TCRP Project B-47 and NCHRP Project 20-102(30)

# Transformational Technologies and Mobility Inclusion Playbook

Appendices B–D are supplemental to *TCRP Research Report 244/NCHRP Research Report 1101: Transformational Technologies and Mobility Inclusion Playbook* (TCRP Project B-47 and NCHRP Project 20-102(30). The full report can be found by searching for the report title on the National Academies Press website (nap.nationalacademdies.org).

Appendix B: Stakeholder Interviews
Appendix C: Underserved Population Focus Groups
Appendix D: Underserved Population Survey

# APPENDIX B

# STAKEHOLDER INTERVIEWS

Appendix B presents findings from the stakeholder interviews to identify mobility gaps that exist for historically underserved populations in accessing transformational technologies. This appendix is organized into sections as follows:

- Stakeholder Interview Findings on New Mobility Options: As part of the TCRP Project B-47, the research team conducted stakeholder interviews with transportation agencies, advocacy and social services organizations, and technology providers.
- Stakeholder Interview Findings on Shared Automated Vehicles (SAVs): As part of the NCHRP Project 20-102(30), the research team conducted stakeholder interviews with agencies and organizations that have deployed SAVs in the past, are in the process of deploying SAVs, or are planning to deploy SAVs.

Major themes emerged from the interviews regarding barriers underserved population groups face in using transformational transportation technologies. The interviews also revealed important gaps in transportation access and possible solutions for addressing these gaps.

## STAKEHOLDER INTERVIEW FINDINGS ON NEW MOBILITY OPTIONS

As part of the TCRP Project B-47, the research team conducted interviews with staff from 27 different organizations. Interviewees were asked about barriers, adaptations, and strategies for underserved populations to overcome barriers in accessing app-based carpooling services, bikesharing services, carsharing services, e-scooter sharing services, and ridehailing services. Table B-1 shows the list of stakeholder interviews conducted.

**Table B-1. List of TCRP Project B-47 stakeholder interviews.**

| | |
|---|---|
| **Accessibility Organizations** | • Easter Seals and National Center for Mobility Management<br>• American Association on Intellectual and Developmental Disabilities<br>• Engineering4Access<br>• American Council of the Blind |
| **Associations Representing Other Underserved Populations** | • Association for Driver Rehabilitation Services<br>• Association of American Retired Persons<br>• Families United Gaining Accessibility<br>• Hopi Senom Transit<br>• Houston Area Urban League<br>• Investing in Place<br>• St. David's Foundation |
| **Transit Agencies** | • Pinellas Suncoast Transit Authority<br>• Northern Arizona Intergovernmental Public Transportation Authority<br>• Los Angeles Metro<br>• King County Metro<br>• Northern Arizona Council of Governments (specific insights from rural and tribal perspectives)<br>• Denton County Transportation Authority |

| | |
|---|---|
| **Advocacy and Research Organizations** | • National Association of Development Organizations<br>• Shared-Use Mobility Center<br>• National Rural Transit Assistance Program<br>• Center for Neighborhood Technology<br>• Urban Institute |
| **Technology** | • INIT (use of Alexa for mobile app)<br>• University of Michigan/Novi-based Pratt and Miller Engineering (automated shuttle)<br>• Smart Columbus (apps for people with cognitive disabilities)<br>• RouteMatch<br>• Tappy Guide |

## Barriers and Adaptations

Barriers varied across populations and suggested solutions, but researchers also found significant overlap. The common barriers affect many populations and prevent them from accessing many different technologies.

### *Discrimination*

Interviewees identified several types of discrimination that reduce access to new mobility services. For example, they cited transportation network company (TNC) drivers canceling trips when learning that their passenger is a person of color. People with disabilities who use service animals also reported TNC drivers rejecting their requests. TNC providers Uber and Lyft have antidiscrimination policies and service animal policies designed to protect against these kinds of discrimination, but additional training can help make drivers and riders aware of these policies and the consequences of violating them (Uber n.d.-a; n.d.-b; Lyft n.d.-a, n.d.-b).

In addition to individual discrimination, interviewees noted that neighborhoods consisting primarily of people with low incomes and/or people of color are often underserved by new mobility services. For example, bikeshare systems may have fewer docks in these neighborhoods, and carshare programs may be less likely to locate cars there. Some bikeshare and carshare programs are working to counteract this trend. For example, the carsharing program BlueLA, in partnership with the Los Angeles Department of Transportation, serves low-income communities in the Los Angeles area (BlueLA n.d.). In 2018, Pittsburgh's bikeshare system, Healthy Ride, made a deliberate effort to expand its service and add stations in predominantly Black neighborhoods (Detto 2018).

### *Affordability*

A common concern across interviews was the affordability of new technologies. Most underserved groups are also more likely to be in poverty than the general population. For people living in poverty and other low-income households, transportation costs are often a significant burden. Ridesourcing (TNC) services, in particular, often come at a high cost per mile, especially compared to options such as public transit. At the same time, many underserved populations, including older adults and people with disabilities, cannot or choose not to drive. Furthermore, many low-income households either cannot afford a personal auto or are car-poor (in households with more drivers than cars).

These factors mean that services such as ridesourcing can be particularly beneficial for these population groups, especially for late-night trips when public transit services are typically either

reduced or not available. Nonetheless, many individuals who stand to gain the most from ridesourcing are least able to afford it. Interviewees also pointed out that as city centers and areas near public transit become increasingly expensive, people with low incomes are often faced with longer commutes, which means that more affordable transportation options, such as walking and cycling, are not an option, and TNC trips are particularly expensive. Interviewees identified programs such as the Pinellas Suncoast Transportation Authority's discounted TNC ride program as a potential solution. The program provides discounted TNC rides to connect people to public transit stops.

In addition to the overall affordability challenges, interviewees highlighted two related barriers: high upfront costs for some new mobility services and lack of access for people without credit cards.

### *Upfront Costs*

Some micromobility programs have high upfront membership costs. Interviewees noted that many bikeshare programs offer a model with an annual membership and no per-trip costs (often up to a certain trip length). Under these models, the per-trip cost for users who use the system frequently is very low. However, for people with low incomes, affording the upfront cost of membership can be prohibitive, even for people who earn just above the federal poverty level because they still struggle to survive (ALICE 2020).

Interviewees highlighted programs like Capital Bikeshare for All in Washington, DC, which offers $5 annual memberships for people who qualify for state or federal assistance programs such as SNAP and WIC (Lyft 2020). In Pittsburgh, the bikeshare system, Healthy Ride, allows transit users to use their ConnectCard (transit smartcard) to access free unlimited 15-minute bikeshare trips (Healthy Ride Pittsburgh 2020). Interviewees also noted the Thrive Allen County program in Allen County, Kansas, which is free for all users, that allows people to check out bikes from locations such as public libraries (Bike Allen County 2020). One interviewee also suggested that a model similar to transit fare capping would be more accessible for people with low incomes. Under such a system, users would pay on a per-trip basis until they meet the annual membership cost, after which trips are free.

### *Access without Credit Cards*

Another challenge is accessing new mobility services without credit cards. Interviewees repeatedly emphasized the importance of maintaining options for users to pay for services without credit cards. Options discussed include payment kiosks, mail-in payment options, and third-party payment options, such as buying tickets or adding money to a pass at a grocery store, pharmacy, or other retail location. One interviewee also suggested coupling mobility services purchases with health care, thereby allowing users to pay for mobility services (in cash) at a healthcare clinic or hospital. Interviewees emphasized that cash payment options should be convenient and well publicized.

### *Access to and Comfort with Cellphones and Smartphones*

New mobility services, including ridesourcing, micromobility, and dynamic carpooling, rely primarily on smartphone apps that enable users to request services. Although this model makes the services particularly convenient for many users, it poses challenges for some others. Interviewees noted that older adults and people with low incomes may not have smartphones or even cellphones. Even when these users do have phone access, interviewees noted that the

challenges extend beyond access to a phone. In many rural areas and tribal communities, the lack of 4G wireless service poses problems when using smartphone apps. Urban communities can also feature wireless dead zones, hampering access to the internet. For people with low incomes, affording a data plan is often a challenge, which makes it difficult for individuals to rely on smartphone apps for on-demand transportation. One interviewee also pointed out that populations experiencing homelessness often do not have access to any phone, even a landline. Finally, for many individuals, including older adults, people with disabilities, and some recent immigrants, lack of comfort using smartphone apps poses a significant barrier.

Interviewees noted that for many app-based transportation services, alternative ways to request service exist. They noted, for example, that services like GoGo Grandparent allow users to request Uber and Lyft rides using a landline telephone (for a fee) (GoGo Grandparent 2018). Interviewees also suggested phone lines with human assistance to identify mobility options and help with booking and payment. They recommended that services enable third parties, including caregivers or healthcare providers, to book and pay for services. One interviewee highlighted SendaRide in Oklahoma City, Oklahoma, which allows healthcare providers to schedule rides for their patients (SendaRide 2020).

### *Accessible Vehicles and Apps*

For people with disabilities, lack of accessible apps and accessible vehicles poses barriers to using new mobility services such as ridesourcing and micromobility. Interviewees noted that mobility providers tend to update their apps frequently, and updates are not always accessible. They highlighted the need for accessibility standards for mobile apps. They also described the diversity of needs among people with disabilities. Not only are the needs of people with ambulatory disabilities distinct from those with vision, hearing, and cognitive disabilities, but there is significant variation within each category as well. For example, some people with cognitive disabilities can use standard apps with limited or no support, while others are unlikely to be able to use apps even with significant training and support.

This diversity also extends to accessible vehicle needs. Interviewees noted that a vast array of wheelchair designs require unique securement processes that can make it especially difficult to provide accessible ridesourcing vehicles. Oxygen cylinders, used by some individuals, require special securement for safe transportation. In the micromobility sphere, handcycles work well for some people with ambulatory disabilities, but not for all. One interviewee suggested tandem bicycles may be a good solution for increasing access to bikeshare. People with disabilities are not the only population with distinct vehicle needs. Interviewees pointed out that people (disproportionately women) traveling with small children require child seats, which are not available in most ridesourcing vehicles or on bikeshare bicycles.

Interviewees also emphasized that it is not just accessible vehicles that are critical for people with disabilities. They noted that many TNC drivers are not trained or do not have the strength to help people in wheelchairs enter or exit the vehicle and secure their wheelchairs.

Another challenge for many people with disabilities is locating and accessing vehicles, such as TNCs. In particular, it is important that pickup and drop-off locations are accessible, without obstacles or curb design challenges. In some cases, interviewees noted, micromobility services actually make things worse for people with vision or ambulatory disabilities because bikes and e-scooters left on sidewalks pose obstacles and obstruct clear paths. Geospatial technology is developing increasingly detailed maps of environments that can help locate accessible pickup

and drop-off locations and help people with disabilities navigate to vehicles. One example noted by interviewees is Tappy Guide, an app that provides navigation guides for people with visual, hearing, and mobility disabilities (Tappy Guide n.d.). For people with vision disabilities, auditory beacons may also help with vehicle location (note that this may not be effective in noisy, busy locations).

Finally, existing vehicles and services limit access for otherwise able-bodied users due to design and policy oversight. According to one interviewee, new mobility options should incorporate considerations for people traveling as a family (e.g., car seats) and vehicle design that is inclusive of diverse body types and user skills (e.g., e-scooters that fit shorter riders or bikeshare systems that include e-bikes and the ability to carry baggage or children).

### *Fundamental Barriers in Rural Settings*

Barriers related to accessing vehicles are often exacerbated in rural areas. Interviewees noted that lack of lighting and unpaved roads can make it extremely difficult to access TNC vehicles, particularly for older adults and people with disabilities. Interviewees also noted that some users fear being picked up by a stranger in a remote location. Unpaved roads, lack of bike lanes, and topography often make bikeshare and e-scooter use difficult. For some roads and weather conditions, even access by a motorized vehicle (e.g., TNC) without four-wheel drive is challenging. Finally, interviewees emphasized that lack of broadband and cellular service in rural locations makes it difficult for people in these areas to use app-based mobility services.

In addition to these access barriers, fundamental challenges are associated with providing services such as ridesourcing and micromobility in rural areas. Low population and job density translate to high per-user costs. In many rural areas, interviewees noted, TNCs have difficulty recruiting enough drivers and riders, and distances between destinations are often too far to make micromobility services usable. Interviewees suggested that in rural areas it is important to work with key institutions, including senior centers, downtowns/business improvement districts, and colleges, to build user and driver pools. Still, they noted challenges. For example, one driver being sick might significantly impact the availability of TNC service in a small town. In addition, in small markets, having enough wheelchair-accessible vehicles can be even more challenging than in more populous cities.

### *Safety Concerns*

Finally, interviewees noted that for some populations, new mobility services trigger safety concerns. Some people, in particular older adults, are concerned about riding with strangers in TNCs and app-based carpooling. Older adults and people with disabilities also have concerns about safely using bikes and e-scooters. One interviewee noted that additional undesirable exposure in public spaces related to some mobility options—bikeshare and e-scooters require increased time navigating streets and sidewalks—increases exposure to sexual harassment, real and perceived violence, unwarranted police attention, and other dangerous or uncomfortable interactions for women and people of color.

### *Documentation and Other Requirements*

Some services require specific documentation. For example, carsharing requires a driver's license and insurability. As such, carsharing will always be inaccessible to some population groups. Additionally, interviewees noted that some individuals, in particular people who are

undocumented immigrants, are unwilling to use services that require users to create an account and share their personally identifiable information.

## Broader Strategies for Improving Access

The interviewees identified several important strategies for addressing access gaps. First, they stressed the importance of information and training to increase awareness and accessibility of new mobility services. Second, they talked about how planning processes can do a better job of addressing gaps in access. Finally, they discussed financing challenges and techniques to fund adaptive solutions.

### *Information and Training*

Interviewees explained that the need for better information is twofold. First, some population groups are not aware of new mobility services and how to use them. Second, populations are often unaware of adaptive solutions. Population groups that include older adults, people who speak little or no English, people of color, and people with low incomes were identified as being particularly likely to lack information.

Interviewees suggested several techniques for better information sharing to inform all communities of available mobility services and adaptive solutions that improve access. Although one interviewee suggested the use of social media, others indicated that this type of marketing is unlikely to reach many populations. They suggested putting information in places where people are already going, such as grocery stores, libraries, healthcare clinics, and public transit stations. One interviewee suggested sending flyers in utility bills to highlight programs that might benefit underserved populations. Radio spots and newsletters were also recommended. One interviewee noted that branded vehicles can help spread awareness.

Hands-on and interactive information campaigns and training can also be important, interviewees emphasized. Not everyone learns well from text-format information. They suggested call-in support lines, buddy programs to help older adults and people with disabilities navigate new mobility options, and outreach from healthcare providers to patients regarding travel options. Interviewees also emphasized the importance of cultural awareness in education and outreach. For example, they noted that in some populations there exists a cultural stigma against bicycling that might limit bikeshare adoption. They recommended using a culturally competent trusted partner, such as an organization that already works with a particular population, to lead in-person outreach.

Finally, training needs are not limited to users. Organizations that work with people with disabilities highlighted the importance of training programs for TNC drivers on how to pick up and interact with passengers with disabilities.

