Final Report

Project Title: Assessing Safety and Mobility Benefits of Autonomous Ride Sharing Services

FDOT Contract Number: **BED31-977-26**

February 14, 2024

Principal Investigator: Dr. Sherrilene Classen
Director: Institute for Driving, Activity, Participation and Technology
Professor and Chair
Department of Occupational Therapy
Phone: 352-273-6883
Email: sclassen@phhp.ufl.edu

DSR Administrative Contact: Stephanie Gray
Assistant Vice President, Division of Sponsored Programs
University of Florida
219 Grinter Hall, PO Box 115500
Gainesville, FL 32611
ufproposals@ufl.edu

Project Manager: Gail M. Holley
State Traffic Engineering and Operations Office
605 Suwannee Street, MS 36
Tallahassee, FL 32399
Phone: 850-410-5414
Email: gail.holley@dot.state.fl.us

Disclaimer Page

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Florida Department of Transportation.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Assessing Safety and Mobility Benefits of Autonomous Ride Sharing Services		5. Report Date February 14, 2024
		6. Performing Organization Code
7. Author(s) Sherrilene Classen, Ph.D.; Carla VandeWeerd, Ph.D.; Nichole Stetten, Ph.D.; Seung Woo Hwangbo, OTD; Sandra Winter, Ph.D.; Yuan Li, MPH		8. Performing Organization Report No.
9. Performing Organization Name and Address University of Florida 1225 Center Drive Gainesville, FL 32611		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. BED31-977-02
12. Sponsoring Agency Name and Address Florida Department of Transportation 605 Suwannee Street, MS 57 Tallahassee, Florida 32399-0450		13. Type of Report and Period Covered Final Report April 2022 – August 2023
		14. Sponsoring Agency Code
15. Supplementary Notes: NA		

16. Abstract

We examined the user perspective about autonomous ride sharing services among older adults (50+ years of age) in three different geographic areas in Florida (Lake Nona, Port St. Lucie, and The Villages). We utilized the Autonomous Ride Sharing Services Survey and participants' lived experiences before and after exposure to the autonomous shuttle. Overall, 240 participants (130 males; 109 females; 1 other) completed the study across the three sites. Overall, the quantitative findings yielded a statistically significant increase in positive perceptions by the older adults after exposure to the autonomous shuttle. Specifically, among all sites, participants demonstrated statistically significant and positive increases in perceptions pertaining to *Intention to Use*, *Trust*, and *Safety*; *Potential Benefits*; and *Accessibility,* with the greatest effect for *Intention to Use*, *Trust*, and *Safety*. We conducted six pre-focus (n=20) and four post-focus groups, across the three sites (n= 31). The six themes that emerged from the data were integration with the quantitative results. Although the *quantitative data* across all three sites demonstrated a statistically significant increase in perceptions for each of the three outcome variables (*Intention to use, Trust, and Safety, Potential Benefits, and Acceptance*), the *qualitative data* illuminated the depth and breadth of participants' experiences pertaining to benefits as well as limitations or challenges that they had experienced before and after riding the autonomous shuttle. This information is foundational in suggesting informational strategies for older adult education in preparing them to use the autonomous shuttle as a source of community mobility. The limitations—including the *Lessons Learned* and *Challenges* related to the operation of the autonomous shuttle—and the strengths—including an approach of team science and working with various collaborators—were discussed. In conclusion, the results reveal that participant perceptions are more favorable after exposure to the autonomous shuttle, but their lived experiences indicated not only the benefits but also challenges and limitations related to the autonomous shuttle. The findings, *Lessons Learned*, and *Challenges* related to the shuttle contribute richly to the field of autonomous ride sharing services as a source of community mobility among older adults and yield foundational information for industry, researchers in the field, and policy makers.

17. Key Words Autonomous Ride Sharing Services; Autonomous Shuttle; Older Adults; Intention to Use, Trust, and Safety	18. Distribution Statement No Restrictions

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 69	22. Price

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

Acknowledgements

The authors express their sincere gratitude to the Florida Department of Transportation for their support and funding of this research project. The authors extend appreciation to the project manager Gail Holley and the Safe Mobility for Life Coalition, who provided valuable assistance and insights throughout the duration of the project. Their expertise and collaboration substantially contributed to the success of this research. The authors are thankful to the participants who generously volunteered their time to participate in this study and all the stakeholders and community organizations who have contributed to this project in various ways, including providing access to resources and facilities, helping with marketing, advertising, recruitment, and enrollment. We also acknowledge the Institute for Driving, Activity, Participation, and Technology (I-DAPT) for providing infrastructure, support, and resources for this project.

Executive Summary

The overarching objective of this project was to identify the user perspective about autonomous ride sharing services among older adults (50+ years of age) in three different geographic areas in Florida (Lake Nona, Port St. Lucie, and The Villages). The researchers solicited their perceptions (via the Autonomous Ride Sharing Services Survey) and lived experiences (via three focus groups conducted before and after exposure to the autonomous shuttle) pertaining to adoption and acceptance practices thereof.

A total of 240 participants (130 males; 109 females; 1 other) were enrolled into the study, across the three sites. Overall, the quantitative findings yielded a statistically significant increase in positive perceptions of the older adults after exposure to the autonomous shuttle. Specifically, among all sites, participants demonstrated a statistically significant and positive increase in perceptions pertaining to *Intention to Use, Trust,* and *Safety*; *Potential Benefits*; and *Accessibility*—with the greatest effect for *Intention to Use*, *Trust*, and *Safety*. Across all sites, a repeated measures ANOVA showed that mean score of *Intention to Use, Trust,* and *Safety* (the main outcome variable for this study) differed significantly between time points with the greatest effect observed after the exposure to the autonomous shuttle. Therefore, exposure to the autonomous shuttle led to an overall significant and substantial increase in *Intention to Use*, *Trust*, and *Safety* across all participant groups, in all three sites combined.

For the qualitative focus groups, we conducted a total of six pre-focus groups across the three sites: Lake Nona (n=2), Port St. Lucie (n=2), and The Villages (n=2). Across all pre-focus groups, a total of 32 older adults participated: Lake Nona (n=6), Port St. Lucie (n=6), and The Villages (n=20). A total of four post-focus groups were conducted across the three sites: Lake Nona (n=1), Port St. Lucie (n=1), and The Villages (n=2). Across all post-focus groups, a total of 31 older adults participated: Lake Nona (n=5), Port St. Lucie (n=6), and The Villages (n=20). Overall, six themes emerged from the data. These were *Perceived Benefits*, *Safety, Experience with AS, Shuttle Experience, AS Adoption,* and *Aging/Disability.*

The integration of the quantitative and qualitative data makes clear the main take-home message of this study: although the *quantitative data* across all three sites demonstrated a statistically significant increase in perceptions for each of the three outcome variables (*Intention to use, Trust, and Safety, Potential Benefits, and Acceptance*), the *qualitative data* illuminated the depth and breadth of participants' experiences pertaining to benefits as well as limitations or challenges that they had experienced before and after riding the autonomous shuttle. This information is foundational in constructing informational strategies for older adult education in preparation of using the autonomous shuttle as a source of community mobility.

We have discussed in detail the limitations, including the *Lessons Learned* and *Challenges* related to the operation of the autonomous shuttle. We have also highlighted the multiple strengths of this study, including an approach of team science and working with various

collaborators, stakeholders, researchers, industry partners, and the Florida Department of Transportation Safe Mobility for Life Coalition.

The results reveal important foundational information about the exposure of older drivers to a mode of autonomous ride sharing services. Specifically, participant perceptions are more favorable after exposure; however, their lived experiences indicated not only the benefits but also challenges and limitations, related to the autonomous shuttle. Finally, the findings of this study contribute richly to the field of autonomous ride sharing services as a source of community mobility among older adults. However, the challenges experienced, and the lessons learned provide foundational information for industry, researchers in the field, and policy makers. Particularly, the findings reveal that although the shuttle holds benefits for older adults to be used as a future source of community mobility, many challenges and concerns exist in these early stages of the piloting and pioneering work related to autonomous shuttle deployment that need to be addressed before the autonomous shuttle can be integrated as a viable mode of transportation within the context of three different geographic areas among older adults in Florida.

Table of Contents

Disclaimer Page ii
Technical Report Documentation Page iii
Acknowledgements iv
Executive Summary v
List of Figures ix
List of Tables x
1. Introduction 1
Background Statement 1
Project Objective(s) 3
Purpose 3
Objective 1: Develop a recruitment plan to enroll older adults (50+ years). 3
Objective 2: Determine older adults' perceptions on autonomous ride sharing services. 4
Objective 3: Conduct focus groups to solicit responses of older adults of autonomous ride sharing services. 9
Objective 4. Synopsize quantitative (survey) and qualitative (focus group) data 11
2. Results 13
Objective 1: Develop a recruitment plan to enroll older adults (50+ years). 13
Objective 2: Determine the perceptions of older adults on autonomous ride sharing services. 16
Objective 3: Conduct focus groups to solicit responses of older adults of autonomous ride sharing services. 17
Pre-Focus Groups 17
Post-Focus Group 18
Objective 4: Synopsize quantitative (survey) and qualitative (focus group) data 18
Lessons Learned (see Appendix A for a detailed description) 28
Educational Strategies of Older Adults (see Appendix A for a detailed description) 29
3. Conclusions 30
Limitations 30
Strengths 31
Concluding Statement 31
References 32
Appendix A. Lessons Learned 35
Stakeholders Involved 35
Summary of Lessons Learned in Working with Industry 36

Recommendations for Research: Practical Strategies for Conducting Autonomous Vehicle Research 39
Challenges Related to the Operation of the Autonomous Shuttles 39
Appendix B. Educational Strategies for the Older Adults on ARSS 41
From Quantitative Data 41
From the Qualitative Data 42
From the Lessons Learned 45
From the Literature 49
Appendix C. Informational Flyer Used at The Villages 53
Appendix D. Beep's Infrastructure Supporting Document 55

List of Figures

Figure 1. The Navya Autonomous Shuttle Operated by Beep 4
Figure 2. Lake Nona Route A 5
Figure 3. Lake Nona Route B 6
Figure 4. The Villages Route 7
Figure 5. Tradition, Port St. Lucie Route 8
Figure 6. The Villages' Information Flyer on the Autonomous Ride Sharing Services Study 14

List of Tables

Table 1. A List of Lake Nona's Community Partners and Facilities for Study Recruitment (n=21) 13
Table 2. A List of The Villages' Channels for Study Recruitment (n=3) 14
Table 3. A List of Port St. Lucie's Community Partners and Facilities for Study Recruitment (n=32) 15
Table 4. Research Participant Enrollment Status (N=240) 16
Table 5. Participants' Demographic Data (N=240) 17
Table 6. Descriptive Statistics for the Three Outcome Variables, i.e., Intention to Use, Trust, and Safety, Potential Benefits, and Accessibility 18
Table 7. Mean Differences between the Outcome Variables for Post-exposure vs. Pre-exposure of Participants to the Autonomous Shuttle for Each of the Three Sites and All Sites Combined 20
Table 8. Repeated Measure ANOVA for Participant Perceptions to the Autonomous Shuttle for Intention to Use, Trust, and Safety Post-exposure vs. Pre-exposure, for Each of the Three Sites and All Sites Combined 21
Table 9. Qualitative Themes and Subthemes 22
Table 10. Integration of Quantitative and Qualitative Data Analysis Results 27

1. Introduction

Background Statement

Older adults (≥65 years), who account for 20% of the U.S. population and almost 25% of the Florida population, are over-represented in multiple-vehicle crashes and accompanying injuries and deaths related to the crashes. In fact, Florida is second in the nation in the number (3,341,250) of drivers 65 or older and now leads the country in the number (682) of traffic fatalities involving at least one driver over 65, according to TRIP data (Scanlan, 2018). According to the Florida Department of Transportation (FDOT), these numbers (calculated from 2013–2017) translate to 37.8 crashes per 1,000 people aged 65 and older, with the counties that we are targeting showing the following crash statistics: Orange (47.3 crashes per 1000 people >65 yrs.), Hillsborough (32.9 crashes per 1,000 people >65 yrs.), Pinellas (31.2 crashes per 1,000 people >65 yrs.), St Lucie (30.5 crashes per 1,000 people >65 yrs.) and Marion (28.7 crashes per 1,000 people >65 yrs.). We expect that implementing countermeasures such as autonomous ride sharing services will significantly advance crash prevention and save lives over the longer term (Spectrum News 13, 2019).

Continued community mobility is a powerful facilitator of autonomy, independence, life satisfaction, and role execution. Autonomous (AV) ride sharing services may hold safety benefits for older adults if they adopt this rapidly emerging technology, but personal (i.e., hesitation, mistrust, safety concerns) and social determinants (e.g., effects of the COVID-19 pandemic) may challenge their acceptance and adoption practices while hindering the widespread deployment of these technologies and delaying safety benefits. Specifically, we must better understand the human-centric needs to accept and adopt AV ride sharing service. Such needs include participant perceptions on allowing technology to make the “driving decisions”. Since participant’s mental models shape their intentions to use the technology, we can benefit by identifying factors that may cause confusion and/or ambiguity related to technology use. Without understanding trust, safety, comfort, and convenience related to AV ride sharing services, we will delay and potentially confound the benefits that lifelong mobility—now in the realm of AV technology—may bring to older adults who can no longer drive, who do not want to continue to drive, or who should not continue to drive.

Previously when older adults resorted to driving cessation, evidence from the literature suggests that such behaviors were linked to decreased out-of-home activities, social isolation, greatly reduced mobility in a shrinking life space, early nursing home admissions, and even premature death. Although driving is a privilege, mobility is a human right, and as such, we have a moral and ethical responsibility to ensure that alternative mobility options exist for older adults, through the lifespan, to keep them engaged in their communities and participating in society.

FDOT (2015) commissioned a study on the general perception of AVs by older adults in 2015. The study showed that even though older adults are less likely to trust AVs, over half of the

respondents were interested in AVs. The University of Florida has also embarked upon developing a survey on the perceptions of older adults, necessary for understanding their adoption practices of AV technologies. These foundational works, combined with new approaches (systematic and evidence-based literature review, evaluating other current AV technology user surveys for item cross-checking, focus group methodologies), have been utilized to develop, refine, and establish psychometrics of a user perception survey targeted at older adults. Items for this survey (Mason et al., 2020; Mason et al., 2021) have been developed from recent literature on older adults and their adoption practices toward technology, as well as user surveys, the Technology Acceptance Measurement Scale, the Technology Readiness Index 2.0, and the Life Space Questionnaire (which captures when, where, how far, how, and why older adults venture from their primary dwelling). We also include items from the FDOT and FSU survey and other national surveys of relevance. Based on the literature, theoretical frameworks, existing surveys, and guided by measurement theory, we have now validated the Autonomous Ride Sharing Services survey, ARSS, to capture older adult perceptions on acceptance and adoption practices of AV ride sharing services.

The literature also indicates that survey results alone are not adequate to understand the adoption and acceptance practices of older adults pertaining to AV ride sharing services. For example, in studies conducted by Classen et al. (Classen et al., 2020; Classen et al., 2021), an interim analysis (N= 69) and a final analysis (N=104) compared older drivers' perceptions before and after a drive in an autonomous simulator and autonomous shuttle. Findings indicated that exposure to this autonomous vehicle technology positively affected older adults' perceptions, especially pertaining to trust, safety, and intention to use. Specifically, in this study, older drivers' trust and perceived safety increased after being exposed to a driving simulator running in the SAE Level 4 mode of automation, or an autonomous shuttle (also running in SAE Level 4 mode of automation), compared to the baseline condition, in which they were exposed to the survey only. Moreover, older drivers' perceptions, as measured by the Autonomous Vehicle User Perception Survey (AVUPS) (Mason et al., 2020; 2021), of the perceived usefulness and cost of autonomous vehicle technology also changed in a positive direction after being exposed to both the autonomous simulator and the autonomous shuttle. However, their perceptions on the items in the AVUPS did not change after their first autonomous vehicle technology exposure, regardless of whether it was the autonomous simulator or autonomous shuttle. Limitations of these studies included that participants were mainly recruited from one geographic area in Florida and lacked educational, socioeconomic, and cultural diversity. However, these studies also indicated that exposing older adults to an autonomous simulator or an autonomous shuttle may promote their acceptance and adoption of autonomous vehicle technologies.

