



AUTOMATED LAST MILE CONNECTIVITY FOR VULNERABLE ROAD USERS – PARTICIPANT SURVEY STUDY

FINAL REPORT

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16. Abstract This study was conducted to gain a better understanding of how senior adults view low-speed automated vehicles (LSAV) and what preconceived attitudes and/or obstacles might prevent their use of this relatively new mobility technology. This was accomplished using representative videos of the LSAV in operation along with online surveys and virtual meetings. 36 participants ranging in age from 62 -87 were recruited locally based on several criteria including their ability to participate virtually. The subjects completed questionnaires before and after focus group participation. The subjects displayed a strong curiosity about the LSAV and a willingness to use it for local travel with 22 of 35 (62.9%) and 18 of 35 (51.4%) reporting that they would likely or very likely use it with, and without, the presence of an onboard operator, respectively. The participants also identified concerns regarding their potential use of an LSAV with a focus on personal safety under a variety of different scenarios including emergencies, nighttime use, mixed traffic, and when traveling with an operator, alone, and/or with a stranger. The findings of this work should inform those developing and deploying LSAV systems so that a fast-growing segment of the population can benefit from this new mobility technology.			
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EXECUTIVE SUMMARY

Low-speed automated vehicles (LSAV) are being deployed in various scenarios to enhance mobility for a wide variety of transportation users. Current applications include providing last-mile connectivity between rider origins/destinations and fixed transit stops and circulating shuttles in areas such as business districts, military bases, parking lots, and theme parks. Their low-access height, integration of self-deploying wheelchair ramps, and high levels of automation also provide opportunities for improved mobility for those with physical or cognitive challenges. LSAVs are typically highly automated battery-electric vehicles that transport up to eight passengers at speeds below 15 mph on predefined and previously mapped routes. An attendant/operator may also be present during operation depending upon manufacturer and service provider policies, state and federal regulations, operational conditions, route complexity, and the specific assistive needs of prospective riders.

An EasyMile EZ10 LSAV was deployed on a route between the Virginia Tech Transportation Institute (VTTI) campus and a nearby bus transit stop to study prospective user attitudes and acceptance regarding trust in technology, system safety, and personal security. The LSAV operated on this route within normal travel lanes and interacted with mixed public traffic that included the full range of transportation users from pedestrians to heavy vehicles.

Human participants ranging in age from 62 to 87 were subjected to questionnaire and focus group surveys before and after their exposure to the LSAV. The original plan was to expose the participants to the LSAV through group trips on the LSAV while in operation at VTTI. Unfortunately, the onset of the COVID-19 pandemic, and the human participant safety protocol changes that resulted, required developing a new research approach for the study. Using an alternative approach to participant exposure to LSAV technology, the research team accomplished the primary goals of the study using online meeting tools, multiple survey methods, and multimedia. Participants were recruited locally in Blacksburg and assigned to study groups based on gender, age, their current mobility, and other criteria. The participants completed an online entrance survey that queried them about their current modes of travel



used and the respective destinations. They then participated in facilitated focus group sessions where interaction among themselves was encouraged. As part of the focus group sessions, the participants viewed narrated video of the LSAV in operation from the viewpoint of a rider in scenarios where a vehicle operator was both present and absent. Finally, an online exit questionnaire was administered.

The findings for the relatively small population of 36 older adults indicate an overall willingness to utilize new technologies to improve mobility mixed with cautionary caveats about the basic safety inherent with most public transportation, especially where the vehicle operated in traffic lanes with other vehicle and where someone of authority was absent from the vehicle. Personal security was a strong concern for participants as was the issue of access to information about the vehicle and the route that would affect their trips. There was not a significant change in the participants' overall attitudes that resulted from their exposure to the LSAV and the focus group discussions.

Unfortunately, some unavoidable bias may have occurred with respect to how participants were chosen for this study since revamped experimental protocols required increased use of technology in light of COVID-related risks.

The knowledge gained through this research and technology deployment will inform future implementations concerning the special needs and attitudes of vulnerable road users and how autonomous technologies should be applied and regulated considering human factors and real-life usage characteristics. Federal, state, regional, and local transit planners considering the use of LSAVs will better understand the deployment aspects and issues related to serving the needs of vulnerable road users.

DESCRIPTION OF PROBLEM

By 2030, one of every five Americans will be retirement age, and seniors will outnumber children for the first time in history (U.S. Census, 2018; see Figure 1). For now, driving remains the primary means for seniors to stay mobile and independent (Davis et al., 2011). However, older drivers generally experience a greater safety risk of causing and being injured in crashes (Li et al., 2003; Stutts et al., 2009). The baby boomers driving these demographic trends also have high expectations for remaining active and engaged as they age. Thus, the needs of older adults will increasingly challenge our transportation policies, processes, and infrastructure. Providing mobility alternatives for seniors and others with disabilities in a manner that is safe, efficient, and environmentally friendly is crucial, and this will remain a major challenge for our nation throughout most of the remainder of this century.

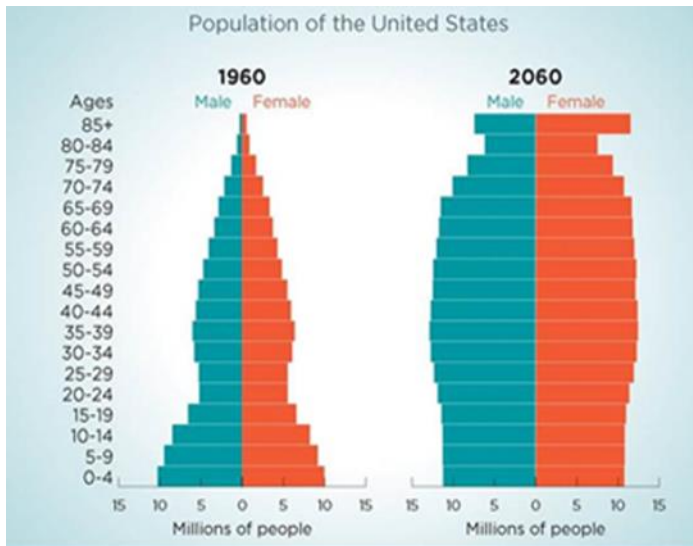


Figure 1. Our aging society – projected demographic shifts from 1960 to 2016 (from U.S. Census Bureau, 2018).

While Americans with Disabilities Act (ADA) paratransit has done much to address the transportation needs of vulnerable road users (VRUs), its long-term economic and environmental sustainability is questionable. New and innovative methods of expanding public transportation access to VRUs are needed to ensure equitable and appropriate connectivity while allowing transit operators to improve the sustainability of their operations.

Based on how heavily VRUs are leveraging fixed-route options, one approach is to develop first and last mile (i.e., “Last Mile”) solutions that improve bidirectional access between users’ homes and destinations and existing fixed-route nodes. Last Mile solutions can also provide access to goods and services within a short range of users’ homes, which would not otherwise require public transit.

There is little doubt that automated driving system (ADS) technologies will play a key role in an envisioned future where older persons as well as others who are transportation-challenged can more safely access the resources they need to maintain their health, well-being, and sense of connectedness. As technology has evolved and our modes of transportation diversify, low-speed autonomous vehicles (LSAVs) have emerged as perhaps the most promising means of providing practical, safe, efficient, and convenient local mobility to meet these needs.

Automated Last Mile connectivity systems have been proposed to provide VRUs with efficient, convenient, and timely on-demand access to existing fixed-route transit systems. The primary components of these systems are LSAVs and the scheduling and routing environment that controls their automated operation. Highly accessible, low-speed, and environmentally friendly electric vehicles that are homed and charged at transit stops are envisioned for this application. Real-time, demand-responsive services of this type typically require a high level of integrated trip planning that may be challenging to VRUs due to cognitive, economic, and physical limitations. These challenges may be further complicated by the autonomous nature of these LSAVs and the respective lack of vehicle driver or attendant available to render aid.

These LSAVs typically operate at or below 15 mph and are designed for roadways with relatively low complexity (e.g., no signalized intersections) and to transport passengers over relatively short distances. These characteristics make LSAVs candidates for providing Last Mile connectivity between fixed-route transit and a rider’s destination. This connectivity can improve the mobility of individuals for whom the last mile may present difficulties. This could include older populations who may have limited mobility, especially those who do not have access to a vehicle or do not drive on their own.



The Virginia Tech Transportation Institute (VTTI) researchers learned from transit agency officials in Blacksburg, Virginia (i.e., Blacksburg Transit), that residents of a local senior living community (Warm Hearth) who use Blacksburg Transit’s service consistently travel to a few common destinations via bus service. This consistency suggested that an LSAV such as the EasyMile EZ10 could provide value either within the community (to reach the closest fixed route stop to Warm Hearth’s facilities) or at their destinations (mobility within a cluster of businesses or services).

Scope and Purpose of the Study

While the technology has the potential to improve mobility for seniors, little is known about the attitudes older populations have towards LSAVs. Additionally, it is unknown if the EasyMile LSAV would meet the needs of older populations in terms of operation, comfort, or trust. Existing literature lacks data from participants who have had the chance to observe an LSAV and discuss its strengths or weaknesses.

Though some work has been done to document the attitudes of older populations (65 and over) toward automation in general, this focus group study was designed to gather the feedback of older participants by having them view and respond to videos of what it is like to approach and ride in an LSAV. The original idea for the study was to allow the participants to ride in the LSAV and hold in-person focus groups, but plans were changed due to the COVID-19 pandemic. Focus group participants took part in an online focus group and had the opportunity to share their thoughts and opinions about the LSAV. This research study will contribute to the knowledge base regarding the attitudes of seniors toward LSAVs.

APPROACH AND METHODOLOGY

The study used a combination of multiple online questionnaires and focus group sessions to assess the preconceived and changing attitudes of older adults with respect to LSAV usage—the latter after their exposure to the vehicle in operation during focus group activities. An experimental plan was developed, Virginia Tech Institutional Review Board (IRB) and VTTI-internal safety reviews were conducted, participants were recruited, and questionnaire and focus group surveys were conducted with 36 individuals. Pre- and post-survey data was

analyzed using non-parametric analysis techniques to determine whether exposure to the LSAV through lifelike video observation affected attitudes of the participants and their willingness to potentially use LSAV technology to enhance their mobility.

The original study plan included prerequisite implementation of an LSAV in a real-world operating environment at VTTI so that study participants would have a very realistic experience with respect to their use of the vehicle. Figure 2 and Figure 3 show the LSAV that was acquired for this study and the route over which that it was operated between VTTI and a nearby Blacksburg Transit bus stop. A second Center for Advanced Transportation Mobility project report documenting these activities is planned as an accompanying report to this document.



Figure 2. A photograph of the VTTI EasyMile LSAV that was implemented for this project. Although much time and effort were spent achieving this task, human participant testing in-person with the vehicle, or otherwise, was forestalled by the occurrence of the COVID-19 pandemic. Revised university experimental protocols that protected human participants were implemented and maintained throughout the data collection phase of work. The research team developed an alternative approach that used multimedia, electronic surveys, and remote online meeting tools to complete the project.