### *Planning for Inclusion*

Fundamental transportation planning challenges impact inclusion. One interviewee, noting the fact that people with low incomes often face longer commutes, stressed the importance of working to better match affordable housing and job locations to reduce commute distances and travel times. This fundamental change can make it more feasible for people with low incomes to use micromobility and reduce the cost of TNCs for these individuals. In addition to these fundamental challenges, foundational planning techniques are critical to improving access to transformational technologies, including public input, data collection and monitoring, and

innovation. Planning and service design often focus on dominant understandings of user experiences and needs (e.g., the needs of cisgender White men) to the detriment of other users who are more vulnerable and less wealthy.

**Listen to Underserved Communities**

Interviewees highlighted the diverse needs of underserved populations and the variety of barriers they face in accessing new mobility services. They stressed the importance of listening to individuals from different communities and population groups. For example, one interviewee noted that talking to a wheelchair user will provide key insights into wheelchair accessibility but will not necessarily provide information on how to better serve individuals with vision disabilities. They suggested forming a task force to address access gaps. Other interviewees stressed the importance of having community discussions in underserved communities, such as neighborhoods with large low-income populations or that consist primarily of people of color. They also noted the importance of having public meetings that accommodate different work schedules.

**Data and Innovation**

The rapidly changing nature of transformational technologies and the significant role of the private sector pose some key planning challenges. Interviewees noted that public agencies making decisions about curb space and working to increase access by underserved populations often do not have access to data from private mobility providers such as TNCs. This factor can make it difficult for them to make informed decisions.

Interviewees also noted that, perhaps because of how fast technology changes, some public agencies are not aware of models that have been tested and implemented elsewhere, such as low-cost bikeshare memberships or landline-based TNC requests. Several interviewees noted that public agencies must be innovative in devising solutions that can fill access gaps. However, one interviewee cautioned against innovation for the sake of innovation and recommended focusing on addressing enduring barriers instead.

### *Addressing Silos*

In some cases, a barrier to good planning and innovation is organizational. People who focus on access for specific populations may be siloed into a specific department, and decisions about policies involving new technologies may be made in isolation. It is important for mobility and access goals to be addressed throughout planning and transportation organizations.

### *Financing Adaptive Solutions*

Many interviewees noted that a lack of funding hampered efforts to expand access to transformational technologies. Providing service to some populations is more expensive than others, meaning that profitability also varies. In many cases, public agencies shoulder the burden of increased costs to ensure service is provided to all.

Interviewees made several suggestions for financing strategies. For example, they cited California's TNC Access for All Act, which is being leveraged to redistribute money from inaccessible TNC trips to support less-profitable accessible trips. In a pilot program, Lyft and First Transit are significantly expanding the wheelchair-accessible TNC fleet in San Francisco and Los Angeles. Interviewees also described programs that use existing paratransit services as a

backstop when TNCs do not have accessible vehicles, which saves paratransit services money relative to providing all-accessible services.

The role of the private sector was discussed in several interviews. Interviewees noted that private-sector companies can take more responsibility in expanding access to new mobility services and discussed examples of employer or university sponsorship programs. Alternatively, partnerships with non-profits have also successfully expanded access. Several small and large bikeshare programs, from Allen County Thrive to Boston's BlueBikes, rely on sponsorship from health insurers, who see active transportation as complementary to their missions.

Interviewees noted that pilot programs can often demonstrate solutions at low cost. However, securing continued funding is sometimes a challenge.

### Benefits of Improving Access

Closing access gaps and ensuring that all populations can use new mobility services provide substantial benefits for all users. For underserved populations that do not have access to a personal vehicle or cannot drive, these services can be critical for accessing jobs and services, including non-emergency medical services. Expanding this access has significant economic implications. Interviewees also emphasized that individuals who cannot drive or do not have a car often face significant isolation, which greatly impacts mental health. However, access to new mobility services may relieve isolation and increase inclusion. Interviewees also discussed the role of ridesourcing as a potential alternative to or form of paratransit. They noted its potential to reduce wait times and save public agencies money.

For all underserved populations, access to new mobility services also provides more flexibility in travel. For example, ridesourcing can be used late at night when traditional transit is not running, and new mobility services also tend to cover broader areas than the zones served by traditional transit. These services also provide an alternative to a personal vehicle when parking is not convenient or is too expensive. Overall, interviewees reflected on the importance of promoting equity and ensuring access to all.

### Synthesis of Gaps

Based on the findings from the literature review (as described in Appendix A) and from the stakeholder interviews (as described so far in this appendix), the research team categorized access to technologies by different population groups (including those primarily targeted in this project). Researchers defined three categories of access:

- Major gap in access and no tested solution (existing/anticipated).
- Adaptations tested for expanding access.
- Minimal barriers for the group.

Table B-2 summarizes gaps and barriers for underserved populations.

**Table B-2. Synthesis of barriers and gaps by technology for underserved populations.**

| Population Group | Transformational Technologies | | | | |
|---|---|---|---|---|---|
| | Ridehailing Services | Bikesharing and E-Scooter Sharing Services | Carsharing Services | App-Based Carpooling Services | Automated Vehicle Services* |
| People with low incomes | ◉ | ◉ | ◉ | ○ | ● |
| People of color | ◉ | ◉ | ◉ | ◉ | ○ |
| People living on tribal reservations | ● | ● | ● | ● | ● |
| People with hearing disabilities | ○ | ○ | ○ | ○ | ◉ |
| People with vision disabilities | ◉ | ● | ● | ◉ | ◉ |
| People with ambulatory disabilities | ◉ | ● | ● | ◉ | ● |
| People with cognitive disabilities | ◉ | ● | ● | ◉ | ◉ |
| People aged 65 years or older | ◉ | ◉ | ◉ | ◉ | ◉ |
| People who speak little or no English | ○ | ◉ | ◉ | ◉ | ○ |
| People who are undocumented immigrants | ○ | ◉ | ● | ◉ | ○ |
| People living in rural areas | ◉ | ● | ● | ◉ | ● |

* Refers to highly automated vehicles or self-driving vehicles.
Legend:
● Major gap in access and no tested solution (existing/anticipated).
◉ Adaptations tested for expanding access.
○ Minimal barriers for the group.

## STAKEHOLDER INTERVIEW FINDINGS ON SAV DEPLOYMENTS

As part of NCHRP Project 20-102(30), the research team conducted 31 interviews with representatives of agencies or organizations that had deployed SAVs in the last five years, were currently deploying SAVs, or planned to deploy SAVs in the future. These deployments include formal deployments, pilot events, research testing, and demonstrations, but all are referred to as "deployments."

The individuals who were sought out for interviews included leaders from transportation agencies/authorities, government agencies, universities, non-profits, and technology providers. The interviews featured discussions of 24 distinct deployment events or future launches that the participants were involved in or associated with, with deployment dates ranging from 2017 to 2024. Table B-3 provides a comparative overview of some of the deployment events, including key metrics for each event.

The overarching questions that the case study interviews hoped to answer included the following:

- How are/will identified population groups facing/face limitations in access from the current and future use of SAV mobility services?
- What barriers exist to exclude or deter these population groups?
- What can be done to reduce these barriers and encourage participation?

The interviews focused on on-demand and demand response trips and included discussions of shared autonomous passenger vehicles as well as shared autonomous microtransit vehicles. Participants were encouraged to consider SAV services throughout each stage of the trip, including but not limited to, trip planning and navigation, fare payment, pickup/drop-off locations, boarding/alighting from vehicles, passenger validation, and the in-vehicle travel experience.

The section begins by (a) situating this research in context due to the emerging nature of SAVs, and (b) discussing geographic considerations, goals for equitable SAV deployment, and methods of measuring equity in the design, development, and deployment of SAVs. It then discusses the results of the interviews—segmented by theme or key takeaway—in detail. The section closes with a discussion on the impact of equitable policies on transportation systems and the next steps, based on the interviews, for equitable SAV deployment.

**Table B-3. Past, current, and future sav deployment events discussed in case study interviews.**

| Name of Deployment | Location | Dates of Deployment | Geography | Vehicle/Fleet Type | Type of Service |
|---|---|---|---|---|---|
| **AAA Free Self-Driving Shuttle** | Las Vegas, NV | 2017–2018 | Urban | Microtransit | Fixed route and on-demand |
| **i-CAVE** | Delft, Netherlands | 2017–Current | Urban | Microtransit | Fixed route |
| **Milo** | Arlington, TX | 2017–2018 | Suburban | Microtransit | Fixed route |
| **Frisco Drive.ai** | Frisco, TX | 2018–2019 | Urban | Passenger | Fixed route and on-demand |
| **University of Buffalo AV** | Buffalo, NY | 2018–Current | Suburban/Urban | Microtransit | Fixed route |
| **Smart Circuit** | Columbus, OH | 2018–2019 | Urban | Microtransit | Fixed route |
| **Brooklyn Navy Yard AV** | Brooklyn, NY | 2019–2022 | Urban | Microtransit | Fixed route |
| **Move Nona** | Lake Nona, FL | 2019–Current | Suburban | Microtransit | Fixed route |
| **The Accessible Autonomous Vehicle (AAV)** | Santa Clara County, CA | 2019–2022 | Urban | Microtransit | Fixed route |
| **Texas Southern University's (TSU's) AV** | Houston, TX | 2019 (Phase 1), 2022 (Phase 2) | Urban | Microtransit | Fixed route |
| **Hillsborough Area Regional Transit (HART) Smart Mobility Alongside Regional Transit (SMART) AV Shuttle** | Tampa Bay, FL | 2020–2022 | Urban | Microtransit | Fixed route |
| **Robo Ride & Medical Robo Ride** | Peoria, AZ | 2020–2022 | Urban | Microtransit | Fixed route |
| **Ultimate Urban Circulator (U2C) Project** | Jacksonville, FL | 2020–Current | Urban | Microtransit | Fixed route |
| **Autonomous Vehicle Advantage (AVA) Service** | Pinellas County, FL | 2020 | Urban | Microtransit | Fixed route |
| **Linden LEAP (Linden Empowers All People)** | Columbus, OH | 2020–2021 | Urban | Microtransit | Fixed route |
| **Automated Driving System (ADS) for Rural America** | Iowa City, IA | 2020–Current | Rural | Passenger | Fixed route |

| Name of Deployment | Location | Dates of Deployment | Geography | Vehicle/Fleet Type | Type of Service |
|---|---|---|---|---|---|
| **The Electric Driverless Demonstration in Yellowstone (TEDDY)** | Yellowstone National Park, WY | 2021 | Rural | Microtransit | Fixed route |
| **Autonomous Vehicles Colorado (AvCO)** | Golden, CO | 2021–Current | Suburban | Microtransit | Fixed route and on-demand |
| **RAPID** | Arlington, TX | 2021–Current | Suburban | Passenger | On-demand |
| **Enhancing Life through Automated Transportation for Everyone (ELATE)** | Youngstown, OH, & Santa Clara, CA | Expected launch 2023 | Urban | Microtransit | Fixed route |
| **ITS4US Deployment** | University of Buffalo, NY | Expected launch 2023 | Suburban/Urban | Microtransit | Fixed route and on-demand |
| **Automated Microtransit (AMT) EcoPRT** | Raleigh, NC | Expected launch 2023 | Suburban | Microtransit | Fixed route and on-demand |
| **Trenton Mobility and Opportunity: Vehicles Equity System (MOVES)** | Trenton, NJ | Expected launch 2024 | Urban | Passenger | On-demand |

## Research Context

To situate this research in context, it is important to note that the general availability of SAE Level 4/5 vehicles has not yet occurred (as of 2022). A central theme of this portion of the project was to address the issues when this leap in technology does occur. In this case, a driver/attendant is not required for the safe operation of the vehicle. The question whether or not an attendant is provided is primarily driven by the needs of passengers with disabilities and also to address improved comfort levels of passengers. With today's technology, it is safe to assume an attendant is required for safe operation with passengers with disabilities or those that need assistance (tie-downs, device storage, older adults, small children, etc.), and many states may require an in-vehicle attendant for SAV services and deployments. Changes in technology (including the SAE Level 4/5 vehicles' operation) may change this presumption and these regulations.

### *Geographic Considerations and Shared Challenges*

SAV deployments face geography-specific considerations depending on whether the SAV is deployed in an urban, suburban, or rural area. Following are the key geographical considerations noted by the interviewees:

- In urban areas: SAVs are often deployed in heavily trafficked downtown areas, business centers, or city campuses. Deployers need to consider the speed capabilities of the vehicle, road characteristics, anticipated traffic patterns and congestion, pedestrian encounters, and on-street parking.
- In suburban areas: SAVs are typically deployed on college campuses, in residential neighborhoods, and in lower-density downtown areas. Deployers must consider vehicle range constraints (i.e., how far the vehicle can travel) as well as speed constraints. Suburban autonomous vehicles are designed to provide first- and last-mile service in neighborhoods and are not intended to travel long distances or travel on highways at top speeds.
- In rural areas: SAVs are tested on unpredictable, rougher roads during all four seasons. Deployers need to anticipate a variety of potential on-road vehicles (e.g., farm equipment, school buses, horse and buggy). Deployment teams also must consider the feasibility of the rural service area size in relation to the vehicle's range capacity and need to anticipate the high speeds of other on-road vehicles and design the vehicle to safely reach these higher speeds.

Despite geographic-based differences in deployment considerations, SAV deployments in geographies of all types often were indicated to experience the following challenges:

- Physical operation challenges: SAV deployers first need to figure out where vehicles can and should operate and how the vehicles will follow the designated mapped route. Deployers then need to consider all possible scenarios that the vehicle can encounter along the mapped route, which is referred to as the vehicle's operational design domain (ODD) (Berman 2019). This process includes considering how the vehicle will recognize traffic signals/signs, how the vehicle will react when encountering other vehicles, what the vehicle will do at crosswalks, and how the vehicle will react in the event of unplanned circumstances (e.g., a pedestrian jaywalking) or unpredicted road changes (e.g., road surface change at a construction site). Deployers additionally need to consider the

reliability of the SAV technology during diverse types of weather events, including intense heat, rain, and snow.

- Regulatory challenges: During the case study interviews, several SAV deployers cited the difficulty of acquiring a governmental permit to operate on public roads. Since automated vehicle operating regulations are state-specific, it is easier to obtain a permit in some states than in others. As of 2021, 10 states have no laws or regulations pertaining to automated vehicles (AVs), whereas the other 40 states have legalized deployment on public roads (National Conference of State Legislatures 2021). As a result, some technology providers based in states without regulations establish partnerships in states with existing regulations to deploy more easily.
- Anticipated safety challenges: SAV deployments require detailed contingency plans and safety management plans, often in collaboration with local police, firefighters, and city government, to anticipate potential emergency situations. These plans include a variety of protocols, such as:
    - Providing controls for the steward[1] on board to take over in an emergency, as well as including an in-vehicle or in-app emergency call button to call a remote operator or safety representative who can take over remotely and communicate directly with passengers.
    - Providing an emergency stop button accessible to riders and a hatch or emergency exit that opens when the emergency stop button is pressed; considering a ramp that can be manually deployed if an electric ramp or lift cannot be deployed; and, if a wheelchair is locked down electronically, allowing the lock to release in the event of a power failure.
    - Sending a link to riders' close contacts and/or caregivers for GPS tracking and sending an alert to contacts if the vehicle goes off route.
    - Providing guidance for passengers in written and auditory formats in-app and in-vehicle on what to do in an emergency to minimize safety concerns.
    - Facilitating ADA training for stewards to safely conduct wheelchair tie-downs, assist passengers with disabilities in boarding and exiting the vehicle, respond to rider questions and concerns, shift the vehicle into manual control for boarding/onboarding, and stop the vehicle safely in emergency situations.