Although we have previous work in this area (Classen et al., 2020; Classen et al., 2021; Mason et al., 2020; Mason et al., 2021) and a continued partnership and previous research with FDOT's Safe Mobility for Life Program and Coalition (SMFLC) (Find-a-Ride, and BDV31-977-128 [UF]), we are also forming new collaborations with industry partners (Beep, https://www.go-beep.com/) and The Villages (Dr. Carla VandeWeerd). As such, we are uniquely positioned to examine the benefits, risks, and challenges associated with accepting and adopting autonomous

ride sharing services as an addition to the menu of possible community mobility options for older adults. Moreover, by extending our study enrollment to older adult participants across the state of Florida (i.e., in four counties), we can overcome the limitations associated with recruiting from one geographic area only, and as such, solicit opinions across the state of Florida to inform policy, practice, and further research.

Project Objective(s)

Purpose

This research aimed to use a multidisciplinary team, industry, and community-based perspective among experts in transportation access, policy, and technology as well as communities of older adults who are potential end users of autonomous ride sharing services. The overarching objective was to identify the user perspective about autonomous ride sharing services (AV ride sharing services), and to solicit responses pertaining to adoption and acceptance practices thereof. We invited older adults' feedback on factors that impact their successful acceptance, adoption, and user practices on autonomous ride sharing services. This was important because (1) we did not have quantifiable data to understand the older adult perspective to engaging in AV ride sharing services, (2) the industry partners may not provide the optimum design features in the autonomous vehicles to safely, comfortably and conveniently accommodate older adults, (3) policy makers did not have data-driven information pertaining to older adults' perceptions in various geographic areas in Florida, which may make deployment decisions for widespread use of autonomous ride sharing services challenging, and (4) educational materials—a critical step toward acceptance and adoption practices—were currently lacking for those 50+.

Therefore, to overcome these limitations, we solicited older adults' responses, before and after being exposed to AV ride sharing services and used their feedback to inform industry provider(s), policy makers, and the SMFLC with their responses, as outlined in ***Objectives 1–4*** below.

Objective 1: Develop a recruitment plan to enroll older adults (50+ years).

We developed community partnerships and contacted and enrolled participants through our networks, outreach, and stakeholder input: a minimum of 150 (60%) and up to 250 (100%) older adults from three prominent areas in Florida. These areas included Lake Nona, Orange County (n=50), The Villages, Marion County (n=127); Port St. Lucie, St. Lucie County (n=63) into the study. Although Altamonte Springs was one of the original areas to be included, we did not because logistical issues prevented us from doing so (see Lessons Learned, Appendix A).

Task 1: *Approach* — After the university's Institutional Review Board (IRB) approval, we worked with local community partners (e.g., FDOT districts, city managers, mobility managers, The Villages research coordinator, Beep stakeholders, and the members of the Florida SMFLC) and developed a list of community partners and community facilities where the shuttle operated. We devised plans to contact each of these partners to outline the intended research plan and formulate an outreach plan to facilitate successful marketing and recruitment strategies. Beep

was responsible for the visibility of signage for the shuttle. With Beep's infrastructure and the help of community partners, we identified a facility where the research assistants completed enrollment and informed consents of the participants before their shuttle ride.

Objective 2: Determine older adults' perceptions on autonomous ride sharing services.

We determined the perceptions of older adults (50+ years of age) for each of the three counties (see Objective 1) via administering the validated Autonomous Ride Sharing Survey (ARSS) survey before and after being exposed to the autonomous shuttle (AS). The autonomous shuttle was provided by Beep and used the Navya autonomous shuttles.

The Navya shuttle is an all-electric autonomous shuttle with bus-door walk-in entry. The Navya shuttle can transport multiple passengers and has seat capacity for 11. The shuttle has both state-of-the-art heating and cooling and provides mobility services to public and private communities. A full suite of sensors, scanners, and cameras are embedded to perceive and react appropriately in various environments, ensuring safe and efficient self-driving. The shuttles are an efficient and flexible alternative to gas-fueled vehicles, integrating seamlessly into current transit systems. Navya shuttles can operate on roads with a posted speed limit of 25 mph or less and incorporate artificial intelligence this is relevant to transportation technology.

Figure 1. The Navya Autonomous Shuttle Operated by Beep (https://www.gobeep.com/deployments)

The shuttle routes, for the three geographic areas, are next described and depicted in Figures 2, 3, 4, and 5.

Lake Nona, Orange County (Route address: 13485 Veterans Way, Orlando, FL 32827)
There were two routes (i.e., Routes A and B) for the shuttle operation in Lake Nona. Route A ran from the Courtyard by Marriot Hotel in Orlando Lake Nona (6955 Lake Nona Blvd, Orlando, FL 32827) to the University of Central Florida College of Medicine (6850 Lake Nona Blvd, Orlando, FL 32827) next to the Veterans Affair Medical Center (Veteran Affairs Medical Center, 13800 Veterans Way, Orlando, FL 32827) and looped back to the starting point. The shuttle operated from 9 am to 3 pm, Monday through Friday.

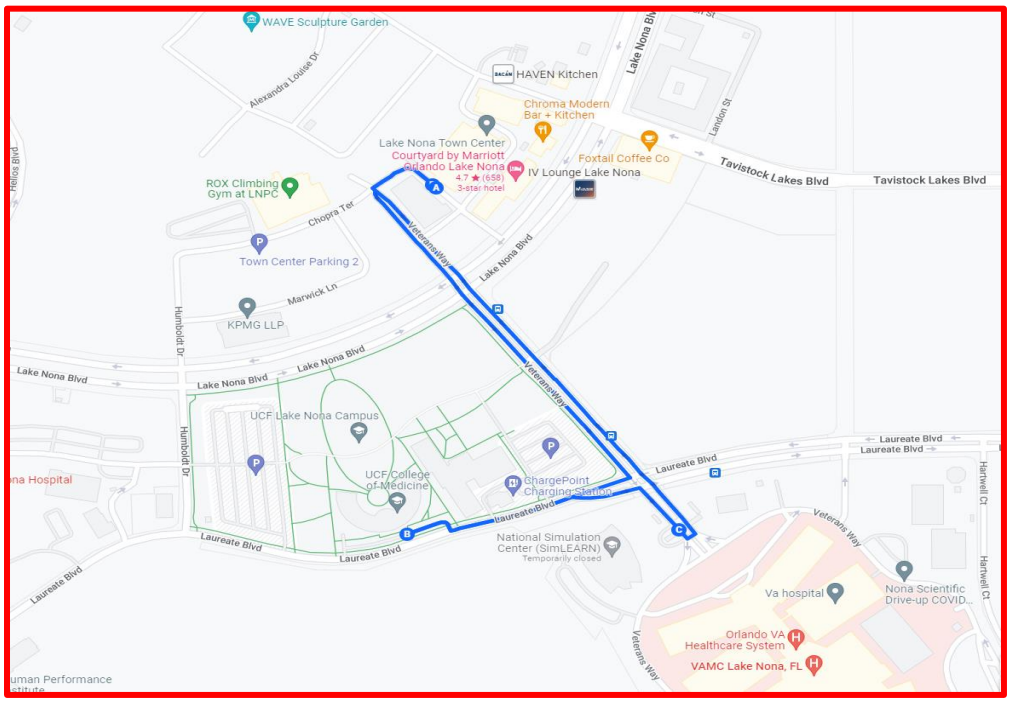


Figure 2. Lake Nona Route A

For Route B, the shuttle ran from Wave Hotel Lake Nona (6100 Wave Hotel Dr, Orlando, FL 32827) to Canvas restaurant (13615 Sachs Avenue, Orlando, FL 32827) and looped back to the starting point. The shuttle operated from 4:30 pm to 10 pm, Monday through Wednesday, 4:30 pm to 11 pm on Thursdays, 4:30 pm to midnight on Fridays, 10 am to midnight on Saturdays, and 10 am to 10 pm on Sundays.

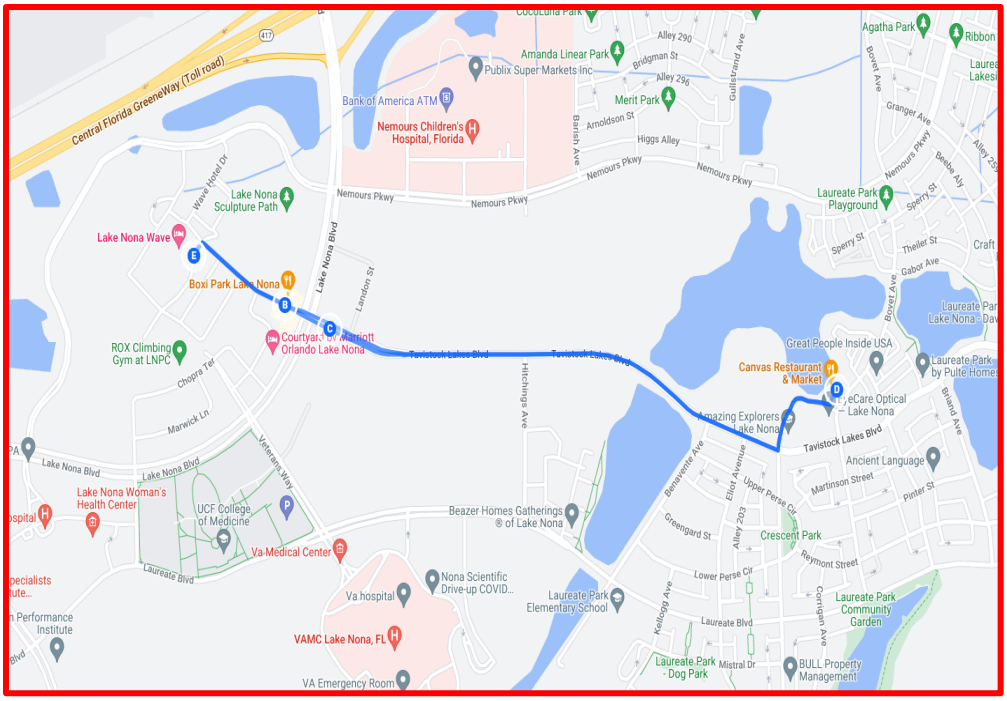


Figure 3. Lake Nona Route B

The Villages, Marion County (Route address: 1451 El Camino Real, The Villages, FL 32159)

The shuttle route in The Villages ran from UF Health (1451 El Camino Real, The Villages, FL 32159), to the medical offices to UF Precision Health location (1400 US-27/441, N, Suite 820, The Villages, FL 32159) and looped back to the start point. The shuttle operated from 8 am to 3 pm, Monday through Friday.

Figure 4. The Villages Route

Port St. Lucie, St. Lucie County (Route address: 10824 SW Village Pkwy, Port St. Lucie, FL 34987)

The shuttle route was in a town center and residential area called Tradition in Port St. Lucie. This route ran from the Tradition Worship Center (10799 SW Civic Ln, Port Saint Lucie, FL 34987) and looped in the Tradition Town Square route, which includes multiple stores (e.g., T.J. Maxx, Target, Burlington), and then back to the starting point. The shuttle operated from 10 am to 2 pm and 5 pm to 10 pm, Monday through Saturday, and from 12 pm to 6 pm on Sundays.

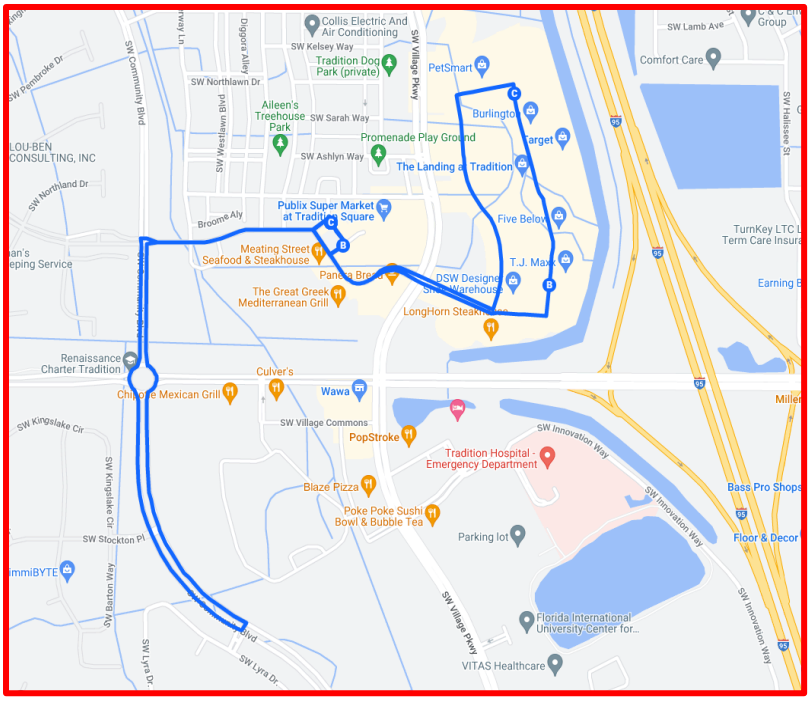


Figure 5. Tradition, Port St. Lucie Route

The Autonomous Ride Sharing Services (ARSS) survey was previously validated in our 2019–2021 FDOT-funded project, Develop, Refine, and Validate a Survey to Assess Adult's Perspectives of Autonomous Ride-Sharing Services for Human Factors and Traffic Operational Observations (BDV31-977-128) and has subsequently been published (Mason & Classen, 2023).

This survey contains 50 items that are organized by the following sections:

- Demographics: Items 1–10
- Modes of Transportation: Items 11–19
- Perceptions of Transportation Options: Items 20–50

The factors involved in this survey are:

- Factor 1: Intention to Use, Trust and Safety: Items 20–32
- Factor 2: Potential Benefits: Items 35–41
- Factor 3: Accessibility: Items 42–48
- Cost and Other: Item 49–50

The psychometrics of this ARSSS are described in detail in the manuscript Mason & Classen (2023). Generally, the ARSSS is a valid and reliable measure to assess older adults' perceptions of autonomous ride sharing services.

Task 2.a.: ***Approach*** — In collaboration with Dr. VandeWeerd at The Villages, Florida, and Mark Reid, SVP of Beep, we planned, developed, and finalized the technology, mapping, infrastructure, operations, permissions, and route for the Navya shuttle in The Villages, for passenger transportation. Here too we have encountered numerous logistical issues that slowed the execution of the project. The details are discussed in the Lessons Learned (see Appendix A) section of this document.

Task 2.b.: ***Approach*** — Following recruitment strategies implemented in Task 1, the graduate research assistants enrolled into the study interested participants who met our inclusion and exclusion criteria. The inclusion criteria are as follows: adults, both genders, all races, 50+ years of age, who can travel to the test site, with a driver's license indicating that they reside in one of the three designated counties in Florida. We utilized a recruitment approach to include participants representing racial diversity in the study; however, our recruitment approach was defined by the route that the shuttle ran and the communities that it served. The exclusion criterion was residents who cannot speak, read, or write in the English language.

We also utilized snowball strategies (e.g., referrals from recruited participants) and visual exposure, i.e., being visible in the area where the residents reside and inviting those who have met our study criteria to participate in the study. Although we initially planned to be in each of the three geographic areas for one week continuously, this turned out not to be the best approach, and we adapted this strategy to include areas where we followed a more targeted marketing approach and recruited participants subsequently.

The trained graduate research assistants engaged in active off-site and—when possible—on-site participant recruitment and enrolled participants who were pre-recruited or newly recruited into the study. From the selected participants, the research assistants gained participant consent for enrollment and administered the ARSSS to solicit participant perceptions before and after a ride in the autonomous shuttle. The shuttle safety operator was on-site to answer any questions pertaining to the shuttle operations and accompanied all riders during the shuttle operation.

The existing COVID-19 protocol was followed in concert with the CDC and county guidelines. Over the course of the study, the COVID-19 protocol was relaxed based on the CDC guidelines and eventually eliminated, other than following best practices for infection control.

All Institutional Review Board (IRB) and ARSSS data were stored in the university password-protected computer and server network in the REDCap system (Harris et al., 2019).

Objective 3: Conduct focus groups to solicit responses of older adults of autonomous ride sharing services.