Figure 3. An aerial photo of the VTTI campus showing the LSAV route extending from the entrance to VTTI Building 2 to the Blacksburg Transit bus stop (maroon line).

Participant Recruitment

VTTI has amassed an extensive database of individuals who either have participated previously or have expressed interest in participating in transportation-related research and provided contact information. This database is private and only accessible to those charged with recruiting subjects. Recruiting attempts were conducted using a variety of methods such as flyers, news advertisements, facility newsletters, email, and contact through word-of-mouth. News and electronic media ads such as VTTI Facebook posts were also used to help recruit participants. Email is only used to provide information about general study requirements to parties who contact VTTI first via email or phone. Recruitment efforts were conducted in the New River Valley region of Virginia.

Flyers were also shared with program coordinators or other appropriate staff at retirement communities or senior centers (e.g., Warm Hearth in Blacksburg, VA), which they then shared with seniors or posted within the facility. In addition, the VTTI participant database was used to recruit participants. A recruitment advertisement was targeted to those who regularly use transit and ridesharing since the team anticipated the recruitment database

would be a resource for recruiting individuals who do not use other modes of transit on a regular basis.

Participant Screening

Before participants filled out the Research Participant Form, they were instructed that the information they provided would be included in VTTI's participant recruitment database for inclusion in other studies at VTTI. Potential participants who contacted VTTI were told about the study over the phone and subsequently screened for eligibility if interested in participating. Those successfully vetted in the screening process were then sent a copy of the information sheet prior to participating (either by mail or electronically). The information sheet used for this study is included as Appendix G.

Participant Screening Criteria

The primary participant screening criteria for this study included the following factors in addition to certain medical screening items:

- Must be 65 years or older.
- Preference for those who live, work, or volunteer in Blacksburg, Christiansburg, or Radford, Virginia areas. Must live, work, or volunteer in the New River Valley.
- Must be a U.S. citizen or permanent resident (green card holder able to work anywhere in the U.S. with NO restrictions, such as a limit on number of hours they can work each week or place they are allowed to work; for example, they cannot be limited to working at only one company or only Virginia Tech). Visa holders are not eligible.
- Must be willing to complete a W-9 and provide social security number for compensation purposes.
- Must have internet, a computer or tablet, and Zoom meeting capabilities.
- Must have normal to corrected-to-normal hearing.
- Must be comfortable reading, writing, and speaking in English.
- Must have normal or corrected-to-normal vision.

Medical Screening

Additional screening factors related to medical circumstances were also used. Mobility limitations could result in exclusion. Studies may include a segment of participants with mobility limitations and/or disabilities if they meet all other criteria and there are enough meeting this criterion to conduct the number of focus group sessions required. If insufficient numbers of prospective participants meet this criterion, exclusion may result. One exclusion used for this study stipulates that a participant must not require assistance due to mobility limitation and/or disability getting to and from a building to the parking lot or street to meet their transportation needs. This does not typically include temporary mobility limitations such as recovering from surgery or foot/leg in a cast/boot while recovering from an injury or procedure. Other medical factors that may have resulted in exclusion were a history of brain damage from stroke, tumor, head injury, recent concussion, or disease or infection to the brain. Respiratory disorders and disease that require the use of equipment for breathing assistance (e.g., bottled oxygen) could also result in exclusion from participation.

After screening, VTTI researchers reviewed the list of eligible participants and determined the best mix of participants to create balanced groups (e.g., ages, genders, frequency of transit/ridesharing).

It should be noted that during an early focus group session, at least one participant raised issues with exclusion criteria related to use of a wheelchair or walker and night blindness. Since these issues are salient to the goals of this study and common issues for the targeted study population (e.g., older persons), the research team relaxed these exclusion rules on a case-by-case basis.

Participant Review of Information Sheet

After screening and scheduling, vetted participants were emailed a copy of the information sheet along with a confirmation of the day and time the VTTI representative reviewed the information sheet with them over the phone. During the call, a member of the VTTI staff reviewed the information sheet with participants and answered any questions. The LSAV was not mentioned in the information sheet or entrance questionnaire, as researchers



preferred to glean participants' original thoughts on the vehicle on the entrance questionnaire and focus group sessions.

Participation Packet Completion

After screening and scheduling, participants were sent a packet of information through the U.S. Postal Service. The packet contained a copy of the information sheet, a W-9 tax form, online meeting (i.e., Zoom) directions, and an outline of the focus group questions. Prior to participating in the entrance session, participants were required to return a signed and dated copy of the W-9 tax form. A pre-addressed stamped envelope was provided. Participants were asked not to fill out their social security number on the W-9 form; during the entrance session, a member of the VTTI staff documented that information to avoid the possibility of it being lost in the mail with release of private information.

Participant Survey Process

Once participants were fully vetted, they were sent email invitations to two Zoom meetings. The description of the activities conducted during those session is described below.

Entrance Session and Entrance Questionnaire

- During this session, a VTTI staff member received the participant's social security number to complete the W-9 tax form.
- Participants completed the first survey instrument, the entrance questionnaire, with assistance from the VTTI staff member. All online surveys were conducted using the Qualtrics XM survey tool.
- During the session, the VTTI staff member determined if the participant's connection to the Zoom meeting with their electronic device was adequate to move on to the focus group session that followed.
- This initial session lasted approximately 30 minutes, and fully eligible participants were invited to take part in the second survey instrument, the focus group.
- After completing the entrance session, participants who did not already have a ClinCard from previous participation in a VTTI study were sent a MasterCard (ClinCard) that they kept throughout participation. It was provided with a \$0 balance.

After VTTI confirmed that the card was received, compensation payment was loaded after completion of each of the three portions: the entrance session and entrance questionnaire (\$15), the focus group session (\$30), and the exit questionnaire (\$15).

Focus Group Session

- Before the focus group session, participants were sent a Zoom invitation by email.
- When they participated via Zoom, five additional participants were present as well as the facilitator and a second researcher to deal with any technical issues.
- Participants were provided in advance with the outline of questions that were asked during the focus group to help them follow along with the session.
- During the focus group sessions, participants viewed videos of the LSAV in operation and shared thoughts and opinions about it. The participants were shown a short informational video about features of the LSAV followed by two videos from the perspective of a person approaching and entering the vehicle. Participants were shown videos where an operator was present and where no operator was present.
- After seeing the videos, the participants discussed their attitudes towards the LSAV and whether they would be willing to use it. The six focus group sessions, each with six participants, lasted about 75 minutes each.

Exit Questionnaire

- Following their participation in the focus group session, participants were asked to complete an exit questionnaire, which took about 15 minutes to complete. Participants accessed the exit questionnaire via an electronic survey link that was provided by email. Participants completed the survey at their own pace. The email that was sent to participants with the link to the exit questionnaire requested that participants contact the research team should they encounter any problems. Participants unable to complete the questionnaire on their own were assisted by a member of the research team. A Zoom meeting was used to assist with survey completion as needed. Participants were instructed at several points during the process that they could refuse to answer any question during the focus group or in the questionnaires and that they may leave the study at any time.

FINDINGS, CONCLUSIONS, RECOMMENDATIONS

Survey Results

Demographics

Thirty-six adults between the age of 62 and 87 participated in the sequence of questionnaire and focus group surveys (mean = 72.4, standard deviation = 6.4). Eighteen females and 18 males comprised the group. The age and self-identified gender of the study participants is summarized in Table 1. Participants were binned into five age ranges as shown.

Entrance and exit questionnaires are included in Appendix E and Appendix F, respectively. This information is sourced from the entrance survey that was completed before focus group sessions were held.

Table 1. Age Distribution and Gender of Participants

Age (years)	Female	%	Male	%	Total	%
62-66	7	19.4	2	5.6	9	25.0
67-71	3	8.3	4	11.1	7	19.4
72-76	5	13.9	5	13.9	10	27.8
77-81	3	8.3	5	13.9	8	22.2
82+	0	0	2	5.6	2	5.6
Total	18	50.0	18	50.0	36	100.0

The employment status of the participants is shown in Table 2 as reported. Free text alternative responses to the choices “full-time employed,” “part-time employed,” and “retired” were allowed.

Table 2. Reported Employment Status

Work Status	Count	%
Retired	27	75.0
Employed - Part time	4	11.1
Employed - Full time	2	5.6
Employed - other	1	2.8
Unemployed	1	2.8
Retired - disabled	1	2.8
Total	36	100

Participants were asked to describe any disabilities that might limit their mobility. Their responses are shown in Table 3. Some respondents reported multiple disabilities. Twenty-five participants reported that they had no disabilities, and 11 reported having at least one disability.

Table 3. Reported Disability Status and Types

Disability Status	Count	%
No disability reported	25	69.4
Disability reported	11	30.6
Total	36	100
Disability type*		
Knee	4	11.1
Wheelchair	2	5.6
Cane	1	2.8
Walking	1	2.8
Scooter	1	2.8
Visual	2	5.6
Dizziness	1	2.8
Oxygen	1	2.8
Hands	1	2.8

** Total count exceeding 11 results from multiple responses*

Entrance Questionnaire Results

Entrance survey questionnaires were administered to so that researchers could better understand the participants' frame of reference as well as their attitudes regarding technology and the LSAV specifically. These surveys also informed the design of the focus group

process. The input that the participants provided may also be used to inform future quantitative studies better suited to hypothesis testing.

Selected Questionnaire Responses

The participants were surveyed on their typical use of 12 different transportation modes on the entrance questionnaire (Appendix E). Their responses are shown in Table 4.

Table 4. Reported Transportation Mode Usage

Transportation Mode	Count*	%
Light vehicle	33	91.7
Walk	22	61.1
Family friends	12	33.3
Public transit (bus)	9	25.0
Bicycle	8	22.2
For-hire service	7	19.4
Paratransit	4	11.1

* Total counts exceeding n (36) result from multiple responses

The participants were surveyed regarding their use of personal portable or wearable technology. Their respective responses are shown in Table 5.

Table 5. Reported Personal Technology Usage

Technology Type	Count*	%
Smart phone	33	91.7
Tablet	23	63.9
Laptop	11	30.6
Fitbit	8	22.2
Smartwatch	5	13.9
Desktop	1	2.8

* Total counts exceeding n (36) result from multiple responses

Participants were asked to identify places they typically visit that are located within ten miles of their home. Their responses are shown in Table 6.

Table 6. Reported Places Visited Within Ten Miles of Home

Location	Count*	%
Grocery store	36	100.0
Doctor	35	97.2
Bank	35	97.2
Pharmacy	33	91.7
Restaurant	31	86.1
Visit family/friends	29	80.6
Place of worship	27	75.0
Salon	26	72.2
Social events	19	52.8
Gym	14	38.9
Job	7	19.4

* Total counts exceeding n (36) result from multiple responses

The participants were asked to identify other places to which they would travel if they had better access to reliable transportation. Their responses are shown in Table 7. Twenty-seven participants did not report any additional places to which they would travel, and 11 reported one or more additional destinations. As expected, common reported travel destinations of importance included those related to shopping, personal care, entertainment friend/family visitation, and banking.