### *Goals for Equitable SAV Deployment*

In addition to testing an SAV's capabilities and determining vehicle limitations (e.g., ODD limitations), deployers cited the following common goals of deployment to improve the equitability of SAV services:

- Integrating community input: Deployers stressed the importance of emphasizing stakeholder and community engagement in the planning, design, and development of the deployment. It is imperative to include both stakeholders and community groups in determining the safest and most effective routes for deployment.
- Focusing deployment efforts on disadvantaged communities: Many deployers target disadvantaged community groups for deployment recruitment, including low-income

[1] Throughout this appendix, the term *steward* refers to an onboard attendant who, depending on the capabilities of the vehicle and the needs of the riders, provides customer service, boarding, and alighting assistance, and can take control of the vehicle in an emergency situation.

populations, populations with disabilities (most commonly visual and mobility disabilities, but also auditory disabilities), and older adults. Additional recruitment techniques include the following:
    - In rural areas, including smaller, underserved communities that lack the physical infrastructure to support transit in deployment events and opportunities.
    - In retirement communities, focusing efforts on older adults to show the benefits of SAVs in enabling safe mobility and transferring rides away from cars/golf carts to decrease crash rates.
    - In transit deserts (areas without transit access), including populations without access to a car in deployment efforts to connect transportation-disadvantaged populations from neighborhoods to transit stations, business centers, and universities.
    - In areas where target communities do not exist, targeting people from the disadvantaged population groups in neighboring or nearby areas to collect data on these communities for future studies.
- Exposing disadvantaged communities to SAV technology: Targeting disadvantaged community members as SAV deployment participants can help increase education and awareness of SAVs and improve acceptance of SAVs as a mode of transportation. In addition to deployments, many deployers hold public demonstrations in disadvantaged communities to let people ride and test the AVs for free, as well as ask questions of deployment operators. Particularly for populations who are distrustful of technology, exposure, and education can aid in increasing trust in SAVs.
- Providing access to new transportation opportunities: By bridging gaps in or providing extensions of existing transportation networks (i.e., first- and last-mile connectivity), deployments in underserved areas aim to provide access to new transportation opportunities for disadvantaged populations. Many deployments feature circular routes connecting disadvantaged communities to essential services and destinations (e.g., business centers, grocery stores, schools, hospitals). For areas lacking fixed-route transit, several deployments use microtransit as an extension of a fixed-route bus to expand the existing transit system.

### *Methods of Measuring Equity*

SAV deployers use a variety of methods, tools, and technologies to measure and document the equity impacts of the service provided. One method includes tracking and monitoring the rider experience—including comfort, safety, and ease of use—by surveying riders before, during, and after SAV trips. Riders are surveyed using tablets, and deployers can evaluate how well vehicle accessibility features work and learn more about the interaction of the vehicle with the passenger. Deployers also monitor the automated dwell time spent serving passengers with disabilities and examine the differences in time spent boarding and alighting from curb spaces in different contexts (e.g., hospital campuses, urban districts, bus stops, and transit centers) to collect data for future deployments.

During the case study interviews, one deployment operation was in the process of developing a more equitable trip-matching algorithm that diverted AVs from high-density, wealthier areas to disadvantaged areas using artificial intelligence (AI) and tracked how the vehicle responded in testing scenarios. Although it was not discussed by deployers, future operators can additionally track the frequency of alternative trip booking/payment use (e.g., kiosk, phone service line, and

prepaid card use per SAV stop), and can allocate more funds or services to these geographic areas in response.

To continue to improve equitable outcomes for SAV services for transportation-disadvantaged communities, more tracking, surveying, and testing should be undertaken, and the results should inform future vehicle design and deployment.

## Equity Considerations

Throughout the interviews with deployers, common themes, and observations arose regarding deployment equity considerations, solutions, and adaptations for improving equity and regarding community engagement and communication methods. There were also shared lessons learned for considerations that required additional effort, research, and development for effective implementation, as well as common discussion points about shortcomings of potential solutions. Four overarching equity-based takeaways are outlined in the following sections.

### *Equity Considerations That Worked*

- Trip-planning considerations:
  - Setting up kiosks at key stops and providing a phone service line to book rides from stops or home so that people without smartphones or people who are distrustful of technology can request service.
  - Linking prepaid cards to riders' accounts to pay for rides if passengers are underbanked, unbanked, or low-income. For underbanked or unbanked populations, in-app money transfer services such as Venmo, Zelle, or Cash App that do not require a traditional bank account can be used, or free services can be provided for riders with low incomes.
  - Providing accessible trip-planning apps for older adults, riders with visual disabilities (e.g., larger text and audible instructions/directions), and riders with cognitive disabilities (e.g., simplified written and audible instructions/directions) to manage trip-planning interactions and offering mobility assistance apps for older adults, riders with ambulatory disabilities, and riders with visual disabilities to assist in navigating streetscapes to access SAVs at pickup stops.
- Boarding and alighting considerations:
  - Installing detectable warning surfaces and level curbs at designated drop-off spots in urban areas so ramps can operate and be accessed easily by riders with ambulatory disabilities, riders with visual disabilities, and older adults.
  - Providing training for stewards in assisting populations with ambulatory disabilities and older adults in boarding, wheelchair tie-downs, and exiting. Providing vehicle familiarization by qualified certified orientation and mobility specialists to riders with visual disabilities.
  - Utilizing ADA-compliant vehicles for older adults and riders with ambulatory disabilities.
  - Providing a button on the side of the SAV or a pin pad to enter a security code sent through the app to open the vehicle door and release the ramp or lift, if applicable, for riders distrustful of technology and riders concerned about privacy and safety. Ensure that the app provides audible directions on where the button is located.
  - Featuring panel screens on the sides of the vehicle exteriors that alert people to what the car will do (e.g., "waiting for you to cross," "stopping for pickup") for riders

distrustful of technology and riders concerned about safety. Creating audible messages for signs for riders with visual disabilities.

- In-vehicle considerations:
  - Including visual and auditory announcements, instructions, and communication capabilities via monitors and headphones for older adults, riders with auditory disabilities, and riders with visual disabilities as required under U.S. Department of Transportation (U.S. DOT) ADA regulations. Providing braille guides describing SAV instructions for riders with visual disabilities. Providing high-contrast guides describing SAV instructions for rides with visual disabilities as well.
  - Including in-vehicle signs and instructions about safety for riders with auditory disabilities and providing in-vehicle display systems to show directions or travel routes for older adults and riders with auditory disabilities. Signs should be high contrast and use an appropriate font (e.g., sans serif font such as Arial) to maximize accessibility.
  - Implementing universally designed vehicles with front-facing vehicle seating arrangements, which enables wheelchair users to sit next to or face non-wheelchair users.
  - Using tablets for surveying riders about their trip experience and the vehicle features pre-, during, and post-trip, with accessible features for older adults and riders with visual disabilities.
  - Making announcements through the in-vehicle and/or in-app interface when a stop is coming, when the vehicle arrives, if there is a detour, or if there is an emergency. These announcements and alerts should be made in multiple, geographically common languages, and real-time translation services (in-app or in-vehicle) should be available in less common languages for people who speak little or no English.
  - Providing an in-vehicle and/or in-app button that riders can press during an emergency that will connect them to the operating center. Providing orientation and familiarization to individuals with visual disabilities by credentialed certified orientation and mobility specialists.

### *Equity Considerations That Require Additional Work*

- Financial challenges:
  - ADA-compliant/accessible vehicles and ramps/lifts can be expensive. Some of the deployments did not use ADA-compliant/accessible vehicles because of the high cost.[2]
  - A need exists to figure out affordable insurance policies for SAVs and how to price SAV services affordably and equitably.
  - Additional efforts are needed to conceive a sustainable business model for the cost of SAVs in rural areas.

[2] Per U.S. DOT ADA regulations, for a vehicle to be used in fixed-route service public transportation in the United States, the vehicles must be ADA accessible. However, the application of ADA to SAVs providing on-demand service in passenger cars is not clear. Some vehicles deployed or discussed during interviews were not accessible or compliant with ADA standards.

- Operational challenges:
  - Wheelchair tie-downs can be difficult to learn for some due to differences in wheelchair types and the strength, mobility, and knowledge required to perform tie-downs.
  - Some deployments noted that stewards are not always trained properly in aiding populations with disabilities.
  - A large diversity in rural area roadway types and conditions exists, including poor lane markings and changes in paved to unpaved surfaces, along with limited digital infrastructure. Additionally, more work needs to be done to address the diversity of pickup/drop-off locations in rural areas and the accessibility of these locations.
- Demographic-specific challenges:
  - The majority of deployments featured in the case study interviews did not specifically include equity considerations for riders with cognitive disabilities and riders who speak little or no English. To improve SAV equitability for these population groups, deployers should focus on including these riders in their recruitment efforts whenever possible.
  - For individuals who are wheelchair users, there needs to be a way to know if there is space for the wheelchair as well as other travel companions before boarding the vehicle.
  - Questions remain about the communication of vehicle wait times, shelter at stops, and safe places for people to rest while waiting for a ride, particularly for populations with disabilities and older populations.
- Policy challenges:
  - Lack of coordination exists between federal/state/city transportation agencies regarding SAV regulations and deployments.
  - There is a lack of SAV regulations permitting SAVs to operate in certain states.
  - Issues and concerns exist related to cybersecurity and data security in the absence of SAV-specific data regulations.

### *Solutions or Adaptations to Improve Equity Outcomes*

- Integrating research into vehicle design:
  - Deployers can work with SAV original equipment manufacturers (OEMs) and other manufacturers to integrate SAV research on disadvantaged populations (particularly populations with disabilities and older adults) into the design cycle—thus attaining more of an information-sharing solution (e.g., exposing OEMs/manufacturers to potential designs that are informed by research efforts working with populations with disabilities).
- Integrating community feedback into future deployments:
  - For projects with multiple phases or iterations, deployers can request feedback in early deployment rounds from transportation-disadvantaged populations. Deployers can then work on incorporating this feedback into later iterations (e.g., older adults want to see more community exposure to SAVs, so future iterations include community SAV testing days in retirement communities).
  - Deployers can use community outreach to find out which design features will benefit the community the most and can work on addressing accessibility concerns for visual, auditory, and ambulatory disabilities throughout the design and development process.

- Improving trust in SAV technology through outreach:
  - Through community outreach efforts, deployers can provide opportunities for transportation-disadvantaged populations who are skeptical of SAV technology to ask questions about boarding and exiting, the safety of pickup and drop-off spots, the booking process, and the riding experience itself.
- Determining demographic-appropriate service provision:
  - Deployers can determine what type of service is best for disadvantaged populations represented in the service area and allocate funds and prioritize service for these groups.
  - For low-income communities or communities with high concentrations of populations with disabilities, the implementation of a circular shuttle route can provide affordable travel access to key destinations, increase community mobility, and improve travel safety.
  - To reduce the cost of service in rural areas, small town clusters can consider investing in one or two shared AVs to connect community members to essential services (grocery stores, medical facilities, etc.).
- Creating policies that enable more equitable service provision:
  - Although cities lack jurisdiction over what vehicles are allowed on the road (which is controlled by the state), cities can control road-based infrastructure decisions. Therefore, cities have the power to create policies to improve transportation access to transportation-disadvantaged communities.

### *Shortcomings of Solutions*

- Design challenges:
  - Vehicles designed using principles of universal design aim to meet the needs of everyone. However, in some cases, there is no one-size-fits-all solution for all riders because one accessible design feature for one group may unintentionally hinder or detract from usability for another group. As such, vehicle OEMs must be deliberate and thoughtful about how to best design a vehicle to fit the needs of diverse riders.
  - Many alternative transportation services do not provide accessibility features specifically for individuals with cognitive disabilities, so this segment of vulnerable road users should be included in pilots and deployments to collect design-based feedback on accessible and comfortable designs.
  - SAVs currently lack standardized designs for family travel (i.e., car seats, child-friendly seat belts, stroller storage space) and lack specifications about liability limitations (since some services will not transport children due to liability limitations).
- Service provision challenges:
  - In rural areas, service density is required to support the cost of providing service. In the future, removing the cost of fuel and the cost of the driver (in a fully driverless scenario) will reduce cost, but passenger volume is necessary to support a sustainable service model.
- Privacy challenges:
  - In shared vehicles, individuals with unperceivable disabilities may not want their disability to be shared with others in the vehicle by an AI-based automated system.

Additional privacy measures must be integrated into automated systems to preserve the knowledge of riders' specific abilities.
    - Although a steward may be trained in aiding people with disabilities or older adults in boarding, exiting, and wheelchair tie-downs, stewards should ask if a rider wants assistance before assuming the person needs help to be respectful of a rider's needs and to preserve rider agency.

## Community Engagement and Communication

In addition to equity-based considerations, the interviews featured common themes and takeaways regarding best practices for community engagement and communication methods for improving SAV equitability. This information included methods of integrating stakeholder and community input and communicating the need for and benefit of expanding SAV access to transportation-disadvantaged population groups. These takeaways are outlined in the following sections.

### *Methods of Integrating Stakeholder and Community Input*

- Involving key stakeholders and community members in the planning, design, prioritization, and deployment processes:
    - Deployers can hold town hall meetings and take questions from the public about the SAV deployment as well as host community testing days for members of the community (particularly disadvantaged community groups) to sit in, ride around, and ask questions about the vehicle to increase trust and acceptance.
    - Deployers can conduct community-based surveys before, during, and after deployment to gain feedback about the efficacy of the deployment, accessibility features, and interest in SAVs as a future service for community members exposed to the service.
    - For projects involving external partnerships, deployers can include partners by asking questions and requesting input from the university, local transportation, or vehicle manufacturing partners. Continuing to meet with external partners to continue support and buy-in is crucial, and in exchange, partners can help facilitate public meetings, disperse public notices to receive feedback on the technology, and engage with the community to create a desirable service outcome.
- Launching robust marketing and education campaigns:
    - Deployers, as well as some vehicle manufacturers, can consider launching community campaigns that disperse educational information about SAVs to community members via city websites, social media, email, flyers, postcards, and radio announcements. Such actions can aid in spreading awareness of the deployment, educating people on SAVs, and increasing exposure to the SAV deployment. On-campus deployers can additionally offer free rides to increase exposure and decrease stigma.
- Initiating targeted community engagement efforts:
    - For the design and planning process, deployers can consider inviting populations with disabilities and transportation advocates to the table to ask what they would like to see in the SAV design. This process can include site visits and work meetings, and the feedback can be integrated into the design of the vehicle.
    - For people concerned about the unknowns of SAV technology, deployers can hold information sessions to explain that the service is similar to public transit (i.e., fixed

route, operates on a schedule) or TNCs (i.e., on-demand, order ride through a phone-based app) and assure community members that the service is safe for all riders.
    - Some deployers can consider focusing community engagement efforts on people who have already experienced riding an SAV and can collect feedback to use in later deployments and engagement efforts.