Using the networks, community partners, and stakeholders (identified in Objective 1) as well as snowballing techniques, we contacted numerous participants of whom we enrolled 32 (initially anticipated to enroll 40 participants): 10 participants from each of the four original demographic areas) in the study. We solicited the opinions of older adults (50+ years of age, across the three

sites) via focus groups, *before* (n=32) and *after* (n=31) the same participants rode in the autonomous shuttle.

Task 3.: ***Approach*** — The graduate research assistants ensured that each focus group participant at the Port St. Lucie and Lake Nona sites was trained and competent in the use of Zoom and assisted the moderator with additional tasks. In The Villages, the research team conducted the focus groups on-site, with all the participants attending the pre- and post-focus groups in group format. The focus groups were facilitated by a moderator using a focus group guide, and the graduate research assistants helped in taking field notes. Focus groups were also recorded via Health Insurance Portability and Accountability Act (HIPAA) compliant Zoom recording system. Questions from the ARSSS informed the focus group guide, and data were recorded and transcribed via the Zoom transcription service in Port St. Lucie and Lake Nona. In The Villages, focus groups were conducted in-person and recorded. The Villages focus group was transcribed by an outside HIPAA-certified company. All focus groups were conducted according to standard qualitative procedures. All data were stored in a password-protected computer and server network of the university.

A pre- and post-focus group design was used to evaluate users' perceptions and experiences before and after a ride on the autonomous shuttle. The qualitative study design was specifically designed to build off previous pilot research and findings from an open-ended questionnaire asking participant perceptions from three population subsets (older adults, young & middle-aged adults, and people with disabilities) on autonomous vehicle technology (Classen et al., 2022). This study aimed to expand these results by asking more in-depth questions via focus groups with older adults in Florida. Pre- and post-focus groups occurred across three locations: Lake Nona, Port St. Lucie, and The Villages.

Before each focus group participants were oriented on expectations and how to interact within a focus group. Focus groups in Lake Nona and Port St. Lucie were held virtually on a HIPAA-certified Zoom platform. Focus groups held at The Villages were held in person. Each focus group was recorded and transcribed verbatim. Focus group sizes were developed to reach saturation. Methodological standards state that saturation is reached on average with four to eight focus group discussions (Hennink & Kaiser, 2022). Additionally, a minimum of three individuals needed to participate (max of 14) for the focus group to occur (Ho, 2006; Krueger, & Casey, 2008).

Pre-Focus Groups **—** Pre-focus groups began with a presentation on the five levels of autonomous driving and a short informational video about the shuttle in which they would be riding. This was done to orient participants to specific terminology and prime them to discuss previous experiences they might have had with autonomous technology or vehicles. After the brief presentation, participants were asked about their initial thoughts about the autonomous shuttle, potential benefits and concerns they had about using the shuttle, beliefs about autonomous technology and shuttle regulation, factors that would make them use an autonomous

shuttle over their own personal vehicles, and how the shuttle could impact their short- and long-term health.

Post-Focus Group — Post-focus groups started with a brief orientation, and then participants were asked about their experience on the autonomous shuttle, how their perceptions of autonomous shuttles changed after their ride, what factors would cause them to use an autonomous shuttle over other transportation options, how the shuttle could impact their short- and long-term health, beliefs about autonomous technology and shuttle regulation, and any other important thoughts they wanted to share.

Two coders reviewed and coded each pre- and post-focus group independently and then met to review codes and ensure consensus. The process of using two coders ensures the trustworthiness concept of credibility (Stahl & King, 2020). Transcripts were re-coded until 90% to 100% consensus was reached, ensuring the trustworthiness concept of dependability (Stahl & King, 2020).

Objective 4. Synopsize quantitative (survey) and qualitative (focus group) data

Using a quantitative (survey) and qualitative (focus group) data collection approach (as previously discussed) we addressed the barriers, challenges, and opportunities (see Appendix A, Lessons Learned and Strategies, and Appendix B, Educating Older Adults on ARSS). Specifically, the data were analyzed from a broad (survey) and in-depth (personal) perspective on the acceptance practices of older adults in Florida are related to autonomous ride sharing services.

Task 4.a. Quantitative (survey) Analysis: *Approach* — Descriptive statistics are conducted on the older adults' age, gender, employment status, race, education, and geographic area. Continuous data are presented as mean (*M*) and standard deviation (*SD*) whereas categorical data are presented as count (*n*) and percent (%). The ARSSS scores are assessed for normality using probability plots, histograms, skewness, kurtosis, and Shapiro-Wilk test. A series of one-way analysis of variances (ANOVAs) are performed on older adults' perceptions to assess differences between the groups at baseline. A one-way mixed ANOVA with time (pre-exposure vs. post-exposure) are used to assess changes between older adults' perceptions before and after riding in the autonomous shuttle. A repeated measures ANOVA reveals the effect of pre- vs. post-exposure for all three groups pertaining to the main outcome variable, i.e., *Intention to Use, Trust and Safety*. Data are stored using Research Electronic Data Capture 10 and collated and managed in R Studios (R Core Team, 2020) using R version 4.0.2 (RStudio Team, 2020) and the tidyverse ecosystem (Wickham et al., 2019). An alpha level of 0.05 is set *a priori.*

Task 4.b. Qualitative (focus group) Analysis: *Approach* — A directed content analysis (Hsieh & Shannon, 2005) approach was used to represent knowledge gleaned from the participants. Focus group interview data were analyzed to explore the participants' perceptions related to the barriers, challenges, and opportunities of autonomous ride sharing services among three sites (Hsieh & Shannon, 2005). This method of analysis was chosen as the most appropriate because

the study itself builds on previously conducted research into user experiences and perceptions of autonomous vehicles (Hsieh, & Shannon, 2005). From the previous study (Classen et al., 2022), the themes of Safety, Perceived Ease of Use, Cost, Availability, Aging, AV Information, and Experience with AV were deductively coded within the pre- and post-focus groups. Inductive coding was used to identify new themes and subthemes within the data (Hsieh, & Shannon, 2005). Content analysis of focus group transcripts followed standard qualitative data analytic procedures (Strauss & Corbin, 1998) of coding and constant comparison using NVivo Pro 11 (QSR).

Task 4.c. Integration of Quantitative and Qualitative Analysis Results: *Approach* — We utilized the results from each activity (surveys and focus groups) to examine (in)consistencies, discrepancies, and trends across the data. We identified the Lessons Learned (Appendix A) and Educational Strategies for Older Adults on ARSS (Appendix B). Utilizing these two documents, we are also laying the foundation for the Safe Mobility for Life Program and Coalition (SMFLC) to develop educational materials to be included in their "Tips on How to Use Transportation Options in Florida" series. (http://safemobilityfl.com/ResourceCenter.htm). We are also able to inform industry of user preferences, specifically design features that may enhance *safety* such as the presence of a handrail or other Americans with Disabilities Act (ADA) compliant strategies such as curbside level boarding; *comfort* such as having a safety operator onboard; or *convenience* such as an overhead monitor with visual displays indicating the route and/or audio announcements related to upcoming drop-off points.

2. Results

The objective of this study was to identify the user perceptions of older adults (50+ years of age from three geographic areas in Florida (i.e., Lake Nona, Port St. Lucie and The Villages) on the autonomous ride sharing services (AV ride sharing services).

Objective 1: Develop a recruitment plan to enroll older adults (50+ years).

We worked with 56 local community partners (e.g., FDOT districts, city managers, The Villages research coordinator, Beep stakeholders, retirement community real estate property managers, and the members of the Florida SMFLC) and developed a list of community partners and community facilities where the shuttle operated. We devised plans to contact each of these partners to outline the intended research plan and formulated an outreach plan to facilitate successful marketing and recruitment strategies. Beep was responsible for the visibility of signage for the shuttle. With Beep's infrastructure (see Appendix D) and the help of community partners, we identified facilities in Lake Nona, Port St. Lucie, and The Villages where the research assistants completed enrollment and informed consents of the participants before their shuttle ride. Table 1 displays 21 of Lake Nona's community partners and facilities that supported participant recruitment, resulting in 50 participants recruited and enrolled in the Lake Nona area.

Table 1. A List of Lake Nona's Community Partners and Facilities for Study Recruitment (n=21)

- Tavistock Development/Resident weekly newsletter
- Lake Nona Chamber of Commerce
- Lake Nona YMCA family center
- Ronald McDonald House Charities of Central Florida
- EVTransports CEO/Founder
- Foxtail Coffee local bulletin boards
- Island Fin Poke local bulletin boards
- Starbucks in Lake Nona local bulletin boards
- Beazer Homes Gatherings® of Lake Nona (55+ condos community)
- Rotary Club of Lake Nona
- Renaissance Senior Center/South Econ Community Park
- Del Webb Sunbridge
- Village Walk at Lake Nona
- City of Orlando Office of Community Affairs
- City of Orlando Transportation Department
- Assistant Traffic Operations Engineer from FDOT Turnpike District Traffic Operations
- Carlin-Rogers Consulting Senior Transportation Consultant & CarFit Instructor
- FDOT District 5 Transit Intermodal Supervisor
- Orange County Office on Aging Program Manager
- Best Foot Forward/Bike Walk Central Florida Program Manager
- Beardall Senior Center

Table 2 indicates the three channels that The Villages research team used to recruit and enroll study participants. The study flyer (see Figure 6 and Appendix C) was posted and distributed using the three channels introduced in Table 2. As a result, a total of 127 participants were recruited and enrolled in The Villages area.

Table 2. A List of The Villages' Channels for Study Recruitment (n=3)

- Publicly accessible locations throughout The Villages, Florida: community pools, mailboxes, recreation centers, community clubs
- Publicly accessible healthcare centers: The Villages Health
- The Villages Health agreed patients' contact lists

Figure 6. The Villages' Information Flyer on the Autonomous Ride Sharing Services Study

Table 3 shows 32 of Port St. Lucie's community partners and facilities that supported this study's participant recruitment. As a result, a total of 63 participants were recruited and enrolled in Lake Nona area.

Table 3. A List of Port St. Lucie's Community Partners and Facilities for Study Recruitment (n=32)

- Transit Operation Manager St. Lucie County Transit Division
- Director of Transportation, Senior Recourse Association
- Publix Super Market at Tradition Square
- Tradition Village Center
- Meating Street Seafood and Steakhouse
- The Landing at Tradition
- Fountains At Tradition
- Tradition Dog Park
- Promenade Playground
- Target
- Panera Bread
- Springs Apartments at Tradition
- Rotary Club
- Port St. Lucie Community Center
- Council on Aging of Port St. Lucie
- City Manager's Office
- City of Port St. Lucie Communications Department
- Beford Park and Heritage Oaks
- Del Webb Heritage Preserve
- Emery, Telaro, and Vitalia
- Esplanade
- Promenade
- Manderlie
- The Estates
- The Lakes
- Townpark
- Victoria Parc
- Westcliffe Estates
- Kane Center (Martin County)
- Log Cabin Senior Center
- Savanna Club Concerned Residents Coalition, Inc.
- Mattamy Homes

With 56 local community partners and facilities' support, the research teams were able to successfully recruit a total of 240 participants for this study. The research teams acknowledge all community partners and facilities' support.

Table 4 summarizes the enrollment status of research participants at each study site.

Table 4. Research Participant Enrollment Status (N=240)

Location	Recruitment goal	Screened eligible	Completed consent	Completed Pre-survey	Completed Post-survey
Lake Nona	50	56	54	53	50
Port St. Lucie	75	95	69	65	63
The Villages	75	132	128	127	127
Altamonte Springs	50	0	0	0	0
All sites	250	283	251	245	240

Objective 2: Determine the perceptions of older adults on autonomous ride sharing services.

The demographics revealed the descriptive data on 240 older adults across the three sites (the autonomous shuttle projects has until date not been launched by Beep in Altamonte Springs). The results pertaining to the perceptions are discussed under Objective 4 (see Table 6).

A total of 240 participants (130 males; 109 females; 1 others) were enrolled into the study. Table 5 shows the descriptive statistics for the demographic information. Out of 240 responses, 222 participants provided age information (M_{age} = 66.83, SD_{age} = 8.9). Overall, more male participants enrolled than females, and the majority identified as being White. Notably, our sample was predominately composed of well-educated individuals, with 67% self-reporting as having a Bachelor's, Master's, or Doctorate degree. More than half of the participants indicated retirement; meanwhile, nearly 30% were still working either full-time or part-time.

Table 5. Participants' Demographic Data (N=240)

Factor	Value	Group			
		Entire Group Frequency (%)	Lake Nona Frequency (%)	The Villages Frequency (%)	Port St. Lucie Frequency (%)
Gender	Male	130 (54%)	30 (60%)	79 (62%)	21 (33%)
	Female	109 (45%)	20 (40%)	48 (38%)	41 (65%)
	Other	1 (1%)	0 (0%)	0 (0%)	1 (2%)
Race/Ethnicity	American Indian or Alaska Native	2 (1%)	0 (0%)	1 (1%)	1 (1%)
	Asian	8 (3%)	4 (8%)	3 (2%)	1 (1%)
	Black or African American	16 (7%)	10 (20%)	0 (0%)	6 (10%)
	Hispanic or Latino	15 (6%)	9 (18%)	4 (3%)	2 (3%)
	Native Hawaiian or Other Pacific Islander	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	White	193 (80%)	24 (48%)	118 (93%)	51 (82%)
	Other	6 (3%)	3 (6%)	1 (1%)	2 (3%)
Education	Less than 9th grade	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	9–12 grade (no diploma)	2 (1%)	1 (2%)	1 (1%)	0 (0%)
	High school graduate	20 (8%)	3 (6%)	7 (5%)	10 (16%)
	Some colleges (no degree)	41 (17%)	4 (8%)	26 (21%)	11 (17%)
	Associate degree	16 (7%)	2 (4%)	8 (6%)	6 (10%)
	Bachelor's degree	84 (35%)	25 (5%)	40 (31%)	19 (30%)
	Master's degree	54 (23%)	13 (26%)	30 (24%)	11 (17%)
	Doctorate	22 (9%)	2 (4%)	15 (12%)	5 (8%)
	Prefer not to answer	1 (1%)	0 (0%)	0 (0%)	1 (2%)
Employment	Work part-time	28 (12%)	7 (14%)	14 (11%)	7 (11%)
	Work full-time	46 (19%)	27 (54%)	10 (8%)	9 (14%)
	Not employed	5 (2%)	2 (4%)	1 (1%)	2 (3%)
	Retired	151 (63%)	10 (20%)	98 (77%)	43 (68%)
	Military Veteran	6 (3%)	2 (4%)	3 (2%)	1 (2%)
	Full-time student	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Disabled/Not able to work	1 (1%)	1 (2%)	0 (0%)	0 (0%)
	Other	3 (1%)	1 (2%)	1 (1%)	1 (2%)

Objective 3: Conduct focus groups to solicit responses of older adults of autonomous ride sharing services.

Pre-Focus Groups

A total of six pre-focus groups were conducted across the three sites: Lake Nona (n=2), Port St. Lucie (n=2), and The Villages (n=2). Across all pre-focus groups, a total of 32 older adults participated: Lake Nona (n=6), Port St. Lucie (n=6), and The Villages (n=20). The focus group results are discussed under Objective 4 (Task 4.b).

Post-Focus Group

A total of four post-focus groups were conducted across the three sites: Lake Nona (n=1), Port St. Lucie (n=1), and The Villages (n=2). Across all post-focus groups, a total of 31 older adults participated: Lake Nona (n=5), Port St. Lucie (n=6), and The Villages (n=20). The focus group results are discussed under Objective 4 (Task 4.b).

Objective 4: Synopsize quantitative (survey) and qualitative (focus group) data

Task 4.a. Quantitative (survey) Analysis Results: *Descriptive Statistics* —

Table 6. Descriptive Statistics for the Three Outcome Variables, i.e., Intention to Use, Trust, and Safety, Potential Benefits, and Accessibility

Outcome Variables	Lake Nona (n=50) *M* (*SD*)	Port St. Lucie (n=63) *M* (*SD*)	The Villages (n=127) *M* (*SD*)	All sites (N=240) *M* (*SD*)
Pre-Exposure *Intention to Use*, *Trust*, and *Safety*	68.74 (±18.85)	60.62 (±20.16)	61.48 (±20.56)	62.77 (±20.27)
Post-Exposure *Intention to Use*, *Trust*, and *Safety*	74.01 (±17.70)	62.86 (±23.33)	67.67 (±19.18)	67.73 (±20.34)
Pre-Exposure *Potential Benefits*	64.74 (±20.55)	53.00 (±23.95)	55.23 (±19.82)	57.03 (±21.42)
Post-Exposure *Potential Benefits*	69.74 (±18.64)	56.57 (±26.64)	60.89 (±21.30)	61.68 (±22.69)
Pre-Potential *Accessibility*	79.20 (±13.29)	72.95 (±17.31)	72.82 (±14.97)	74.19 (±15.45)
Post-Exposure *Accessibility*	82.83 (±13.24)	73.34 (±23.63)	76.68 (±17.35)	77.08 (±18.72)

Note: Mean (*M*) and standard deviation (*SD*) of the three outcome variables for pre- and post-shuttle exposure in Lake Nona, Port St. Lucie, The Villages, and all three sites combined.

