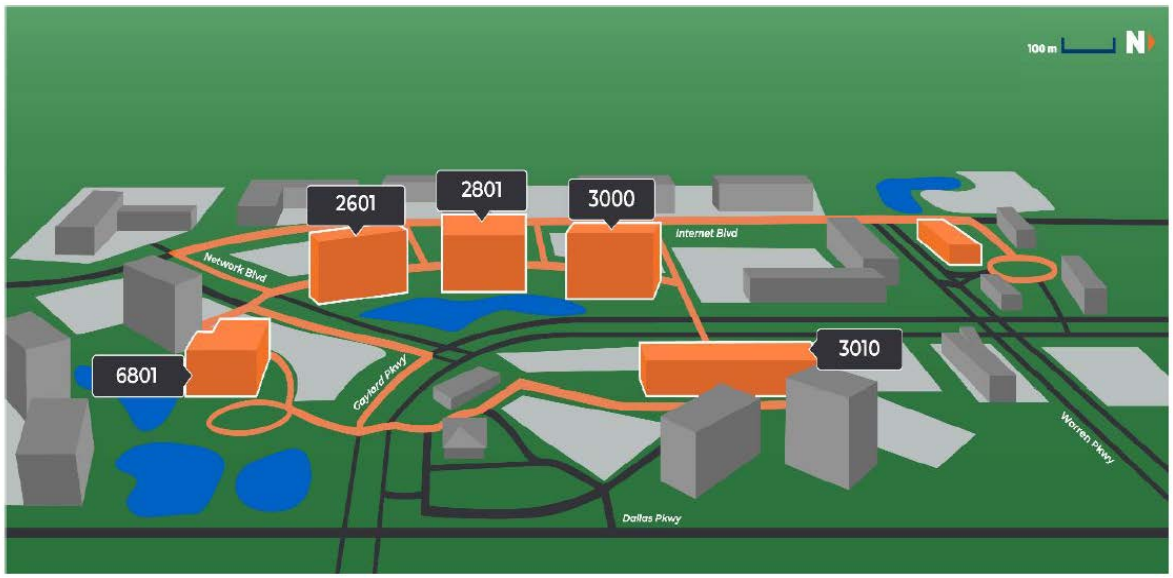
Table 1. Focus Group Participant Demographics....4

Introduction

Self-driving vehicles bring the promise of safer streets, reduced congestion, enhanced traffic flow, and greater mobility inclusion. However, more information is needed to fully assess how self-driving vehicles will impact drivers, the economy, equity, the environment, and the overarching concern—safety.

According to the U.S. Department of Transportation, more than 1,400 self-driving cars, trucks, and other vehicles are currently in testing by more than 80 companies across 36 U.S. states and the District of Columbia (Etherington, 2019). Thus far, single-occupancy vehicles (traditional cars) are the prevailing mechanism for autonomous technology experimentation, although a number of cities are testing low-speed shuttles. Cities can derive educational value from the pilots, including information on the specific nature of the technology, its capabilities, operating challenges, and how the city's own typography impacts performance. Pilot cities get advanced knowledge of and better insight into the public's willingness to accept a self-driving vehicle presence and, in turn, can use their pilots to educate the public.

Seeking such benefits, in July 2018, Frisco, Texas, became the first city to pilot-test a self-driving shuttle service on public roads in Texas. The service, launched by Drive.ai, provided rides to employees and residents of HALL Park, a large office campus in Frisco (Figure 1).



Source: Brian Moen, City of Frisco

Figure 1. Frisco Drive.ai Pilot Service Area.

The Drive.ai pilot in Frisco involved the following:

- Ride-hailing service.
- Geofenced area.
- Well-mapped fixed route.
- Onboard safety drivers.
- Three Nissan NV200s vans.

Travelers could request a free ride using a Drive.ai app, and the vans would pick them up and drive them a short distance to nearby shops and restaurants. The pilot operated for 8 months and served nearly 5,000 riders across 3,100 trips.

The Drive.ai pilot represented Society of Automotive Engineers (SAE) Level 4 automation since it operated in a well-mapped geofenced area on a fixed route. Figure 2 depicts the differences among automation levels as prescribed by SAE.

VEHICLES WITH AUTOMATION

LEVEL	0 None	1 Assistance	2 Partial	3 Conditional	4 High	5 Full
What car does	Nothing	Assists; Accelerate, brake or steer	Assists; Accelerate, brake and steer	Everything for short periods of time	Everything restricted operating environment	Everything
What driver does	Everything	Everything with some assistance	Everything with more assistance	Remain alert ready to resume control	Nothing restricted operating environment	Nothing

Source: Johanna Zmud, Texas A&M Transportation Institute

Figure 2. SAE Levels of Automated Vehicle Technology.

The timeline for when self-driving vehicles will evolve from their testing phase to become a concrete reality for consumers is highly uncertain. Automotive manufacturers and suppliers, such as GM, Daimler, Ford, Continental, and Bosch, along with technology firms, such as Drive.ai, Google, and Tesla, are making significant investments in hardware and software capabilities as well as in testing and piloting vehicles. Yet, many industry analysts suggest that it could take a decade or more to address the many technology, public perception, legal, and regulatory challenges (Narayanan, 2019).

Initiatives such as the Drive.ai pilot in Frisco are important for monitoring and tracking consumer acceptance, trust, and likely use of self-driving vehicles. An important transportation policy and planning question is the following: In what ways will people change current travel and location choice behavior because of access to self-driving vehicles? The answer to this question depends on how and by whom they will be adopted and used.

Researchers at the Texas A&M Transportation Institute (TTI) have been monitoring and tracking these issues for the past 5 years. They have documented the significant influence of demographic factors such as age (particularly for younger and older age segments) and having a mobility impairment; attitudinal factors such as data privacy concerns; and behavioral factors such as being an early adopter of (a) technology in general, (b) new mobility services such as ride-hailing, and (c) advanced driver assistance systems (ADASs) on their personal vehicles (Sener & Zmud, 2019; Sener, Zmud, & Williams, 2019; Zmud & Sener, 2017; Zmud, Sener, & Wagner, 2016). The Drive.ai pilot in Frisco provided TTI researchers with the opportunity to examine the influence of having taken a ride in a self-driving vehicle on individuals' acceptance, trust, and future use.

Methodology

This study included an online survey of Frisco residents, followed by a focus group of Drive.ai pilot riders. The Institutional Review Board of Texas A&M University approved the research protocol.

Online Survey of Frisco Residents

In spring 2019, TTI conducted an online survey of Frisco residents (aged 18 years or older), including both Drive.ai pilot riders and non-riders. Once the survey questions were finalized and approved, they were programmed into Qualtrics. The survey instrument was then tested by the project team members prior to fielding the survey. A video describing the levels of automated vehicle (AV) technology was embedded in the survey to raise knowledge levels and increase the reliability of responses to subsequent questions that addressed attitudes and opinions relating to the different levels of automation in vehicles today and in the future. The final survey instrument is provided in the Appendix.

The survey respondents were recruited to participate through the Drive.ai app as well as through outreach by the City of Frisco (via the *Frisco Focal Point Newsletter* and Nextdoor). The initial recruitment began on March 27, 2019, with Drive.ai's recruitment email to approximately 1,000 subscribers. On April 5, 2019, the City of Frisco announced the survey in its *Focal Point* newsletter (see Figure 3). On April 15, 2019, the survey was posted on Nextdoor, which is the world's largest private social network for neighborhoods (Nextdoor, n.d.) and has more than 62,000 residents in the City of Frisco network. The survey was posted periodically between April 15 and May 15 in both the newsletter and on Nextdoor to increase the recruitment rate. It was closed on May 19, 2019, and a total of 840 useable surveys were obtained. Among those, 620 people responded to every question asked of them.

Take the Survey: **Self-Driving Vehicles in Frisco**

The Frisco Transportation Management Association (TMA) is looking for feedback from Frisco residents about self-driving vehicles. This ten minute survey asks participants to share overall opinions about technology, public transportation, as well as regular and self-driving vehicles.

This online survey is being conducted by Texas A&M Transportation Institute (TTI) and funded by the Frisco TMA.

The Frisco TMA is a collaborative partnership between the City of Frisco, Denton County Transportation Authority (DCTA), Frisco Station Partners, Blue Star/The Star and HALL Group/HALL Park. Its first project was the recently completed self-driving vehicle pilot program in The Star, HALL Park and Frisco Station.

Figure 3. Frisco Survey Initial Recruitment Post in the *Focal Point* Newsletter.