Table 7. Reported Other Places Visited with Ten Miles of Home

Travel to Other Places	Count	%
None Reported	27	75
As Listed Below	9	25
Total	36	100
Other Places Reported		
Grocery store	7	19%
Pharmacy	5	14%
Bank	5	14%
Restaurant	5	14%
Visit family/friends	4	11%
Doctor (10 mi)	3	8%
Salon	3	8%
Other (Hardware, rec. center)	3	8%

Travel to Other Places	Count	%
Place of worship	2	6%
Social events	2	6%
Gym	1	3%
Job	0	0%

* Total counts exceeding n (36) result from multiple responses

Exit Questionnaire Results

Online questionnaires were administered to participants after all focus group sessions were completed. One participant did not answer all questions presented. The survey included the following introductory statement:

“For the next set of questions, please imagine that we are in a post-COVID-19 period where COVID-19 no longer poses the health risk that it does today. We don’t want you to ignore your feelings about COVID-19 because we know this pandemic may influence how you feel about transportation in the future. But what we’d like you to do is imagine that we are at a point in time where COVID-19 is no longer a concern.”

Participants were asked to report their prior awareness and exposure to LSAVs. Their responses are included in Table 8.

Table 8. Participant Awareness and Exposure to LSAV

Response	Aware of LSAV		Exposure to an LSAV	
	Count	%	Count	%
Yes	11	30.6	6	16.7
No	25	69.4	30	83.3
Total	36	100	36	100

The participants were queried in multiple questions about their use of LSAVs with respect to whether an onboard operator was present or not. Their responses with respect to their likelihood of use are summarized in Table 9.

Table 9. Participant Likelihood of Usage with Respect to Operator Presence

Response	With Operator		Without Operator	
	Count	%	Count	%
Very Likely	8	22.9	5	14.3
Likely	14	40.0	13	37.1
Not Sure	10	28.6	11	31.4
Unlikely	3	8.6	4	11.4
Very Unlikely	0	0.0	2	5.7
Total	35	100.0	35	100.0

Study participants were questioned about their perception of personal safety with respect to the presence of strangers onboard in scenarios where an LSAV operator was present or not. Their responses are provided in Table 10. In the questionnaire, strangers are defined as those who are “unfamiliar” to the participant.

Table 10. Perceived Safety with Respect to Operator and Strange Passenger Presence

Response	Operator Present						No Operator					
	No Passenger		Strangers Onboard		Seated Next to Stranger		No Passenger		Strangers Onboard		Seated Next to Stranger	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Very Safe	15	42.9	12	34.3	9	25.7	4	11.4	3	8.6	3	8.6
Safe	13	37.1	17	48.6	21	60.0	17	48.6	17	48.6	15	42.9
Not Sure	6	17.1	6	17.1	4	11.4	10	28.6	12	34.3	13	37.1
Unsafe	1	2.9	0	0.0	1	2.9	3	8.6	3	8.6	3	8.6
Very Unsafe	0	0.0	0	0.0	0	0.0	1	2.9	0	0.0	1	2.9
Total	35	100	35	100	35	100	35	100	35	100	35	100

The participants were asked to indicate to which places they would travel in circumstances with and without the presence of an operator. Their responses are shown in Table 11. “Would not ride” indicates an unwillingness to use the LSAV regardless of operator presence and “No Other Places” indicates that the places a participant would willingly travel to are independent of the presence of an operator.

Table 11. Likelihood of Travel to Destinations Using the LSAV with Respect to Operator Presence.

Response	Operator Present		No Operator	
	Count	%	Count	%
Doctor	33	94.3	26	74.3
Grocery store	28	80.0	26	74.3
Pharmacy	29	82.9	24	68.6
Salon	21	60.0	16	45.7
Bank	24	68.6	19	54.3
Place of worship	22	62.9	15	42.9
Restaurant	19	54.3	17	48.6
Visit family/friends	16	45.7	12	34.3
Social events	17	48.6	12	34.3
Gym	17	48.6	13	37.1
Job	10	28.6	6	17.1
No Other Places	5	14.3	1	2.9
Would Not Ride	0	0.0	4	11.4

Finally, participants were given the option of providing any additional comments on the LSAV. Those comments are listed below verbatim.

- No. of LSAV deployed/needed
- Slow speed a concern
- Wanted to ride it
- More information needed before riding it
- Service area and cost
- More safe with an operator to help
- Price and physical safety while riding
- Safety over ride options
- Would not ride in a shuttle after dark without an operator
- Would use in a controlled environment (e.g. campus) in lieu of walking. Considered being unsafe if mixed with normal traffic.
- Wanted to ride it once to know how it works

- Schedule and cost information needed. Interior need to be improved
- Ideal for campus trips
- Concerns about safety around other vehicles due to low speed; needs to be deployed in a well-structured environment
- Likes the concept and the sustainability aspect; needs more info on cost, schedule, safety, etc.
- Door to door service request
- Safety features needed
- Eager to try one
- Looking forward to their availability
- Interested in riding on one; cost may be an issue
- Safety & routing
- Considers useful
- Doesn't see its practicality/Needs more info
- Low speed & safety are main concerns
- Not a viable option in rural area
- Appears useful but wanted to use an app for access it; speed increase
- Likes the idea
- Not suitable/safe for roads due to low speed

Focus Group Survey Results

The focus group analysis centered on what participants said about the LSAV after reviewing a series of videos about it. Audio from the focus group discussions was transcribed and used for the analysis. The route of questioning the facilitator followed is included as Appendix A, and a basic description of the videos that participants viewed and snapshots of the inside of the LSAV that participants saw during the focus groups are included in Appendix B.

To analyze how participants answered questions about the LSAV, the research team conducted a qualitative analysis. The approach was a modified version of framework methodology (Ritchie & Spencer, 1994). Using this iterative approach, an analyst reduced

the data through summarization and synthesis while maintaining the links to the original data, thus allowing for a comprehensive and transparent analysis. The five steps of the analysis process are summarized as follows:

1. **Determine Focus:** The research team determined that the focus of the qualitative analysis would be on participant questions about the LSAV, reactions to it (with and without an operator), what would keep them from riding (with and without an operator), improvements that would make them more likely to ride (with and without an operator), and comments about riding with unfamiliar passengers (with and without an operator). The icebreaker/introductions at the beginning of the focus groups were not included in the analysis.
2. **Familiarization:** An analyst created transcripts of the question sequence from the focus groups (see Appendix A) beginning after the icebreaker/introductory section of the audio. After transcription was completed, the same analyst reviewed each transcript to become familiar with the data set (i.e., transcripts for seven focus groups). Participant names were replaced with codes during the transcription process.
3. **Identify Thematic Framework:** Based on a review of the data set and awareness of the priorities outlined in Step 1 (Determine Focus), the analyst identified themes (e.g., Safety, Security, and Trust in Technology). Appendix C provides a list of the themes along with working definitions and examples. This thematic framework was created by the research team and used by the research analyst to guide data coding and charting.
4. **Data Coding and Charting:** The analyst applied the thematic framework to each transcript, color coding comments by theme and then arranging them in Microsoft Excel spreadsheets (or thematic charts). Thematic charts were created for analysis based around the four major sections of the focus group discussion:
 - a. Questions about the LSAV.
 - b. Operator onboard discussions (reactions, barriers, and improvements to the LSAV with an operator).
 - c. No operator onboard discussions (reactions, barriers, and improvements to the LSAV without an operator).
 - d. Discussion of unfamiliar passengers both without and with an operator onboard.

These thematic charts were further sorted by emerging subthemes and analyzed. For example, under the focal area of “Questions about the LSAV,” there was one subtheme “Speed” that emerged under the theme “Safety.” Some of the focal areas were broader than others (i.e., included more themes and subthemes). There were also cases where a subtheme appeared to crosscut thematic areas; in particular, several

subthemes crosscut the themes “Trust in Technology and Safety.” Instances of crosscutting subthemes are identified in the results. While the thematic framework and coding/charting were carried out by one primary analyst, the outcomes were reviewed by the research team.

- 5. Interpretation:** The analyst applied the themes and subthemes detailed in the charts to better understand the information provided by the participants. When reporting out the data, the analyst only used themes/subthemes that were mentioned in at least three of the seven focus groups.

As noted in the methods section, though the research team tried to recruit participants with mobility limitations, it was difficult to assemble focus groups in which all the participants had mobility limitations that prevented them from driving. Due to the mixture of participants with and without mobility limitations that inhibited their ability to drive, the research team did not segment out older drivers versus those with mobility limitations in the analysis, as most participants in the focus groups were currently driving at some level. All seven focus groups were analyzed together.

During interpretation/analysis, as mentioned above, all the focus groups were considered together (drivers over 60 as well as people over 60 with mobility limitations) because most of those with mobility limitations still drove. However, there were a few instances, which are pointed out in the results section, where all three of the groups that were screened as having some mobility limitation responded in a manner of interest. There were also a few cases where at least three of the four groups that had not been screened specifically for mobility limitations responded in a manner of interest. Though the groups were assembled for overall analysis, cases where some interesting finding emerged were pulled out and discussed with the understanding that many of those with mobility limitations still drove in some capacity. These issues may be appropriate for further investigation rather than formulating a definitive statement at this point about those with a mobility limitation versus those without.

Focus Groups

The results of the data interpretation are provided for each of the major focal areas (e.g., Questions, Operator Discussions, No Operator Discussions, Unfamiliar Passengers). A summary of the themes (i.e., Safety, Trust in Technology, and Security) and subthemes (e.g.,

Speed, LSAV Operation) that arose from participant comments are provided in tables and discussions below. Example quotations from participants are also included.

Questions

Participants were shown an introductory video of the LSAV traveling on a low-speed road (entrance road to VTTI). This road has a posted speed limit of 24 mph. The video included an audio overlay that provided details about the LSAV (see Appendix B). After participants viewed the video, they were asked to share any questions they had about the LSAV. Several subthemes emerged from the questions raised across groups. The subthemes fell under the themes of “Safety” and “Trust in Technology” (see Table 12). Each subtheme is described below.

Table 12. Questions about the LSAV

Theme	Subtheme
Safety	<i>Speed</i>
Trust in Technology	<i>LSAV Operation</i>
	<i>Operator Presence</i>

Safety (Speed)

Questions about the speed of the LSAV came up in four of the seven groups. Participants were concerned that an LSAV traveling at 14 mph on regular roads could be a hazard. Participants asked if there would be a special lane or route for the LSAV. Some of the questions participants voiced included:

- “At 14 miles an hour and everything, are they going to have a separate section of the road for it like the bicycle lanes? Because at 14, it would seem like it would probably back up traffic.”
- “Does it go in special routes? For something traveling this slow, I’d be a little worried about all these delivery drivers trying to get around me if it were on a regular road?”

It is noteworthy that in all the mobility limitation groups, there were safety-related questions raised about the speed of the LSAV. The issue was raised in only one of the other groups (drivers over 60).

Trust in Technology (LSAV Operation)

Participants in three of the focus groups had questions about how the LSAV operates. In a few groups, participants raised questions about basic operations in an LSAV (e.g., how fast the LSAV doors close, how to tell it to start or stop). In a couple of other groups, participants asked questions about operations in an emergency.