### *Methods of Communicating the Benefit/Need of Expanding Access*

- Transportation benefit argument:
    - SAVs have the potential to provide convenient, affordable, and reliable transportation options, particularly in transportation deserts and for transit-dependent populations and disadvantaged populations. For people who work during off-peak hours and people who are unable or choose not to drive, SAVs can provide a safe and dependable transportation option. Policymakers, planners, and transportation professionals can advocate for SAVs in disadvantaged communities due to the technology's ability to bridge gaps in access and provide dynamic transportation options where none previously existed.
    - The United States has an aging population that will require accessible transportation options that enable mobility to essential destinations that SAVs can provide. For older adults, SAVs can help enable connections to family, friends, and other community members, which can create social as well as health benefits. Additionally, using AVs to transport home health personnel so older adults do not need to leave their homes to go to the hospital will produce significant health benefits.
    - For populations with disabilities, SAVs can provide more accessible and flexible transportation options as well as increase mobility opportunities.
- Economic benefit argument:
    - The first- and last-mile services that SAVs provide can support connectivity, improve job access, and create economic opportunities for transportation-disadvantaged populations.
    - Spontaneous travel in SAVs that is efficient and affordable has positive impacts on the local economy, whereas restrictions on transportation are associated with negative quality of life and higher healthcare costs.
- Funding and implementation benefit argument:
    - SAVs have begun to be incorporated into statewide transportation plans, safety plans, and greenhouse gas emission reduction plans in the last few years. By including SAVs in these plans, federal funds can be allocated to supplement deployment funding and support the development of equitable deployments.
    - If AVs are cost-prohibitive on a large scale, cities can consider implementing AVs on a smaller scale to support demand-responsive services to provide improved accessible transportation options for riders with disabilities.

## Impact of Equitable Policies on Transportation Systems

Currently, and in the future, SAV policies can shape existing transportation systems for better or for worse. For example, in urban areas, transit agencies are often economically restrained and may not have the capital for SAV fleet development, which requires significant funding. At the local and state level, policies that allow private-sector involvement (or at least public-private partnerships) may address these funding needs. Additionally, SAV OEMs and manufacturers

work at a different pace and with different systems and resources than academia and transportation advocacy organizations. As such, there is often a mismatch in trying to integrate inclusive design principles into quickly evolving technology. With privatization or working with private companies, there is a concern that equitability may not be prioritized as highly as profits, so SAV regulations and policies will need to be enacted to ensure equitable outcomes.

It is evident that the COVID-19 pandemic has resulted in local, state, and national transportation funding constraints, and transit systems are still in recovery as a result. If a policy is enacted that enables SAV services (as well as public transit services) to be more convenient for riders (e.g., reliable and accessible service, operation in locations that lack existing transit service), and if economic incentives for riders are provided, a myriad of positive effects can occur on the transportation system. These effects might include disincentivizing driving private vehicles, helping transit systems recover, reducing congestion and traffic, shortening commute times, and increasing economic productivity.

States with forward-thinking SAV policies should consider planning for the integration of SAV fleets and transit fleets and discourage planning for private AVs to avoid adding cars, traffic, and congestion to the road and to keep SAV services affordable. Furthermore, these states should consider guiding the development of SAV infrastructure, including identifying key communities and key routes, working on improving 5G availability, and expanding broadband in low-density areas to expand the ODD and ensure equitable outcomes for disadvantaged communities. Equitable SAV policies and regulations have the potential to help develop reliable, affordable, and convenient service that enables transportation opportunities for transportation-disadvantaged populations and encourages these riders to choose SAV services.

### Next Steps for Equitable SAV Deployment

In general, the deployment events considered accessibility and equitability for transportation-disadvantaged populations (within funding and resource constraints) during the planning, design, and deployment processes. In considering the inevitable progression of SAV technology within the next 5 to 10 years, deployers are hopeful that the service will continue to become more equitable for disadvantaged population groups and can close existing service gaps for populations lacking transportation access. Deployers cited the following current and future action items that can help transportation agencies, technology providers, and policymakers continue to improve SAV equitability:

- Economic action items:
  - Expand and subsidize public transit and SAV deployments in disadvantaged communities to provide more convenient and affordable travel options to improve transportation accessibility.
  - Increase federal and state grant funding opportunities for SAV development and deployment in areas with high concentrations of disadvantaged populations, transit-dependent populations, and/or areas in which there are gaps in existing transportation networks to improve SAV accessibility and increase SAV exposure.
  - Work to implement multiple, long-term funding sources to sustain SAV services and encourage the development of public-private partnerships to promote stakeholder alignment and enable lower-cost travel options for disadvantaged populations.

- Engagement action items:
  - Engage communities early and often and include community members in the decision-making process to build the public's trust and acceptance of SAVs.
  - Hold more community deployment events to make it easy for people to participate, increase comfort with SAVs, and demystify SAVs.
  - Promote the alignment of common goals across the SAV planning process for stakeholders, including communities, elected officials, local and state transportation departments, and SAV manufacturers and operators.
  - Increase tools and data collection for SAVs to learn more information about passenger travel patterns and gather feedback on the travel experience, while also preserving rider privacy.
- Education and communication action items:
  - Provide education about what SAVs are, what they are used for, and what types of beneficial services they provide, with clear communication across stakeholder and community groups.
  - Maintain honesty and transparency in education and communication efforts, particularly for populations who are distrustful of technology.
  - Provide ample opportunities for community members to ask questions of stewards and operational assistants at deployment events.
  - Address safety concerns and perceived feelings of unsafety early to decrease stigma and improve acceptance and trust in SAV technology.

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# APPENDIX C

# UNDERSERVED POPULATION FOCUS GROUPS

Appendix C presents findings from the virtual focus groups conducted with historically underserved populations. The appendix is organized into sections as follows:

- Focus Group Findings on New Mobility Options: As part of the TCRP Project B-47, the research team conducted virtual focus groups with underserved communities before conducting the online survey (see Appendix D for the online survey). The focus group discussions focused on travel during COVID-19 and the awareness and use of ridehailing, app-based carpooling, carsharing, and bikesharing and e-scooter sharing services.
- Focus Group Findings on Shared Automated Vehicles (SAVs): As part of the NCHRP Project 20-102(30), the research team conducted additional virtual focus groups with underserved communities after conducting the online survey. These focus groups were conducted to discuss SAVs and learn more about how participants perceived such services.

## FOCUS GROUP FINDINGS ON NEW MOBILITY OPTIONS

As part of the TCRP Project B-47, in October and November of 2020, the research team conducted eight virtual focus groups. The main purpose of the focus groups was to elicit information to aid in finalizing the online survey questions. However, the focus groups provided keen insights into the travel behaviors and preferences of underserved populations. The discussion also touched on awareness of, attitudes toward, and potential use of self-driving vehicles. All services were described to participants before asking them questions.

Focus groups were held with the following population groups:

- Older adults.
- People with low incomes.
- People residing in rural areas.
- People who spoke little to no English (in particular, Spanish speaking).
- People with disabilities, specifically grouped by individuals with these conditions:
  - Visual disabilities.
  - Ambulatory disabilities.
  - Hearing disabilities.
  - Cognitive disabilities.

Groups were held via Zoom, and each one had between four and six participants. Persons in Groups 1–4 in the previous list were recruited by Plaza Research in Houston, Texas. Persons in Groups 5–8 were recruited via online advocacy networks. All focus group participants were paid an incentive of $125. Viewpoint Streaming was hired to provide technical assistance to all participants in the use of Zoom technology to ensure that all could participate fully in the focus groups. Two paid American Sign Language (ASL) interpreters were enlisted for the group with hearing disabilities, and closed captioning through the Zoom application was also used. Primavera Strategies, a specialized Hispanic research firm, was hired to administer the focus group for the participants who spoke little to no English (Spanish speaking).

## Older Adults

The research team conducted one focus group for six participants aged 70+[1] that consisted of four females and two males. Most were retired; one held a full-time ministry position. Most also lived in the suburbs of Houston; two lived in a more urban area. Ages ranged from 70 to 76. They all mostly drove their own cars but sometimes used public transit for certain trips, like traveling to the medical center or downtown. One woman said she would use public transit more if there were fewer transfers. Two people had used Uber/Lyft for occasional travel, such as going to the airport. The reasons this group primarily relied on their own vehicles were the following: convenience, low cost of gas, and the freedom a personal vehicle affords. One individual used a bulky oxygen tank, so driving his personal vehicle was easier.

### *COVID-19*

Participants had different perspectives on the impact of COVID-19 on their travel. A couple of them talked about canceled leisure travel (e.g., cruise), but most said there was little impact because they usually drive their own cars. One participant said she does not go out as much as she used to—which used to be every day.

### *Ridehailing*

All six participants had heard of Uber/Lyft; five of them had used one or the other, albeit infrequently. The ones who have used it mentioned that they like talking with the drivers, whom they found to be friendly. The perception was that these services were less useful for persons with limited mobility. People like to feel comfortable when they are riding somewhere, and sometimes ridehailing makes them feel crammed in. A couple of women did not feel comfortable riding in a car with a stranger. Members of this group also believed that drivers were reluctant to do short trips because they receive less money.

Those participants who had used such services liked knowing the cost before the trip. One person first let her kids help her with the Uber app and has since used it by herself. Most individuals in this group did not seem to have problems using the technology and had the necessary phones to use the services. They seemed proud to have the app and know how to use it.

Only one person—who did not have an iPhone—said putting all of the necessary information in an app would be difficult. In addition, she thought that might be a barrier for quite a few older adults. She wanted to use a regular telephone to call the service.

Most participants thought Uber/Lyft was a good option but qualified that response by saying they would rarely need to use it since they have their own vehicles. However, when they cannot drive (now or in the future) it is better than a cab because the cost is known in advance, and clients can see and write reviews of Uber drivers; moreover, cabs seem a little old-fashioned. Additionally, in comparison to a bus, an Uber/Lyft is more convenient.

### *App-Based Carpooling*

Of the six respondents, three individuals had carpooled in the past—two for work and one for leisure. Their carpool experiences, which occurred many years previously, preceded today's use of apps for the procedure. That feature was off-putting to them. They described knowing the

[1] Note that, for this data collection effort, the research team intentionally sought perspectives from individuals aged 70 and above to gather specific insights on this age group. However, the playbook is based on all insights obtained from the study, generally adhering to the standard definition of 65+ for the older population group.

persons in their carpools very well and being comfortable traveling with them. One man indicated that carpools work best with repetitive trips, so it would be worth the hassle of coordinating the travel. Although he does not currently carpool, if he did, he would use the app and be open to being matched up with someone. He was definitely in the minority, though; although they may share rides with friends now and then, most of the group did not like the idea of being matched up with someone whom they did not know. One respondent said, "I don't need to look at an app to find people to ride with." Additionally, carpooling was not needed since most do not now make repetitive trips.

### *Carsharing*

A zero awareness existed of carsharing. One or two individuals thought it would be good if, for instance, one's vehicle was in the shop and one could carshare for 2 to 3 hours to go to an appointment or the like. However, in general, the thought of short-term rental of someone else's vehicle or a shared fleet vehicle for a few hours was off-putting. One respondent commented, "I don't know who sneezed in the vehicle." There also was a reluctance to be responsible for a vehicle that was not one's own (whether a Zipcar or a Turo). All participants thought it was a poor choice for older adults. They did not like the Turo model even though it was cheaper than the Zipcar. The idea of paying to use a stranger's car was very foreign to them and seemed rife with large liability issues.

### *Bikesharing and E-Scooter Sharing*

Five respondents were aware of shared bikes and scooters, and one had used a shared bike while on vacation in San Antonio. It was a motorized bike. She called it entertainment. However, most of the group thought shared bikes were too dangerous for them to use. If they were to ever use them, they would want safe infrastructure and e-bikes (less pedaling). They were not interested in scooters at all. Everyone considered them a poor option for safety reasons.

### *Self-Driving Vehicles*

Everyone had heard of self-driving vehicles. Thoughts differed, but none of them were exceedingly positive. The consensus was that more testing must be done, and the technology proven safe before the group would even consider using them. Below are some representative comments about the topic:

- "It's still in the process of being tested; they haven't come up with one that can safely be on the road."
- "Negative information about them is not being disseminated. There is an agenda to make them work."
- "The idea is too futuristic. It's in the 'can't wait to have it but don't really need its category.'"

Participants did not like removing the human from the control of the driving situation. One individual brought up a Tesla accident. They wanted more information on the comparisons of accident rates between human-driven and machine-driven vehicles. One idea that was broached was that these vehicles might be safer in rural areas rather than in heavily congested areas. Getting in a car without any other person in it was scarier to them than getting into an Uber vehicle in which the driver is unknown. One person said that he would like to take part in some sort of study of them so he could get more used to the idea.

### *Best Mode of Transportation Overall*

Everyone said Uber/Lyft was the best mode of transportation for them overall. They liked the human connection (for personal service and friendly conversation). It is a new technology, but it has been proven safe and reliable. As one participant noted, "They have proven over time that they will get you there."

## People with Low Incomes

The research team conducted one low-income focus group that had four participants: three females and one male. This group was diverse, containing two Hispanics, one African American, and one White person. They ranged in age from 23 to 28. Two lived in the Houston suburbs, and two lived in urban Houston. Two were unemployed, and two worked part-time. Three reported household incomes of less than $25,000, and one reported income of $25,000 to $40,000. One person was single, two were separated, and one had a family.

Although all participants had used public transit in Houston, no one relied on it. Most drove for their daily travel. All four persons owned vehicles, although one woman's vehicle had been broken down for many months. During that time, she used Metro Rail to go back and forth to school.

### *COVID-19*

During COVID-19, two respondents reduced the amount they traveled. One of those persons has been working from home. The other person said travel has become more complicated for her; her car was broken, and she did not want to take the Metro because of COVID-19. Uber is too expensive, so she has had to depend on her family to transport her (and her kids) from Point A to Point B.

One person said he was traveling more, but he goes to specific places that are not crowded. He had a vehicle and was starting a business, so he arranged meetings with prospects at different restaurants. Another person, a nursing student, said her school was shut down because it is in the medical center, but she was traveling more—but only around her neighborhood. She had been visiting older adults in her neighborhood and usually walked to those visits.

### *Ridehailing*

All four participants had heard of Uber/Lyft; three had used it. When the users were asked what they liked about it, several answers were given: (a) the cars are super clean and very nice; (b) drivers are courteous (e.g., offer water); (c) the drivers can be rated; (d) the user felt safe and felt the kids were safe; (e) pre-information about the driver is provided (like the license plate), and the app tracks the journey, and (f) the exact cost is provided upfront. What they did not like was the expense. All of these participants were on a tight budget. The woman who had not used it said that she has a car, but if her car were to break down, she would call her family or friends rather than pay for Uber/Lyft. Another said she uses it when there are no buses available or when nobody can come to pick her up. People in the group talked about Uber/Lyft being a last resort because of the price. None seemed concerned about having to set up an account or having to keep a credit card on file in the app.

Three of the four said that ridehailing would be a very good option for them if the price was cheaper. The convenience and perceived COVID-19 safety (relative to transit) would be worth it.

One said it would just be an okay option because she relies on family and friends for transport. She would rather not pay for transport.