Upon completion of the data collection, the researchers conducted checks to ensure that the final analytical dataset was logical and free of error. Once the analytical datasets and data preparation were completed, the researchers conducted several bivariate and univariate descriptive analyses to examine consumer acceptance, trust, and future use of self-driving vehicles.

Reflecting the demographics of the city, the survey sample was educated, affluent, and auto-dependent. The median age of the sample was 48. In addition, 56% of respondents identified as male, while 43% identified as female; a couple of respondents selected "other" for their gender. Nearly as many respondents had earned a post-bachelor's degree (37%) as a bachelor's degree (42%). The majority were employed and lived in households earning a total income of $150,000 or more. Over half (52%) lived in households with no children. Nearly half (48%) lived in households owning two motorized vehicles (car, truck, SUV, motorcycle, van, etc.), and 36% had three vehicles. Virtually all respondents drove almost every day (97%) and did not have any medical conditions that prohibited them from driving (99%). Other transportation modes were not regularly used. In terms of public transit, 45% never used it, and 45% used it rarely. Likewise, there were no regular users of ride-hailing services. One-third (35%) were occasional users, another third (35%) used ride-hailing rarely, and the remaining never used ride-hailing services.

Focus Group of Frisco Drive.ai Pilot Riders

After the online survey portion of the study was complete, a focus group was held with 15 persons who had taken a ride in a Drive.ai pilot vehicle. Recruited participants for the focus group were individuals over the age of 18 years who had a driver's license and owned a vehicle. In addition, participants represented a balanced mix by gender, age, and ownership of vehicles with automated features. Table 1 provides focus group participant demographics.

Table 1. Focus Group Participant Demographics.

Age Category	Gender	Automated Feature
18–34	Female	No
18–34	Female	Yes
18–34	Female	Yes
18–34	Male	No
18–34	Male	Yes
35–64	Female	No
35–64	Male	No
35–64	Male	Yes
35–64	Female	No
35–64	Male	No
35–64	Male	Yes
35–64	Female	No
35–64	Female	Yes
35–64	Male	Yes
65+	Male	Yes

Results

Self-Driving Vehicle Knowledge, Awareness, and Experience

The vast majority of survey respondents (98%) had heard of self-driving vehicles before taking the online survey. This significant level of awareness is due to national media attention on self-driving vehicles, coupled with local media attention on the Drive.ai pilot as well as direct experience of some individuals with riding in the Drive.ai vehicles. While people can imagine a world where vehicles drive themselves, they are less likely to realize that some of the automated features already in their vehicle that utilize equipment, sensors, and data represent levels leading up to the self-driving vehicle of the future. After viewing the video on AV technology embedded in the survey, 54% of the respondents rated their level of understanding as "excellent" and 39% rated it as "very good."

The foundational level of knowledge could have been higher for this sample than for others. Many had experience with AV technology. A little more than half (53%) reported frequent use of personally owned vehicles with advanced safety driver assistance features that can intervene in the driving of the vehicle, such as lane keeping assist or automated parking assist. These vehicles would be at an SAE Level 1 or 2. In addition, respondents were asked if they had ever taken a ride in a Level 4 or 5 self-driving vehicle. As seen in Figure 4, about one in five respondents (18%) had ridden in a Level 4 or Level 5 self-driving vehicle (mostly in Frisco but also in some other cities such as Las Vegas and San Francisco).

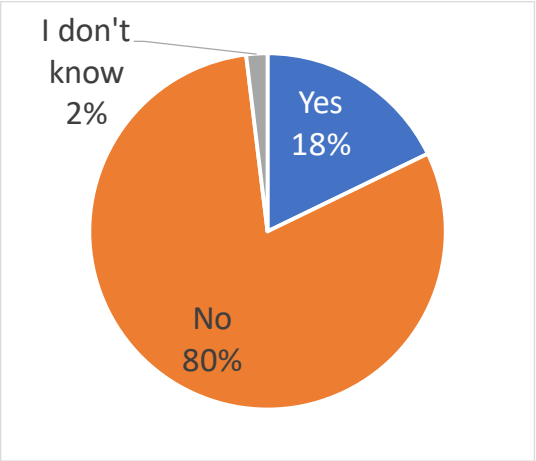


Figure 4. Reported Ridership in a Level 4 or 5 Vehicle Technology.

Self-Driving Vehicle Acceptance, Preferences, and Opinions

The majority of sampled Frisco residents (54%) had a favorable opinion of self-driving technology, while 24% had a negative opinion and 22% were neutral. Past experience riding in a self-driving vehicle, like in the Drive.ai pilot, had a positive effect. While 78% of respondents who had experienced self-driving vehicles had a positive opinion, that value dropped to 49% for people who had not experienced riding in a Level 4 or 5 AV (see Figure 5).

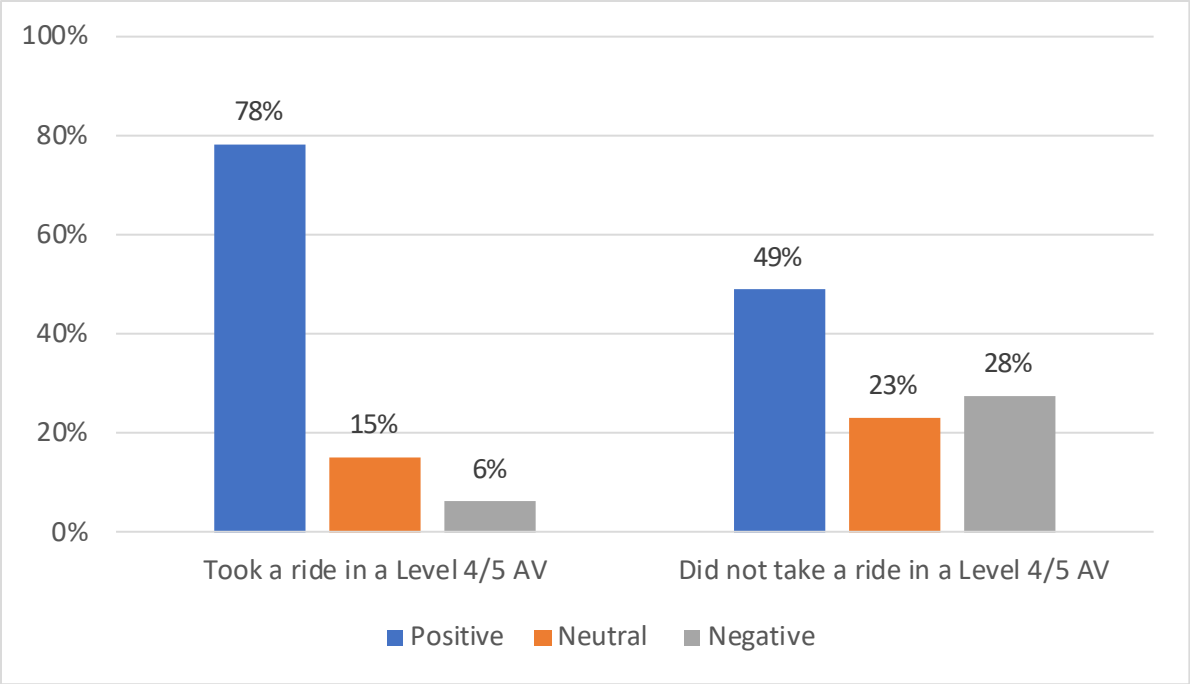


Figure 5. Opinion Toward Level 4/5 Vehicle Technology by Experience Riding in a Self-Driving Vehicle.

Respondents were asked their preferred level of AV technology if cost were no barrier and they could own a vehicle with any level of automated technology within the next couple of years. As seen in Figure 6, acceptance of vehicles at higher levels of automation (Levels 4 and 5) was high.