- “A concern of mine would be whether or not there's some kind of control on the door or how fast it would close?”
- “[W]ould that stop [emergency stop] be hooked up to like a department or emergency room in case it was some kind of a health issue?”

Trust in Technology (Operator Presence)

A few participants across three of the focus groups had questions about the presence of an operator. There was not one common question that consistently arose about the operator, rather there were a variety of questions. Questions included what is meant by an operator of an LSAV, when it would be indicated that an operator is onboard, and how a rider could request an operator be present.

- “I'm wondering ... when they say an operator, just specifically what they mean?”
- “If you were apprehensive about, you know, accepting the automation, could you request an operator be onboard?”

Reactions – Operator

After sharing questions about the LSAV, participants saw a second video. In this video, an operator was present at the door of the LSAV, and participants were told an operator would be onboard. The video of the LSAV operating on the low-speed road (e.g., VTTI access road) was similar to the introductory video, except without the added audio overlay. After viewing the second video, participants were asked to share one word that described their reaction to the LSAV and to provide a sentence description of that word. Appendix D

includes a table of the participants’ reactions to the LSAV (both with the operator and without). The table includes the one-word reactions provided by each participant. Several themes/subthemes emerged when participants shared their reactions to the LSAV (Table 13).

Table 13. Reactions to LSAV with Operator

Theme	Subtheme
Safety	<i>Small</i>
	<i>Slow/Designated Pathway</i>
Trust in Technology	<i>LSAV Operation Hesitation</i>
	<i>Helpful for seniors</i>
	<i>Willingness to try</i>

Safety (Small)

During the discussion of reactions to the LSAV (with an operator), under the theme Safety, a subtheme emerged about the small size of the LSAV and how it might be unsafe in a crash. Participants shared concerns about the LSAV being too small to be safe on regular roads with larger vehicles going faster than the LSAV. A couple of participants mentioned their preference for larger and/or sturdier vehicles and that preference making them a bit unsure about the LSAV.

- “Too small for large scale ... you can't really put this on a normal street ...they would push you off in New Jersey ... On personal property or at a housing development or something like that, I see it ... I see it as being dangerous out on the street.”
- “There would be a concern about someone else, a larger vehicle or vehicle going faster hitting this smaller vehicle ... I've never ridden in something that is this small and going at such a slow rate of speed, but I think there would be somewhat of a fear factor involved in that since I'm used to having a sturdier, larger vehicle surrounding me.”

Safety (Slow/Designated Pathway)

As in the Questions focal area, the issue of speed came up in reactions to the LSAV. In five of the focus groups, there were participants who raised concerns about the LSAV speed (i.e.,

14 mph) being too slow to safely operate with regular traffic. This time, the issue was raised across groups and not limited primarily to the groups that had indicated a mobility limitation. A number of safety concerns related to the slow speed of the LSAV were raised, the most common being that other drivers will try to pass the LSAV even when it may not be safe to do so.

- “Well 14 miles an hour is not moving very fast. I’m just wondering how safe it would be with other traffic.”
- “I think ... other drivers would get frustrated and there could be wrecks because people [are] trying to get around it, that type of thing.”

In relation to the slow speed of the LSAV, several groups discussed how the LSAV might be operated safely. The most common idea mentioned was for the LSAV to have a designated lane. A few participants compared the designated lane to bike lanes and noted that such lanes do come with challenges (e.g., drivers not respecting bike lanes, some roads not conducive to adding bike lanes).

- “Would they need a separate road like you would a bicycle, a separate lane for something that would go at this speed so not to hinder traffic? Because safety is a big issue out there on the roads now.”
- “Seems to me it would be best if it had a designated lane. And that wouldn't work in certain areas the way the roads are laid out.”

Trust in Technology (LSAV Operation)

Under Trust in Technology, a subtheme emerged regarding LSAV Operations. Even though participants saw an operator at the door of the LSAV in the second video and were told there would be an operator onboard, some participants were unsure about how the LSAV would be controlled. Across three groups, participants raised a variety of concerns about basic and emergency operations. No single issue of concern was raised across multiple groups. Some examples of the concerns included how the LSAV knows where it is going, how it maneuvers in city traffic around cars and pedestrians, how riders open the doors, or what happens if it gets hit (e.g., opening doors, moving it off the road). Similar comments arose in the earlier discussion on Questions about the LSAV.

Trust in Technology (Hesitation)

A small subtheme under “Trust in Technology” was “Hesitation.” A few participants across three groups described being hesitant about the LSAV. Some described liking the concept but needing to understand it more. A few ideas emerged about what more participants might need before they were comfortable using the LSAV. Examples included seeing more videos of the LSAV in action or having an opportunity to try it out. This subtheme of “Hesitation” was raised again in later discussions.

Trust in Technology (Helpful for Seniors)

A subtheme that emerged across four of the focus groups was the idea that this type of LSAV would be “Helpful for Seniors.” A couple of participants commented that this type of LSAV could provide more independence for seniors who are no longer able to drive. In two of the focus groups, it was mentioned that it would work well in a retirement community.

- “I think it's a technology and improvements in transportation especially for the elderly, which I am one of. It's just amazing. It means mobility beyond what I would have had 20 years ago... Gives me more independence.”
- “I see a perfect application for this kind of a van as being a retirement community.”

Trust in Technology (Willingness to Try)

A final subtheme under “Trust in Technology” was “Willingness to Try the LSAV.” Across four of the groups, some seniors shared their interest in the LSAV and their desire to try it.

- “I think it's something very novel that I've never tried before, and I would love to try it.”
- “Well obviously it would be, you know, safer to have an operator, but it sounds exciting to me. I'm seeing it as just a bus on a fixed route. And yes, it would have an operator initially, then probably it would start running without one. Looking forward to it.”

Poll (LSAV with Operator)

After participants had an opportunity to share their reaction to the LSAV, they were asked if they would be willing to ride the LSAV (with the operator) on a low-speed road (i.e., 14

mph) to a place they wanted to go. Only a couple of participants indicated they would not ride the LSAV; most were either not sure or said they would ride (Table 14).

Table 14. Willingness to Ride (Operator)

	Would Not Ride	Not Sure	Would Ride
Participants	2	17	17

Barriers to Riding

After the poll, participants were asked what would keep them from riding the LSAV. The primary issues raised were safety related. Participants discussed lack of information about the LSAV and the speed of the LSAV being too slow for travel in regular traffic (Table 15).

Table 15. Barriers to Riding the LSAV (Operator)

Theme	Subtheme
Safety	<i>Too Slow</i> <i>Lack of Information</i>

Safety (Too Slow)

Participants in three of the groups brought up the issue of the LSAV’s speed (14 mph) as a barrier to riding it. Some of the participants voiced concerns about how other traffic would behave around an LSAV traveling at that speed (e.g., unsafe passing, trying to outrun the vehicle). This issue was a recurrent theme/subtheme about the speed of the LSAV that came up under discussions of Questions and Reactions to the LSAV (with operator).

- “I think it comes down to traffic speed. Maybe it's because I live off STREET, but I don't see it as a viable safe option unless there is a way to accommodate maybe a separate lane for it.”
- “[T]he speed would be a factor for me ... most areas, 25 is the slowest and if it can only go 14 it’s not going to keep up with traffic ... I don’t think it would be very safe.”

Safety (Lack of Information)

In three of the focus groups, participants discussed the issue of lack of information as something that would keep them from riding the LSAV. The most common barriers mentioned across the three groups were lack of information on the design of the LSAV and the need for information on its crashworthiness. Though there was not one type of information related to design mentioned repeatedly, some examples of the types of design information that participants wanted to know more about before riding included the capacity of the LSAV and the LSAV safety features (e.g., safety restraints, airbags). For a listing of the types of information that were relayed to the participants about the LSAV in the introductory video, see Appendix B. The focus group facilitator purposefully did not answer questions about the LSAV outside of what was on the list provided during the introductory video but allowed the participants to share what types of information they would want to know.

- “I’m not going to get in that thing unless I know more about it. So, it’s lack of information right now.”
- “How is it made? Does it have airbags? Would there be a limit on how many people could end up being in there so it’s not like you’re sardines packed in there? ... what kind of testing has been done on it in crash, like crash studies? I would assume that would all take place before it would actually be used, but it’s something I don’t know.”

Suggested Improvements

After participants shared what would keep them from riding the LSAV, they were asked what would make the LSAV better so that they would be more likely to use it. Two main subthemes emerged under the theme of “Safety” (Table 16). Participants described how the LSAV would be better if it were implemented in a closed environment and if there were design improvements made.

Table 16. Suggested Improvements (Operator)

Theme	Subtheme
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Safety	<i>Closed Environment</i> <i>Design Improvements</i>
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Safety (Closed Environment)

In three of the groups, when asked what would make the LSAV better, participants discussed implementing the LSAV in a closed environment (e.g., campus, designated pathway). The main idea was that it would be safer in a closed environment because it would not be competing with other traffic. A similar idea was discussed earlier in the results (i.e., having a designated pathway).

- “[I]f this smaller vehicle was on its own pathway it wouldn't be competing with larger, faster cars.”
- “A closed system somewhere where they can actually have a route and they painted on the ground this is our LSAV bus route.”

Safety (Design Improvements)

Four groups made suggestions for improving the LSAV related to the LSAV design. There was not a specific design suggestion that cut across all groups. Some participants appeared to be speaking about design issues that would be a barrier to usage after they were asked what would make them more likely to use the LSAV. For instance, a few participants discussed how the LSAV is small and there is not much room to maneuver inside for people who are tall or who use a walker or wheelchair. A few other participants described how there needs to be supports for people to hold onto as well as to assist in getting up/sitting down (e.g., arm rests, handrails). It should be noted that while there were not arm rests, there were handrails shown in the video of the LSAV. It can be assumed, to some extent, that participants were suggesting in these discussions that they would like the LSAV to be big enough for them to safely maneuver inside even with assistive devices such as walkers and that the LSAV have adequate supports (e.g., grab bars, arm rests).

Reactions – No Operator

After participants finished discussing improvements to the LSAV (with the operator), they were shown a final video about the LSAV. The facilitator explained that there would be no operator in this video, and no operator was shown at any point during the video. Participants were then asked to share their reactions to the LSAV without an operator. Several themes/subthemes emerged (Table 17).

Table 17. Reactions to the LSAV (No Operator)

Theme	Subtheme
Safety	<i>Assistance</i>
Crosscutting Safety and Trust in Technology	<i>Emergency Notification</i>
Security	<i>Handling Threats</i>
Trust in Technology	<i>Hesitation</i> <i>More Information</i> <i>Willingness to try</i>

Safety (Assistance)

Across three focus groups, the concern was raised that people who might need assistance would not have it without an operator. Some of the participants who voiced this concern were worried they would need to help someone who required assistance and did not want that responsibility. A few others said there should be some sort of attendant on the LSAV to help them or others who may need assistance.