Interpretation — Lake Nona: Table 6 shows that Lake Nona had the lowest number of participants (n=50) among the three sites. At baseline, the average survey score for *Accessibility* was the highest, followed by *Intention to Use*, *Trust*, and *Safety*, and then *Potential Benefits*. After exposure to the autonomous shuttle, the order of the average scores stayed in the same sequence (*Accessibility* > *Intention to Use*, *Trust*, and *Safety* > *Potential Benefits*). A lower *SD* indicates that the scores are closely clustered around the average score, suggesting less variability, while higher *SD* indicates more variability. All three outcome variables' *SDs*

decreased after exposure to the autonomous vehicle compared to baseline, suggesting that the scores for outcome variables become more closely clustered around the average score, indicating more consistency and stability, with less variability.

Port St Lucie: Port St. Lucie had slightly more participants than Lake Nona (n=63). Like Lake Nona, the average scores for both baseline and after autonomous vehicle exposure showed the same sequence, having *Accessibility* score the highest, followed by *Intention to Use*, *Trust*, and *Safety*, and *Potential Benefits* scores. Conversely to Lake Nona, all *SDs* increased after exposure to an autonomous vehicle compared to baseline in Port St. Lucie, suggesting that scores for the outcome variables became more spread out and less clustered around the average score. This higher variability indicates potential factors in Port St. Lucie that lead to more varied reactions to autonomous vehicles compared to Lake Nona.

The Villages: The Villages had the most participants among the three sites (n=126). Like the other two sites, the average scores for baseline and after autonomous vehicle exposure followed the same pattern, with *Accessibility* scoring the highest, followed by *Intention to Use*, *Trust*, and *Safety*, and *Potential Benefits*. For *SD*, mixed results were observed, having higher *SD* in *Potential Benefits* and *Accessibility* and lower *SD* in *Intention to Use*, *Trust*, and *Safety* after autonomous vehicle exposures, suggesting that *Potential Benefits* and *Accessibility* domain has higher variability, and *Intention to Use*, *Trust*, and *Safety* became more consistent and stable, closely clustered around the average score.

All sites: Combining all three sites, the average scores showed a similar pattern, with *Acceptance* as the highest score, followed by *Intention to Use*, *Trust*, and *Safety*, and *Potential Benefits*, before and after exposure to the autonomous shuttle.

In summary: Participants in Lake Nona had the highest scores for *Intention to Use*, *Trust*, and *Safety* compared to the other two sites and when all sited were combined. For *Potential Benefits*, Lake Nona participants' ratings were the highest followed by The Villages, and Port St. Lucie. Likewise, participants in Lake Nona showed the highest *Accessibility* scores among the three sites The participants in Lake Nona gave higher ratings to their autonomous shuttle experiences, most likely because the shuttles are and have been running consistently in Lake Nona, during days, nights, and weekends for a few consecutive years now.

***Inferential Statistics* —**

Table 7. Mean Differences between the Outcome Variables for Post-exposure vs. Pre-exposure of Participants to the Autonomous Shuttle for Each of the Three Sites and All Sites Combined

Post-exposure vs. Pre-exposure to the Autonomous Shuttle	Lake Nona (n=50)	Port St. Lucie (n=63)	The Villages (n=127)	All sites (N=240)
Intention to Use, Trust, and *Safety*	F = 5.27 t[49] = 2.79 (p = 0.004) **	F = 2.24 t[62] = 1.17 (p = 0.12)	F = 6.19 t[126] = 5.28 (p < 0.001) ***	F = 4.96 t[239] = 5.56 (p < 0.001) ***
Potential Benefits	F = 5.00 t[49] = 2.55 (p = 0.007) **	F = 2.36 t[62] = 1.05 (p = 0.14)	F = 5.66 t[125] = 4.42 (p < 0.001) ***	F = 4.65 t[238] = 4.71 (p < 0.001) ***
Accessibility	F = 3.63 t[49] = 2.39 (p = 0.01) **	F = 0.38 t[62] = 0.15 (p = 0.43)	F = 3.85 t[126] = 2.97 (p < 0.001) ***	F = 2.89 t[239] = 2.88 (p < 0.01) **

Note: F = Mean ANOVA differences for pre- and post-exposure; t_{cutoff} = 0.01, corresponds with p = 0.05; $^{*}p < 0.05$, two-tailed. $^{**}p < 0.01$, two-tailed, $^{***}p < 0.001$, two-tailed.

Lake Nona: According to Table 7, participants in this site demonstrated a statistically significant and positive increase in perceptions pertaining to: *Intention to Use*, *Trust*, and *Safety*; *Potential Benefits*; and *Accessibility*—with the greatest effect for *Intention to Use*, *Trust*, and *Safety*.

Port St. Lucie: We did not observe any statistically significant changes in participant perceptions pertaining to: *Intention to Use*, *Trust*, and *Safety*; *Potential Benefits*; and *Accessibility*.

The Villages: Participants in this site demonstrated a statistically significant and positive increase in perceptions pertaining to: *Intention to Use, Trust,* and *Safety*; *Potential Benefits*; and *Accessibility,* with the greatest effect for *Intention to Use*, *Trust*, and *Safety*.

All sites: Across all sites, participants demonstrated a statistically significant and positive increase in perceptions pertaining to *Intention to Use, Trust,* and *Safety*; *Potential Benefits*; and *Accessibility,* with the greatest effect for *Intention to Use*, *Trust*, and *Safety*.

Table 8. Repeated Measure ANOVA for Participant Perceptions to the Autonomous Shuttle for Intention to Use, Trust, and Safety Post-exposure vs. Pre-exposure, for Each of the Three Sites and All Sites Combined

	df	*F*	*p*	*Partial Eta Squared*
Lake Nona	49	7.80	0.007^{**}	0.021
Port St. Lucie	62	1.47	0.25	0.003
The Villages	126	27.84	$5.57\times10^{-7***}$	0.024
All sites	239	30.87	$7.31\times10^{-8***}$	0.015

Note: df = Degree of Freedom; *F* = F Statistic indicating the size of the effect; *Partial Eta Squared* = Variance explained by *Intention to Use, Trust, and Safety*; $^{*}p < 0.05$, two-tailed. $^{**}p < 0.01$, two-tailed, $^{***}p < 0.001$, two-tailed.

Normality checks were carried out on the dependent variable *Intention to Use*, *Trust*, and *Safety*, *w*hich were normally distributed.

For Lake Nona participants, a repeated measures ANOVA showed that the mean score of *Intention to Use*, *Trust*, and *Safety* differed significantly between time points [F(1,49) = 7.8, p = 0.0074], with the greatest effect observed after the exposure to the autonomous shuttle (Table 8). Specifically, after being exposed to the autonomous shuttle, the participants' responses on *Intention to Use*, *Trust*, and *Safety* showed a noticeable increase.

For participants in Port St. Lucie, a repeated measures ANOVA showed that the mean score of *Intention to Use*, *Trust*, and *Safety* did not differ significantly between two time points [F(1,62) = 1.47, p = 0.25].

For participants in The Villages, a repeated measures ANOVA showed that mean score of *Intention to Use*, *Trust*, and *Safety* differed significantly between time points [F(1,126) = 27.84, $p = 5.57\times10^{-7}$], with the greatest effect observed after the exposure to the autonomous shuttle. Like Lake Nona, the participants in The Villages showed a significant and substantial increase in *Intention to Use*, *Trust*, and *Safety* after experiencing the autonomous shuttle.

Across all sites, a repeated measures ANOVA showed that mean score of *Intention to Use*, *Trust*, and *Safety* differed significantly between time points [F(1,239) = 30.87, $p = 7.31\times10^{-7}$] with the greatest effect observed after the exposure to the autonomous shuttle. This indicates a consistent effect observed across the various locations. The exposure to the autonomous shuttle led to an overall significant and substantial increase in *Intention to Use*, *Trust*, and *Safety* across all participant groups in all three sites combined.

Overall, these findings suggest that the experience with the autonomous shuttle positively impacted participants' perceptions, resulting in increased *Intention to Use* it, greater *Trust* in its capabilities, and a heightened sense of *Safety* while using it because participants generally exhibited more favorable responses to the technology after exposure.

Task 4.b. Qualitative (focus group) Analysis Results

Overall, six themes emerged from the data. These were Perceived benefits, Safety, Experience with AS, Shuttle Experience, AS Adoption, and Aging/Disability (see Table 9).

Table 9. Qualitative Themes and Subthemes

Themes/*Subthemes*	Definitions
Perceived benefits	Individuals perceived the AS to be useful and identified themes such as value, benefits, and advantages of using ASs over other personal vehicles or traditional ride sharing services.
Perceived ease of use	Individual's perception of the effort required to use ASs. This included themes such as complexity in using the shuttle, ease of learning, and the ease of interacting with the technology of user-friendliness.
Availability	Availability of ASs included where in the local area one could use the AS services or providers. Participants were concerned about adequacy of infrastructure to support AS usage, included availability of charging stations and/or available support systems for maintenance and repairs.
Safety	Individual's perception of the safety factors related to ASs included perceived risks, hazards, and potential crashes associated with ASs.
Environment	Benefits of the shuttle being electrical and thoughts about driving environment, including traffic reduction, road improvements, and interactions with other vehicles and drivers.
Trust and reliability	Participants' perceptions of the trustworthiness and dependability of ASs included aspects such as participants' confidence in the technology's ability to navigate safely, the reliability of the shuttle's performance, and their trust in the system's ability to operate safely and effectively in various driving scenarios.
Aging/Disability	Participants identified progressive decrease in physical, physiological and/or cognitive functions resulting from aging or health declines. They discussed these in the context of disabilities and/or chronic illnesses affecting one's ability to drive.
Experience with AV and AS	Individual's actual experience with AVs and ASs included perceptions related to their past interactions with AVs and ASs and the feedback they have received from other AV and AS users.
Shuttle Experience	Participants' experiences related to using the study's AS included topics such as the ease of boarding and disembarking, the overall efficiency of the shuttle system, and any notable positive or negative experiences encountered during their shuttle rides.
Comfort	Participants' perceptions of comfort while using the AS included discussion of their feelings of physical comfort (e.g., seating comfort, vehicle ergonomics) as well as psychological comfort (e.g., feeling safe, relaxed, or confident) during the shuttle ride.

Table 9. Qualitative Themes and Subthemes continued

Speed	Participants' perceptions pertaining to the speed of the AS included their opinions on the shuttle's acceleration, deceleration, and overall speed during the ride. Participants discussed their experiences with the vehicle's speed in relation to their expectations or preferences.
AS Adoption (Acceptance)	Participants' inclination or readiness to adopt and utilize ASs in the future included their expressed intentions, plans, or willingness to use ASs for their transportation needs. Participants also revealed their motivations, barriers, and factors influencing their intention to use ASs in the future.
External variables	External factors that may influence the adoption and use of ASs included media coverage, governing authority regulations, social influence, and cost.

Each one of the six themes and their subthemes, as synopsized in Table 9, is further discussed below, with explicit examples given by the participants.

Perceived Benefits —

The theme "perceived benefits" included two subthemes: (1) perceived ease of use and (2) availability. Participants described how riding the shuttle was effortless (i.e., ease of use) and how, if routes were expanded (i.e., availability), it would create a huge benefit to their community. Specifically, it will potentially provide increased accessibility to healthcare providers and for an aging and/or disabled population. Participants also described one of the biggest benefits of the autonomous shuttle was the ability for them to multitask during the ride, and to socialize with other riders. Exerts below show a few examples of participants expressing these sentiments:

> *"I think people being able to get out more — that they didn't have a car and had to rely on somebody else. They would become more independent, that they can say hey, I'm going to go swimming now. Opposed to when somebody else wants to go."*

> *"Imagine, for example, having shuttles running up and down some of the major roads... And that would be a way to help people quickly get from one end to the other with two or three stops along the way. And then when you get off of there to be able to pretty quickly pick up one of those more individual ones, the more the Uber type things that get you to where you really want."*

> *"I guess it was a misconception that I had. I was comparing this shuttle to more of the Uber or Lyft rather than — So if I need to go to the doctor's appointment, and I'm handicapped, it's not going to come to my house and pick me up."*

> *"I like the idea. You would have things to do. The first one that'd be doing something than just sitting there looking at the road. I hate that while driving. This was like having a chauffeur. And I'm all for that."*

***Safety* —**

The theme "safety" included two subthemes: (1) trust and reliability and (2) environment. Safety was the most common theme brought up by participants across all locations. During pre-focus groups, many participants had questions and concerns about how safe the autonomous shuttle was. After riding the shuttle, many participants expressed how impressed they were with how safe and overly cautious the shuttle was. After being exposed to the autonomous shuttle, participants expressed that consistent exposure to the shuttle and its features will help increase feelings of trust and reliability. Participants expressed how the autonomous shuttle could improve safety and improve environmental safety (i.e., congestion, air quality). Excerpts below show a few examples of participants expressing these sentiments:

> *"Well, one thing about this vehicle, it's electric. You don't have the fumes from gasoline or diesel-powered vehicles."*

> *"The other thing is I think it would dramatically increase the safety for the community because whenever I'm going around roundabouts, which I personally don't like roundabouts, I would feel much more comfortable having a beep vehicle in the other lane going around the circle than many of my neighbors and future neighbors. I think it would be safer."*

> *"I think once — it is you've got these different levels here. I think once a vehicle has gone through all the appropriate testing and certification that a backup driver is not needed, then there's no need to have the additional cost of the backup drive[r]"*

> *"I guess I still think that there's a little division about self-driving cars and whether you can do another task while you're in there or if people would be falling asleep at the wheel and not be that emergency person that could handle an emergency should that occur. That seems not clear to me"*

***Aging and/or Disability* —**

Many participants described that the autonomous shuttle had the potential to provide independence and mobility to an aging and/or disabled population. Participants also suggested that future iterations of the shuttle should be even more disability friendly. Exerts below show a few examples of participants expressing these sentiments:

> *"Yes. And so you maintain your own independence. If you have any people lose their licenses when they get older and that's part of aging. That could just keep them up and about a little bit longer."*

> *"For disabilities, the on demand autonomous, you really do need another human being if I get my legs broken, I don't want to just be in the vehicle I want somebody else on that."*

> *"Thinking about people's disabilities, you want both visual indicators and audio. Audio indicators, consistency in how that's done."*

***Experience with Autonomous Shuttle* —**

During the pre- and post-focus groups, participants discussed their previous experiences with autonomous technology and vehicles. Many participants had experience with autonomous vehicle features such as adaptive cruise control and assisted braking, but only a few individuals had experience with AVs (i.e., the Tesla). If participants did not have previous experiences with AVs, they had sought out information through various media forms to learn more about the technology. Excerpts below show a few examples of participants expressing these sentiments:

> *"I mean, my car does yell at me if I seem to be like turning the wheel a little bit too much or not turning it enough. It yells at me."*

> *"Well, I believe it was PBS that had a documentary about autonomous vehicles. But in that one it was tractor trailers crisscrossing the United States with autonomous drivers. Although they did keep a driver in the truck. Because it's still, as you say, in test mode. But they also, I think in the same show they were showing them in Scotland, I do believe. That same idea. They really want to go with it."*

> *"I've been driving a Tesla for seven years"*

***Autonomous Shuttle Experience* —**

The theme "shuttle experience" occurred exclusively within post-focus groups. The theme "shuttle experience" included two subthemes: (1) comfort and (2) speed. Overall, participants described a positive and comfortable experience when riding in the autonomous shuttle. The largest complaints expressed by participants were the slow speed and abrupt braking. Excerpts below show a few examples of participants expressing these sentiments:

> *"Well, I'm very positive of the vehicle, so I think similar to what we have now. I would hate to be behind a vehicle that you know is going to go slower than the speed limit of 20 miles per hour around the circle. No one's going to want to get back up, especially villagers. We'll get ahead and almost t-boned as you said."*

> *"I've never ridden anything that's autonomous like that. To me, it's a whole better experience. I never thought it was going to be."*

> *"Not as scary as I thought."*

> *"That's the only thing I noticed a little bit different. We would probably do the braking a little bit slower. But other than that, I thought it was fine."*

> *"We sat around and talked during the ride."*

***Autonomous Shuttle Adoption* —**

The theme "AS adoption" included several factors all grouped into one subtheme, i.e., external variables. The theme "AS adoption" occurred only in the post-focus groups and is where

participants described factors that would make them more likely to use autonomous shuttles versus their own personal vehicles. Participants mentioned many external factors that would influence their decisions such as governing regulations and cost, but overall AS adoption most commonly occurred alongside the themes Perceived Benefits and Safety. Participants described that they would be mostly likely to use an autonomous shuttle regularly if it was safe, and readily available, like an Uber/Lyft, or had routes that went along busy areas (doctor's offices, shopping centers). Excerpts below show a few examples of participants expressing these sentiments:

> *"I don't think we can use it right now. And I don't even know trying to implement this all before the roadways are all in place to be able to allow them to do what they have to do. I mean the AI is here. We know that the AI today is way better than any of us. All of us put together."*

> *"Start the rollout sooner rather than later, it's probably being starting it up in a phased basis. It might be slow. It might be a really boring circle or something but getting started sooner is the best thing because then people start to see it."*

> *"We talked about signs and autocues. Eventually you're going to need grab bars above because I can imagine that people will probably be standing as you get more riders. Music."*

> *"It's like when you mentioned the GPS out that gets you to the wrong place. But it's just how many times did it get you to the right place. It's the future*."