### *App-Based Carpooling*

All four group members were aware of traditional carpooling. No one had heard of app-based carpooling or ridesharing. When asked specifically if it seemed an appealing transportation option, most said no because it did not seem safe to ride with strangers. One person often travels with her daughters (ages 11 and 13), and she is not okay with them being in a car with a stranger. She would only carpool with a friend. Another woman also mentioned "stranger danger." In the end, the idea of riding with random strangers held zero appeal (even if there was a star rating system and the cost was less expensive than Uber/Lyft). The only factor that would make them feel more comfortable using this process was if the other riders and drivers were connected to their school, work, social, or sports networks.

When asked to rate this mobility option for themselves, two said "poor" because of stranger danger; two said "okay" if the ridesharing was within a known network or community of people (work, school).

### *Carsharing*

There was no awareness of carsharing. The group did not like the idea of going to the carsharing location to pick up the car, which is much different from Uber/Lyft picking up and dropping off the passenger wherever he or she wants to go. Again, the cost was a barrier—both the subscription fee and the hourly charge. One group member commented, "It charges you by the hour. I cannot afford something like that. There's no way I could afford [the subscription fee] and then on top of that pay an hourly charge." One mother was concerned about kids in the car. She said, "What do I do if the kids accidentally stain a seat?" There were questions about who pays in the case of an accident—the renter or the company—and whether that holds true even if the driver is not at fault. When told that the subscription fee covers insurance, people were still concerned about the cost of the subscription fee. One individual stated, "Seventy-five dollars is a lot of meals for my kids."

People did not like the idea of peer-to-peer carsharing even if the cost was less expensive because of the uncertainty of knowing how clean or how well maintained the car was. For instance, will the car be empty or filled with children's toys? One person said she is not a fan because "I don't like borrowing people's cars in the first place. It's uncomfortable to be responsible for someone else's car." People thought it was good that it was cheaper, but it was not a service that they would use. People liked the carsharing model in which a company was responsible for the vehicle.

When asked how good of an option carsharing (not peer-to-peer) would be for them, three said it would be a poor option. One person said very good in the right scenario, like if they were to win the lottery. Moreover, that person also said that, depending on how far one is traveling, it might be better than an Uber/Lyft.

### *Bikesharing and E-Scooter Sharing*

Two group members used microtransit. Everyone liked the idea, but they thought of these two modes as fun leisure activities, not as transportation modes. Upon consideration, one person said they would be a great transportation mode in the downtown area "only because I think getting exercise at the same time as you're traveling is great."

When asked if they would use microtransit if it were available in their neighborhoods, one woman said, “I would take it to the grocery store and back.” Another person said they too would use it because “I don’t like being in a car all the time.” The cost seemed reasonable since they would only be using it for short distances.

Several people had safety concerns about riding in traffic. None of these individuals had bike/scooter sharing services in their neighborhood, and they were aware that one has to ride on the streets when no bike paths are available in their neighborhoods.

Three people thought that this method would be a very good travel option for them; one thought it would be just okay because of safety concerns, but if there were bike lanes, it would make a difference.

### *Self-Driving Vehicles*

Everyone had heard of self-driving vehicles. For example, one person was aware of the Nuro service that delivered groceries for Kroger. She said it concerned her greatly that small green cars were driving around with no people in them. She said she has seen multiple accidents with self-driving cars but gave no specifics other than it was probably due to other drivers. The others said that driverless cars make them uncomfortable. One person referenced the Houston Metro Rail, in which the operator just “presses the go button and that’s it.” She said there have been a lot of accidents because the operator cannot stop in time.

It was difficult for them to consider the benefits. One person did say they take out the human error, but there can still be a computer error or technical error. Another person said, “What happens when a kid dodges into traffic? Are they going to be able to stop in time?” She knew there were sensors but did not trust them. Their comfort level of acceptance was not improved when told that part of the expense for Uber/Lyft was the driver cost, so theoretically an automated robo-taxi would be cheaper. They were still more concerned about safety than cost.

When told that a driverless vehicle would not be subject to stranger danger, there was still apprehension. One person said, “When you have nobody in the car and it’s driving around, that’s scary as well. It’s not like an individual, it’s more of a corporation.” This person wanted to research who was creating the software and know how they renewed the software. The group member also wanted to understand the evidence-based practice put into the operation. In other words, concerns rose above the level of just being afraid of riding without a driver.

Still, two of the four said that they would try one, if only for a short distance. The others did not want to relinquish control. They talked about the topic like it really would not happen. It was farfetched to believe a self-driving vehicle could be safe. When asked what they would feel safer riding in, whether a self-driving car, shuttle, or bus, most replied (in order of most safe to least safe) bus, shuttle, and car. They selected the bus first because the bus is bigger and feels safer. If it gets hit or hits another vehicle, there is less chance of it flipping over or of a passenger being severely hurt. One person said the opposite—car, shuttle, bus—because of COVID-19. The two persons in the group who said they would not try self-driving vehicles expressed concerns about safety. Even if the vehicles were proven safe, the two thought they could never feel safe in a driverless vehicle. Two persons said it would be acceptable, but they still have safety concerns, so they would only feel comfortable using it in special situations, like if the vehicle was traveling a very short distance, or if the individual was 100 percent sure that the vehicle was safe.

### *Best Mode of Transportation Overall*

One person said bikesharing was the best mode of transportation overall simply because it provides exercise, but the main selling point is that it is "dirt cheap." Her second choice was Uber/Lyft because she has used it before and knows that it is safe. A second person thought carpooling was the best option, but it would need to be connected to or affiliated with a certain organization with which she is familiar. Her second option would be Uber/Lyft but only if they offered student discounts. The last two people selected Uber/Lyft because they have tried it before and so are more comfortable with it.

## People Residing in Rural Areas

This focus group had six participants: three males and three females. They ranged in age from 33 to 55, and they represented diverse races and ethnicities: White, Hispanic, and Asian. They all lived in a rural area outside of Houston. Most lived about 25 to 30 miles from downtown. Four were employed, one was unemployed, and one was retired. Their household incomes ranged from middle to high income. When asked how they typically traveled, they all said via private vehicle. Two people said they might also take Uber/Lyft if going into town for social activities that might include drinking. One person said once in a while he takes the regular bus into town. However, these individuals were primarily personal vehicle users.

### *COVID-19*

Unlike other groups, people in this group said COVID-19 has not changed their travel behavior much. They were heavily dependent on personal vehicles. COVID-19 might have changed the variety of destinations but not how they traveled to those destinations or how frequently.

### *Ridehailing*

All six participants had heard of Uber/Lyft. All but two had used the service. One male said that while he has not used Uber, he has used UberEATS. Another person said he has not used it because he does not feel comfortable with other people driving him around.

Of those participants who had used it, they all said they like that the services are available in their rural locations, that the drivers are vetted, and that there are driver ratings. It was a tried and true technology that is predictable—wherever one uses it, it is always the same.

Because they live so far out, it takes a while for the vehicle to arrive when called. However, unlike taxis, they know that a vehicle *will serve* their areas. One participant said, "Most of the time, Uber/Lyft will take you or pick you up from somewhere out in the middle of nowhere." Exactly how long on average it might take for a vehicle to arrive depends on the driver and time of day. One person talked about waiting as little as 15 minutes or as long as 45 minutes. The length of time does not seem to bother people because they use Uber/Lyft for specific types of trips that they have thought about in advance. Usage is not a spur-of-the-moment request for a ride. The Uber/Lyft is summoned early because the user knows it is going to take a long time for the vehicle to arrive.

Group users also said that the app works most of the time; they did not experience connection problems. Even though they live out in the rural area of town, they are close to Houston, so the connectivity is very good. The accuracy of geolocation is sometimes problematic but not a barrier.

One barrier to use is the cost. It can be prohibitive; for one person, a one-way trip to Houston was $50, and to the nearest airport was $35. Another person mentioned that going downtown costs about $30 for a concert or other event, but the return can cost $60 due to the time of day.

Of the six people, one person said ridehailing was a good transportation option, two said it was an okay option, and three persons said it was a poor option.

### *App-Based Carpooling*

This service was not familiar to this group. No one had used app-based carpooling, but one person had used traditional carpooling.

The concept, even though it could be more affordable than ridehailing, was not well received. Most did not like the idea of getting into a car with "random strangers." One person said, "Saving money is always appealing, but being in a car with a stranger is not." The ratings helped mitigate the concern a little. Two people thought a barrier to use is that there just would not be the availability of service; as one person stated, "There's not too many people around me who are going where I need to go."

When considering this option, they explored it from the angle of being drivers and having passengers defray the cost of the trip. Thus, the idea of insurance and liability came up. One person stated, "So that's the first thing I think of if I'm driving somebody—if my insurance is going to cover them." The distinction with ridehailing is that a company does cover liability.

One person thought carpooling was a very good option, two thought it was okay, and three thought it was poor. The person who thought it very good believed it would be great to have someone with whom to share the fuel bill. Others did not like the idea of carpooling with random people.

### *Carsharing*

No one was familiar with the concept, and none had used it. Because they are all drivers, they first thought about the concept from the perspective of peer-to-peer renting of their own vehicles. Because they tended to rely on their personal vehicles as a primary travel mode, they did not envision their vehicle being available for rental. In addition, they were concerned about liability or insurance issues if someone other than themselves was driving their vehicles. One asked, "If somebody gets in an accident if it's my car and I allowed it, is there a contract that removes my liability?" When asked specifically if they would want to rent someone else's car, the answers were still negative. A participant asked, "What if I get into an accident or it breaks down? Who pays for that?"

More traditional carsharing, like Zipcar, was not well received either. These individuals have their own vehicles, and driving their cars to pick up the carsharing vehicle did not make logical sense. A use case that seemed to make sense was if a personal vehicle were to break down or need service. However, in that use case, as in others that came up, people wanted the vehicle brought to them (sort of like an Enterprise rental). They could not envision having to locate it in an app and then go to that location. A second use case that seemed acceptable was when traveling out of town. In that instance, a carshare might be a more affordable option than a typical rental car. One group member posited, "I'm not using the rental car every second of the day while I'm there, you know, and those costs add up."

When specifically probed on whether they would use this in their local areas, the unanimous response was that no one could envision cars being parked in the areas in which they live. Everyone thought this option was a bad one. Two said it would be okay, but only in very specific situations—it would not be something that would typically be used. One person mentioned that it may enable a household to make do with one car instead of multiple ones. However, the biggest issue was whether it would be located where someone could walk to it. If one needed to take a vehicle to reach the vehicle, it did not make sense.

### *Bikesharing and E-Scooter Sharing*

Everyone had heard of bikesharing and scooter sharing. A couple of people had used them when traveling in other cities. When asked if they would use microtransit in their neighborhoods, a few people said they would use them for recreation, but most people said it was not feasible to rely on microtransit for transportation. In rural areas, country roads without shoulders exist. One person who has her own bike said when she wants to go on a bike ride, she loads it in her car and travels someplace safe to ride.

If there were shoulders or sidewalks, then people would be amenable to using microtransit. One respondent said, "It's always good to get exercise at the same time if the roads are paved for the bike lanes." However, people did not talk about using microtransit for daily use.

One person said in general it would be a poor transportation option, three people said it would be okay, and two people said it would be very good. The reasons those two people thought it a very good option were that it would be economical, and it would mean installing bike lanes on the roads near them, which was a safety issue they felt needed to be addressed.

### *Self-Driving Vehicles*

Only one person had not heard about self-driving vehicles. In general, people in this group did not trust the technology. One said, "It's hard to release the responsibility of driving to a computer." A second person talked about how hard it was to give up control of the vehicle. Another worried about the time when there would be mixed traffic (humans and driverless). Another person said that for safety, it would have to be "all vehicles or none." One person had heard about someone getting into an accident: "Someone died, Tesla did this, Tesla did that. So, I've yet to learn or read something positive."

Not all comments were negative. One woman with a long commute mentioned that commuting would be a different experience "because I could like take my makeup bag and get ready in the car instead of having to add that time onto my day." Another person expanded on the thought: "I would sit back and relax, and that's the likability."

When asked about the mode that they would feel most comfortable riding in, four said shuttles because it is bigger than a car if one gets hit and smaller than a bus if it hits another vehicle. Moreover, it would operate in designated lanes or designated areas. Another person's rationale for naming shuttles as the best option was not a fear of crashing but a perception of what would work best in her neighborhood. Two selected a bus because it is bigger and safer. Most said it would be 10 to15 years before self-driving vehicles are available for their use.

### *Best Mode of Transportation Overall*

Participants were asked to select the best mode from a mode that they have not used. Self-driving shuttles were selected by four people; a self-driving car by one person; and bikesharing by one

person (if there was necessary infrastructure). The rationales given for the self-driving shuttles were "not having to worry about being behind the wheel," but participants reiterated that "the technology will not be safe until 10 to 15 years from now." For now, they feel it is a poor option, but once safe, it will be a good option.

## People Who Spoke Little to No English (Spanish Speaking)

The research team conducted three mini-groups composed of either three or four immigrant Spanish-speaking Hispanics per group for a total of 11 participants. All could speak little to no English. Their households earned less than $40,000 per year, their highest level of education was high school, they lived in Houston, and they were employed in construction, painting, loading, office cleaning, food service/restaurants, landscaping, or sewing. Most relied on rides from friends and family or used city buses because they had limited transportation options. Many households did not have a car, or they shared a car with a spouse or parent; many did not have a license or did not have a valid U.S. license but still knew how to drive. Of the households with cars present, the cars were shared, and many of those cars were currently inoperable or out of commission.

### *COVID-19*

People in these groups were ages 29 to 44, and many had young children in their households, which made public transportation challenging during COVID-19 because some of their young children did not consistently wear a mask. This element made parents apprehensive about mass transportation and resulted in minimizing the number of trips taken.

All participants in these groups worked less and suffered reduced pay and greater economic struggles because of COVID-19. One woman, a seamstress, was reduced to a quarter of her hours and pay as a result of COVID-19. COVID-19 complicated these participants' ability to care for, school, and transport their young children. One respondent had a child with autism, and taking public transportation became very difficult for the child due to his resistance to mask-wearing and other protective behaviors. Another respondent had health issues and spoke of difficulties with transportation because he often needs to transport medical equipment.

One man had to return home because he forgot his mask and was not allowed on the city bus. Having masks and other PPE available on mass transit, possibly for a nominal fee, can be helpful for these groups' families, who have a lot to deal with and may find themselves needing to use mass transit or other modes of transportation in unexpected situations such as when their children lose their masks and protection.

### *Ridehailing*

Of all services discussed, Uber and Lyft were by far the most familiar service to this group and had been known for many years. Most respondents used the Spanish app on their phones to facilitate communication even though they usually had English-speaking drivers and had limited verbal interaction with them. They said they were accustomed to the situation and knew how to make it work.

They liked that Uber and Lyft were fast, direct, nearby at all hours, punctual, and not too expensive for occasional use. Ridehailing also eliminated the need for parking. They liked that drivers received reviews, which added a sense of security.

The biggest concern about ridehailing was safety, especially for women. Some had ridden in cars that smelled badly of cannabis or that were dirty, but it did not happen often. Every now and then they got poor drivers who drove too fast or drivers who were unpleasant or in a bad mood. One participant did not appreciate being made to sit on a piece of plastic because he had been painting and his clothes were damp after a day of work. He felt the restriction was excessive, but it happened only once.

Some participants acknowledged that technology or the lack of having a credit card or the fear of credit card fraud could be a fear for others, but not for them. Overall, participants thought ridehailing was a good or very good option.