- “I would feel like I would have to, myself, look at each person that was getting on if they needed help or needed something that I would feel responsible to support them ... but in today's society I probably would feel reluctant to do that responsibility.”
- “[T]he autonomous part is fine with me. But ... the safety, not so much having a driver, but having an attendant because ... I would have to have help if I fell, and I wouldn't expect the other people on the bus to help me up.”

Crosscutting Safety and Trust in Technology (Emergency Notification)

Across three of the focus groups, participants wanted to know how emergency services would be notified (e.g., crash or medical emergency) if there was not an operator. These discussions included conversations about how the LSAV might alert emergency services if there was a crash or how it would know if there was a medical emergency on the LSAV. Participants discussed how they could possibly reach out for assistance using an emergency button or their cell phones. A few participants also discussed the need for someone to be monitoring the LSAV in case someone fell and was unable to reach an emergency button. There was not one consistent issue across all the groups, but a variety of discussions around these issues of needing clarification on how emergency notification would take place on an LSAV. This issue appeared to crosscut “Safety” and “Trust in Technology” as people were voicing safety concerns that were related to how the LSAV emergency notification would function.

- “Presumably the vehicle itself would realize it was in an accident and be able to notify first responders, but I think the occupants would feel better if they were able to notify EMS as well.”
- “[Y]ou may not be in a position to where you can push the button. Because I may not be able to reach it from the floor. But I guarantee you they [person remotely monitoring] would see me laying there.”

Security (Handling Threats)

In three of the focus groups, the issue of security threats on an LSAV without an operator were discussed. A variety of threats were voiced (e.g., people who are drunk, rowdy, or trying to rob a senior citizen). Participants wanted to understand how security threats would be handled if there is not an operator. For instance, some participants discussed if there would be someone onboard for security. In one focus group, the idea of cameras was raised as a way to either monitor the LSAV remotely or record activity on it.

- “I was thinking about it from a security angle. Because anyone can just jump on it. Bunch of people just get on it and go joy riding with it and, you know, that type of

thing. How would that be monitored? Or what safeguards are in place to, you know, to prevent that from happening?”

- “Maybe the operator is a security officer rather than an operator.”

Trust in Technology (Hesitation)

Across four of the focus groups, participants shared concerns or hesitation about the technology. Issues were raised such as concern over computer malfunctions, the ability of a computer to respond in situations like a vehicle breakdown, or just uncertainty about the absence of an operator in general. A similar subtheme was documented (i.e., “Trust in Technology: Hesitation”) earlier in the results under discussions of the LSAV with an operator.

- “What if the vehicle breaks down? I mean, I just want somebody able to react to situations instead of a computer.”
- “I don’t think I want to use it right away if it were available. I think I would have to wait and see how things worked out with it with having no operator.”

Under this subtheme of “Hesitation” emerged a concern that crosscut “Safety” and “Trust in Technology.” In three of the groups, participants raised concerns about the technology malfunctioning in some manner that would affect safety (e.g., crash).

- “[W]hat if we come to a corner and this thing says, ‘okay, there’s nothing preventing me from going through this intersection,’ and you go through because of a computer glitch and you get blindsided by somebody? So that’s my concern with self-driving vehicles, safety.”
- “If you’re going to ride on something that doesn’t have an operator, you need to feel confident that you know how it operates, that you know it operates safely, that it’s not going to crash into the side of a building or into another car or something.”

Trust in Technology (More Information)

In four of the focus groups, participants had questions or shared that they wanted more information about the technology. This subtheme seemed related to the earlier subtheme (“Hesitation”). Participants had a range of questions/concerns that included how the LSAV communicates with its home base, how the LSAV stops and starts, and how the LSAV

operates. A few participants shared concerns about lacking information on what riders are supposed to do in the absence of an operator.

- “I’d like to know more about the technology. What makes it stop? Like if another vehicle is suddenly in front of us made the wrong turn, what goes on mechanically to make the vehicle stop? I’d just like to understand it.”
- “[W]hen you don’t have an operator or someone else on the vehicle then you’re dependent on everyone to kind of figure it out on their own ... not having an operator there means everything has to be pretty self-evident and intuitive so that you can operate it without having to have an engineering degree.”

Trust in Technology (Willingness to Try)

Another subtheme under “Trust in Technology” was “Willingness to Try the LSAV.” In five of the focus groups, discussions came up in which participants indicated a willingness to try the LSAV. A similar subtheme was documented under discussions about the LSAV with the operator. In this case (no operator), each of the focus groups with participants who had indicated a mobility limitation included comments about willingness to try. This does not mean all the participants in those groups indicated they were willing to try the LSAV, only that such comments were made in each of those groups.

- “I wouldn’t mind being one of the first people to use it. I’m more of a risk taker.”
- “I feel very curious about this. I was curious about what the screen seems to be over the emergency exit, what goes on that. And I would just like to try it. No matter actually how practical it is in the beginning, I’d like to go on a maiden voyage to really experience it.”

Poll

After discussing their reactions to the LSAV without an operator, participants were polled to see if they would ride the LSAV on a low-speed road to a place they wanted to go. There were again, as in the first poll regarding willingness to ride with an operator, a few participants who indicated they would not ride the LSAV and an almost even split between those who were not sure or would be willing to ride (Table 18).

Table 18. Willingness to Ride Poll (No Operator)

	Would Not Ride	Not Sure	Would Ride
Participants	3	17	16

Barriers to Riding

After being polled, participants were asked what would keep them from riding the LSAV without the operator. The primary issues appeared to crosscut “Safety” and “Trust in Technology.” Participants discussed the lack of information on how problem scenarios would be addressed without an operator and a lack of experience with the LSAV as issues that would prevent them from riding (Table 19).

Table 19. Barriers to Riding (No Operator)

Theme	Subtheme
Crosscutting Safety and Trust in Technology	<i>Lack of information regarding problem scenarios</i>
	<i>Lack of experience</i>

Crosscutting Safety and Trust in Technology (Lack of Information Regarding Problem Scenarios)

In three of the focus groups, discussions arose about what would happen in problem scenarios, in particular ones where the LSAV would need to stop. The subtheme crosscut “Safety” and “Trust in Technology” because the concerns tended to be about how the LSAV might react in scenarios that might be safety related. There was no one scenario that came up across groups, though participants did describe similar scenarios. Some of the scenarios included the LSAV needing to stop for something outside the LSAV (e.g., an animal runs in front of the LSAV), the LSAV needing to stop for something inside it (e.g., a sick passenger), or the LSAV stopping due to mechanical issues. The participants in these discussions indicated wanting more information about how the LSAV would react in such scenarios and/or what role passengers might have in the absence of an operator.

- “[I]f there’s an emergency and you don’t have an operator who stops it? That’s my question. Or gets it started again for that matter?”
- “I would say what would happen in terms of a mechanical problem, that kind of a safety. Would it just stop and then you’re just sitting there? What would happen next?”

Crosscutting Safety and Trust in Technology (Lack of Experience)

In four of the focus groups, when asked what would prevent them from riding the LSAV, participants mentioned needing experience with the LSAV. There was not one type of experience mentioned across all groups, but participants mentioned wanting an LSAV ride in a closed and controlled test area and/or wanting to see it work. Though this was mentioned under barriers, it is in some respects also what participants may need to feel more comfortable with the LSAV (e.g., seeing the LSAV and taking a test ride in safe/controlled conditions). It is listed as a crosscutting issue because some participants described their need to see/experience the LSAV as being related to their safety.

- “I would want to have it do a test ride in a closed scenario. Closed and controlled scenario.”
- “I’d like to see it work or have some classes. Let me try it out in a test area, not ... throw me out in the public with it.”

Suggested Improvements

When participants were asked what would make the LSAV better so that they would be more likely to ride it (LSAV without the operator), two subthemes emerged. The subthemes were related to “Clear Messaging” and “More Information/Experience with the LSAV.” These two issues were again considered as subthemes that cut across “Safety” and “Trust in Technology” (Table 20).

Table 20. Suggested Improvements (No Operator)

Theme	Subtheme
Crosscutting Safety and Trust in Technology	Clear Messaging
	More Information and Experience

Crosscutting Safety and Trust in Technology (Clear Messaging)

In three of the focus groups, participants described wanting clear messaging or instructions on what to do in general on the LSAV and/or if something went wrong. This suggestion for improvement seems to address the barrier raised about wanting more information about what to do in a problem scenario. Some participants described written directions, like those found on the exit row of an airplane or the back of a hotel door, while another participant mentioned the idea of audio instructions. The form of the instructions seemed less important than the idea that clear messaging would be important in the absence of an operator.

- “Maybe there could be some audio instructions giving you some basic information when you get on. Kind of like when you ride the metro in DC, and they tell you, you know, move to the center of the car or next stop is, or that sort of thing.”
- “Directions when you get in about these things, clear directions to follow if something would happen.”

Crosscutting Safety and Trust in Technology (More Information and Experience)

The cited barriers to using the LSAV without the operator were related to a lack of information and experience. In four of the focus groups, a suggestion for improving the LSAV or making participants more likely to use it was having more information and experience with the LSAV. Words like “knowledge” and “experience” came up across these groups. In terms of experience, a common idea was having the opportunity to see the LSAV and take a test ride under safe conditions (e.g., closed course). This subtheme crosscut “Safety” and “Trust in Technology,” as a few participants’ requests for information/experience with the technology seemed closely related to their assessment of its safety.

- “[M]ore knowledge about the ins and outs of this vehicle and also just feeling more comfortable with the concept of it. Seeing how it works in other cities, you know, just making it more ‘normal.’”
- “To be able to ride it in an area that you know is safe, and understand how it works, that type of thing. And then, you know, take it for a ride for [its] normal route.”

Unfamiliar Passengers

After participants discussed the LSAV without the operator, they were asked how they would feel about riding the LSAV with someone unfamiliar. At first, they were asked how they would feel about riding with an unfamiliar passenger if there was not an operator onboard, and then they were asked if their feelings would change if there was an operator onboard. The subthemes that arose under the discussions of riding with unfamiliar passengers fell under the theme of “Security” (Table 21).

This question was not brought up by the facilitator until the very end of each focus group as researchers wanted to see if these types of security issues were raised without prompting. Most themes/subthemes up to this point had been about “Safety” and “Trust in Technology.”

Table 21. Unfamiliar Passengers

Theme	Subtheme
Security	<i>Expected/Not a problem</i> <i>Risk assessment</i> <i>Issues at night</i> <i>More secure with operator</i> <i>Elevator comparison</i>

Security (Expected/Not a Problem)

In all but one of the focus groups, there were comments from some of the participants that they would expect to ride the LSAV with people who were unfamiliar and/or it would not be a problem. A couple of participants compared it to riding other transit (e.g., Blacksburg Transit). In a few cases, participants qualified this comfort level (e.g., more comfortable during the day, on familiar routes).

- “It would be just like riding a bus now. You don't know the people on the bus.”
- “I'd feel more comfortable getting on if there was someone there that I didn't know if it was in the day and I knew where it was going. I wouldn't be opposed to riding with someone I didn't know.”