Task 4.c. Integration of Quantitative and Qualitative Analysis Results

Table 10 displays an integration of the main quantitative and qualitative findings, for each of the three outcome variables, across all sites.

Table 10. Integration of Quantitative and Qualitative Data Analysis Results

Outcome Variables	Quantitative Results for All Three Sites (n=240)	Qualitative Results for All Three Sites (N=31)
Intention to Use, *Trust*, and *Safety*	Across all sites, participants demonstrated a statistically significant and positive increase in perceptions pertaining to *Intention to Use*, *Trust*, and *Safety* ($p < 0.001$).	Overall, participants shared their motivations, challenges, and circumstances that influenced their intention to use the AS. Participants observed safety benefits related to the shuttle, i.e., the shuttle being electric, potential for congestion mitigation, and the observed caution (e.g., slowing down) that the shuttle displayed in interacting with pedestrians. Moreover, participants expressed their trust in the safety of the technology and mentioned that the shuttle performed reliably. However, pertaining to safety challenges, some participants focused on the risks, dangers, and potential crash involvement associated with autonomous shuttle. Thus, although participants were generally in favor of trust and reliability of the autonomous shuttle, some concerns (as discussed above) were also mentioned.
Perceived Benefits	Across all sites, participants demonstrated a statistically significant and positive increase in perceptions pertaining to *Potential Benefits* ($p < 0.001$).	Generally, participants shared perceptions that the AS, when used as a source of community mobility, could have more benefits compared to the personal automobile. Participants particularly highlighted the ease of learning and interacting with the technology. However, concerns arouse about insufficient infrastructure for the AS, such as availability of charging stations, or support for repairs when the shuttle breaks down.
Accessibility	Across all sites, participants demonstrated a statistically significant and positive increase in perceptions pertaining to *Accessibility* ($p < 0.01$).	In general, participants shared their experiences and concerns related to boarding and disembarking the autonomous shuttle. Participants also shared their observations pertaining to the shuttle's seating comfort and described the pros and cons of the ergonomic designs of the shuttle. Furthermore, participants emphasized the necessity of expanded availability (e.g., operation time, extended routes, door-to-door services) of the shuttle.

Lessons Learned (see Appendix A for a detailed description)

We have learned multiple lessons while conducting this research (see Lessons Learned, Appendix A). We can summarize these lessons as follows:

The operations of autonomous shuttles pose several challenges that need to be addressed for their successful deployment. These challenges broadly pertain to hardware technical issues, accessibility concerns, speed restrictions, seating capacity constraints, high costs, limited weather tolerance, technical issues, electrical concerns, battery power limitations, seating capacity constraints, reliance on safety (e.g., signal strength) operators, comfort seating and riding. Although some of the challenges (e.g., shuttle design elements) are out of the research team's scope to resolve, other issues such as ease of use, comfort, education, marketing, and collaboration must be addressed prior to shuttle deployment.

The successful deployment of autonomous shuttles depends on overcoming several challenges. These challenges can be broadly categorized into hardware, accessibility, cost, and comfort. Overcoming these challenges is critical to ensure the safe, efficient, and user-friendly operation of autonomous shuttles in various environments and to ensure shuttles meet the needs of passengers utilizing this mode of transportation. Recommendations for addressing these challenges are divided into three categories: Field Deployment, Research, and Policy, each briefly summarized below.

- Field Deployment: Develop training programs for shuttle operators and maintenance personnel to ensure they are equipped with the necessary skills to maintain autonomous shuttles prior to deployment. Conduct regular safety inspections and maintenance checks to ensure the shuttles are in good working condition prior to scheduled rides. Conduct pilot tests in controlled environments to identify and address any issues before deploying the shuttles in real-world settings. Collaborate with local governments and transportation authorities to ensure regulatory compliance and obtain necessary permits.
- Research: Conduct research on user needs and preferences to inform shuttle design and operations. Develop and implement technology and systems to improve shuttle safety, reliability, and efficiency.
- Policy: Understand and share policies and regulations to ensure the safe and responsible deployment of autonomous shuttles. Establish guidelines for data privacy and security to protect passenger information.

By implementing these recommendations, researchers and stakeholders can work toward overcoming the challenges of autonomous shuttle deployment and ensure the safe and efficient operation of these vehicles, while also enhancing the riders' experiences. However, we have also found that older adults may need specific information to educate them on the use of the autonomous shuttle.

Educational Strategies of Older Adults (see Appendix B for a detailed description)

As informed by four areas related to this research, i.e., the quantitative survey data, the qualitative focus group results, the lessons learned in the field (discussed above), and from the published literature (Abraham, et al., 2017; Booth, et al., 2022; Classen, et al., 2021; Faber, et al., 2020; Rahman, et al., 2019; Siegfried, et al., 2021), we have formulated key messages to inform further developing the educational strategies. These are discussed in detail (see Educational Strategies of Older Adults, Appendix B).

1. Addressing the safety issues of autonomous shuttles
2. Addressing issues pertaining to trusting the autonomous shuttles
3. Offering rider experiences
4. Customizing educational materials to older adults' preferences
5. Highlighting the potential benefits of autonomous shuttles
6. Emphasizing features that support inclusive, accessible, and available autonomous shuttle services.

3. Conclusions

The overarching objective was to identify the user perspective about autonomous ride sharing services among older adults in three different geographic areas in Florida and to solicit their responses pertaining to adoption and acceptance practices thereof.

The integration table (Table 10) makes clear the main take-home messages of this study. That is: the *quantitative data* across all three sites demonstrated a statistically significant increase in perceptions for each of the three outcome variables (*Intention to use, Trust, and Safety, Potential Benefits, and Acceptance*), the *qualitative data* illuminated the depth and breadth of participants' experiences pertaining to benefits as well as limitations or challenges that they had experienced before and after riding the autonomous shuttle. This information is foundational in constructing informational strategies for older adult education (see Educational Strategies, Appendix B). Such educational strategies may further enhance older adults' *Intention to Use, Trust, and Safety; Potential Benefits;* and *Acceptance* of the autonomous shuttle as a source of community mobility.

Limitations

We have experienced limitations and challenges in this study, next described.

Although the demographics in this study were consistent for Central and North Central Florida, the oversampling of the White *race,* may have influenced the estimates of this study. This study was conducted after the peak of the pandemic, which could have deterred some from participating. Factors associated with this progression or regression (e.g., increasing or decreasing levels of technological sophistication, number of personnel involved, weather-related issues) could have plausibly impacted the observed increases in *Intention to use, Trust, and Safety* scores when participants were exposed to the autonomous shuttle. Moreover, we have identified important *Lessons Learned* in the field (see Appendix A). Much of the information described in the *Lessons Learned* pertains to the factors that influenced the smooth operation of the shuttle—and 14 points highlighting these challenges are described in detail under *Challenges Related to the Operation of the Autonomous Shuttles*.

This study has inherent biases, such as a self-selection bias, spectrum bias, Hawthorne bias (i.e., the presence of a safety operator, required by NHTSA, in the shuttle), and demand characteristics (i.e., the effect of word-of-mouth referral on enrollment; effect of weather patterns). Even though we have attempted a rigorous recruitment strategy, we can at best describe the sample as a convenience sample across three Florida locations. Many challenges were experienced pertaining to the smooth operation of the shuttle that may have further influenced the participant perspectives. Thus, this study's findings, although they provide foundational knowledge for the AV technology industry, are only generalizable to study participants and settings that fit the demographic profile and context of this study.

Strengths

However, we have also identified multiple strengths pertaining to this study, next described.

The study included 240 older adults representing three different demographic areas in Central and Nort Florida that allowed for within and between-subject comparisons using well-validated questionnaires and information obtained from focus groups. The findings reveal important foundational information about the exposure of older drivers to a mode of autonomous ride sharing services vehicle. Specifically participant perceptions are more favorable after exposure; however, their lived experiences indicated not only benefits, but also challenges and limitations of the autonomous shuttle. Moreover, we have generated knowledge on *Lessons Learned* in working with industry, multiple partners and a variety of stakeholders—not previously examined to this extent in the extant AV and driving literature. This informational is foundational to inform policymakers, industry partners and researchers, alike. Likewise, we have also generated (from the quantitative data, qualitative data, and literature) information for recommending educational strategies for older adults who are interested in exploring autonomous ride sharing services. This study was conducted on the principles of team science, including a collaboration between the university, the industry partner (Beep), the Florida Department of Transportation, the Safe Mobility for Life Coalition, research staff at The Villages Florida, as well as stakeholders involved in Port St. Lucie and Lake Nona, Florida. The team members, although varied in educational and experience level made a substantive contribution to the successful execution of the study.

Concluding Statement

Finally, the findings of this study contribute richly to the field of autonomous ride sharing services among older adults, Particularly, the findings reveal foundational information in the early stages of piloting and pioneering work in autonomous shuttle deployment, within the context of three different geographic areas, among older adults in Florida.

References

Abraham, H., Lee, C., Brady, S., Fitzgerald, C., Mehler, B., Reimer, B., & Coughlin, J. F. (2017, January). Autonomous vehicles and alternatives to driving: trust, preferences, and effects of age. In *Proceedings of the Transportation Research Board 96th Annual Meeting*. Washington, D.C.: Transportation Research Board. Pp. 8–12. https://agelab.mit.edu/static/uploads/autonomous-vehicles-and-alternatives-to-driving.pdf

Booth, L., Tan, T., Norman, R., Anund, A., & Pettigrew, S. (2022). Experiences of older adults interacting with a shared autonomous vehicle and recommendations for future implementation. *Transportation Research Part F: Traffic Psychology and Behaviour, 90*, 100–108. https://doi.org/10.1016/j.trf.2022.08.014

Classen, S., Mason, J., Wersal, J., Sisiopiku, V., & Rogers, J. (2020). Older drivers' experience with autonomous vehicle technology: interim analysis of a demonstration study. *Frontiers in Sustainable Cities, 2*, art. 27. https://doi.org/10.3389/frsc.2020.00027

Classen, S., Mason, J., Hwangbo, S. W., Wersal, J., Rogers, J., & Sisiopiku, V. (2021). Older drivers' experience with autonomous vehicle technology. *Journal of Transport & Health, 22*, 101107. https://doi.org/10.1016/j.jth.2021.101107

Classen, S., Sisiopiku, V., Mason, J., Stetten, N., Yang, W., Hwangbo, S. W., McKinney, B., & Kwan, J. (2022). *Final STRIDE project A5: Barriers and Facilitators of People with Disabilities in Accepting and Adopting Autonomous Shared Mobility Services*. U.S. Department of Transportation, University Transportation Centers Program. https://stride.ce.ufl.edu/wp-content/uploads/sites/153/2022/12/STRIDE-Project-A5-Final-Report-Nov-2022.pdf

Faber, K., & van Lierop, D. (2020). How will older adults use autonomous vehicles? Assessing the role of AVs in overcoming perceived mobility barriers. *Transportation Research Part A: Policy and Practice, 133*, 353–363. https://doi.org/10.1016/j.tra.2020.01.022

Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., ... & Duda, S. N. (2019). The REDCap consortium: Building an international community of software platform partners. *Journal of Biomedical Informatics, 95*, 103208. https://doi.org/10.1016/j.jbi.2019.103208

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine, 292*, 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Ho, D. G.E. (2006). The focus group interview: Rising to the challenge in qualitative research methodology. *Australian Review of Applied Linguistics, 29*(1), 5.1–5.19. https://doi.org/10.2104/aral0605

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–1288. https://doi.org/10.1177/1049732305276687

Krueger, R. A., & Casey, M. A. (2008). *Focus groups: A practical guide for applied research (4th ed.).* Sage Publications.

Mason, J., Classen, S., Wersal, J., & Sisiopiku, V. (2020, March 26). Survey design on the perceptions of autonomous vehicles: Face and content validity [Poster presentation]. *American Journal of Occupational Therapy*, 74(4, Supplement 1), 7411500025p1. https://doi.org/10.5014/ajot.2020.74S1-PO3607

Mason, J., Classen, S., Wersal, J., & Sisiopiku, V. (2021). Construct validity and test–retest reliability of the autonomous vehicle user perception survey. *Frontiers in Psychology: Quantitative Psychology and Measurement*, *12*, 626791. https://doi.org/10.3389/fpsyg.2021.626791

Mason, J., & Classen, S. (2023). Develop and validate a survey to assess adult's perspectives on autonomous ridesharing and ridehailing Services. *Future Transportation, 3*(2), 726–738. https://doi.org/10.3390/futuretransp3020042

Rahman, M. M., Deb, S., Strawderman, L., Burch, R., & Smith, B. (2019). How the older population perceives self-driving vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*, *65*, 242–257. https://doi.org/10.1016/j.trf.2019.08.002

R Core Team. (2020). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.

RStudio Team. (2020). *RStudio: Integrated Development for R*. Boston, MA: RStudio, PBC

Scanlan, D. (2018, March 14). Seniors more prone to traffic fatalities in Florida, new study says. *Jacksonville.com*. https://www.jacksonville.com/story/news/2018/03/14/on-road-seniors-more-prone-to-traffic-fatalities-in-florida-new-study-says/12995146007/

Siegfried, A. L., Bayne, A., Beck, L. F., & Freund, K. (2021). Older adult willingness to use fully autonomous vehicle (FAV) ride sharing. *Geriatrics, 6*(2), 47. https://doi.org/10.3390/geriatrics6020047

Spectrum News 13. (2019, March 28). Watchdog: Fatal crashes among elderly drivers in Florida increasing. *Spectrum News 13*. https://www.mynews13.com/fl/orlando/news/2019/03/28/watchdog--fatal-crashes-among-elderly-drivers-in-florida-increasing

Stahl, N. A., & King, J. R. (2020). Expanding approaches for research: Understanding and using trustworthiness in qualitative research. *Journal of Developmental Education*, *44*(1), 26–28. https://www.jstor.org/stable/45381095

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research techniques: Techniques and procedures for developing grounded theory* (4th ed.). Thousand Oaks, CA: SAGE Publications; 1998.

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., . . . Yutani, H. (2019). Welcome to the Tidyverse. *Journal of Open Source Software, 4*(43), 1686. https://doi.org/10.21105/joss.01686

Appendix A. Lessons Learned

While collaborating with various stakeholders conducting the Autonomous Ridesharing Service (ARSS) Study, we have learned valuable lessons and gained valuable insights that have shaped our understanding of working with industry partners. In this document we are describing four main areas:

- The stakeholders involved
- Lessons learned in working with industry
- Recommendations for research
- Challenges related to the operation of the autonomous shuttle.