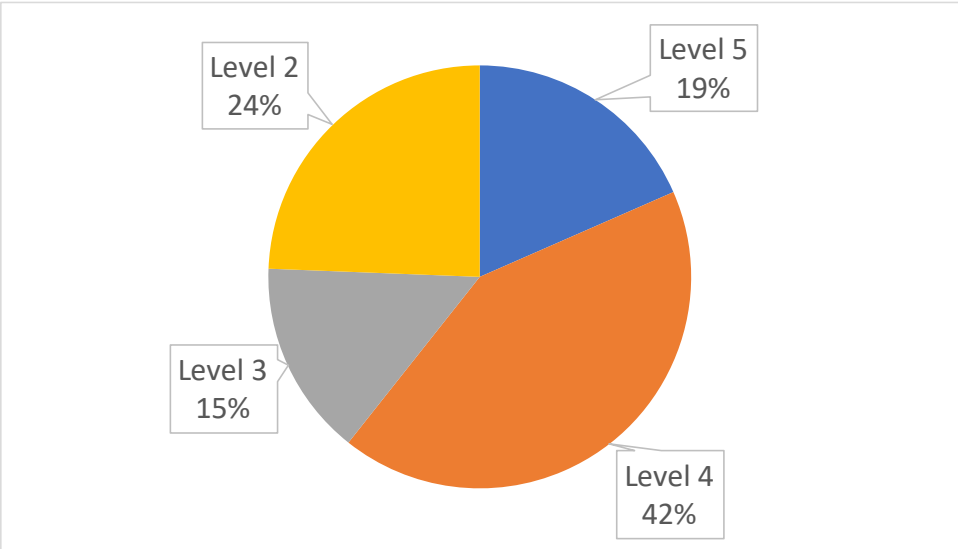


Figure 6. Preferred AV Level to Own.

Results from the open-ended text responses indicated that many people did not prefer (or accept) Level 5 vehicles yet because they did not fully trust the technology. They understood that at this level, the onboard computer system is completely in charge of the driving, and they were generally not ready to cede that level of control to an autonomous vehicle. However, a small proportion of people—nearly one in five (19%)—were ready to cede control of driving to an AV. The most frequently cited reasons for preferring to own vehicles at Level 5 were (a) trust in the technology, (b) personal benefits (such as making travel less stressful, more relaxing, and fun), and (c) societal benefits (such as increasing safety, reducing congestion, and reducing the need for parking).

In regard to lower levels of automation, about one in four respondents (24%) noted that they would prefer a Level 2 vehicle, which is the highest level of automated technology in vehicles today. The smallest proportion of respondents reported a preference to own a Level 3 vehicle (15%). At this level of automation, the vehicle controls the driving task for short periods of time and the driver must remain alert to take over at any time. This low preference level was generally attributed to the fact that people believed this setup is not consistent with the main benefit of automated systems—to be able to do other things or zone out during driving.

When looking at demographics, the results indicated that preference to own a vehicle at Level 4 or 5 was highest among young people (18–34 and 35–44 years of age; Figure 7), early adopters of technology (Figure 8), current users of ride-hailing services (Figure 9), and those with ADASs in their personally owned vehicles already (Figure 10). Finally, as shown in Figure 11, people who had experienced self-driving vehicles were also significantly more inclined to own a vehicle at the higher levels of automation than those who had not: Level 4 (52% vs. 42%) and Level 5 (28% vs. 17%).

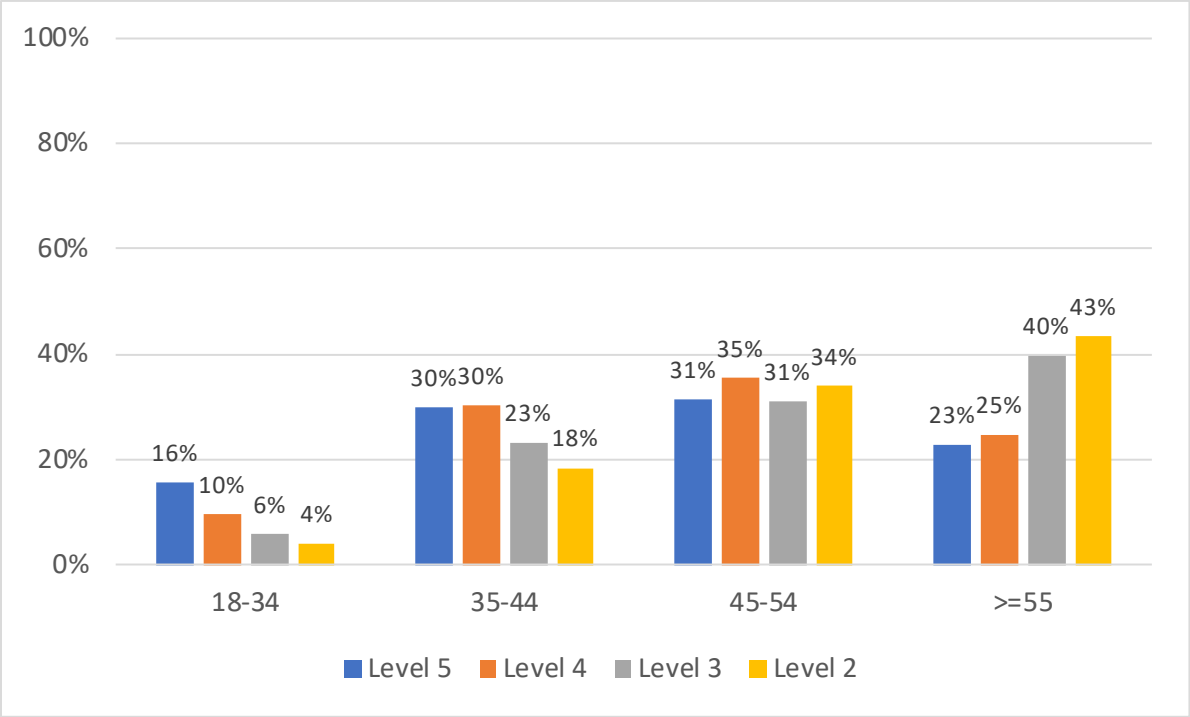


Figure 7. Preferred AV Level to Own by Age.

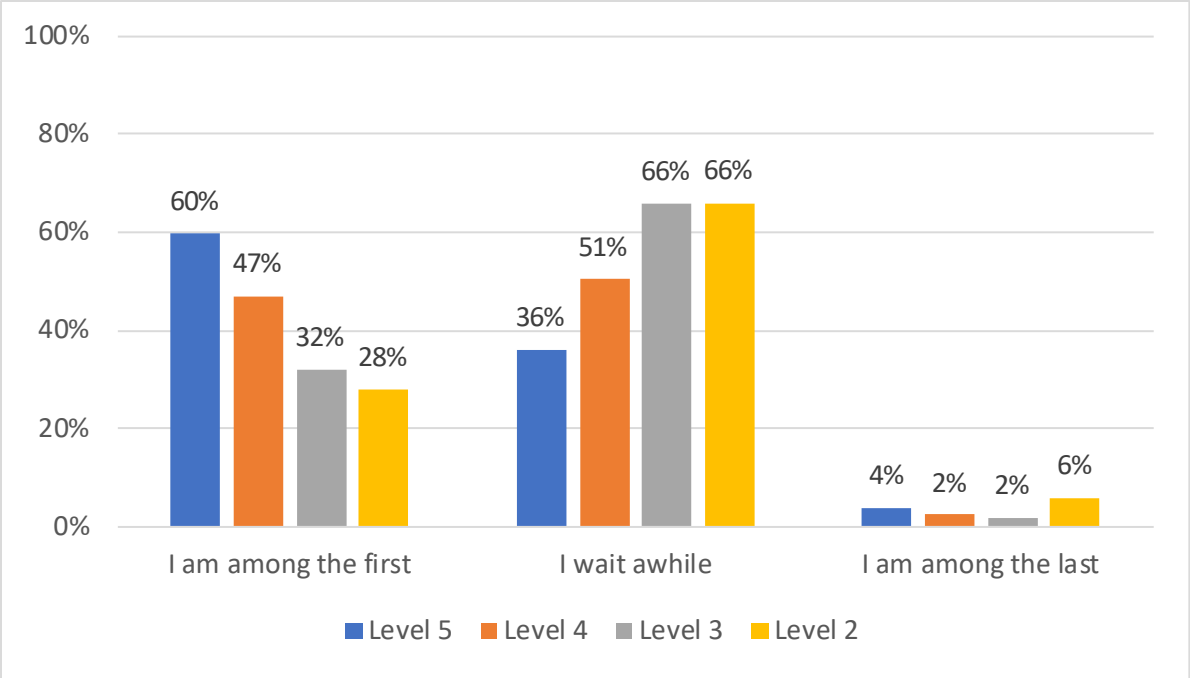


Figure 8. Preferred AV Level to Own by Technology Adoption.