### *App-Based Carpooling*

Only one person had heard of carpooling. No one knew details about how it worked, and no one had tried it. Respondents' first questions were about pricing and length of the trip because they wanted to understand how drivers decided who got dropped off first and last.

They liked that the app showed photos of drivers and riders; they assumed it would be less expensive than ridehailing and the city bus. Two women liked the idea of meeting new people and expanding their social circles.

The main issues with carpooling were punctuality and potential difficulties with other people in a group of strangers. They felt that it would be worrisome for long trips because they did not know the people with whom they would be riding. They expressed interest in trying it with one rider and without kids because of the potential complications from several strangers riding together. They did not foresee using it for work or an appointment for which they needed to be on time. They also thought carpooling worrisome because of COVID-19, the inability to social distance, and not knowing whether others took enough precautions. Finally, concern about potential prejudice against Latinos or Spanish speakers was expressed.

They rated carpooling as a good and inexpensive alternative to the city bus because it seemed to be less expensive than ridehailing.

### *Carsharing*

Some people in the groups had heard of carsharing, but they had little information other than it was less expensive, and cars that belonged to other people could be rented. A great deal of interest was expressed because many of them lacked access to working vehicles. They liked the idea of being able to use carsharing for errands, for large groups, for moving big items, for having car access when their car breaks down (which was the case for a few), and for taking trips. They also liked that carsharing is less expensive than other rental cars. The main barrier is that many did not have valid and current driver's licenses. Carsharing, like other modes of transportation, seemed a bit risky to the group during COVID-19, but not as risky as many other options, like riding a city bus or using ridehailing services. Overall, they rated carsharing as good to very good, depending on whether they had access to a driver who would be able to rent a vehicle.

### *Bikesharing and E-Scooter Sharing*

Most had seen these options, but none had used them except for one respondent whose family used them while visiting Dallas and San Antonio. The participants liked that the bikes and

scooters could be used to get around town and could be dropped off at any designated location. They thought that these modes would be good for recreation and exercise.

The main barrier was that they cannot find these options in their parts of town or in areas where they need supplemental transportation to get from one point to another. They did not think these options reasonable for day-to-day practical trips that often required taking small children.

### *Self-Driving Vehicles*

There was some awareness of self-driving cars due to two of the groups each having a male participant who was familiar with Tesla and had extensive knowledge of that company's cars. One respondent had taken a short drive in a Tesla, and, as the other members of his group listened in awe, he described the vehicle parking itself. Others had seen them in movies but had no real awareness or experience with them. After extended discussions, most thought they would be on the market in 15 or 20 years.

All participants in these groups expressed real interest and excitement about trying self-driving cars one day. Participants had faith that the government or regulators would not allow self-driving vehicles on the road unless the technology was extensively tested and safe for the public, even though most would not want to be the first to try them. They were curious about how the technology is designed to keep them and others safe in the case of emergencies or obstructions. One group reasoned that an autonomous car does not get drunk, fall asleep, or drive while drugged or tired. Ultimately, most saw self-driving vehicles as a good or very good option. They wondered if these vehicles would be affordable, but they did not think they would personally ever be able to afford one. They wanted to see these self-driving vehicles endorsed by a government or regulatory entity to ensure safety requirements are met. They worried most about the vehicle going on the highway or the vehicle hurting a child.

They were asked how the risk of a self-driving car might compare to flying in an airplane. This comparison helped to dismiss some apprehension, with many reasoning that if airplanes can be made to fly, then self-driving cars ought to be able to be made safe for the roads.

They thought a self-driving Uber or Lyft vehicle would be appealing because of both COVID-19 and their general distrust of strangers as drivers.

The groups were distinct in their preference for an autonomous car, bus, or shuttle. Some preferred a car because they aspired to own it and thought that owning the car would be most useful and provide the greatest value. Others preferred a bus because riding it would provide a shared experience, and for some, the large size of a bus implied greater security. They imagined that being on a bus would be more like an excursion taken with other people, and it would be an entertaining experience. They also thought that a bus would be accessible and more realistic given the high cost of a self-driving car. A few preferred the shuttle for similar reasons as the bus, but they found the smaller size to be less troublesome and confined to a restricted safer zone.

### *Best Mode of Transportation Overall*

Of those vehicles that the groups had not tried, self-driving vehicles were the preferred option, followed by carsharing, which was very appealing because of the need for vehicle access. Two respondents said—based on their need to run errands, transport items, and accommodate large families—they were going to look into carsharing companies after the group's discussions.

Finally, two people in one group were interested in the carpooling idea as an inexpensive alternative to the city bus that might also be a good way to meet new people.

## People with Visual Disabilities

This group had six participants—three males and three females. Four lived in/near Seattle, one lived near Dallas, and one lived in Austin. The ages of participants ranged from 21 to 64.

### *COVID-19*

COVID-19 affected virtually all travel for this group, with most in the group traveling less due to not wanting to leave the house. As one person said, travel has "dropped like a stone." That person, a musician, said that with COVID-19, his gigs have dried up, so now he only goes out for essential travel. Sometimes he has asked some of the School for the Blind instructors to get a school van and take him to the grocery store because he has no other option. Another person (a teleworker) said that she can "probably count on two hands the number of times she's even been in a car since March." One person who lives in downtown Seattle and walks a lot for daily errands said that his travel has not changed much at all. Everything is within walking distance for him. Another respondent in downtown Seattle said she continued to travel by bus during COVID-19; however, she makes sure she wears a mask. She commented that the lower bus ridership has been a good thing for passengers like her.

### *Ridehailing*

All six persons had used Uber or Lyft. They characterized ridehailing as enabling the blind community to be independent and travel spontaneously. However, the biggest barrier is cost; they wondered why no subsidy exists, as with paratransit and the bus system. They pointed out that it takes three times the amount of time to use paratransit or the bus system as it takes to use Uber/Lyft.

Most use the regular app with voiceover. Occasional hiccups occur, like when the app is updated and suddenly the functions do not work anymore, or when stuff that used to be easy is changed and is now difficult. It is not easy to figure it all out. Several in the group needed to get a sighted helper to figure it out. They did not think there was much difference in how they were treated between Uber and Lyft and knew that many drivers drive for both. Interestingly, no one mentioned any challenges caused by curbside infrastructure. People did mention congestion problems at the curb, meaning sometimes so many vehicles are parked curbside, it's difficult to know which one is the correct Uber or Lyft.

Participants reported the following likes about ridehailing:

- Spontaneity:
  - Capability to put in an address and request a ride.
  - Short wait for a ride to arrive.
  - Unnecessary to know in advance exactly when you are going and returning—unlike paratransit.
- Safety features that can let people know the trip route.
- Electronic payment, no cash.

Their dislikes included the following:

- Manner of verifying/finding the ride—standard license plate number and picture of the car.
- Safety—navigation of busy streets and loud environments, especially if the rider also has a hearing disability.
- Geographic location is inaccurately placed in the app so the driver does not know where the passenger is or drops the passenger off at a nearby but not exact destination.
- Denial of a ride (driver cancels trip) because of a service animal.
- Getting in a vehicle without knowing that the driver is deaf; the app voiceover needs to say, "Your driver is deaf. Text to communicate."
- Cost—monthly public transit passes can be quite cheap, whereas depending on distance, one ridehailing ride may cost the same as what the monthly pass costs.

Possible solutions included the following:

- Include a visual disability mode in the app so the driver knows the person has a disability:
  - The driver can see a photo of the passenger (with a cane or service animal).
  - With a passenger photo, the driver can get out of the vehicle and attempt to find the passenger with visual disabilities within a reasonable amount of time (perhaps within a 5-minute window, as with paratransit).
  - The driver can provide an auditory signal (e.g., honking the horn three times) to indicate to a blind passenger the direction the passenger needs to walk.
  - Passengers must be able to disclose their disability (important information for drivers to have) without risk of having the ride canceled.
- Train drivers to always ask, "Are you ____? My name is such and such." Additionally, drivers need to read (confirm) the destination to the blind passenger.
- Make drivers more sensitive or aware of the need to drop off a passenger as close to the desired destination as possible.

### *App-Based Carpooling*

One person had used Waze Carpool several years ago in Southern California when his vision was better. A second person had heard of something like it in the Seattle area. The rest were not aware of this type of service, and they had a hard time latching onto the concept of what it was.

Participants reported the following likes about app-based carpooling:

- Creates a regular arrangement with the same person.
- Good for regular school/work/volunteer type of opportunity.

Dislikes included the following:

- Safety.
  - Do not know anything about the other passenger(s).
  - Adequate safety features are not built into the app.

### *Carsharing*

This mode was not discussed with this group because these people are not drivers.

### *Bikesharing and E-Scooter Sharing*

People talked about these modes offering value in recreation. One person wondered if there was a use for bicycles for persons with low vision and another person was intrigued by the tandem

bike idea. She wondered if there could be a function in the app where you can "request a pilot" and be charged extra for one.

However, several talked about there being competition for pedestrian pathways, sidewalks, and bike paths. There were also safety concerns about being hit by scooters (more than by bicycles) and concerns about tripping over them.

### *Self-Driving Vehicles*

At the mention of self-driving vehicles, several people right away said, "Sign me up," "I'll take out a loan right now," or "Just mortgaged my house." All were aware of self-driving vehicles. One person who lived in downtown Seattle said he could not justify the financial investment in a self-driving car because the public transit system is just so good there. Perhaps if he lived in outlying suburbs or a rural area, the cost of the investment could be justified.

Participants liked the following about self-driving vehicles:

- Independence.
  - Participant's comment: "If I get a hankering for a Dairy Queen blizzard, I can go get it myself. Don't have to depend on anyone."
  - Participant's comment: "I can just leave. Don't have to pay Uber, get my friend to pay Uber, or hope the paratransit will get there in time or pick me up too early."

The one dislike was as follows:

- The cost of a self-driving personal vehicle; people with disabilities also often have low incomes (one person cited 70 percent unemployment). Participants did not think that subsidies would be forthcoming.

Lack of trust in the technology did not seem to be an issue. One person said, "If a drone can deliver a pizza to my door, then, yes, I trust the technology." A few people felt safer in a smaller mode form (vehicle or shuttle). People did not like the idea of a self-driving bus with no human on board. As one respondent pointed out, "The bus driver doesn't only operate a bus." They wanted human interaction regardless of the form factor. Even with an automated Uber or Lyft, they need and want human interaction—the driver is important in enabling the connection between the would-be passenger and the vehicle. Otherwise, the passenger will have to use a "visual interpreting service like AIRA to be my eyes." Several people have used their visual interpreting services, which use a phone's camera to look around and provide needed help. There are English speakers around the globe who can aid 24/7, but it is a paid service.

These participants suggested several different types of solutions for not having a driver in the vehicle. For instance, "In order to find an unattended Uber in the parking lot, the app would have to have a button that makes the vehicle flash its lights and honk its horn and open and close its doors or something." Several people mentioned a need for a refreshable braille display on the car door or a need for the car to automatically speak the would-be passenger's name out loud, similar to how buses speak the bus stops out loud. Others mentioned that the passenger can have a person in a call center who is available throughout the ride. Another potential solution is for the phone app to send out a Bluetooth signal, and the vehicle for the ride can respond to it.

### *Best Mode of Transportation Overall*

Of the options discussed in the focus group, most said that ridehailing was the best current option. One person mentioned app-based carpooling because of cost. All had autonomous

vehicles as their second choice, with the majority wanting a personal vehicle (although they were unsure about really being able to afford one). One person's second choice was an autonomous shared ride, and one person's second choice was an autonomous bus with a human attendant on board.

### People with Ambulatory Disabilities

This group had six participants: one male and five females. Two lived in/near Seattle, and the rest lived in Austin. Two used motorized wheelchairs. Four were not wheelchair users, but they had mobility disabilities. The ages of participants ranged from 30 to 62. In their introductions, all talked about being in lockdown since March. Here are some details about these participants:

- The male (38 years old) lives in the suburbs outside Seattle with his parents, who are in their 70s. Consequently, he is very concerned about COVID-19, both for himself and his parents. He has balance and other mobility issues due to a head injury. Pre-COVID-19, he normally traveled by bus or light rail. He is not employed.
- A female participant (30 years old) had a debilitating disease in March and moved from rural Oregon, where driving was her primary mode of travel, to urban Austin. In Austin, she relies on the bus system. She is currently living with a roommate but is transitioning to living independently. She is not currently employed.
- Another female (52 years old) also has an ambulatory disability due to a debilitating illness. She lives with a roommate in suburban Austin. She primarily uses paratransit (Metro Access) to travel. She takes it to work, grocery stores, doctor appointments, and social activities. She lives near Walgreens, and she can walk there. She works in the field of assisting people who are blind or have low vision.
- Another woman (40 years old) lives by herself in Seattle. She is employed at a university. She had a roommate pre-COVID-19, but after the onset of COVID-19, she decided it was not worth the health risk. She has a car that she can drive, but her decision to drive depends on (1) the weather and (2) parking at the destination. When she does not drive, she tends to use the bus or the train. She talked about the difficulty of getting access to green space because of the unsafe behaviors of other people in parks, so she has taken to walking in cemeteries.
- A woman (59 years old) who is a motorized wheelchair user lives with an attendant in her own home in suburban Austin. She is not employed. She owns her own van, which has been modified to be accessible for her. This van is what she uses to travel. During COVID-19, when her van broke down, she rode the bus. She found it very clean, with drivers behind plexiglass. There were spaces between seats, so people did not sit close. She also mentioned that very few people were actually on the bus.
- Another woman (62 years old) who is a motorized wheelchair user lives by herself in urban Austin. She uses her motorized wheelchair to get around locally; she has access to good sidewalk infrastructure and says the good, sunny Texas weather helps. For longer trips, she has someone drive her in her own van. It is not always guaranteed that she can find or arrange for someone to drive her. Her second option in those situations is the bus, which goes right by her house. She is also retired from the public transit authority in Austin.

### *COVID-19*

Most said COVID-19 has affected their frequency of travel, which has significantly decreased. A few said they changed their modes of travel—that is, they stopped using the bus or Uber and started calling friends to drive them.

### *Ridehailing*

Everyone was aware of Uber/Lyft. Four respondents had used it; two had not. One had not because of a recent ambulatory disability and not being sure of how accessible vehicles are—for instance, whether the driver can/will load the walker or wheelchair for her. Previous to the onset of her illness, she lived in rural Oregon and drove her own vehicle. Moreover, now she does not like the idea of using a vehicle that will have previously given rides to many other people because of the health risks due to COVID-19. The other person who had not used ridehailing is in a motorized wheelchair. She said that she knew there were accessible vehicles (Uberwav). She has heard both good and bad stories about ridehailing. She is reluctant to use it because she does not want to take it somewhere and then get stuck returning home because there is not an accessible vehicle available. A few people mentioned discounts when Uberwav first started in Austin, but they were not sure if these were still going on. Discounted fares were of great interest to the group.

People who use ridehailing like it because of convenience—in other words, the length of total travel time, which is considerably shorter than paratransit. People also liked being picked up and dropped off at their origin and destination, unlike a bus. Additionally, it is cheaper than a taxi. However, Uber/Lyft is much more expensive than paratransit. They would prefer that the transit options available to them not take so much time to use (e.g., five hours for one trip).