Stakeholders Involved

- Industry partners
  - Manufacturer (EasyMile, NAVYA)
  - Autonomous vehicle service provider in charge of planning routes, deploying, and managing the operation (TransDev, Beep)
- Local transportation providers or transit corporations (Jacksonville Transportation Authority, Gainesville Regional Transit System)
- Research funding agencies
  - Florida Department of Transportation (FDOT)
- Regulatory stakeholders
  - United States Department of Transportation (USDOT)
  - The Society of Automotive Engineers International (SAE)
  - National Highway Traffic Safety Administration (NHTSA)
- Community groups
  - Retirement communities, real estate companies (Mattamy Home)
  - Group leaders and key informants (e.g., county commissioners, hospital heads, etc.,)
  - Businesses located in the communities where the shuttle operated.
  - Areas where target populations are likely to congregate (e.g., senior centers, libraries, recreation centers, parks, etc.)
  - Transportation advocacy organizations.
  - Groups on social media platforms (e.g., Senior groups on Facebook, etc.)
  - Local newspapers, radio stations, media
  - Local advocacy groups (e.g., Disabled Veterans of America, Retired Nurses, etc.,)
- Academic institutions
- Legal experts
- Emergency services (e.g., police, fire, emergency medical services)
- Infrastructure providers (institutions willing to provide support services such as charging portal, landscape maintenance, antenna hosting, etc.)

Summary of Lessons Learned in Working with Industry

Regular and clear communication: Working with autonomous shuttle industry partners has taught us the importance of regular and clear communication.

With industry, unexpected events and issues can arise anytime that can significantly impact research progress and operation. By maintaining open communication with industry stakeholders, researchers may stay informed about the situation and quickly adapt to any challenges. For example, the shuttle may temporarily change operation times and stop locations due to community events or challenges with the shuttle operational structure (e.g., charge time, losing satellite signal etc.). We implemented biweekly meetings with our industry partners and in-person communications. Such regular communication allowed us to promptly address operational issues with the shuttles and reschedule participant appointments.

2. *Education and training*: While this technology has the potential to enhance transportation and provide numerous benefits, it is important to ensure that users are fully informed about its capabilities and limitations to facilitate adoption.

This includes educating users about how the shuttles operate, their safety features, and how to interact with the technology appropriately. This can be done in advance of shuttle arrival by harnessing local media; hosting educational events; meeting with community leaders and emergency support personnel, and/or distributing educational flyers. In addition, having a research assistant and/or safety operator on board the shuttle during rides can help to alleviate any concerns or fears that users may have about the technology. Education and training are particularly important for those who may be more hesitant to use autonomous shuttles due to unfamiliarity with the technology. It is also essential to properly educate first responders, emergency personnel, and safety operators because the technology is still evolving and electrical issues are frequent.

3. *Challenges in autonomous shuttle technology*: While autonomous shuttle technology continues to improve with every iteration, current technology is not without limits.

For example, speed restrictions imposed by the National Highway Traffic Safety Administration (NHTSA) require that the shuttle not travel faster than 15 mph. This can feel slow to users and feel disconcerting, causing concern that other vehicles might cause an accident by driving around the shuttle to pass. As a result, participants have expressed a desire for improved acceleration. Additionally, rain, detection of objects on the road, high winds, or shadows from trees influence the smooth operation of the shuttle. When these kinds of circumstances are encountered, the shuttle may not move or operate smoothly. Severe circumstances such as heavy rain, lightning, and thunderstorms may impact autonomous shuttle operation. Furthermore, the sensors on the shuttle can be too sensitive, often detecting objects such as leaves as hazards and bringing the vehicle to an abrupt emergency stop.

Further, shuttles may have variable efficiency in air conditioning and braking, which reduce the comfort of the riders. For example, hot weather dramatically impacted the battery life of the shuttle, limiting use of air conditioning in the hot Florida climate to ensure that the shuttle could maintain timely operations on its scheduled route.

These limitations emphasize that the technology is still in its early stages and requires ongoing research and real-world testing to improve its capabilities and address these limits. As such, it is important to approach the deployment of autonomous shuttles with caution and to carefully consider the risks and benefits of using this technology in various contexts.

4. *Accessibility and inclusivity*: Accessibility and inclusivity must be addressed when designing and deploying autonomous shuttles to ensure everyone can use them regardless of their abilities.

Designs that comply with Americans with Disabilities Act (ADA) regulations, such as the height of emergency buttons, handlebars, and ramp installations, are not optimized for people with disabilities on many existing autonomous shuttles. While many autonomous shuttles are equipped with ramps to assist individuals with disabilities, it is important to ensure that these ramps are reliable and user-friendly. For example, in some cases, the ramps may not work properly, or may require an individual's assistance (e.g., a safety operator) for ingress or egress. We recommend accommodations, such as lowering the doorsteps for shorter individuals, installing softer seat cushions, and improving back supports for older adults and individuals with disabilities to enhance their comfort and increase the likelihood that they will utilize this mode of transportation. Disabled, and non-disabled participants alike often expressed that fixed routes of the shuttle were limiting as they would have challenges in accessing fixed pickup locations. Disabled older adults, in particular, expressed high regard for personalized pickup and drop-off to meet IADL needs (e.g., visiting doctor’s office, picking up medical services, getting groceries etc.,)

5. *Collaboration and partnership* play a pivotal role in facilitating the successful deployment of autonomous shuttle services and promoting participant engagement. Various stakeholders must collaborate to ensure a successful rider experience.

Collaboration of multiple key individuals and groups is necessary to ensure a successful autonomous vehicle experience for communities and riders. These individuals and groups include industry partners responsible for deploying the autonomous shuttles, regulators who oversee safety and operations, stakeholders with a vested interest in the deployment, funding organizations to provide financial support, community organizations to assist with marketing and advertising, and community members themselves. Collaboration enables open dialogue, addresses concerns, and ensures that the deployment aligns with the needs and expectations of the community.

6. *Motion sickness*: While autonomous shuttle rides for this project were limited in duration and speed, no dropouts occurred during or after the autonomous shuttle ride due to motion sickness. This suggests the autonomous shuttle technology is well-suited for transporting passengers without causing discomfort or adverse reactions to motion sickness provocation.

Future studies may aim to test motion sickness at faster speeds and more complex routes, which may better simulate real-world scenarios. The seating configuration of the autonomous shuttles is bidirectional (with passengers seated to face both forward and rear directions), which could impact passengers' perceptions and motion sickness, especially in more complex environments and at higher speeds. Further research is required to determine whether seating direction plays a role in passenger comfort and safety.

7. *Exposing autonomous shuttle to a diverse range of potential users* will be pivotal in its widespread adoption and success.

Significant diversity among participants' expectations and satisfaction levels regarding autonomous technology was observed in the field. Some participants expressed enthusiasm about current advancements and eagerly anticipated future developments, while others held more conservative views and focused on potential drawbacks in the present. Acknowledging and accommodating these diverse perspectives is essential for fostering inclusive and meaningful research outcomes.

8. *Implementing innovative strategies for recruitment and marketing* is essential in educating new communities about the potential benefits of autonomous shuttles and facilitating engagement. For example, a community could organize an autonomous vehicle-themed event to engage local citizens in shuttle deployment experiences.

Hosting a dedicated event where individuals can ride and experience autonomous shuttles firsthand or organizing community activities that cater to the interests of older adults presents a practical in-person approach to overcoming skepticism and generating interest. By providing an opportunity for direct interaction with the technology, participants can gain firsthand experience and develop a better understanding of its benefits.

9. *Surrounding infrastructure*: Reliable and high-quality modern infrastructure is vital for successful community operation and research activities. However, in some areas, we have encountered challenges with infrastructure.

Inconsistent Internet service can cause significant disruptions, including signal loss for the shuttles. In turn, Internet service can impact the shuttle's capacity to function and its overall service quality and hinders the smooth operation of essential systems. To mitigate these issues, we recommend conducting a field investigation before launching the service, improving the underlying infrastructure, potentially upgrading network capabilities, and addressing any geographical or environmental factors that may obstruct the signal.

Recommendations for Research: Practical Strategies for Conducting Autonomous Vehicle Research

1. *Collaboration and partnership* play a key role in promoting research participant engagement.

Collaboration of multiple key individuals and groups is necessary to ensure recruitment success among research participants. Collaboration with local communities and stakeholders is crucial for building trust, ensuring transparency, and engaging potential participants. By involving community leaders, advocacy groups, and public officials, researchers can address concerns, dispel misconceptions, and communicate the goals and benefits of the study effectively.

2. *Implementing innovative strategies* for recruitment, data collection and participant compensation.

To facilitate research with older adult populations, it is important to streamline the processes for recruitment, data collection, and participant compensation because time efficiency and ease-of-use are important principles in conducting research with older adults and/or individuals with disabilities. Making participant-facing materials (e.g., flyers) easy to understand, wide dissemination of educational materials (i.e., local newspaper articles, social media), computer-enhanced data collection (i.e., online, or iPad-based surveys), offering one-on-one support for survey completion, and completion of administrative compensation processes in advance can reduce participant burden and enhance capacity for robust data collection.

3. *Implementing innovative strategies* for simplifying the compensation process and reducing waiting time.

Participants should be compensated for participating in the study in real time, upon completion. To improve participant recruitment and enhance the compensation experience, consider utilizing pre-loaded gift cards that require no activation or sending pre-loaded e-gift cards via text or email. These approaches may eliminate the need for multiple steps associated with traditional gift card processes, such as activation and balance loading. Some participants reported a burden as a result of needing to self-activate the Visa gift card and waiting for the balance to be loaded. In such a process, one participant was upset and expressed complaints to the research assistant via text using inappropriate words. This incident occurred during the gift card activation process and wait time.

Challenges Related to the Operation of the Autonomous Shuttles

1. The weather tolerance of the shuttles is limited, as they can only operate in light rain, while heavy rain and lightning impede the operation of the autonomous shuttle.
2. Shuttle reboots failed due to technical issues during the turning-on process of the shuttle, related explicitly to TransDev.
3. Electrical issues may arise because the vehicle is battery-powered and requires a charging station, which could cause fire or other damage.
4. During the summer season, air conditioning consumes a significant amount of battery power, which can become problematic and may require the shuttle to stop operating to recharge.

5. The failure to operate on the designated route and signal errors can be, in part, attributed to technical issues with the antenna.
6. The shuttle is limited to a maximum speed of 15 miles per hour due to restrictions imposed by the National Highway Traffic Safety Administration (NHTSA).
7. Autonomous shuttles typically have limited seating capacity, which can be a drawback when large groups need transportation.
8. The high cost of purchasing and maintaining autonomous shuttles can make them cost-prohibitive for some organizations or individuals.
10. The autonomous shuttle requires constant assistance from the safety operator when encountering roadblocks, such as construction or vehicles and pedestrians obstructing the road.
11. The light detection and ranging (lidar) system can be overly sensitive. It may detect an object, such as the shade of a tree, which may cause the shuttle to come to a hard stop, potentially disrupting the traffic flow and the riders' comfort.
12. Uncomfortable (e.g., small seats) seating can significantly affect passengers' experience, particularly during abrupt stops or movements, leading to a negative user experience and making the ride less enjoyable.
13. The current shuttle operates in pre-planned fixed routes, providing a limited travel range.
14. Shuttle space is limited, and it is unclear how items like groceries, or medical equipment such as oxygen tanks would be accommodated.

Appendix B. Educational Strategies for the Older Adults on ARSS

In this document, we are providing strategies to develop educational materials for older adults based on findings from:

- Quantitative data
- Qualitative data
- Lessons learned from the field
- Published literature.

From Quantitative Data

Intention to Use, Trust, and Safety
Across all sites (i.e., Lake Nona, Port St. Lucie, and The Villages), participants demonstrated a statistically significant and positive increase in perceptions on *Intention to Use*, *Trust*, and *Safety*.

Recommendation: Develop educational materials for older adults to address how intention to use, trust, and safety perceptions increased after exposure to an autonomous shuttle. Explain that practical exposure to an autonomous vehicle may contribute to increasing familiarity and reducing anxiety about autonomous vehicle technology. Also share specific data (e.g., number of currently deployed autonomous shuttles, crash numbers) and real-life examples (e.g., transparent examples addressing both positive and negative sides such as successful autonomous shuttle operation in other states as well as autonomous shuttle incidence occurred in other states), which can help build trust.

Potential Benefits
Across all sites (i.e., Lake Nona, Port St. Lucie, and The Villages), participants demonstrated a statistically significant and positive increase in perceptions on *Potential Benefits*.

Recommendation: Develop educational materials for older adults to address how perceptions on potential benefits of autonomous shuttles increased after exposure to an autonomous shuttle. Explain the positive impact (e.g., maintaining connection with other friends and community with continued independent mobility) of actual experience of riding the autonomous shuttle.

Accessibility
Across all sites (i.e., Lake Nona, Port St. Lucie, and The Villages), participants demonstrated a statistically significant and positive increase in perceptions to *Accessibility*.

Recommendation: Develop educational materials for older adults to address how perceptions on accessibility of autonomous shuttles increased after exposure to an autonomous shuttle. Explain the impact of the autonomous shuttle exposure on accessibility perception (e.g., ease of boarding and disembarking) and understand how autonomous shuttles are designed for smooth and a better accessibility.

From the Qualitative Data

Definitions of Themes and *Sub-themes*

Perceived benefits: Individuals perceived the AS to be useful and identified themes such as value, benefits, and advantages of using ASs over other personal vehicles or traditional ride sharing services.

Recommendation: Develop educational materials for older adults to address the potential benefits (e.g., increased safety, reduced congestion, environmental gains, increase productivity, increased mobility independence, and alternative public transportation option) of using autonomous shuttles.

Perceived ease of use: Individual's perception of the effort required to use ASs. This included themes such as complexity in using the shuttle, ease of learning, and the ease of interacting with the technology of user-friendliness.

Recommendation: Develop educational materials for older adults addressing how autonomous shuttles are designed and operated (e.g., where the ramps and handlebars are installed in autonomous shuttles, how autonomous shuttles' sensors spot objects and stop the shuttle) and how quickly, accurately, and easily the autonomous vehicle technology can be learned and interacted with (e.g., understand where sensors are located and how they function, how to communicate with command center using autonomous shuttle embedded cameras and microphones).

Availability: Availability of ASs, including where in the local area one could use AS services and providers. Participants were concerned about adequacy of infrastructure to support AS usage, included availability of charging stations and/or available support systems for maintenance and repairs.

Recommendation: Develop educational materials for older adults that inform about the local availability of autonomous shuttles in their area, detailing when autonomous shuttles are operating or plans for future operation. Identifying and listing all autonomous shuttle service providers and their accommodations for older adults, explaining the process of booking and accessing the autonomous shuttles, with step-by-step instructions and guidance, discussing the cost, payment options, and discounts/promotions for older adults, and sharing any testimonials and success cases of positive experiences of older adults who already have utilized such similar autonomous shuttles services in their area would be necessary.

Safety: Individual's perception of the safety factors related to ASs included perceived risks, hazards, and potential crashes associated with ASs.

Recommendation: Develop educational materials that inform older adults about the safety features and technologies (e.g., various safety systems such as emergency brake, sensors)

incorporated into autonomous shuttles, highlighting their potential to reduce accidents caused by human error. Inform older adults about cybersecurity, emergency preparedness, legal and regulatory framework for autonomous shuttle safety in general terms, testing and validation procedures that autonomous shuttles go through before being deployed, and passenger safety recommendations (e.g., fastening seatbelts, holding handlebars). Lastly, education may emphasize that autonomous shuttles are going through continued evaluation, reporting, and monitoring to ensure that safety is always improved.

Environment: Benefits of the shuttle being electrical and thoughts about driving environment, including traffic reduction, road improvements, and interactions with other vehicles and drivers.

Recommendation: Develop educational materials that inform older adults about the benefits of electric vehicles and autonomous shuttles' positive impact on the environment (e.g., decreased air pollution, decreased traffic congestion). The concept of cleaner air and reduced greenhouse gas emissions by electric vehicles may be introduced, and how autonomous shuttles can contribute to traffic reduction and improved traffic flow may be discussed. Explain that autonomous shuttles may potentially lead to road improvements (e.g., compatible signs and signals for all road users) and enhanced infrastructure (e.g., dedicated autonomous vehicle lanes), and thus contribute to creating safer and more efficient transportation systems.