It was interesting to note that in the groups where participants had indicated they had a mobility limitation, there appeared to be less concern about riding with someone unfamiliar. While some of the participants still voiced concern, there appeared to be a greater comfort level overall with riding with someone unfamiliar by those who had indicated before the focus group that they had some type of mobility limitation. This could possibly be due to those with mobility limitations using alternative transit more often than participants who did not indicate they had a mobility limitation.

Security (Risk Assessment)

In four of the focus groups, discussions emerged in which people described how they would need to do some sort of risk assessment to decide if it was safe to get on the LSAV with someone unfamiliar to them if there was not an operator onboard. Participants discussed needing to make eye contact or look and see if someone made them feel uncomfortable or unsafe before getting on the LSAV. A few participants described how their concern would be greater if there was only one other person on the LSAV. A couple of participants compared this risk assessment process to the one they would make when deciding if they should get on an elevator with an unfamiliar person. Enough comments came up throughout the focus groups about elevators that there is a separate discussion later in this results section.

- “I guess you could always look in and see if it was somebody that perhaps was frightening and decide not to go in if you felt afraid.”
- “If there were two people in there, I wouldn't feel as compromised. But if there's no operator and it's just the general public that's in there, it's a rather small amount if it's just one person, I would feel compromised.”

Security (Issues at Night)

In four of the focus groups, concerns were discussed about riding the LSAV at night. A couple of participants said they would not ride the LSAV at night without an operator. A few participants said they would feel more comfortable riding at night if there was an operator onboard.

- “I would not ride one without an operator after dark. I'll be honest. I wouldn't do it.”
- “I'd feel more comfortable with an operator at night.”

Security (More Secure with Operator)

In five of the groups, discussions came up about how the presence of an operator made participants feel more secure and safe. A few participants discussed how an operator likely would have been through security or background checks, which would make the participants more comfortable.

- “I would feel more secure that there was someone from the company or whatever that would kind of oversee what was going on.”
- “I’m assuming that anyone that’s operating the vehicle has been through certain security checks and the background checks, that type thing.”

Discussions about feeling more secure with an operator occurred in all the groups where participants had not indicated they had a mobility limitation in advance of the focus group. The discussion only occurred in one of the focus groups where participants had indicated they had some sort of mobility limitation. This finding is in line with the earlier subtheme (“Security: Expected/Not a Problem”) where focus groups with participants who indicated mobility limitations had not voiced as much concern about riding with someone unfamiliar.

Security (Elevator Comparison)

Throughout the focus group discussions, occasionally the comparison of the LSAV to an elevator emerged. Discussions about elevators came up in three of the focus groups when discussing the question of unfamiliar passengers. There was not one consistent point across all three focus groups when comparing elevators to LSAVs, but a variety of points arose that the researchers thought were worth noting.

Participants mentioned how the decision to get on an elevator would be like the decision to get on the LSAV with someone unfamiliar (e.g., look them in the eye). One participant described how elevators had operators in the past who were identifiably separate from typical passengers and could be an authority on the elevator and that a similar concept might be needed in the beginning with LSAVs. Finally, in one of the focus groups, participants described how, when there is an emergency on an elevator, passengers can pick up a phone or press a button to get help (e.g., speak to someone of authority). Participants discussed how

getting help on an elevator in an emergency might be similar to getting help on an LSAV without an operator.

- “I’m careful about getting on an elevator. If there’s just one person on the elevator, sometimes I just don’t get on. It all depends. I have to look them in the eye.”
- “In the olden days they had elevator operators, and they invariably had some sort of a uniform that separated them from the typical person who was getting onboard... If you put somebody on there, you want to separate him from everybody else, at least for a period of time. He is the one in authority. He is or she is the one that you’re going to listen to if there is a problem.”

This comparison of the LSAV technology to elevators made by the focus group participants is not unique. Chris Urmson, former head of Google’s self-driving-car project, was quoted making similar comparisons: “There’s another really interesting parallel in the way they [elevators] were introduced. The technology was this magic thing that would whisk you up floors. You couldn’t possibly imagine relinquishing your life to this thing. So, it was people’s job to sit in the elevator and press the button for you—because it was so complicated. People grew accustomed to it, and they realized they didn’t really need the person there to press the button” (LaFrance, 2015).

DISCUSSION

Questionnaires

Reported use of personal technology among the participants was surprisingly strong, where most (33 of 36) reported using a smartphone with accompanying strong use of other devices such as tablets (23 of 36), laptop computers (11 of 36), and other wearable technologies such as fitness monitors and smart watches. The apparent prevalence of reported technology use may also stem from study screening criteria where participants were required to answer questionnaires online and use virtual meeting technology to attend focus group sessions.

When asked about the destinations to which they would travel within 10 miles of their homes, and where they might travel if they had access to better or additional mobility options, the participants did not reveal that they would visit a wider variety of places if their

travel mobility improved. Perhaps this question should have instead asked whether the frequency of their travel to the places they typically go would increase were better options available. When asked similarly about their anticipated travel destinations after focus group sessions, their responses did not change significantly after exposure to the LSAV.

The participant responses varied on whether the presence of an operator and/or stranger onboard would affect their likely usage. In general, the participants were more likely to use an LSAV to travel to their customary destinations when an operator was onboard. This preference increased significantly when participants shared a ride with strangers and especially when they might be required to sit next to a stranger. There was no significant change in their likely destinations with and without an operator. It is worth noting, however, that participants seemed more sensitive to whether an operator was present on trips to their doctor or place of worship.

At the completion of questionnaire and focus group activities, the participants were asked an open-ended question regarding any additional thoughts they would like to share regarding LSAVs. These comments generally reflected the topics already discussed in the focus group session, including:

- An interest in riding in an LSAV
- The slow speed of the shuttle being a problem when sharing traffic lanes with faster vehicles
- Prospective usage in a campus-like setting
- General safety concerns with respect to the presence of an operator, safety overrides, and crash safety

Other comments mentioned but not widely discussed in the focus group sessions included the following:

- That the LSAV is not well suited for use in rural areas
- The prospect of door-to-door LSAV operation
- The positive environmental sustainability benefits of an LSAV
- The cost of using an LSAV
- How their usage might depend on whether it is night or day
- LSAV interior accommodations needing improvement

Focus Groups

There were many issues discussed in the focus groups, but several issues emerged that may inform the development and implementation of LSAVs for older users (60 and over) and those with mobility limitations. Below is a summary of a few of these issues pulled from the results. For a fuller understanding of participant reactions, barriers to usage, and suggestions, please reference the results section of the report.

- **Using a designated lane and/or closed environment to address speed concerns**
 - A subtheme that recurred throughout the focus groups was the “Speed of the LSAV.” Some participants were uncomfortable with the slow speed (14 mph) of the LSAV on regular roads. There were suggestions that having a designated lane or confining the LSAV to closed environments (e.g., campus, retirement community) might alleviate this issue.
- **Having a continued operator presence**
 - Some participants discussed how having an operator present, at least in the beginning, would be important. An elevator analogy was made to this technology and how it would be helpful to have an operator there to show people how it works (basically and in emergencies), to assist people who may have mobility limitations, and to provide a measure of security. Participants also discussed the issue that while the presence of an operator may be phased out in time, there may need to be some LSAVs where an operator or assistant remains present (e.g., for mobility limitations).
- **Providing more information**
 - A recurring subtheme was that participants wanted more information about the LSAV for both basic and emergency operations. Participants cited understanding basic operations (e.g., opening doors) and what happens in an emergency (e.g., a crash or an ill passenger) as being important. Along these lines, clear messaging was mentioned, particularly in the event of a problem scenario such as a passenger needing assistance in the absence of an operator onboard.

- **Moving from hesitancy to willingness to try**
 - Overall, there appeared to be a mix of hesitancy and willingness to try the LSAV among participants. While the polling showed a few participants who were unwilling to try the LSAV, most participants indicated they were unsure or willing to try it out. Providing the types of information and experience that participants want and need should help those who are unsure to decide if they would like to use this technology in the future.

One recurring theme that arose from both questionnaire and focus group surveys, and that has particular significance to issues identified during the implementation of the LSAV at VTTI and elsewhere, is that of vehicle speed. Participants identified potential concerns related to both high and low vehicle speeds where the former might result in passenger injuries from crashes and where the latter might be a prime causal factor contributing to those crashes due to traffic speed differential. An early implementation of an LSAV in Columbus, Ohio, resulted in the injury of a passenger during an emergency vehicle stop while traveling at only 7 mph and led to a National Highway Traffic Administration (NHTSA) moratorium on EasyMile LSAV operations (Reuters News, 2020). In LSAV implementations performed as part of this project and elsewhere, the low rate of vehicle travel has led to problems with nearby traffic flow and with signalized intersection clearance.

STUDY LIMITATIONS

There were a few study limitations the research team felt worth noting. One of the study limitations was that only those participants who were willing and able to use the Zoom virtual meeting platform could participate. The research team assisted those who wanted to participate but needed some help setting up Zoom, yet if someone did not have internet access and/or willingness to go where access was available, they were unable to participate. This may have created an inherent bias in a study focused on acceptance of new technology. Though the intention at the onset of the study was to do the sessions in person, due to the risks COVID-19 posed to participants and respective research protocol limitations, the research team was compelled to hold the focus group sessions virtually to ensure the safety of participants and others.

Another study limitation was the challenge the research team experienced in recruiting certain segments of interest. For example, the research team initially considered recruiting participants who primarily used other forms of transportation (e.g., Uber, Lyft, bus) as opposed to driving. The research team did not end up segmenting for transit use because the less urban nature of the community in which the focus groups were conducted made it difficult to recruit people who primarily use other forms of transit.

The research team was also interested in including participants who had mobility limitations that might prevent them from driving. This recruitment effort ended up including a mix of participants with varying levels of mobility limitations that impacted their ability to drive (some drove, and some did not). Despite this, the effort to recruit this segment enabled the research team to get a better mix of participants with mobility limitations than might have occurred if that had not been a recruitment goal in the study. The insight these participants provided was valuable and appreciated.

Future Research

It would be helpful to explore further the willingness to use the LSAV in populations with mobility limitations. Some of the participants with mobility limitations shared their willingness to try, while some were concerned that without an operator present it would not be possible for them to use the LSAV (e.g., needing help locking down a wheelchair). Conducting further research on how to ensure this technology meets the needs of users with mobility limitations would be beneficial.

These focus groups were conducted with participants who live in a more rural area where use of other forms of transportation (e.g., Lyft, bus) is not as common as it might be in urban settings. Conducting the focus group sessions in an urban area with regular users of alternate forms of transportation would be beneficial.

Finally, an area of future research may be assessing how to develop an LSAV outreach effort so that participants of various ages and needs are provided with the information and experience they need to feel comfortable using the LSAV. Some participants in this study mentioned wanting a test ride in the LSAV in a safe environment (closed course) before

trying it on the road. They also mentioned wanting to learn more about topics such as crashworthiness and how the LSAV operates. Learning how to tailor information and experiences to reach target populations for the LSAV would be beneficial for future implementation.