No one in the group relied on ridehailing for their mobility needs because of the expense. They use it when time is short when they can share a ride and the cost, or when traveling to/from transit. One person mentioned that at a transit stop, it is a challenge for him because there is no designated curbside spot in which Uber/Lyft drivers can park. He said, “It’s a free-for-all at the curb.” Those situations can make taking Uber or Lyft to a transit station very stressful. Another person mentioned that she could walk to the nearest bus stop from her house, but she does not because the sidewalks are in such bad condition. She related, “I have to walk in the middle of the road with my walker, and it’s ridiculous because [the transit stop] is a block away. I’m not going to pay an Uber or Lyft to come take me to the bus. It’s right there.”

One person who uses a motorized chair mentioned she uses ridehailing in situations—such as needing to make a quick doctor’s appointment—when she wants to be on time. This person had previous experiences in which there was not an accessible vehicle available for her. She commented, “It freaked me out.” She said that the fact that vehicles show up in the app is a very good thing. If there is one, then the ride is confirmed, but sometimes she has to wait for the ride to be confirmed. In those situations, she “kicks it into high gear”—that is, she figures out how to take the bus or get someone to drive her because she does not know whether her ride will be confirmed or not.

Several people (who were not wheelchair users) talked about learning that they needed to better communicate their disability to drivers because their disabilities are not overtly noticeable. One ambulatory person mentioned that she moves slowly and has trouble entering and exiting the vehicle, but drivers do not always notice her disability. One time the Uber driver started pulling away from the curb before she had fully exited the vehicle. She was hit by the car door and felt

lucky that she was not dragged down the street. She mentioned having more positive experiences with Uber/Lyft drivers than with taxi drivers; she wishes she could take Uber more often because of the convenience, but she cannot afford it. Therefore, she uses it when she does not have the time for paratransit or when she is on a social activity with other persons who can share the cost.

Another ambulatory person said it is challenging for her to enter or exit when drivers do not pull up to the curb. They assume she can easily make it to the middle of the street. She says they are a bit more sensitive to the access/egress location if she has requested a ride from a medical facility. Driver training was mentioned as a useful solution to this issue since that practice is not just unsafe for people with a disability but for everyone. A similar issue is getting the driver to stop at the right location. One individual talked about being dropped off away from his location and having to walk a bit farther (across crosswalks, etc.), which can be unsafe because of his weak vision. He stated, "Drivers are not trained to work with people with disabilities."

Of the six participants, three persons said ridehailing was a very good option for them, one said it was an acceptable option, and two said it was a poor option. Of these two, one person was concerned about the uncertainty of being able to get a return-home ride; the other person is immunocompromised. She will not ride in a shared vehicle that she cannot confirm has been sanitized. She felt safer on the bus or in a paratransit vehicle.

### *App-Based Carpooling*

None of this group's members had heard of app-based carpooling/ridesharing. Some had heard of more traditional carpooling. One person who retired from Capital Metro was aware of its formal carpooling program. Some were aware of conventional carpooling but said they dismissed carpooling of any type as an option for them because they thought that all carpool members have to take turns driving. None of the people in the group were current drivers. They were intrigued that they could be in a carpool just as a passenger. Another person was in a traditional carpool organized by her work. She said it helped her keep transportation costs down, but she was not interested in the app-based option because she has too many apps on her phone and too little memory.

Participants mentioned concerns like "What happens when somebody gets sick or goes on vacation? You have enough other people in the carpool who can drive," and "I wouldn't want to wake up in the morning and get a call or text that the driver can't drive today." They characterized it as an unreliable option. One person said, "I take Metro Access because, even though it's got its problems, it is reliable. If there is a problem, I can call a number, and they're like, 'I'll come and get you, but it'll be an hour.' That's when I use the Uber/Lyft app."

Although they liked that it might be a more cost-effective option than ridehailing, they had concerns about it. One concern about app-based carpooling was that it was only good if going someplace regularly; therefore, it would best come in handy if one were working. Moreover, they did not like the thought of being matched with and riding with an unknown driver or unknown passengers.

A very big issue was that there was no guarantee of wheelchair accessibility or that drivers would show concern for and be observant of slower mobilities. They were concerned about drivers' attitudes, frustrations, and expectations of them as would-be passengers. One person mentioned a possible solution to the latter issue would be to put a heads-up message in the app, such as "I've got a wheelchair" or "I've got a walker." Another concern was whether a person

with a disability creates a liability issue. One participant asked, "What if they have to tie me down? What if the strap breaks?" Additionally, a driver might be worried about the time it takes to deal with someone with a disability. One person remarked, "We would then just get bypassed for hours because nobody wanted to take on additional liability."

No one felt carpooling was a very good option for them, though two believed it was an acceptable option. One of the two, who was price sensitive, thought it might be good for longer trips (e.g., from one small city to another) because instead of paying an expensive Uber/Lyft fare, one could simply pay for some gas. The other one who felt it acceptable framed it in the context of being able to build a list of desired amenities into the app—like Airbnb—geared more toward accessible options for people with needs. "I have a wheelchair; I need to sit in front; I want to be picked up first." This person felt such options would be good for ridehailing as well. The app could feature a pull-down menu of items.

### *Carsharing*

Half of the group was aware of carsharing (with Car2Go as the most recognized brand); however, participants were not sure about whether extra insurance or liability coverage was required for users with a disability.

All group participants said it would not be an option for them because they do not drive and/or cannot get a driver's license because of their disabilities. In addition, the fleets probably do not accommodate people in wheelchairs. Another person said that Zipcar is part of the suite of transportation options offered by her employer, but she does not take advantage of it because the modifications that she needs to drive a vehicle are very specific. One woman said that even though she has a car she can drive, she would much rather be driven than drive herself.

### *Bikesharing and E-Scooter Sharing*

All were aware of rentals for bicycles and e-scooters, and they did not like them. One person remarked, "I absolutely hate them. I live downtown and people just drop them on the sidewalk, which blocks people like myself in a wheelchair." Another said, "They run into you." Yet another noted, "A lot of people are using them for fun. Not to go to/from the bus stop."

Even though there was a backlash in the group toward microtransit because of the way the devices litter the sidewalks, one person in the group had used a scooter share to travel from a bus stop. He said it was a little nerve-racking for him because his balance is not good, and he also did not have a helmet. He found it fun and easy to use, although braking was hard. Three others said they were interested in trying them because they looked like fun, and two said they were uninterested because they were too dangerous.

Another female said she got excited when she saw the sit-down bikes. She was concerned that she might not have the balance to use it and even emailed the company to ask if it might modify the bikes for people with disabilities. The firm replied in the negative. They did not have plans to make any other types of bikes. The focus group participant thought that it would be great "if those racks of two-wheeled bikes had a bike that was a like a tricycle—one wheel in front and two wheels in back with a basket in the front." This person liked the fact that it was a relatively inexpensive option and fun.

A third person in the group identified two key barriers for her: (1) she cannot power a bike with her feet, so the bike would have to be modified to be powered by her hands, but she does not see that as an option; and (2) the infrastructure. Bikes and scooters use bike lanes, and she does not

feel comfortable having "little white lines separating her from traffic." She also felt that Seattle has not specified when one can ride microtransit on the sidewalk and when one cannot. She does not like the fact that she is expected to move when someone is riding a scooter or bike on the sidewalk.

When asked about microtransit as an option, two said it was a very good option, two said it was an acceptable option, and two said it was a poor option. One person who said it would be acceptable, asked if there were bikeshare programs with recumbent bikes. Recumbent bikes are easier for people with mobility disabilities to use and are a great form of exercise.

### *Self-Driving Vehicles*

Five of the six participants had heard of self-driving vehicles. People in the group were excited about the prospect but did not see it being a transportation option for 10 to 20 years. Technology would be a "great equalizer" for people who do not drive. One person in a wheelchair said she likes the idea very much: "I would love to just get on and go where I need to go and not have to deal with attitudes of [bus] drivers—they don't want you; they don't want a wheelchair getting on a bus." But she would worry about locking down her chair. "I can't use my hands."

The group talked more about self-driving cars than about shuttles or buses. Their interest was in having a more convenient mode of transportation than public transit. Another participant who was excited about self-driving cars saw them as an alternative to fixed-route transit, which he said has a "large number of limitations." He said he thinks they are a long way off due to safety issues, but he knows there is a lot of testing going on. Others picked up on the safety concerns. One person said she does not trust that current GPS technology can accurately pinpoint her location when walking through the streets of Austin so that a self-driving car can avoid hitting her. She thought the technology might be 10 years in the future, after lots and lots of testing. Another person was concerned that there would be mixed traffic—self-driving vehicles and conventional vehicles on the roads. He did not think that drivers would consent to a computer doing all the thinking. One person had friends with vehicles that had automation in them, such as technology-assisted parallel parking. She said self-driving vehicles would be great, but there was still a lot of work to be done. She questioned how technology can see the lane markings in the snow. She believed, "If I can't see them, it can't see them."

### *Best Mode of Transportation Overall*

Participants were asked which of the options discussed were the best and second-best options for them. Several people wanted to say fixed-route transit, but that option was not allowed. It had to be one of the new mobility options that were discussed. Thus, most said Uber/Lyft because of the convenience. For a second choice, most indicated self-driving buses or shuttles. Some preferred buses because they were bigger and therefore safer. One person thought that an automated bus would always arrive on time. Others liked the shuttles because they would travel at slower speeds and mix with conventional vehicles on the roads better; getting on and off them would also be easier. One woman indicated that she would be interested in an automated car but did not think it would ever be affordable for her. Many said automated cars would not work for them because they would not be accessible, and one individual indicated that the best choice for her would be microtransit "if all of her modification fantasies" were put in place.

## People with Hearing Disabilities

This group consisted of six participants: four females and two males. They ranged in age from 19 to 73. Focus group facilitation was assisted by two ASL interpreters, and closed captioning was also provided through the Zoom app.

- The youngest participant, a 19-year-old female, is an African American who lives in a relatively rural area outside of Dallas. She primarily depends on her grandmother for transport, but sometimes she uses DART paratransit. She has both vision and hearing disabilities. She reads lips, ASL, and closed captioning in large font sizes.
- The second female (35 years old) is Indian and lives in suburban Houston with her mother. She is employed, has a driver's license, and drives a personal vehicle. She uses bilateral hearing aids and has had them since age 2. She prefers spoken English (she reads lips) to ASL, which she prefers over closed captioning.
- The third female (43 years old) is White, employed, and lives in the rural suburbs outside of Austin with her husband and children. There is no public transportation in her area. She has a driver's license and travels by personal vehicle. If she needs to, she will plan in advance and can use Uber. She is completely deaf. She uses both closed captioning and ASL interpreters.
- The oldest participant, a 73-year-old female, lives with a housemate in urban Portland, Oregon. She has both hearing loss and 2 percent vision in one eye only. She is a retired mobility instructor. She primarily travels by public transportation and purchased her condo to be close to bus routes.
- One male (35 years old) is White and lives by himself in urban Chicago. He also uses public transportation and moved to his current residential location because it was well-served by transit. He uses a cochlear implant; he prefers spoken English and also uses ASL.
- The second male (39 years old) has hearing difficulty and does not use hearing aids. He uses ASL and closed captioning. He lives by himself in suburban Houston. He has a driver's license and uses a personal vehicle, but if the car is not working, he uses the bus.

### *COVID-19*

Most participants significantly curtailed their daily travel during COVID-19. One person who relied on her vehicle to travel back and forth to work said she is working at home now, and her VMTs changed from 7,000 miles every three months to 250 miles. She does not go out to restaurants, does almost all her shopping online, and also uses telehealth for doctor's visits. A male participant talked about his travel becoming very local; he relied on walking to locations in his neighborhood because he wanted to avoid the public transit system. Another male who pre-COVID-19 used his vehicle said that he began using Uber more frequently. He avoided public transit because of the requirement for masking. If people are masked, he cannot communicate with them. In addition, he does not normally communicate with the Uber driver. He just gets in and they go. The 19-year-old woman said she purposefully travels less because traveling is more complicated because of the mask requirement. She cannot communicate with the paratransit staff, so she just relies on her grandmother. The retired woman does not travel much at all. She relies on her housemate to do most of the shopping. She went from using the city bus almost daily pre-COVID-19 to almost never using it now. She says she is on Zoom as much as 12 hours a day. The female from Austin said she is a homebody because of COVID-19; she no longer has

a long commute to and from her home. When she needs to go out to shop or to a doctor's appointment, she uses her personal vehicle. She is not willing to get into Uber during COVID-19, which is her only other option.

### *Ridehailing*

All six had heard of Uber/Lyft, and five had used it. The youngest person said that she would never use them; she said, "I'm terrified I would get kidnapped." The oldest woman said she has never used it by herself. She is not comfortable hailing the ride on a smartphone. A friend did help her add a silhouette of a woman using an information cane to her profile. She uses ridehailing when she is going to an unfamiliar destination, which would take too many transfers via bus, or when she is carrying too many items. Another woman who lives outside of Austin said she uses Uber a lot and communicates with them via text through the app. She said some drivers try to call her by voice instead of text, which creates a communication barrier. Another male said he has used both Uber and Lyft but does so infrequently because of his income. Ridehailing is quite expensive, which is why he relies on public transit. He said it is great for accessibility, but "I don't use it a lot simply because of my income." The other male said he prefers using Uber/Lyft to drive his personal vehicle because he feels that they are safer (he may be drinking or on medication), but he also raised the issue of expense, so he uses it only when he thinks he needs it for safety. The woman who lives outside of Austin also said that she uses ridehailing when she wants to go out and have a little bit of fun and she might be drinking. However, it is $50 one way, so she does not use it often. Currently, she does not feel comfortable doing it because of COVID-19.

Only one person was scared for her safety (afraid of riding with unknown drivers), but several were concerned about being able to locate the vehicle or about the driver being able to locate them. The concern was that the driver would not see them, leave, yet still charge them.

Four persons said ridehailing was a good option, one said it was a so-so option, and one said it was not a good option. When asked if their opinions would change if the challenges were overcome, the participants said they would not.

### *App-Based Carpooling*

One person had heard of app-based carpooling. None had used it. Although the notion of having someone else drive is positive and it was considered to be more affordable than ridehailing, participants were concerned about not knowing the driving record of the person driving. A professional ridehailing driver seemed safer. The star ratings did not mitigate the concern.

Another person discussed how networking to find rides (like when he was in college) was difficult due to communication barriers. It was hard to find people who might be traveling the same way. He said, "You don't hear those conversations when people are sharing information." An app could resolve that issue. He expressed no concern about a stranger being the driver, explaining that he uses public transit right now, and those people are strangers too. He saw app-based carpooling as another form of public transportation and said that he would also pay attention to the star ratings. The woman who lived outside of Austin said that it was more reasonably priced than ridehailing and that was important to her. Thus, she considered this a good option if available. She would try to find out about the drivers' backgrounds, though.

The older woman was not interested in this option; she is intimidated by the app. She said she is good at getting rides from family and friends, so she could probably come up with a needed ride without having to resort to the app.

Another woman said that she would consider it because it was cheaper than ridehailing. However, the fact that no one has heard of it means that the marketing of this option needs to be stronger. She said one drawback was if one scheduled a ride and the vehicle or driver turned out to be unacceptable; one would be left with no alternative. No real accountability or background checks exist as they do with Uber or Lyft.

Two of the six persons thought this was a good option for them.