Trust and Reliability: Participants' perceptions of the trustworthiness and dependability of ASs included aspects such as participants' confidence in the technology's ability to navigate safely, the reliability of the shuttle's performance, and their trust in the system's ability to operate safely and effectively in various driving scenarios.

Recommendation: Develop educational materials that describe the extensive testing that autonomous shuttles go through to establish older adults' trust and reliability, and the extensive safety records that are maintained. Education materials may also cover the comparison of the safety of autonomous shuttles against that of conventional automobiles using data and statistics.

Aging/Disability: Participants identified progressive decrease in physical, physiological, and/or cognitive functions as a result of aging or health declines. They discussed these in the context of disabilities and/or chronic illnesses, affecting one's ability to drive.

Recommendation: Develop educational materials for older adults that address autonomous shuttles' potential benefits for older adults having driving difficulties due to aging-related physical, physiological, or cognitive changes. Include details on autonomous shuttles' functions that enable increased accessibility and independence, providing a safe and reliable alternative to traditional driving. Safety functions such as emergency braking, adaptive cruise control, lane maintenance may be introduced, supporting older adults with declining physical functions. Autonomous shuttles' accessibility (e.g., wheelchair ramp, handlebars, safety hooks) may cater to older adults with disabilities or limited mobility.

Experience with AV/AS: Individual's actual experience with AVs/ASs included perceptions related to their past interactions with AVs/ASs and the feedback they have received from other AV/AS users.

Recommendation: Develop educational materials that include a brief overview of different AV and AS perceptions and experiences, from those who have never used or interacted with AVs and ASs to those who have. Also, include personal stories and testimonials of older adults who have used AVs and ASs, highlighting their positive experiences and benefits, as well as challenges and difficulties they encountered. To promote interactive learning environments, planning Q&A or discussion sessions, and hosting workshops where older adults can interact with AVs and ASs and learn about their features, benefits, and potential usage scenarios would be effective.

Shuttle Experience: Participants' experiences related to using the study's AS included topics such as the ease of boarding and disembarking, the overall efficiency of the shuttle system, and any notable positive or negative experiences encountered during their shuttle rides.

Recommendation Develop educational materials for older adults that specifically focus on autonomous shuttle experiences. Educational materials may cover the introduction of the autonomous shuttle system and its purpose and benefits. The materials may explain the ease of boarding and disembarking, highlighting the features such as ramps and handlebars that cater to olde adults' needs. The autonomous shuttle systems' efficiency and reliability may be discussed by factors such as timeliness, frequency, and route coverage. In addition, any concerns or negative experiences may be addressed to assure older adults that steps are taken to improve the systems.

Comfort: Participants' perceptions of comfort while using the AS included discussion of their feelings of physical comfort (e.g., seating comfort, vehicle ergonomics) as well as psychological comfort (e.g., feeling safe, relaxed, or confident) during the shuttle ride.

Recommendation: Develop educational materials for older adults addressing the concept of comfort in autonomous shuttles, detailing how physical and psychological well-being are prioritized during transportation. Physical comfort features may be introduced such as seat comfort, adjustable seats, spacious interior, seatbelt location, and vehicle ergonomic designs that relate to ease of movement and safety. For psychological comfort, older adults may be educated that feelings of relaxation, safety, confidence, as well as discomfort, and concerns could be experienced during autonomous shuttle ride.

Speed: Participants' perceptions pertaining to the speed of the AS included their opinions on the shuttle's acceleration, deceleration, and overall speed during the ride. Participants discussed their experiences with the vehicle's speed in relation to their expectations or preferences.

Recommendation: Develop educational materials for older adults that introduce how the speed of autonomous shuttles impacts its overall ride experience. Older adults' experiences with

autonomous shuttles' acceleration, deceleration, and overall speed may be shared taking into account factors such as comfort and perceived safety, and how such experiences relate to secure and reliable travel.

AS Adoption: Participants' inclination or readiness to adopt and utilize ASs in the future included their expressed intentions, plans, or willingness to use ASs for their transportation needs. Participants also revealed their motivations, barriers, and factors influencing their intention to use ASs in the future.

Recommendation: Develop educational materials for older adults that address their intentions and factors influencing their willingness to use autonomous shuttles. Older adults' motivations for autonomous shuttles may be increased mobility, convenience, and mobility independence. Older adults' barriers to use autonomous shuttles may be concerns about safety, trust, and unfamiliar technology. As such, these factors may be introduced and discussed to inform older adults with autonomous shuttles, and therefore, inspiring and motivating older adults to embrace autonomous shuttle technologies.

External variables: External factors that may influence the adoption and use of ASs included media coverage, governing authority regulations, social influence, and cost.

Recommendation: Develop educational materials for older adults that address external variables that may influence autonomous shuttle adoption and use. The educational content may include the impact of media coverage on public perception, emphasizing the need for reliable sources of information about autonomous shuttles. The educational content may also include how authority regulations help to ensure the safety and responsible use of autonomous shuttle technology and how social influences including those from family, friends, and the community in shaping opinions and decisions regarding autonomous shuttle adoption. Lastly, cost may be discussed and how it could impact the environment (e.g., reduced emission), transportation fee (e.g., shared ride sharing services, alternative public transportation option), and vehicle-related expenditure (e.g., maintenance fee, gas, insurance).

From the Lessons Learned

Summary of lessons learned in working with industry:

1. *Regular and clear communication:* Working with automated shuttle industry partners has taught us the importance of regular and clear communication.

With industry, unexpected events and issues can arise anytime that can significantly impact research progress and operation. By maintaining open communication with industry stakeholders, researchers may stay informed about the situation and quickly adapt to any challenges. For example, the shuttle may temporarily change operation times and stop locations due to community events or challenges with the shuttle operational structure (e.g., charge time, losing satellite signal etc.,). We have implemented biweekly meetings with our industry partners

and in-person communications. Such regular communication allowed us to promptly address operational issues with the shuttles and reschedule participant appointments.

Recommendation: Develop educational materials to address the importance of clear and regular communication and include content to allow older adults to access up-to-date shuttle information, e.g., apps.

2. *Education and training:* While this technology has the potential to enhance transportation and provide numerous benefits, it is important to ensure that users are fully informed about its capabilities and limitations to facilitate adoption.

This includes educating users about how the shuttles operate, their safety features, and how to interact with the technology appropriately. This can be done in advance of shuttle arrival by: harnessing local media; hosting educational events; meeting with community leaders and emergency support personnel, and/or distributing educational flyers. In addition, having a research assistant and/or safety operator on board the shuttle during rides can help to alleviate any concerns or fears that users may have about the technology. Education and training are particularly important for those who may be more hesitant to use autonomous shuttles due to unfamiliarity with the technology. It is also essential to properly educate first responders, emergency personnel, and safety operators, as technology is still evolving, and electrical issues are frequent.

Recommendation: Develop educational materials to provide information to users on the technology of the shuttle. Inform older adults that autonomous shuttle technology is an emerging and evolving technology. Also, older adults may benefit from knowing that first responders and safety operators are trained before any shuttle launch in any area—and as such are ready to intervene in case of an emergency.

3. *Challenges in Autonomous Shuttle Technology*: While autonomous shuttle technology continues to improve with every iteration, current technology is not without limits. For example:

Speed restrictions are imposed by the National Highway Traffic Safety Administration (NHTSA) require that the shuttle not travel faster than 15 mph. This can feel slow to users and feel disconcerting, causing concern that other vehicles might cause an accident by driving around the shuttle to pass. As a result, participants have expressed a desire for improved acceleration. Additionally, rain, detection of objects on the road, high winds, or shadows from trees influence the smooth operation of the shuttle. When these kinds of circumstances are encountered, the shuttle may not move or operate smoothly. Severe circumstances such as heavy rain, lightning, and thunderstorms may impact autonomous shuttles' operation. Furthermore, the sensors on the shuttle can be too sensitive, often detecting objects such as leaves as hazards and bringing the vehicle to an abrupt emergency stop.

Further, shuttles may have variable efficiency in air conditioning and braking, which reduces the comfort of the riders. For example, hot weather dramatically impacted the battery life of the shuttle and limited use of air conditioning in the hot Florida climate in order to ensure that the shuttle could maintain timely operations on its scheduled route.

These limitations emphasize that the technology is still in its early stages and requires on-going research and real-world testing to improve its capabilities and address these limits. As such, it is important to approach the deployment of autonomous shuttles with caution and to carefully consider the risks and benefits of using this technology in various contexts.

Recommendation: Develop educational materials addressing information about vehicle automation level (i.e., Society of Automotive Engineering), relevant regulations and policies (i.e., National Highway Traffic Safety Administration), so that older adults are aware of how autonomous shuttles operate on our roads.

4. *Accessibility and inclusivity:* Accessibility and inclusivity must be addressed when designing and deploying autonomous shuttles to ensure everyone can use them regardless of their abilities.

Designs that comply with Americans with Disabilities Act (ADA) regulations, such as the height of emergency buttons, handlebars, and ramp installations, are not optimized for people with disabilities on many existing autonomous shuttles. While many autonomous shuttles are equipped with ramps to assist individuals with disabilities, it is important to ensure that these ramps are reliable and user-friendly. For example, in some cases, the ramps may not work properly, or may require an individual's assistance (e.g., a safety operator) for ingress or egress. We recommend accommodations, such as lowering the doorsteps for shorter individuals, installing softer seat cushions, and improving back supports for older adults and individuals with disabilities to enhance their comfort and increase the likelihood that they will utilize this mode of transportation. Disabled, and non-disabled participants alike often expressed that fixed routes of the shuttle were limiting as they would have challenges in accessing fixed pickup locations. Disabled older adults, in particular, expressed high regard for personalized pickup and drop-off to meet IADL needs (e.g., visiting doctor’s office, picking up medical services, getting groceries).

Recommendation: Develop educational materials to address the importance of ADA compliant regulations. Educate older adults that these options may not currently exist in the shuttles as these shuttles have been manufactured overseas in the absence of knowledge of ADA regulations.

5. *Collaboration and partnership* play a pivotal role in facilitating the successful deployment of autonomous shuttle services and promoting participant engagement. Various stakeholders must collaborate to ensure a successful rider experience.

Collaboration of multiple key individuals and groups is necessary to ensure a successful autonomous vehicle experience for communities and riders. These individuals and groups include industry partners responsible for deploying the autonomous shuttles, regulators who oversee safety and operations, stakeholders with a vested interest in the deployment, funding organizations to provide financial support, community organizations to assist with marketing and advertising, and community members themselves. Collaboration enables open dialogue, addresses concerns, and ensures that the deployment aligns with the needs and expectations of the community.

Recommendation: Ensuring that older adults know that autonomous shuttles are on the road as a result of the team efforts is important. Experts in technology (e.g., engineers), experts in autonomous shuttle operation (e.g., safety operators), funding organizations (e.g., Florida Department of Transportation), community organizations and their leaders (e.g., senior centers), researchers and scholars, and community members, are all contributing to the autonomous shuttles' deployment and operations—and if any one of those groups are out of sync, it may hinder the smooth operation of the autonomous shuttle.

6. *Motion sickness:* While autonomous shuttle rides for this project were limited in duration and speed, no dropouts occurred during or after the autonomous shuttle ride due to motion sickness. This suggests the autonomous shuttle technology is well-suited for transporting passengers without causing discomfort or adverse reactions to motion sickness provocation.

Future studies may aim to test motion sickness at faster speeds and more complex routes, which may better simulate real-world scenarios. The seating configuration of the autonomous shuttles is bi-directional (with passengers seated to fast both forward and rear directions), which could impact passengers' perceptions and motion sickness, especially in more complex environments and at higher speeds. Further research is required to determine whether seating direction plays a role in passenger comfort and safety.

Recommendation Our study findings indicate no severe motion sickness occurrence; however, factors e.g., faster speed, complex routes, bidirectional seating positioning of the shuttle, may lead to motion sickness provocation in the future as autonomous shuttle technology advances.

7. *Exposing autonomous shuttle to a diverse range of potential users* will be pivotal in its widespread adoption and success.

Significant diversity among participants' expectations and satisfaction levels regarding autonomous technology was observed in the field. Some participants expressed enthusiasm about current advancements and eagerly anticipated future developments, while others held more conservative views and focused on potential drawbacks in the present. Acknowledging and accommodating these diverse perspectives is essential for fostering inclusive and meaningful research outcomes.

Recommendation: Develop educational materials to inform older adults that users/rides of autonomous shuttles may have different demographics (e.g., levels of education, age, gender, income) expectations, experiences, and perceptions toward autonomous shuttles.

8. *Implementing innovative strategies* for recruitment and marketing is essential in educating new communities about the potential benefits of autonomous shuttles and facilitating engagement. For example, a community could organize an autonomous vehicle-themed event to engage local citizens in shuttle deployment experiences.

Hosting a dedicated event where individuals can ride and experience autonomous shuttles firsthand or organizing community activities that cater to the interests of older adults presents a practical in-person approach to overcoming skepticism and generating interest. By providing an opportunity for direct interaction with the technology, participants can gain firsthand experience and develop a better understanding of its benefits.

Recommendation: Develop educational materials to suggest community events where groups of older adults can ride the shuttle and share their experiences to the neighbors and throughout the community.

9. *Surrounding infrastructure:* Reliable and high-quality modern infrastructure is vital for successful community operation and research activities. However, in some areas, we have encountered challenges with infrastructure.

Inconsistent internet service can cause significant disruptions, including signal loss for the shuttles. In turn, Internet service can impact the shuttle's capacity to function and its overall service quality and hinders the smooth operation of essential systems. To mitigate these issues, we recommend conducting a field investigation before launching the service, improving the underlying infrastructure, potentially upgrading network capabilities, and addressing any geographical or environmental factors that may obstruct the signal.

Recommendation: Develop educational materials informing older adults that the surrounding infrastructure could impact autonomous shuttle operations. Older adults may be flexible and understand the issues (i.e., signal) that occur sometimes, considering the early stage of implementing an emerging technology (e.g., autonomous shuttles) in the real-world.

From the Literature

We synopsized the findings of six studies from the literature, as indicated below.

1. Siegfried, A. L., Bayne, A., Beck, L. F., & Freund, K. (2021). Older adult willingness to use fully autonomous vehicle (FAV) ride sharing. *Geriatrics, 6*(2), 47. https://doi.org/10.3390/geriatrics6020047

The qualitative analysis from older adults (age 65 and older) yielded the following results, in priority order: (1) a desire for a proven safety record in terms of performance and technology and

(2) dependability and accuracy of autonomous ride sharing. Older adults' concerns about FAV ride sharing included safety concerns and preferences for social interaction with drivers.

Recommendation: Develop educational materials to address safety, role of the safety operator in communication with the older adults, and role of the command center in monitoring in-vehicle experiences.

2. Classen, S., Mason, J., Hwangbo, S. W., Wersal, J., Rogers, J., & Sisiopiku, V. (2021). Older drivers' experience with automated vehicle technology. *Journal of Transport & Health, 22*, 101107. https://doi.org/10.1016/j.jth.2021.101107

The study results showed that older adults' perceptions of safety, trust, and perceived usefulness of autonomous vehicle technology (i.e., automated shuttle and driving simulator operating in autonomous mode) increased after exposure to the autonomous vehicle technology. The group-by-time interaction effects showed statistically significant change in perceptions of autonomous vehicle technology pertaining to intention to use, trust, perceived usefulness, control/driving efficacy, and safety.

Recommendation: The study highlights the positive impact of exposure to autonomous vehicle technology on older adults' perceptions. The findings suggest that firsthand experiences with autonomous vehicle technology may lead to increased safety, trust, perceived usefulness, and intention to use., Educational materials may include encouraging the older adults to "try" rides before making decisions in accepting an AV as a more permanent choice for transportation.

3. Faber, K., & van Lierop, D. (2020). How will older adults use automated vehicles? Assessing the role of AVs in overcoming perceived mobility barriers. *Transportation Research Part A: Policy and Practice, 133*, 353–363. https://doi.org/10.1016/j.tra.2020.01.022

The qualitative analysis from four older adult focus groups (N=24) revealed the following themes: (1) Mode preference, (2) Socialization, (3) Cost and payment, and (4) Trust and control. Older adults expressed a strong preference for on-demand autonomous vehicles, particularly in peripheral areas, and automated public transit services to address boarding and alighting difficulties. They desired the ability to travel together and accommodate various mobility devices. Cost and payment considerations influenced mode preference, and trust and control were important factors, with concerns about system failures and the absence of an operator. Autonomous vehicle ambassadors played a significant role in influencing trust and safety perceptions.