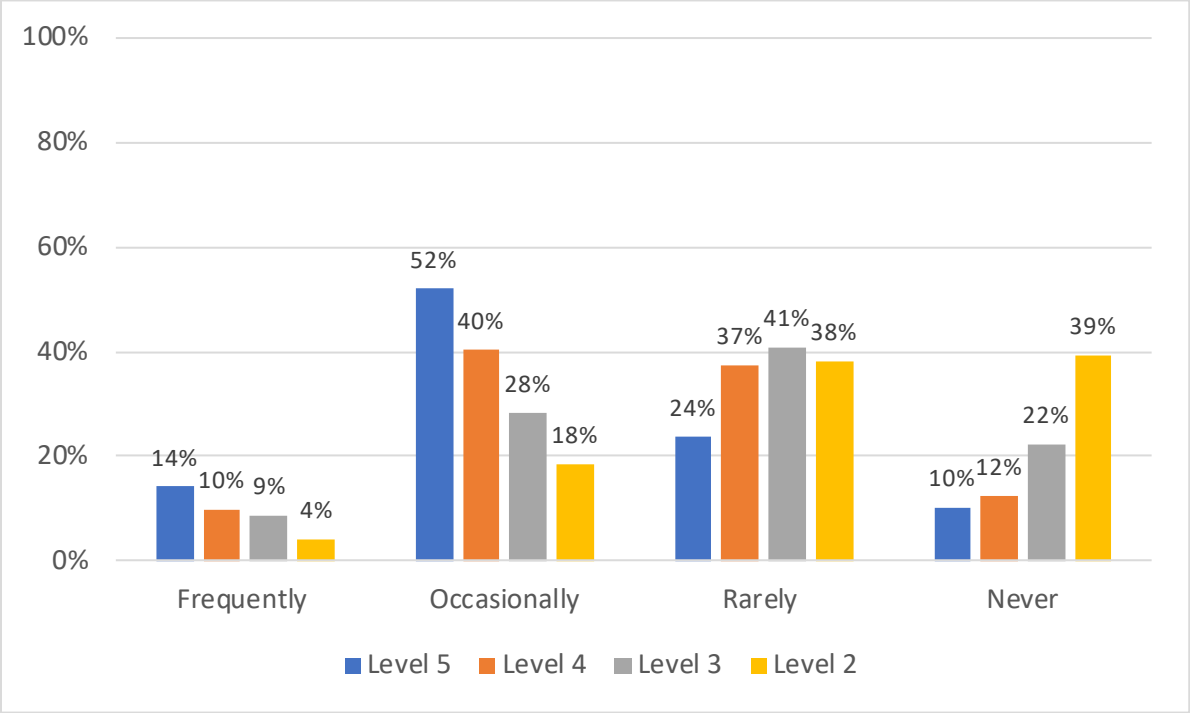


Figure 9. Preferred AV Level to Own by Experience with Ride-Haling.

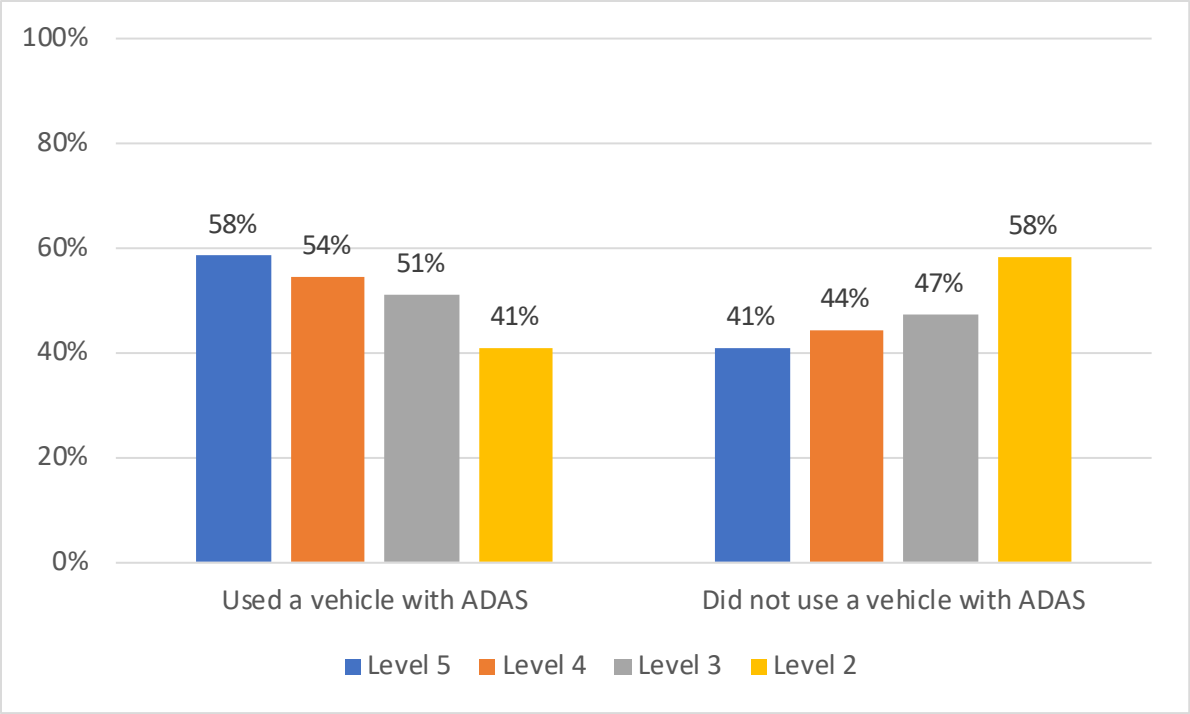


Figure 10. Preferred AV Level to Own by Experience with ADASs.

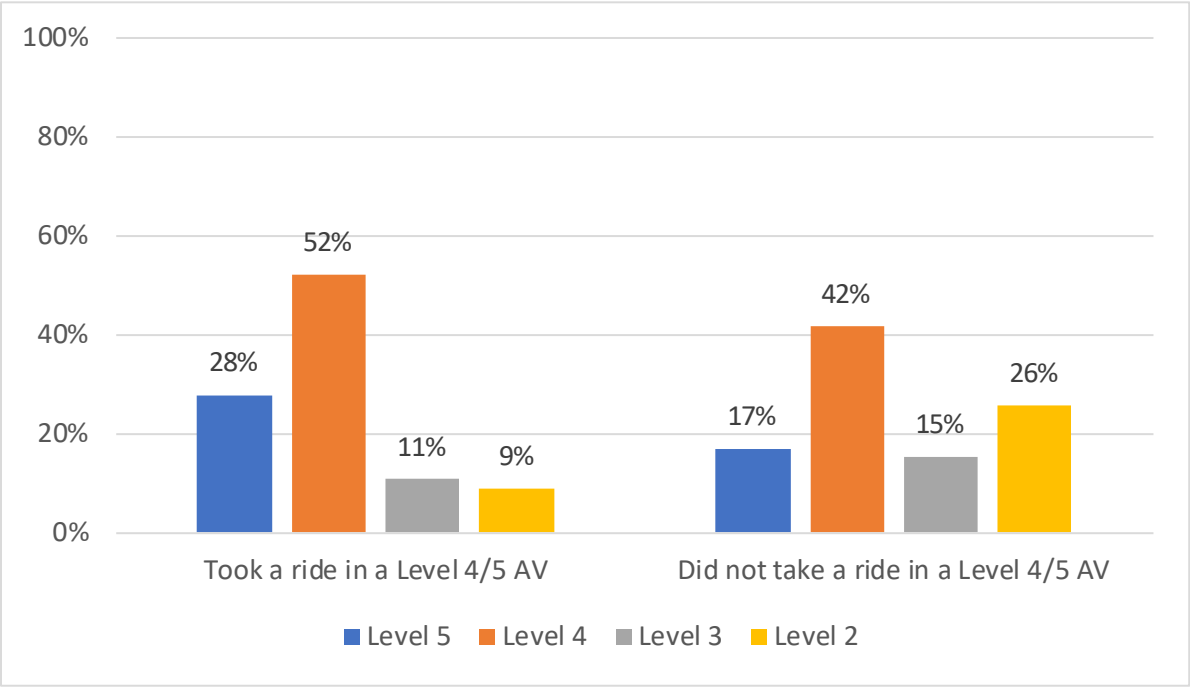


Figure 11. Preferred AV Level to Own by Experience Riding in a Self-Driving Vehicle.

People in the Frisco sample were very aware of the potential safety benefits of self-driving vehicles (Levels 4/5). When asked about what level they trusted most to reduce the likelihood of being in a crash (and assuming all levels of vehicle automation are operating on public roads today), Level 4 ranked the highest and Level 3 the lowest (see Figure 12).