Statement on COVID-19 Study Impacts

The timely completion and scope of this project was adversely impacted by the COVID-19 pandemic on multiple fronts. The primary COVID challenges revolved around revised rules for working with human participants and the risks presented by having multiple people share the confined space within the vehicle. This required a complete revision of the experimental plans, including recruiting, IRB, and safety compliance components. This ultimately resulted in a major change of scope from that originally envisioned with a primary effect on how participants were exposed to the LSAV technology and how focus group surveys were executed. In both cases, direct interactions between participants and the LSAV and between multiple participants were reduced to what could be achieved using multimedia presentations (i.e., video) and virtual meeting spaces (i.e., Zoom).

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APPENDIX A: BASIC FOCUS GROUP QUESTION ROUTE

Below is the basic question route used by the facilitator to guide each focus group discussion along with a brief description of the videos used to demonstrate the LSAV.

Focus Group Question Route

- Icebreaker/Introductions
 - Please share the place you go to most often within 10 miles of your home, and the form of transportation you typically use to get there
- Video 1: Introductory
 - What questions do you have about the LSAV?
- Video 2: LSAV with Operator
 - What is your reaction to the LSAV?
 - If you could ride this LSAV on a low-speed road to a place you wanted to go (and by low-speed, I mean 14 mph or less), would you use it? (Poll)
 - No, I would not ride this LSAV
 - I'm not sure if I'd ride this LSAV
 - Yes, I would ride this LSAV
 - What would keep you from riding the LSAV?
 - What would make the LSAV better so you would be more likely to use it?
- Video 3: LSAV without Operator
 - What is your reaction to the LSAV?
 - If you could ride this LSAV on a low-speed road to a place you wanted to go (and by low-speed, I mean 14 mph or less), would you use it? (Poll)
 - No, I would not ride this LSAV
 - I'm not sure if I'd ride this LSAV
 - Yes, I would ride this LSAV
 - What would keep you from riding the LSAV?
 - What would make the LSAV better so you would be more likely to use it?
- Unfamiliar Person Discussion



- How would you feel about riding in the LSAV (no operator) if there is a person onboard who is unfamiliar to you?
 - Would the presence of an operator change how you felt about riding in the LSAV with someone unfamiliar to you?
- Closing
 - We want to understand how seniors feel about these LSAVs. What, if anything, have we missed?

APPENDIX B: LSAV VIDEOS

Each of the videos shown to participants is described below along with information the facilitator provided about the clips.

Video 1: Introductory Video

The brief introductory video (roughly 1 minute and 30 seconds) showed the LSAV traveling down a low-speed road (VTTI access road) from the point of view of someone entering and then riding inside the vehicle. While the introductory video was playing, a narrator audibly described each of the following points below. The focus group facilitator also read each of these points out to the participants again after the initial video in case participants did not hear the first time and displayed the points as captions on the screen for participants to read.

LSAV Information

- Those who do not drive may soon be able to make short trips in a vehicle like this.
- Travels at a top speed of 14 mph.
- Electrically powered and operates quietly.
- Can travel on a pre-mapped route without a driver.
- Equipped with seat belts for each sitting passenger.
- Four emergency stop buttons that passengers may use to stop the vehicle quickly.
- Doors open and close using buttons located inside and outside the vehicle.
- An operator may ride onboard to assist passengers and drive if needed.
- Equipped with a wheelchair ramp that deploys with the push of a button.
- Equipped with air conditioning and heating to keep passengers comfortable.



Video 2 – LSAV with Operator

Video 2 was a brief silent video (i.e., roughly 45 seconds) that showed the LSAV driving on the same low-speed road. In the video, there was an operator stationed outside the LSAV. Before the video clip began, the facilitator introduced the clip and let participants know the role of the operator. Below is a snapshot from the video of the LSAV with the operator.

- **Focus Group Facilitator Introduction to Video Clip 2:** You are about to view another video clip of the LSAV. The person you'll see in the video is an operator who is there to ensure the safe operation of the shuttle and to assist passengers.



Video 3 – LSAV without Operator

Video 3 was also a brief silent video (i.e., roughly 45 seconds) that showed the LSAV driving on the same low-speed road. In the video, there was not an operator stationed outside the LSAV. Before the video clip began, the facilitator introduced the clip and let participants know that the only difference between video clip 2 and video clip 3 was the absence of the operator. Below is a snapshot from the video of the LSAV with no operator.

- **Focus Group Facilitator Introduction to Video 3:** You are about to view the third video clip of the LSAV. The difference in this case is that there is not an operator onboard.



APPENDIX C: FOCUS GROUP THEMATIC FRAMEWORK

Below is the thematic framework the research team created that was used by the primary analyst for coding. These themes were applied to the transcripts during coding. Subthemes were identified later once the themes had been pulled from the scripts into the Excel spreadsheets for further analysis.

Research Focus 1 – Safety

Research Focus 2 – Security

Research Focus 3 – Trust in Technology

Theme	Definition	Examples
Safety	Participant perceptions regarding the safety of LSAV. This could include LSAV safety (e.g., crashworthy) or passenger safety (e.g., injury). Includes positive and negative perceptions of safety as well as questions about safety and suggestions participants made regarding safety.	LSAV: “Yeah, it seems safe. Well, because it's going so slow. I mean ... if you hit something, it's not going to be very hard, so it seems safe. That’s why I say it seems safe. But if somebody hits you, that's a whole other deal.”
		Personal: “Cramped. C-R-A-M-P-E-D. It looks like I'd be falling over people's feet and packages ...”
Security	Participant perceptions about personal security in the LSAV (e.g., safe from intrusion, harm from others). Includes positive and negative perceptions of security as well as questions about security and suggestions participants made regarding what would make them feel more secure.	“I would feel more secure that there was someone from the company or whatever that would kind of oversee what was going on.”
		“I don't think in this area I'd worry about it.” (<i>riding with someone unfamiliar with no operator onboard</i>)

<p>Trust in Technology</p>	<p>Participant apparent trust (or lack thereof) in LSAV technology. The focus is on words/comments that are indicative of a point about the self-driving technology (e.g., technology, computer). Includes positive and negative perceptions of the self-driving technology as well as participant questions about the technology and suggestions for improving their trust in the technology.</p>	<p>“... there appeared to be total reliance upon the computer. I did not see a steering wheel. I did not see brakes when they showed things in there for someone to override it. And that does scare me. I work an awful lot with computers and they’re not always totally reliable...”</p> <p>“I’d like to understand it... I would like to know something about the technology before I go on my maiden voyage. And that could be a short video I’d watch online, or it could be on that screen there in the LSAV. But I would just like to know what makes it tick.”</p>
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APPENDIX D. REACTIONS TO THE LSAV WITH AND WITHOUT AN OPERATOR

FG#	(Operator)	(No Operator)
FG1	Necessary	Questionable
FG1	Futuristic	Tight
FG1	Small	Futuristic
FG1	Innovative	Uncomfortable
FG1	Slow	Speed
FG1	Adaptable	Unsure
FG2	Cautious	Cramped
FG2	Financing	Needs work
FG2	Curiosity	Curious
FG2	Innovative	Innovative
FG2	Positive	Safety
FG2	Limited	Lacking
FG3	Sustainable	Safety
FG3	Ugly	Light
FG3	Small	Needs an operator
FG3	Compact	Safety
FG3	Small	Assistance
FG3	Number	Hand Holds
FG4	Space	Responsible
FG4	Convenient	Confusion
FG4	When	Exciting
FG4	Possibilities	Futuristic
FG4	Convenient	Curious
FG4	Good	Adventurous
FG5	Restrictive	Scary
FG5	Comfortable	Open
FG5	Interesting	Convenient
FG6	Space Efficient	Safety
FG6	Unsafe	Cramped
FG6	Science Fiction-y	Seats Uncomfortable
FG6	Cramped	Crowded
FG6	Possible	Possible
FG7	Lane	Scary
FG7	Safety	Safety
FG7	Cozy	OnStar
FG7	Cool	Safety



APPENDIX E: PARTICIPANT ENTRANCE QUESTIONNAIRE

Entrance Questionnaire

Directions: *Entrance questionnaire will be administered over zoom during the intake session.*

1. Would you please indicate your gender? (***Pull from screening***)
 - Male
 - Female
 - Other _____

2. What town do you live in? _____

3. If you work, what town do you work in? _____

4. If you volunteer, what town do you volunteer in? _____

5. What is your current age? _____

6. Would you describe your current occupational status as: (Check **one**)
 - Full-time employed
 - Part-time employed
 - Retired
 - Other _____

7. Do you use any of the following forms of portable or wearable technology? (Read each option and check **all** that apply).
 - Smart phone
 - Tablet
 - Smart watch
 - Activity tracker (e.g., Fitbit)
 - Other: _____

8. What forms of transportation do you typically use? (Read each option and check **all** that apply.)
 - I drive a light vehicle such as a car, truck, van, or SUV
 - I have friends and/or family take me where I need to go
 - Public transportation, bus
 - Public transportation, train or subway
 - Motorcycle
 - Scooter
 - Bicycle
 - Walk
 - Specialty Service: Paratransit (a bus, shuttle, or minivan equipped for people with disabilities)
 - Commercial For-Hire Service (Uber, Lyft, Taxi, Limo)
 - Medical Transport Services (a service which is solely designed to go to/from medical appointments).
 - Senior Service Bus
 - Other: _____

9. What places do you go to within 10 miles of your home? (Read each option and check **all** that apply.)

- Doctor's office, hospital, medical appointment
- Grocery/retail store, shopping
- Pharmacy, drug store
- Salon, barber shop (hair, nails, etc.)
- Bank
- Restaurant, fast food
- Place of worship
- Visit family and/or friends
- Social events, entertainment, bar
- Gym, recreation/exercise
- Other (please specify) _____

10. Are there places within 10 miles of your home that you'd go more regularly if you had access to reliable transportation?

- Yes
- No

If yes (Read each option and check **all** that apply)

- Doctor's office, hospital, medical appointment
- Grocery/retail store, shopping
- Pharmacy, drug store
- Salon, barber shop (hair, nails, etc.)
- Bank
- Restaurant, fast food
- Place of worship
- Visit family and/or friends
- Social events, entertainment, bar
- Gym, recreation/exercise
- Other (please specify) _____

11. Do you have any mobility limitations or disabilities which require you to need assistance when you travel to your typical destinations?

- Yes _____
 - If yes, can you please describe? _____
- No _____

APPENDIX F: PARTICIPANT EXIT QUESTIONNAIRE

Directions: Exit questionnaire may be completed with VTTI staff (e.g., phone or zoom), but preference is for participants to complete it individually via a link to the survey.

Exit Questionnaire

1. Before the focus group, had you ever seen or heard anything about self-driving shuttles?
 - Yes
 - No

If Yes: How had you seen or heard about self-driving shuttles? Check **all** that apply.

- Radio
 - TV
 - Newspaper
 - Word of Mouth (Friends or family)
 - Social media/Internet
 - Other _____
 - I have never seen or heard anything about self-driving shuttles.
2. Before the focus group, had you ever ridden in a self-driving shuttle?
 - Yes
 - No

For the next set of questions, please imagine that we are in a post-Covid-19 period where Covid-19 no longer poses the health risk that it does today. We don't want you to ignore your feelings about Covid-19 because we know this pandemic may influence how you feel about transportation in the future. But what we'd like you to do is imagine that we are at a point in time where Covid-19 is no longer a concern.