Recommendation: Educational materials may address these themes, highlighting convenience (e.g., on-demand service), accessibility (e.g., spacious, lower-floor, and automated ramp), socialization (e.g., leisure trips together with friends when family is unavailable), cost factors (e.g., costs and payment for existing transport modes and different autonomous vehicle service modes to meet daily mobility needs), safety measures (e.g., autonomous vehicles' capability to predict various traffic situations), user control (e.g., possible to take over the control of the

autonomous vehicle), and the role of autonomous vehicle ambassadors (e.g., ambassadors may impact how passengers think and trust safety of the autonomous vehicle) in fostering trust and acceptance among older adults.

4. Rahman, M. M., Deb, S., Strawderman, L., Burch, R., & Smith, B. (2019). How the older population perceives self-driving vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour, 65*, 242-257. https://doi.org/10.1016/j.trf.2019.08.002

The online survey from older adults (aged 60 and over, *N*=173) to assess their perceptions on self-driving vehicles (Society of Automotive Engineering Level 5) indicated that older adults generally perceive self-driving vehicles with a positive attitude, perceived usefulness, trust, social norm, and acceptance as users of the technology. However, their perception as pedestrians was either neutral or negative, except for the perceived usefulness. The results also indicated that older adults who are familiar with self-driving vehicles tend to have a more favorable perception.

Recommendation: The findings suggest that educational materials should focus on highlighting the benefits and potential of self-driving vehicles for older adults as users, addressing concerns related to pedestrian interactions, and increasing familiarity with the technology.

5. Abraham, H., Lee, C., Brady, S., Fitzgerald, C., Mehler, B., Reimer, B., & Coughlin, J. F. (2017, January). Autonomous vehicles and alternatives to driving: trust, preferences, and effects of age. In *Proceedings of the Transportation Research Board 96th Annual Meeting*. Washington, D.C.: Transportation Research Board. Pp. 8–12. https://agelab.mit.edu/static/uploads/autonomous-vehicles-and-alternatives-to-driving.pdf

The survey indicated that respondents, including older adults (75+ of age), expressed satisfaction with technology in their vehicles but indicated a mismatch between their satisfaction and preferred methods of learning. While there was willingness to consider transportation alternatives, fewer respondents, including older adults, had actually utilized them. Older adults expressed a willingness to use automation but showed less interest in full autonomy compared to younger drivers.

Recommendation: Educational materials may address preferred learning methods (e.g., trial-and-error, the ability to use websites, dealer interactions), encourage exploration of transportation alternatives (e.g., car sharing, ride sharing), and address older adults' specific concerns (e.g., discomfort to forgo the control of the vehicle, not fully understanding the autonomous vehicle technology) regarding automation to promote effective use and acceptance of AV technology.

6. Booth, L., Tan, T., Norman, R., Anund, A., & Pettigrew, S. (2022). Experiences of older adults interacting with a shared autonomous vehicle and recommendations for future implementation. *Transportation Research Part F: Traffic Psychology and Behaviour, 90*, 100-108. https://doi.org/10.1016/j.trf.2022.08.014

Older adults (*N*=63) were interviewed while interacting with shared autonomous vehicles. The results indicated older adults' suggestions for ways to optimize older people's receptiveness to shared autonomous vehicles. Findings are summarized as the participants' recommendations relating to (1) ensuring the physical characteristics (i.e., interior design, vehicle accessibility, ride quality) of the shared autonomous vehicles are appropriate for older people, (2) the optimal operating procedure (i.e., operating speed, route accessibility, operating time and destinations) for the shared autonomous vehicles in a retirement use case context, and (3) encouraging apprehensive older adults to use autonomous vehicles (i.e., technicians on board, exposure to shared autonomous vehicles, utility of shared autonomous vehicles services) in the future.

Recommendation: By incorporating the recommendations above into the development of educational materials, it is possible to address older adults' specific needs, concerns, and preferences regarding shared autonomous vehicles. This data-informed approach ensures that the materials provide relevant and tailored information, ultimately promoting a better understanding and acceptance of autonomous vehicle technology among older adults.

From the literature above, the main takeaway messages that may inform developing educational strategies are safety issues, establishing trust, offering first-hand experiences, customizing educational materials to older adults' preferences, highlighting the benefits of autonomous vehicles, and addressing particular issues with regard to the control of the autonomous shuttle and its interactions with pedestrian.

In summary, from the *Lessons Learned* and the *Literature*, six main messages emerged, to inform the development of educational strategies. These are: (1) addressing the safety issues of autonomous shuttles, (2) addressing trust, (3) offering rider experiences, (4) customizing educational materials to older adults' preferences, (5) highlighting the potential benefits of autonomous shuttles, and (6) emphasizing features supporting inclusive, accessible, and available autonomous shuttle services.

Appendix C. Informational Flyer Used at The Villages

Beep Research Study Questions & Answers

Summary of the Beep project

UF Health Precision Health Research Center, UF Dept. of Occupational Therapy, and Beep Inc. are partnering on a comprehensive study to capture older adult perceptions on acceptance and adoption practices of automated vehicle (AV) ridesharing services. Using a validated autonomous ridesharing services survey (ARSS) at other geographic areas in Florida, UF and Beep will evaluate how autonomous ridesharing services may hold safety benefits for older adults and provide continued community mobility, independence, and life satisfaction. The Villages is the latest site identified for the study focusing on older adults (over 50 years old). The survey period in The Villages will happen over the first week of April, with one autonomous shuttle implemented, operated, and monitored by Beep. The other geographical locations for the study include Orange County, Hillsborough County, Pinellas County, St. Lucie County, and Marion County.

What is the purpose of the project?

The purpose of this project is to study the perspectives of older adults on automated ride-sharing services (AV ride-sharing), and to solicit responses pertaining to adoption and acceptance practices.

How is this project funded?

The project is funded by the Florida Department of Transportation and Department of Veterans Affairs.

What will happen after this project?

Data gathered from the study will provide guidance and guidelines to support the adoption of this new technology. The guidelines will address user preferences related to safety, comfort, and convenience as well as provide recommendations for FDOT, Beep, and other organizations on how to provide education to passengers for AV Ride Sharing services as a future transportation option.

beep UFHealth PRECISION HEALTH RESEARCH CENTER

How will Beep, The Villages, and PHRC ensure the safety of riders and those sharing the road with the AV?

Safety is a top priority for Beep and has touched every aspect of this project. Below are numerous ways we make sure our riders and those we share the road with are safe and comfortable.

- The specific planned route the Beep vehicle will ride is chosen because it is the most optimal for passenger and road-sharing safety
- There is a shuttle attendant in the Beep vehicle at all times
- Local first responders are trained in how to respond to Beep emergencies
- The Beep vehicle is monitored in real-time by an on-the-ground team
- The Beep vehicle is also monitored remotely by a team at Beep Headquarters
- The Beep vehicles battery percentage, data, and location will be continually monitored by the Beep headquarters team

Is the autonomous vehicle available to the general public?

The study is only open to adults who are 50 years and older and who agree to participate in the program. All of the automated shuttle routes being tested by Beep across the state of Florida are free and open to the public, with the exception of the one-week project in the Villages in partnership with UF. The one-week research test in the Villages is closed to the general public. Those interested in riding on the shuttle must meet study legibility requirements and enroll in the study.

Appendix D. Beep's Infrastructure Supporting Document

Appendix C content covers the explanation of what autonomous vehicles are, the potential advantages of autonomous vehicles, how safe autonomous vehicles are, how ridership is occurred, overall information about Beep, and Beep's autonomous shuttle deployment.

Frequently Asked Questions

Autonomous Vehicles

What are autonomous vehicles?
An autonomous vehicle (AV), also known as a driverless or self-driving vehicle, is a vehicle capable of sensing its environment and moving with little or no human input. The shuttles are manufactured by Navya in France.

What are the advantages of autonomous vehicles?

- Safety: With the use of LiDar sensors, the Navya autonomous shuttle has more eyes on the road than a human driver possibly could. This results in safe transportation for riders, and other vehicles on the road.
- Environmentally Friendly: The Navya autonomous shuttle is 100% electric. Using electricity generated from a power plant burns less fossil fuel and is more efficient than generating power/fuel for personal use (i.e., the internal combustion engine on a vehicle). In addition, fewer moving parts means less environmental impact due to reduced maintenance and there are no consumable fluids onboard, like oil or engine coolant, that can harm the environment.
- Connectivity: In the future, autonomous vehicles, such as this Navya autonomous shuttle, could be used as a complimentary and long-term solutions for circulator service, a first mile / last mile solution, or in areas to ease parking concerns.
- Equity: Beep leads the way in innovation and introduces cutting-edge technology to allow residents and visitors alike to experience a future transit solution.

Safety

What safety features does the Navya Autonomous Shuttle have for its riders?
The Navya Autonomous Shuttle is equipped with seatbelts, an onboard emergency kit, and an emergency stop button. The shuttle is in constant communication with the Beep Command Center through interior cameras and GPS locators that monitor her movement and location. A shuttle specialist is always on board to ensure passenger safety and comfort.

How is the Navya Autonomous Shuttle monitored?
The Navya Autonomous Shuttle and its shuttle specialist are in constant communication with the Beep Command Center located in Orlando, Florida. The personnel in the Beep Command Center continuously monitor the shuttle's movement and operations. The shuttle specialist can communicate with the command center at any time should the need arise. The shuttle is also equipped with cameras so that the command center can see outside and inside at any time.

When and why is there a shuttle specialist on board?
The shuttle specialist will always be onboard while operational per federal regulations, ensuring a pleasant and safe experience for our passengers. Our team of shuttle specialists are highly trained to provide prompt and efficient transportation for all our guests. They are also trained on the shuttle's safety features and can take over manually at any time by utilizing a controller on board. They are also very friendly and serve as ambassadors for the autonomous shuttle to educate riders on how the shuttle operates.

How does the Navya Autonomous Shuttle safely navigate traffic signals and stop signs?
When the shuttle approaches a traffic signal or sign, the shuttle specialist will take control of the operating systems. The shuttle specialist will complete a visual check of the intersection before entering. Once the intersection has been deemed clear, the shuttle specialist will let the shuttle know that it is safe to proceed.

How does the Navya Autonomous Shuttle safely share the road with other vehicles?
The Navya Autonomous Shuttle will share the road with buses and other vehicles during operational hours. Like transit buses and traditional vehicles, the shuttle will observe all traffic signals. The shuttle specialist onboard will also do a visual check of the intersection before entering to ensure the vehicle's safe operation. There are 9 optical sensors on the outside of the shuttle, providing a 360-degree view of the environment. Each sensor allows the shuttle to respond to traffic or pedestrians that may come in the vehicle's path.

Brandon Corsentino Brandon.Corsentino@ridebeep.com www.ridebeep.com

Frequently Asked Questions

Safety Continued

What training has taken place to ensure the safety of passengers riding onboard?
Shuttle specialists have been fully trained on the safety features of the vehicle. The service personnel in the Command Center are also trained on how to respond to an emergency should the shuttle specialist need assistance. Beep has conducted safety training with First Responders, to ensure they are familiar with the Navya Autonomous Shuttle and trained on appropriate actions to take if the need arises.

Riding

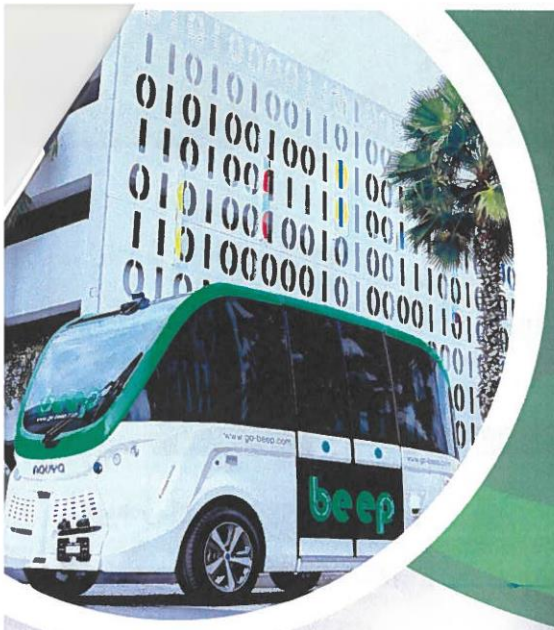
How many passengers can the Navya Autonomous Shuttle carry?
The Navya Autonomous Shuttle can transport up to 8 passengers. Passengers are required to always wear a seatbelt while the vehicle is in motion.

What ADA features does the Navya Autonomous Shuttle have?
The Navya Autonomous Shuttle has several features onboard that allow all riders, to ride and experience the technology. When pulling up to a stop station, the shuttle kneels toward the curb. The shuttle specialist will then deploy a ramp allowing for passengers to board. Once onboard, there is a Q'Straint system to secure both the passenger and mobility device when the vehicle is in motion. When disembarking and boarding, the shuttle specialist onboard will announce the next stop and following on the route. The Navya Autonomous Shuttle is also equipped with monitors that display a route map and upcoming stop names.

Can I bring my pet aboard the Navya Autonomous Shuttle?
Service and companion animals are allowed to ride the Navya Autonomous Shuttle.

Does the Navya Autonomous Shuttle offer air-conditioning and heating?
The Navya Autonomous Shuttle is equipped with a heating and air conditioning system.

Brandon Corsentino Brandon.Corsentino@ridebeep.com www.ridebeep.com



beep

Autonomous Mobility Solutions

TURNKEY AUTONOMOUS SOLUTIONS FOR YOUR COMMUNITY

About the Beep

Headquartered in Orlando, Florida within the 17 square-mile development of Lake Nona, Beep is the leading operator of autonomous, electric shuttles delivered in a "mobility as a service" model.

Beep has successfully contracted and implemented autonomous mobility solutions for the public and private sector across 10 communities in four states for master-planned communities, transit operators and municipalities in Florida, Georgia, Wyoming and Arizona. Beep's flagship project in Lake Nona, an advanced district in the City of Orlando, is the largest and most tenured autonomous shuttle network in the United States.

Who We Are

Controlled speed, multi-passenger, electric autonomous mobility solutions provider offering fully managed services in private and public communities

Unique service offerings including innovative processes and software to more effectively manage, operate and maintain electric AV fleets

Built and led by a **proven executive team** of technology entrepreneurs and transit safety specialists

First **autonomous vehicle command center** in the U.S. to monitor all vehicle video and performance data thus improving safety and the rider experience.

Proven solutions designed by transportation specialists to ensure safe and secure implementation of mobility services on public roadways

Delivering the next generation of services, technology and software for safer, more sustainable passenger mobility

Brandon Corsentino Brandon.Corsentino@ridebeep.com www.ridebeep.com

beep

103,000
Live Road Hours

91,000
Passengers Carried

330+
1st Responders Trained

Largest Private
Sector Autonomous Deployment

Sustainability
Eliminated Many Tons of Carbon Emissions

Largest Public
Sector Autonomous Transit Project

SERVING OUR CLIENTS

BACKED BY VISIONARIES

COVERED BY MEDIA

Our Deployment Locations

Lake Nona, Florida
5 Routes Tested
8 Autonomous Shuttles

Tampa, Florida
2 Routes Tested
2 Autonomous Shuttles

Dunedin, Florida
2 Routes Tested
2 Autonomous Shuttles

Jacksonville, Florida
1 Route Tested
2 Autonomous Shuttles

Clearwater, Florida
1 Route
2 Autonomous Shuttles

Peachtree Corners, Georgia
1 Route Tested
4 Autonomous Shuttles

Port St. Lucie, Florida
3 Routes Tested
4 Autonomous Shuttles

St. Petersburg, Florida
1 Routes Tested
2 Autonomous Shuttles

Peoria, Arizona
2 Routes Tested
3 Autonomous Shuttles

Yellowstone National Park, Wyoming
2 Routes Tested
2 Autonomous Shuttles

Brandon Corsentino Brandon.Corsentino@ridebeep.com www.ridebeep.com