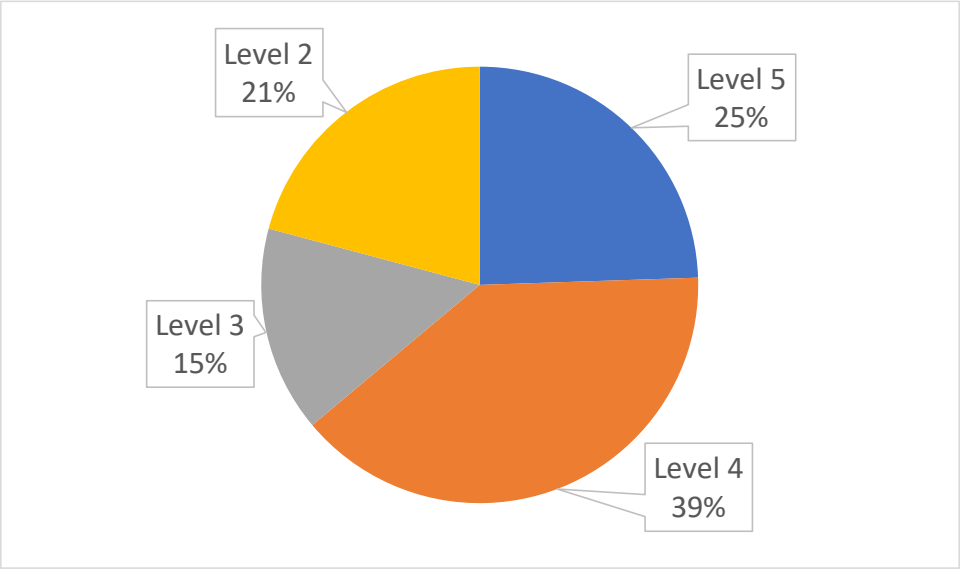


Figure 12. Most Trusted AV Level to Reduce Crash Likelihood.

When asked about their rationale for the most trusted level of automation to reduce the likelihood of a crash, respondents' answers were insightful:

- People who reported most trusting Level 5 thought the technology would be fully tested to be safe, would best address human driving errors and distractions, and would represent the most advanced safety features.
- People who most trusted Level 4 did not believe in the readiness of the Level 5 technology and felt Level 4 is the next best thing in terms of advanced safety features.
- People who most trusted Level 2 and Level 3 also did not believe in the technology readiness of higher levels of automation, and they were not psychologically ready for self-driving cars.

Nearly 90% of persons who had taken a ride in a Level 4/5 AV trusted these higher levels of automation to reduce crash likelihood (Figure 13). This percentage dropped to 62% among persons who had not taken a ride. While this percentage of trust among non-riders is still a majority, it is significantly less than the percentage among Level 4/5 AV riders.

Figure 14 provides a comparison distribution between preferred level to own versus most trusted level to reduce the likelihood of being in a crash. For most respondents, a Level 4 vehicle was both the preferred one to own in a few years and the one they most trusted to reduce the likelihood of being in a crash. These consumer preferences regarding Level 4 vehicles are reflected in plans of major OEMs, many of whom have announced plans to roll out Level 4 vehicles for ride-sharing applications and highway driving in the next 5 years (Walker, 2019).

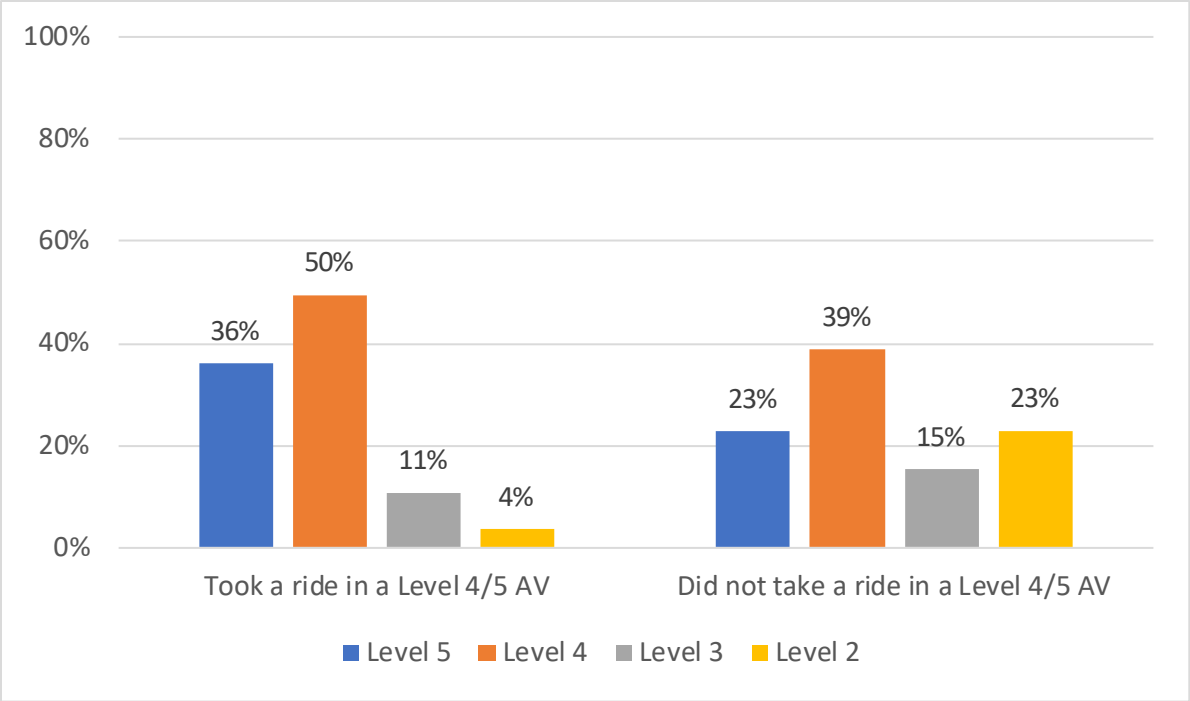


Figure 13. Most Trusted AV Level to Reduce Crash Likelihood by Experience Riding in Self-Driving Vehicle.

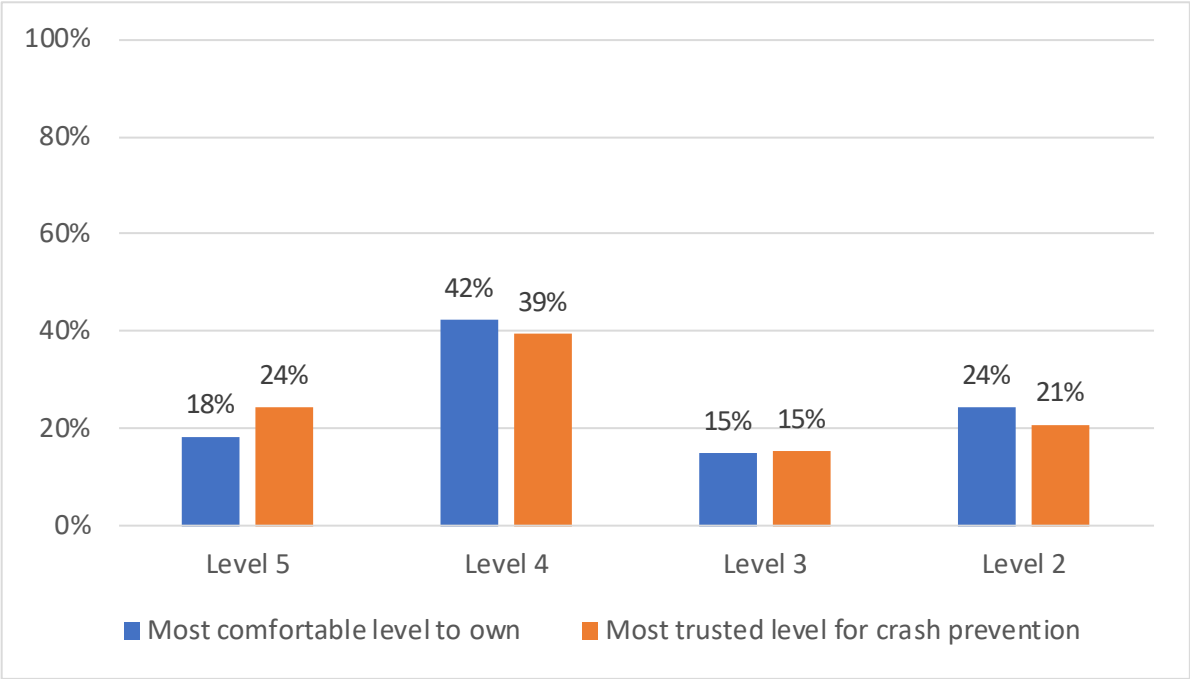


Figure 14. Preferred AV Level to Own versus Most Trusted AV Level to Reduce Likelihood of Being in a Crash.