We'd like to ask your feelings about riding in a self-driving shuttle with an operator present.

3. If a self-driving shuttle **with an operator** were available today, how likely would you be to use it? Check **one**.
 - Very Likely
 - Likely
 - Not Sure
 - Unlikely
 - Very Unlikely
4. How safe would you feel riding in a self-driving shuttle **with an operator** if there are no other passengers on the shuttle? Check **one**.
 - Very safe
 - Safe
 - Not Sure
 - Unsafe (Follow-up with open-ended prompt)
 - Very unsafe (Follow-up with open-ended prompt)
 - What about this situation would make you feel unsafe? _____

5. How safe would you feel riding in a self-driving shuttle **with an operator** if there are several other passengers on the shuttle? Check **one**.
- Very safe
 - Safe
 - Not Sure
 - Unsafe (Follow-up with open-ended prompt)
 - Very unsafe (Follow-up with open-ended prompt)
 - What about this situation would make you feel unsafe? _____
6. How safe would you feel riding in a self-driving shuttle **with an operator** if you have no option but to sit next to someone unfamiliar to you? Check **one**.
- Very safe
 - Safe
 - Not Sure
 - Unsafe (Follow-up with open-ended prompt)
 - Very unsafe (Follow-up with open-ended prompt)
 - What about this situation would make you feel unsafe? _____
7. What places would you go in a self-driving shuttle **with an operator** if one were available? Check **all** that apply.
- Doctor's office, hospital, medical appointment
 - Grocery/retail store, shopping
 - Pharmacy, drug store
 - Salon, barber shop (hair, nails, etc.)
 - Bank
 - Restaurant, fast food
 - Place of worship
 - Visit family and/or friends
 - Social events, entertainment, bar
 - Gym, recreation/exercise
 - Other (please specify) _____
 - I would not ride in a self-driving shuttle with an operator

We'd like to ask your feelings about riding in a self-driving shuttle without an operator present.

8. If a self-driving shuttle **without an operator** were available today, how likely would you be to use it? Check **one**.
- Very Likely
 - Likely
 - Not Sure
 - Unlikely
 - Very Unlikely

9. How safe would you feel riding in a self-driving shuttle **without an operator** if there are no other passengers on the shuttle? Check **one**.
- Very safe
 - Safe
 - Not Sure
 - Unsafe (Follow-up with open-ended prompt)
 - Very unsafe (Follow-up with open-ended prompt)
 - What about this situation would make you feel unsafe? _____
10. How safe would you feel riding in a self-driving shuttle **without an operator** if there are several other passengers on the shuttle? Check **one**.
- Very safe
 - Safe
 - Not Sure
 - Unsafe (Follow-up with open-ended prompt)
 - Very unsafe (Follow-up with open-ended prompt)
 - What about this situation would make you feel unsafe? _____
11. How safe would you feel riding in a self-driving shuttle **without an operator** if you have no option but to sit next to someone unfamiliar to you? Check **one**.
- Very safe
 - Safe
 - Not Sure
 - Unsafe (Follow-up with open-ended prompt)
 - Very unsafe (Follow-up with open-ended prompt)
 - What about this situation would make you feel unsafe? _____
12. What places would you go in a self-driving shuttle **without an operator** if one were available? Check **all** that apply.
- Doctor's office, hospital, medical appointment
 - Grocery/retail store, shopping
 - Pharmacy, drug store
 - Salon, barber shop (hair, nails, etc.)
 - Bank
 - Restaurant, fast food
 - Place of worship
 - Visit family and/or friends
 - Social events, entertainment, bar
 - Gym, recreation/exercise
 - Other (please specify) _____
 - I would not ride in a self-driving shuttle without an operator

13. If you have any other thoughts about self-driving shuttles, please let us know.

APPENDIX G: PARTICIPANT RECRUITMENT INFORMATION SHEET

Information Sheet for Participation in a Research Study



Principal Investigator: Andrew Alden
Title of Study: Mile
Sponsor: Center for Advanced Transportation Mobility

You are invited to participate in a research study. This form includes information about the study and contact information if you have any questions.

➤ **WHAT SHOULD I KNOW?**

The study will explore the attitudes of mature adults about new forms of transportation. If you choose to participate, you will be asked to complete some questionnaires and take part in an online focus group with up to five other participants. The questionnaires and focus groups will cover topics like your transportation preferences and how you feel about new technologies in vehicles.

Participation in this study involves using Zoom video conferencing software, to connect multiple people electronically from the comfort of their own home or office. Full participation involves participating in 3 parts. Parts one and two are connecting with the research team via a Zoom invitation by email, scheduled on different days. You will also complete an exit questionnaire online after the two sessions are completed. The initial session, to complete forms and questionnaires, should last approximately 30 minutes, the second session, the focus group, should last approximately 75 minutes, and the final exit questionnaire should take approximately 15 minutes to complete for a total participation time of approximately 2 hours.

Minimal risk is involved in filling out questionnaires and participating in a focus group. The risks of completing questionnaires is no more than when doing activities in daily life like filling in forms. Taking part in the focus group is similar to taking part in a group discussion.



To minimize your risk, you will never be required to do anything that you are not prepared or willing to do. You may decide not to be in the study or to leave the study at any time. In addition, any analysis that is done of the focus group will not include any personal information. You may refuse to answer any question during the focus group or in any of the questionnaires.

If you agree to take part in this research study, you will be compensated \$15 for the initial entrance video session, \$30 for the focus group session, and \$15 for the completion of the exit questionnaire, for a total of \$60 for full participation of all three parts of the study. If you choose to withdraw from the study, or the experimenter has to end a session early, you will receive compensation for the amount of time you have participated, at a rate of \$30 per hour rounded to the next half hour (e.g., \$30 for 60 minutes completed). All participants will receive a minimum of \$15.

All compensation, whether for the full amount of \$60 or any partial amount, will be issued using a MasterCard (issued by the company ClinCard). This MasterCard will be sent to you after the entrance session. The MasterCard you receive in the mail will have a zero balance until we have confirmed that you received it via USPS mail. Compensation will be loaded on the card for completion of the entrance session (\$15), the focus group session (\$30), and the exit questionnaire (\$15). Please allow up to one full business day for activation of the amount to the card after each payment has been loaded on the card. Once initially activated, this card cannot be used past its expiration date. The issuing bank will also begin deducting a monthly service fee of \$4.50 after three months of inactivity. Be sure to check the ClinCard documentation in the envelope with the MasterCard we provide to you for more information.

➤ CONFIDENTIALITY

We will make every effort to limit the use and disclosure of your personal information, including research study records only to people who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, and other authorized representatives of Virginia Tech. In addition, we cannot promise that other participants in the focus group will keep confidential what you say during the group discussion. Personal information, such as your full name, age, address, etc will not be disclosed during the group session.

To assist in maintaining confidentiality of all participants, we ask all participants to only connect to the Zoom video conference sessions while in the privacy of their home or office, and not while in a public setting such as a coffee shop or library.

A recording will be made of the Zoom session and a transcript may be created. No names or images will be used in the analysis or reporting of results. The Zoom



recording will be made using a VT Zoom account and will be downloaded to the secure VTTI server upon completion of the session. An audio recording of the session will also be made, downloaded to the secure VTTI server, and erased from the audio recorder. Data gathered in this study will be treated with confidentiality. Coding will be used so that your name is not linked with data used for analysis or reporting (e.g., Participant #10). Data that identifies you will not be shared with anyone besides VTTI employees. Any transcripts that are used for analysis or quotes that are used (e.g., in reports or presentations) will not include names.

Electronic data will be stored on a secure password protected server at VTTI. Any data collected on paper will be stored in a locked filing cabinet. Contact information and other auxiliary study information (such as that collected for payment purposes) will be stored separately from research data. Study data will be stored throughout the lifetime of the data (up to 30 years). De-identified study data will be maintained indefinitely. Access to the data will be under the supervision of the Principal Investigator who may allow other VTTI researchers access to de-identified data for use in other IRB approved research projects. Project sponsors will have access to the study's de-identified data. No names or other identifiable data will be provided to the sponsor. If identifiers are removed from your private information collected during this research, that information could be used for future research studies or distributed to another investigator for future research studies without your additional informed consent. The results of this research will be presented in summary form (you will not be identified) at conferences, in presentation, reports, academic papers, and potentially as part of a thesis/dissertation.

➤ WHO CAN I TALK TO?

If you have any questions or concerns about the research, please feel free to contact Andy Alden (aalden@vti.vt.edu, 540-231-1526). You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact the Virginia Tech IRB Office at 540-231-3732 (irb@vt.edu).

Please keep a copy of this information sheet for your records. VTTI has emailed an electronic copy and will include a paper copy in the packet mailed to you via USPS.

APPENDIX H: PUBLICATIONS, PRESENTATIONS, AND POSTERS RESULTING FROM THIS PROJECT

Publications:

Grove, Kevin, and Andrew Scott Alden. *Low-Speed Autonomous Shuttles-Lessons Learned from Real-World Implementation*. No. 2021-01-1010. SAE Technical Paper, 2021.

Presentations:

Volpe on *FTA Automated Vehicle Testing*, by Andy Alden, Blacksburg, VA (3/13/2018)

Pennsylvania AV Summit on *Automated Freight*, by Andy Alden, Pittsburgh, PA (4/9/2018)

WVAMPO/WVLTAP conference, *Autonomous Vehicles: Are We Ready?*, by Andy Alden, Morgantown, WV: (4/18/2018)

American Meteorological Society AV conference, by Andy Alden, Washington, DC: *Weather Impacts on AVs*, (4/25/2018)

APICS DC Metro DC Chapter Meeting, Future Transportation – *How Automation and Intelligent Systems Will Impact the Movement of People and Goods*, by Andy Alden, Greencastle, PA, (4/26/2018)

CTAV Young Professionals in Transportation - Training & Networking Symposium, *Transportation Trends*, by Andy Alden, Blacksburg, VA: (4/27/2018)

Virginia Unmanned Systems Advisory Board, *VTTI Overview on AV Research*, by Andy Alden, Richmond, VA; (August 22, 2019).

VTTI Onsite Demonstration of the CATM Last Mile Project Autonomous Shuttle and presentation on current research for Nissan Corp., by Andy Alden and Kevin Grove, (July 9, 2019)

Extended meeting on the topic of low-speed autonomous vehicle (LSAV) deployment in Virginia. Approximately 30 participants included representatives from Fairfax County, Virginia Beach and Dominion Electric Power. Presentation by Kevin Grove Kevin on VTTI's experience with the EasyMile LSAV as part of this project. (1/30/2020).

Hampton Roads Innovation Collaborative Tech Tuesday, *Developments in Ground Automation*, presentation and panel discussion by Andy Alden, (5/25/2021)

VDOT CAV Readiness Workshop, VTTI and CAV Issues and Research, by Andy Alden (6/3/2021)

NCAT CATM Symposium, Automated Last Mile Connectivity for Vulnerable Road Users – Project Update, by Andy Alden, 11/5/2018