The experience of riding in a Level 4 or 5 AV significantly reduced the fear of using a self-driving vehicle (Figure 15). More than one-third (36%) of surveyed Frisco residents reported that they would be afraid to ride in a Level 5 self-driving vehicle; however, this percentage was reduced to 15% among those who had experienced a Level 4 or 5 AV. Three-fourths of those respondents (76%) stated that they would not be afraid to ride in a Level 5 self-driving vehicle, compared to 41% of the people who had not experienced a Level 4 or 5 AV.

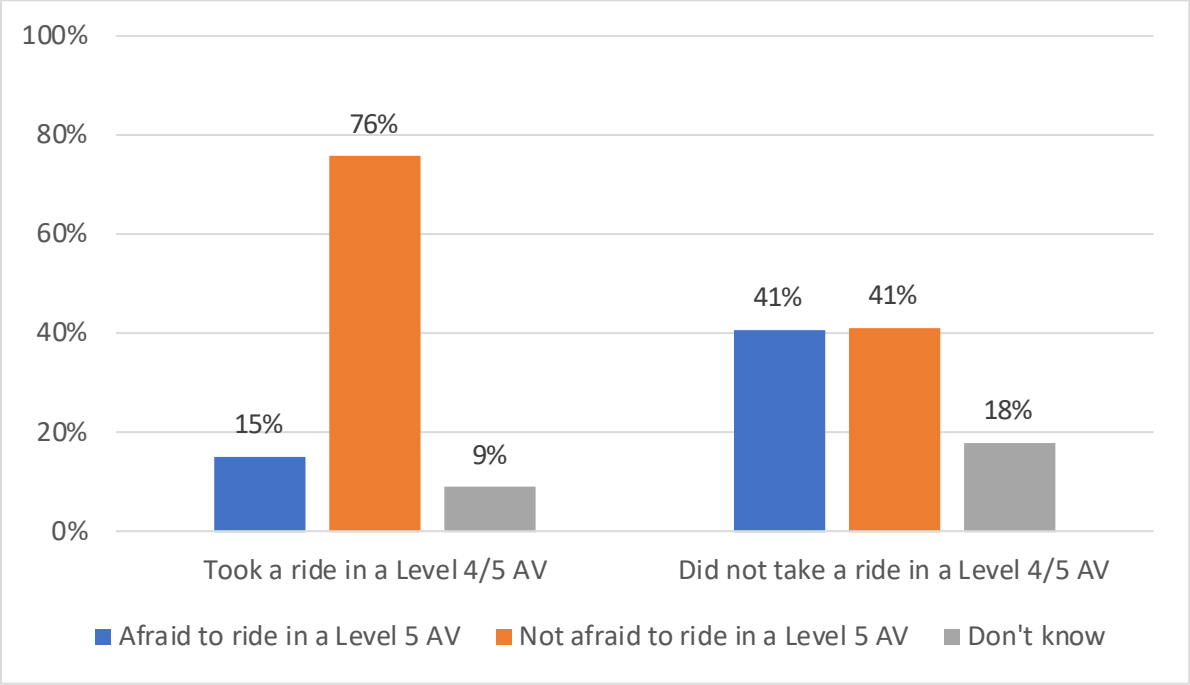


Figure 15. Fear of Using a Level 5 AV by Experience Riding in a Self-Driving Vehicle.

Behaviors Related to Level 5 Self-Driving Vehicles

To gather more insight into behaviors related to self-driving vehicles, respondents were asked to imagine that Level 5 self-driving vehicles were available for them to purchase and/or use today and then asked how likely they would be to:

- Purchase a Level 5 self-driving vehicle.
- Use self-driving vehicles in the form of a ride-hailing service like Lyft or Uber.
- Use self-driving vehicles in the form of a small, low-speed shuttle as on-demand transit.

Figure 16 shows the results. Most Frisco residents (63%) reported that they would rather not own a self-driving vehicle. Instead, they would prefer to use them as a low-speed shuttle, like the Drive.ai service (49%), or as a ride-hailing service (48%). This finding is interesting given the auto-dominant lives of Frisco residents. Virtually all persons who stated that they would prefer the ride-hailing option would also prefer to travel alone or with known traveling companions (78%) rather than use the ride-splitting or shared option.

People who chose the small, low-speed shuttle did so because they believed it would be the safest option (i.e., it is slow on a regular route), while ride-hailing was selected by people who valued shared transport or who wanted to test a self-driving vehicle before buying. Purchasing a Level 5 self-driving vehicle was the choice of people who just prefer traveling in a personal vehicle. In general, these findings were similar regardless of individuals' experience with a Level 4 or 5 vehicle, with one additional observation worth noting. For people who preferred to purchase a Level 5 self-driving vehicle, while just being interested in traveling in a personal vehicle was still their main reason, a considerable number also indicated they would like to purchase a self-driving vehicle because they just like the technology.

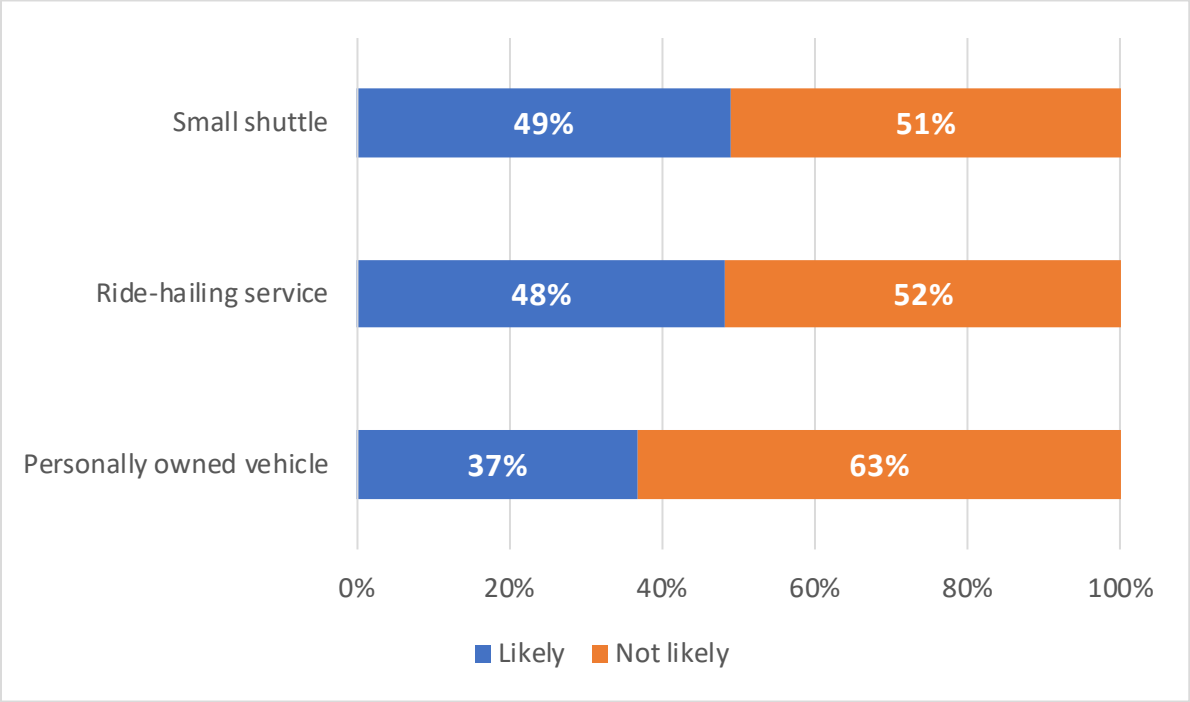


Figure 16. Preferred Form of Level 5 Self-Driving Vehicle.

A follow-up question asked about the pooling option of ride-hailing services. Respondents who were likely to use the Level 5 self-driving ride-hailing service were asked whether they would use it as a shared/split fare service (where they ride and share the cost with people they do not know) or as a non-shared service (where they ride alone or with their traveling companies). The results indicated a strong tendency toward non-shared service (Figure 17). People who chose to travel alone most often cited safety concerns for traveling with strangers and desire for direct travel without making stops, as well as general dislike for traveling with other people and desire for privacy. On the other hand, for respondents who chose to share their ride, the most cited reason was cost savings of a shared ride system, though many indicated it would be a situational choice depending on many factors such as time constraints and trip destination.

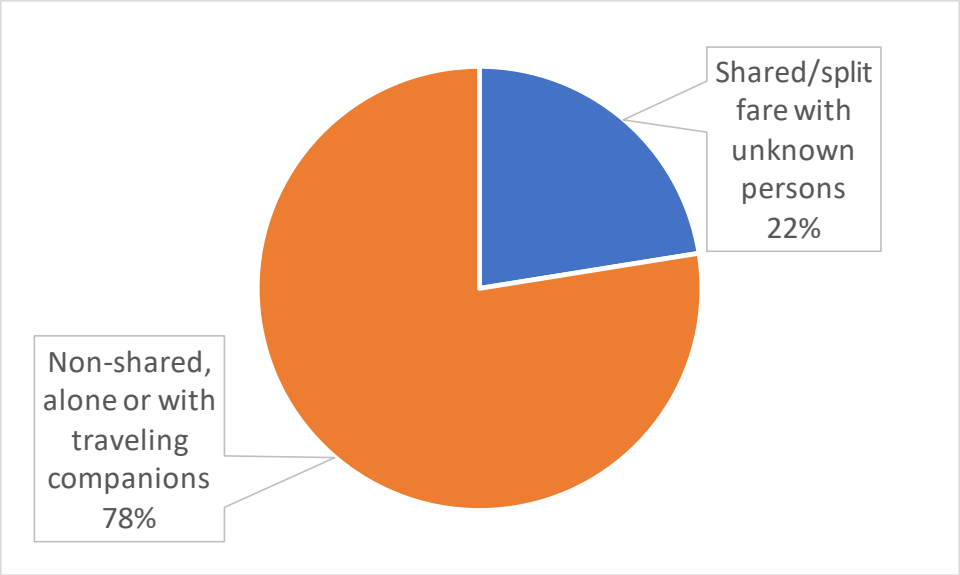


Figure 17. Preferred Mobility Option of Level 5 Self-Driving Vehicle.

Overall Benefits and Concerns of Self-Driving Vehicles

Regardless of the type of self-driving vehicle that Frisco residents would use, their thoughts on the greatest benefit to them personally was the same: to have an improved travel experience (i.e., not having to pay attention; able to do productive tasks; less stressful, more relaxing and fun; and faster, more efficient, less traffic). This benefit was cited much more frequently than having a safer travel experience.

On the other hand, when asked about the greatest benefit to society, safety was the most frequent response. This was especially true for those who preferred using self-driving personally owned vehicles or ride-hailing vehicles. For those who would use AVs as a low-speed shuttle, congestion, air quality, and mobility enhancement benefits were also cited.

The biggest overall concern was that the self-driving technology is so new. Frisco residents want to see self-driving vehicles in action through pilot tests to trust that they are reliable and safe. More limited concerns were noted about the safety of self-driving vehicles in their interactions with non-AVs and with pedestrians and bicyclists, their capability to react safety to unforeseen circumstances (such as animals running into the road or road construction), and the uncertainty of what to do or whom to contact in emergency situations (such as a system outage).

Drive.ai Experience

Results from the focus group with 15 persons who had taken a ride in a Drive.ai self-driving vehicle revealed that virtually all participants had positive opinions about the pilot project and believed that it enhanced the innovative image of the City of Frisco. One person indicated that it was a selling point for hiring potential employees, especially those in the younger generation.

Most participants enjoyed the experience of riding in the vehicle, but they expected less human interaction from the safety driver during the trip. They expressed frustration that the vehicle was

overly cautious at difficult intersections and would not proceed quickly enough through the intersection, that there were long wait times to be picked up by the vehicle, and that the vehicle did not appear more futuristic. All felt safe driving or walking on the same road as the vehicle, mainly because it drove so timidly and followed the speed limit and other rules, which human drivers often do not. Overwhelmingly, the group supported the safety priority of Drive.ai. There was consensus that safety should come first and the technology and speed can always be improved later.

The project was designed as a service to get people to lunch places and other locations within a large office campus. The group was asked if the service was what they had expected. The overwhelming response was that it would be nice if it could go to more destinations, including other places around Frisco. Seating capacity needed to be increased because it was cramped for three riders. The group was overwhelmingly supportive of future endeavors and would like to see something similar in the future but with more vehicles and expanded service. The group was asked if they would prefer to own a self-driving vehicle or use an on-demand service such as Drive.ai. Participants overwhelmingly responded that they would still want to own their own cars because they did not want to give up their independence and freedom; however, many were willing to use an on-demand service on an as-needed basis.

Conclusions

This research examined acceptance of, concerns about, potential usage of, and factors influencing usage of self-driving vehicles among Frisco residents. Frisco residents were generally accepting of vehicles at higher levels of automation; there was greater acceptance of Level 4 because people are not ready to cede complete control in a self-driving vehicle they might personally own. They would be more likely to use self-driving vehicles as small shuttles or as ride-hailing vehicles, and they would use these types of services occasionally for specialized purposes. Shuttles were viewed as the safest option at present because they are slow and travel in well-mapped geofenced areas.

A main finding was that the experience of riding in a self-driving vehicle had a significant positive influence on Frisco residents' preferences, attitudes, and potential usage. The biggest overall concern among residents was that the self-driving technology is so new. Frisco residents want to see the self-driving vehicles in action through pilot tests to trust that they are reliable and safe.

Generalizing the results from the Frisco survey findings to other geographical areas should be done with caution. A similar survey conducted in a different geographic context may result in significantly different findings.

It will be critical for cities to support autonomous vehicle pilots to gather insight into their residents' thinking about self-driving vehicles for future policy and planning. This study gathered information on residents' perceived benefits and concerns related to self-driving vehicles. Opinions on the primary personal benefit (i.e., improved travel experience) differed significantly from those on the primary societal benefit (i.e., safety). The greatest concern was that the technology is new, so residents want to observe more pilot tests. In this light, planning for AVs should be considered an extension of planning for transportation in general.

References

Etherington, D. (2019). *Over 1,400 self-driving vehicles are now in testing by 80+ companies across the US*. Retrieved from https://techcrunch.com/2019/06/11/over-1400-self-driving-vehicles-are-now-in-testing-by-80-companies-across-the-u-s/?guccounter=1&guce_referrer_us=aHR0cHM6Ly9mci5zZWFyY2gueWFob28uY29tLw&guce_referrer_cs=0D99XVxURm3Pvtsn0gBvFg

Narayanan, A. (2019). *Self-driving cars run into reality—And are further away than you think*. Retrieved from https://www.investors.com/news/self-driving-cars-hit-delays-driverless-cars-timeline/

Nextdoor. (n.d.). *About us*. Retrieved from https://about.nextdoor.com/

Sener, I. N., & Zmud, J. (2019). Chipping away at uncertainty: Intent to use self-driving vehicles and the role of ride-hailing. *Transportation Planning & Technology*. Manuscript accepted for publication.

Sener, I. N., Zmud, J., & Williams, T. (2019). Measures of baseline intent to use automated vehicles: A case study of Texas cities. *Transportation Research Part F: Traffic Psychology and Behaviour, 62*, 66–77.

Walker, J. (2019). *The self-driving car timeline: Predictions from the top 11 global automakers*. Retrieved from https://emerj.com/ai-adoption-timelines/self-driving-car-timeline-themselves-top-11-automakers/

Zmud, J. P., & Sener, I. N. (2017). Towards an understanding of the travel behavior impact of autonomous vehicles. *Transportation Research Procedia, 25*, 2500–2519.

Zmud, J., Sener, I. N., & Wagner, J. (2016). Self-driving vehicles: Determinants of adoption and conditions of usage. *Transportation Research Record: Journal of the Transportation Research Board, 2565*, 57–64.

Appendix: Frisco Automated Vehicle Online Survey

Informed Consent

You are being invited to take part in a research study, which includes an online survey conducted by the Texas A&M Transportation Institute (TTI) and funded by the Frisco Transportation Management Association. The purpose of this study is to measure acceptance and usage of self-driving vehicles. This survey will take about 10 minutes to complete.

The questions that you will be asked to answer pose no more risks to you than you would come across in everyday life. Your participation is entirely voluntary, and you can refuse to take part at any time. If you decide you do not want to participate, there will be no penalty to you. Information about you and related to this study will be kept confidential to the extent permitted or required by law.

You may click here to read the project information sheet.

You may contact TTI researcher Dr. Ipek Sener for study details or to tell her about a concern about this research at 512-407-1119 or i-sener@tti.tamu.edu. For questions about your rights as a research participant, to provide input regarding research, or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office by phone at 1-979-458-4067, toll-free at 1-855-795-8636, or by email at irb@tamu.edu.

If you would like to take part in the study, please continue by clicking the "Next" button below.

Questionnaire

Q1. How old are you? [RECORD OPEN NUMERIC RESPONSE; IF LESS THAN 18, THANK AND TERMINATE]

Q2. When it comes to adopting new technology in which category do you fall on the adoption curve?

- I am among the first of my friends to adopt new technology
- I wait awhile before adopting new technology
- I am among the last of my friends to adopt new technology, if I adopt at all

Q3. How many motorized vehicles does your household own or lease? Please include cars, trucks, SUVs, motorcycles, and vans.

- Zero [SKIP Q4]
- One
- Two
- Three or more

Q4. Do any vehicles that you frequently use have any advanced safety driver assistance features that can intervene in the driving of the vehicle, such as lane keeping assist or automated parking assist?

- Yes
- No
- I don't know

Q5. How often do you currently use ride-hailing services like Lyft and Uber?

- Very frequently—at least once per day
- Frequently—at least once per week
- Occasionally—at least once per month
- Rarely—at least once per year
- Never

Q6. How often do you currently use any type of public transit or para-transit service?

- Very frequently—at least once per day
- Frequently—at least once per week
- Occasionally—at least once per month
- Rarely—at least once per year
- Never

Q7. Have you ever heard of self-driving vehicles before participating in this survey?

- Yes
- No
- I don't know

Please watch the following short video on levels of automated vehicle technology before answering the following questions. Please press play and wait to click next until you have watched the full video. Link to video: https://www.youtube.com/watch?v=RA4XAohIP-Y&feature=youtu.be [Note: the end time of the video shown is: 1:23]

Q8. After viewing the video, how would you rate your understanding of the levels of vehicle automation?

- Excellent understanding
- Very good understanding
- Understand some things
- Don't understand very much
- Don't understand anything

Q9. If cost was no barrier and you could own a vehicle with any level of automated technology within the next couple of years, with what level would you be most comfortable?

- Level 5: the vehicle is always self-driving; human does not drive. The car does not have a cockpit (i.e., steering wheel and brake/accelerator pedals).
- Level 4: the vehicle is capable of total self-driving in certain operating conditions, although a human can still request control, and must be capable of taking over if needed. If the driver ignores a warning alarm, the car has the authority to pull over and stop safely.
- Level 3: the vehicle is capable of self-driving, but the human driver must always remain alert to the driving context and be able to take over control within a few seconds if notified by the vehicle that human intervention is needed.
- Level 2: the driver is always in control of the vehicle, but the automated vehicle technology can control steering and acceleration/deceleration functions if desired.

Q10. Why did you select that level of automation to the question above? [OPEN TEXT RESPONSE]

Q11. Assume all levels of vehicle automation are operating on public roads today, what level of vehicle automation would you trust the most to reduce the likelihood of your vehicle being in a crash?

- Level 5: the vehicle is always self-driving; human does not drive. The car does not have a cockpit (i.e., steering wheel and brake/accelerator pedals).
- Level 4: the vehicle is capable of total self-driving in certain operating conditions, although a human can still request control, and must be capable of taking over if needed. If the driver ignores a warning alarm, the car has the authority to pull over and stop safely.
- Level 3: the vehicle is capable of self-driving, but the human driver must always remain alert to the driving context and be able to take over control within a few seconds if notified by the vehicle that human intervention is needed.
- Level 2: the driver is always in control of the vehicle, but the automated vehicle technology can control steering and acceleration/deceleration functions if desired.

Q12. Why did you select that level of automation to the question above? [OPEN TEXT RESPONSE]

Q13. Imagine that Level 5 self-driving vehicles, i.e., always self-driving anywhere, were available for you to purchase and/or use today. Using a scale from 1 (Not at all likely) to 4 (Extremely likely), please indicate your likelihood to do the following.

Level 5 Self-Driving Alternatives	Not at all likely	Somewhat unlikely	Very likely	Extremely likely
Purchase a Level 5 self-driving vehicle				
Use self-driving vehicles in the form of a ride-hailing service like Lyft or Uber			[Ask Q14 and Q15]	[Ask Q14 and Q15]
Use self-driving vehicles in the form of a small shuttle as on-demand transit (capacity to hold 8-10 persons)				

Q14. Would you more often use the self-driving ride-hailing service as a shared/split fare service (where you ride and share the cost with people you do not know) or as non-shared service (where you ride alone or with your traveling companions)?

- Shared/split fare with unknown persons
- Non-shared, alone or with traveling companions

Q15. What is the main reason for your answer to the question above? [OPEN TEXT RESPONSE]

Q16. Which one of the three Level 5 self-driving alternatives would you be the most likely to do?

- Purchase a Level 5 self-driving vehicle [ASK Q19, Q20, Q21; SKIP Q22-Q27]
- Use Level 5 self-driving vehicles in the form of a ride-hailing service like Lyft or Uber [ASK Q22, Q23, Q24; SKIP Q19-Q22 and Q25-27]
- Use Level 5 self-driving vehicles in the form of a small shuttle as on-demand transit (capacity to hold 8-10 persons) [ASK Q25, Q26, Q27; SKIP Q19-24]

Q17. What is the main reason for your answer to the question above? [OPEN TEXT RESPONSE]

Q18. Would you be afraid to ride in a Level 5 self-driving vehicle?

- Yes
- No
- I don't know

Q19. What is your greatest concern, if any, with Level 5 self-driving vehicles that you would personally own? [OPEN TEXT RESPONSE]

Q20. What do you think would be your greatest personal benefit, if any, of Level 5 self-driving vehicles that you would personally own? [OPEN TEXT RESPONSE]

Q21. What do you think will be the greatest benefit, if any, to society of Level 5 self-driving vehicles that you would personally own? [OPEN TEXT RESPONSE]

Q22. What is your greatest concern, if any, with Level 5 self-driving vehicles that you would use as ride-hailing service? [OPEN TEXT RESPONSE]

Q23. What do you think would be your greatest personal benefit, if any, of Level 5 self-driving vehicles that you would use as ride-hailing service? [OPEN TEXT RESPONSE]

Q24. What do you think will be the greatest benefit, if any, to society of Level 5 self-driving vehicles that you would use as ride-hailing service? [OPEN TEXT RESPONSE]

Q25. What is your greatest concern, if any, with Level 5 self-driving vehicles that you would use as small shuttle? [OPEN TEXT RESPONSE]

Q26. What do you think would be your greatest personal benefit, if any, of Level 5 self-driving vehicles that you would use as small shuttle? [OPEN TEXT RESPONSE]

Q27. What do you think will be the greatest benefit, if any, to society of Level 5 self-driving vehicles that you would use as small shuttle? [OPEN TEXT RESPONSE]

Q28. Have you ever taken a ride in a Level 4 or 5 self-driving vehicle?

- Yes
- No [SKIP Q29]
- I don't know [SKIP Q29]

Q29. In what city or cities have you taken a ride in a Level 4 or 5 self-driving vehicle?

Q30. What is your gender?

- Male
- Female
- Other

Q31. Do you have any medical conditions that prohibit you from driving?

- Yes
- No

Q32. Which of the statements below best describes you?

- I have never driven before
- I used to drive but I have stopped driving for good
- I drive but not very often
- I drive regularly (almost every day)

Q33. In terms of employment, are you:

- Working—as a paid full-time employee
- Working—as a paid part-time employee
- Working—self-employed
- Not working—on temporary layoff from a job
- Not working—looking for work
- Not working—retired
- Not working—disabled
- Not working—other; please specify here

Q34. In what zip code do you live? [OPEN TEXT RESPONSE]

Q35. How many persons live in your household (including you)?

- One [SKIP Q36]
- Two
- Three
- Four
- Five or more

Q36. How many children 16 or younger live in your household?

- None
- One
- Two
- Three or more

Q37. What is the highest degree or level of school you have completed?

- Grade 12 or less
- High school graduate
- Associate degree or some college
- Bachelor's degree (e.g., BA, BS)
- After Bachelor's degree (e.g., MA, MS, MD, JD, Ph.D.)

Q38. What best describes your total household income for last year?

- Less than $25,000
- $25,000 to $49,999
- $50,000 to $99,999
- $100,000 to $149,999
- $150,000 to $199,999
- $200,000 to $249,000
- $250,000 or more
- I prefer not to answer

Q39. What is your overall opinion towards Level 5 self-driving vehicle technology?

- Positive
- Neutral
- Negative

Thank you for your participation in this survey.