### *Carsharing*

Three persons had heard of carsharing; no one had used it. Only three of the six persons had a license to drive. One person with a license talked about it possibly being a better option than having to maintain and pay for his own vehicle if he continued to travel less like he is now. However, when things return to normal, it will not be as worthwhile. He said one perk would be the possibility of having a different car every time because he could try out something new. The woman who lives outside of Austin said her area is too rural for carsharing to be viable. The other female with a license said she was quite independent; she wants to have her own vehicle without having to deal with the hassle of finding and renting one. She was also concerned there might not be enough vehicles in her area.

The three persons with driver's licenses thought it could be a good option for them, depending on availability.

### *Bikesharing and E-Scooter Sharing*

All were aware of bikesharing or e-scooter sharing. None thought it was a good option for them. Many talked about balance issues. A concern for all was the littering of pedestrian walkways with the scooters.

### *Self-Driving Vehicles*

Five of the six persons had heard of self-driving vehicles. Four of the six would feel comfortable riding a self-driving vehicle. One male said he would prefer a self-driving car, not to buy but to rent, through a carsharing service. He does not want to buy one because he feels the technology makes it too expensive. He said, "I can't imagine I would ever be able to afford it." The woman living outside of Austin said she would be interested in a self-driving car over a shuttle and a shuttle over a bus. She put "bus" last because she does not think rural suburbs will have self-driving, fixed-route buses. She also stated that she will not consider using a vehicle until the technology is proven 99.9 percent safe. The male living in urban Chicago said he always rolls his eyes when people talk about self-driving vehicles because they will never be as efficient as light rail or other forms of public transportation. He is concerned about increased congestion caused by self-driving vehicles driving all over the place. He said it might be a good option if one lives in a rural area. He prefers self-driving buses or shuttles. One of the women did not trust the technology. She raised the issue of glitches with computer technology now. If she did use one of these vehicles, she would want her personal vehicle because of the convenience. She would use it to travel back and forth to work.

The other two women did not trust the technology. They said it might be 10 years until it is proven safe. Several of the women said that they like having a driver; not being able to talk to a driver and ask questions such as "Where am I?" is a negative.

One of the males said he was concerned because people who develop these new technologies often do not consider people with disabilities. He talked about the technology being voice-activated and wondered how a person with an accent might affect performance. Their speech might not be recognized by the AI. Those sorts of challenges would need to be fixed before people who are deaf or hard of hearing use them. The other male agreed with this point. He said, "My iPhone can't understand my own voice. I have the voice off completely because there is no sense in even trying to talk to Siri. It never gets it right." He used the example of the Instapot. It is very sound-based, and there is no visual information to tell him that the food is done.

Self-driving technology needs to have visual indicators, such as to indicate where the next street is. One of the females agreed. An automated voice on self-driving technology is not useful for the hard of hearing (although it would be for those with visual disabilities). Instead, those who are hard of hearing want the vehicle to be equipped with a map they can follow, captions, and vibrations.

### *Best Mode of Transportation Overall*

Most said that public transit is the best for them overall, but if they chose one of the new mobility options, it would be either ridehailing or self-driving vehicles. Half of the group said the best option for them would be Uber/Lyft because it is a proven technology. Half said the best option was self-driving vehicles, but only one participant was interested in shuttles or buses. App-based carpooling was mentioned as the second option for two persons, whereas all of the others mentioned self-driving vehicles or Uber/Lyft as second.

## People with Cognitive Disabilities

The research team conducted three dyads composed of two participants with cognitive disabilities per group plus two helpers. Another one-on-one interview with a participant with cognitive disabilities demonstrating similar demographics was conducted in an informal interview and is included selectively to add insights learned from his unique perspective. All participants were given the option of bringing a helper or caregiver to help describe mobility challenges and help them acclimate to the flow of the conversation. One mom and one mentor joined the discussion as aides. Participants ranged from ages 22 to 33, and all received a University of California, San Diego Brief Assessment of Capacity to Consent (UBACC) score of 17 or over (14.5 was the required minimum)[2]. They were a representative mix of gender and race/ethnicity, and all the participants relied on others for 50 percent or more of their transportation needs.

[2] All participants with cognitive impairments were given the University of California, San Diego Brief Assessment of Capacity to Consent (UBACC) (https://pubmed.ncbi.nlm.nih.gov/17679641/). This instrument is a 10-question battery of open-ended questions where each response is rated on a scale from 0 to 2 (0=incapable; 1=partially capable; 2=clearly capable). As recommended by the UBACC study, the research team administered a slightly modified 9-question instrument to each respondent. Total potential scores on the UBACC range from 0 to 20 and, as determined by the study, those who score 14.5 or above out of 20 were determined as capable of giving consent and were invited to participate. Those who scored below 14.5 were not included in the study.

They resided in a mix of urban and suburban neighborhoods. None of them had a license, although some had learner's permits and had tried to learn but had not been successful. Some of the 20-somethings were still trying but were not optimistic about earning a license soon. Those participants in urban areas walk quite a bit, and most relied on parents or aides to drive them day-to-day; more than half used the city bus before COVID-19. Most used Uber or Lyft on occasion, and one used the train to get to the community college. All in the group who used city buses were quite knowledgeable about bus routes and schedules.

Most were from middle-class families. They all lived in Austin and were employed in maintenance, at restaurants, and at a thrift shop. They all currently participated in social services programs, and some had taken classes at the local college. All relied on someone who had a car—most often a parent, family member, or case worker.

### *COVID-19*

COVID-19 affected all of their employment and school situations, with everyone earning less, struggling more, traveling less, and getting proficient with Zoom. Aides, parents, and participants expressed concern about social isolation, lack of stimulation, and lack of purposeful activity such as work and school given the difficulties and risks associated with COVID-19. All said they took needed precautions due to COVID-19; they stopped using mass transportation and curtailed their use of Uber and Lyft.

### *Ridehailing*

All group members but one were aware of Uber/Lyft and had used them in the past. Most had the app on their phones, which was installed by a parent or aide. Most important, Uber/Lyft gave them greater freedom and independence to easily move around town. They liked ridehailing because they did not have to pay cash, and it provided the opportunity to meet new people and have different experiences. However, half were no longer using Uber/Lyft because of COVID-19.

One male said he did not like having different drivers. He felt anxious about the driver being on time and that riding with a stranger would be a risk. He said, "He could kidnap me." Two said it was expensive and that cost was an issue. One person (during an informal interview) explained that he was dyslexic and could not find the Uber in the Home Depot parking lot where he worked. He had become anxious about using the service for fear of not being able to find them and becoming lost, late, or abandoned. He reasoned that if the driver got out of the car and waved a hand or flag, it would dispel his fear and he would be more interested in using them again. One person experienced an inappropriate conversation in which the driver described a female passenger who lifted her shirt. He was made to feel uncomfortable, discussed it with his mother, and contemplated reporting him but ultimately decided that he was sensitive, and the driver may not have realized that. This anecdote was very disturbing to the female participant in the dyad who felt that he should have called the police.

All participants concerned about cost thought ridehailing would be a very good option if the cost was reduced. One person would use it more if he had the same driver, and one would use it if the driver would get out of his car and gesture so that he could be found.

### *App-Based Carpooling*

Half the participants had heard of informal carpooling, but none had used it. After explaining the concept, two liked the socializing aspect and thought it seemed less expensive than ridehailing. Some thought the photos with reviews made it seem safer.

Almost all in this group said that they would be nervous in a car with strangers, and one said it was almost as bad as hitchhiking. One believed this service would be too complicated to figure out, and it was not how he would like to meet new people. No one was interested in this service during COVID-19.

One suggestion was to utilize an app that enables a group of friends who are already acquainted with each other to efficiently organize rides, ensuring that the driver does not feel exploited or burdened by providing transportation for everyone else. Half thought carpooling was a good option to facilitate transportation across their existing networks. The other half thought this was a poor option because of the risk of danger from riding with strangers and the difficulty of coordinating the ride because everyone is going to different places.

### *Carsharing*

None of the participants had heard of carsharing, and none of the participants had a license. They could recall times when parents or caregivers could not provide a ride because their car was in maintenance and thought this feature might come in handy in such situations. One parent said it was like VRBO for cars, and because she had used that before, she thought she might want to try it. They also liked the idea of not having to pay for parking at night when traveling.

Most had no dislikes but did not think this service applied to them personally because they were not drivers. Most also said they were less interested in carsharing during COVID-19 because of not knowing who had been in the car before.

Overall, one person thought this option was very good because it provides another form of transportation if cars are not available, three thought it was an acceptable option, and two thought it was a poor option.

### *Bikesharing and E-Scooter Sharing*

All of the group were aware of rentals for bicycles and e-scooters, and one person had rented an e-scooter for recreation and found it fun and easy to use. Three others said they were interested in trying them because they looked like fun, and two participants said they were uninterested because they were too dangerous. One said he would try a motorized scooter only if there was a seat on it because his balance was not good.

Two people said they liked them because they were eco-friendly. One thought they would save time and be an easier and more enjoyable alternative to walking. One major dislike is that many people litter the sidewalks with them which creates a hazard for walkers. All said COVID-19 would not affect their usage as long as they took the necessary precautions, like sanitizing hands before and after.

The main barrier to their use is the lack of availability in their neighborhoods and in places where they would be useful for travel from bus stops to school or work. Weather is another barrier, but it is not particularly problematic in central Texas. Overall, one said they were a very good option, two said they were an acceptable option, and two said they were a poor option.

### *Self-Driving Vehicles*

Everyone had heard of self-driving vehicles. They wondered how they would know where to go and whether one would need a license to drive them. Two people said that self-driving cars would make them feel more independent because they would not have to rely on others to get around.

Upon further reflection, most rejected the idea because they did not trust the technology. They thought the cars could be hacked, there could be errors in the programming, sensors could break, and the whole idea was dangerous and inferior to human instinct and decision-making. They also thought that the cars would be too expensive. They also expressed concern that self-driving vehicles would take away jobs from drivers and reduce human interaction. Many said it just felt wrong, and it would eliminate opportunities such as personal connections and stories that can emerge from human-driven transportation (much like the stories depicted in *Driving Miss Daisy*).

When asked to choose between a self-driving bus, car, or shuttle, most preferred owning their own car if they could afford it. One preferred the bus because he could not imagine himself driving. COVID-19 did not affect their interest in self-driving cars since there was no one in the vehicle to worry about. They found self-driving shuttles or buses more worrisome during COVID-19 because it might present an issue with social distancing.

If they could be assured that self-driving vehicles were safe and secure, half said autonomous vehicles might be a good option, one said it was an acceptable option, and two said they would never consider them.

### *Best Mode of Transportation Overall*

Of the vehicles that they had not tried, two said self-driving vehicles were the preferred option because of the independence they offer, and one of them chose the self-driving bus rather than a car or shuttle. One participant said carpooling was the best mode because it offered the opportunity to meet people, one person preferred Uber/Lyft, and two people chose rental e-scooters.

## FOCUS GROUP FINDINGS ON SAVS

In June 2022, the research team hosted two virtual focus groups to discuss SAVs and learn more about how the participants perceived such services. The focus group discussions included people with disabilities from across the United States and followed a high-level outline that covered the following:

1. Background information, including ground rules and explanation of SAVs.
2. Daily trip-making practices and factors, including COVID-19, influence modal decisions.
3. Awareness and knowledge of or experience with SAVs.
4. Perceptions of SAVs (including barriers and opportunities).

The research team recruited focus group participants from previous survey respondents by emailing and calling to invite those survey respondents who indicated they would be interested in further study involvement. In total, the research team contacted more than 100 people and obtained commitments to participate from 14, though four were unable to participate on the days of the focus groups due to last-minute conflicts or technical difficulties (June 15 and 21, 2022).

Participants lived in rural, suburban, and urban areas across the United States; included seven people who identified as female and three who identified as male; represented ages across the spectrum (18+); and included people who identified as either African American or White. All participants had one or more disabilities (hearing, vision, ambulatory, cognitive) and were from low-income households (below $40,000). Upon completion of each focus group, participants who attended were each paid a $125 incentive.

To establish a baseline for discussing SAVs with participants, the research team first discussed participants' current mode choices (including how those choices have been impacted by the COVID-19 pandemic) as well as whether any of the participants had experienced SAVs firsthand. Participants' mode choices and relevant COVID-19 impacts are described in Table C-1 (none of the participants had experience using SAVs and did not arrive at the focus group with more than a cursory understanding of the concept).

**Table C-1. Participants' mode choices.**

| Participant | Current Modes | COVID-19 Impacts |
|---|---|---|
| 1 | • Avoids fixed route due to the need to climb stairs and/or stand.<br>• Uses paratransit service and free medical transportation through an insurance provider. | • Paratransit has returned to shared rides, which are not as comfortable as solo rides during earlier stages of COVID-19. |
| 2 | • Does not own a car.<br>• Relies on family for rides due to convenience and feelings of vulnerability in transit. | • College student with responsibilities during a pandemic—had to continue traveling.<br>• Attempted to use Uber or Lyft, but masks made communication difficult, and pricing was not predictable.<br>• Continued asking family for rides. |
| 3 | • Cannot drive and relies on friends to get around.<br>• Disability causes them to identify as "homebound."<br>• Uses paratransit sparingly, but requires morning pickup and late afternoon return, which is exhausting and inconvenient. | • COVID-19 delayed medical procedure by six months.<br>• Travel patterns did not change much with the pandemic because of homebound status pre-COVID-19. |
| 4 | • Limits driving—up to 5 miles from home on surface streets—to limit risks from disability symptoms.<br>• Does not use transit because service is poor/confusing, and stops are far.<br>• Can get to some doctors and grocery stores—all other trips are provided by family members because delivery is too expensive. | • Masks make understanding others difficult—this factor, combined with anxiety in crowds, makes transit even less accessible during the pandemic.<br>• Travel patterns did not change much with the pandemic because pre-COVID-19 routines did not involve public options (though local transit is still suspended due to COVID-19). |
| 5 | • Cannot drive.<br>• Lives within walkable distance of some destinations.<br>• Rides transit to get elsewhere but cannot access job opportunities reliably with the current service model.<br>• Recently lost access to subsidized taxi for other errands, but family helps. | • Locked down at the beginning of the pandemic and stayed isolated for 13 months to protect personal/family health.<br>• Only traveled to places within walking distance. |

| Participant | Current Modes | COVID-19 Impacts |
|---|---|---|
| 6 | • Does not own a car.<br>• Rides transit to access groceries (free pass for disabled veterans).<br>• Requests rides from friends. | • Continues to wear masks on the bus despite having the option not to. |
| 7 | • Does not own a car, and rural area is not walkable.<br>• Would prefer to drive, but disability precludes this option.<br>• Has groceries delivered.<br>• Daughter provides transportation to the doctor.<br>• Paratransit is available, but roundtrip is three hours or more for errands and is limited to within the county boundaries. | • COVID-19 is a major factor in transportation decisions.<br>• Anything that can be delivered is acquired this way—only trips are to the doctor. |
| 8 | • Just got license back, but gas is expensive.<br>• Uses mobility scooter (4-mile roundtrip range) or medical transportation, but medical transportation has lengthy waits.<br>• Moving soon to be closer to important destinations. | • COVID-19 is not a concern.<br>• Not vaccinated, and decisions did not change. |
| 9 | • Drives about once per week for groceries and other errands—difficult to get in/out of the vehicle, but no other options.<br>• Uses mobility device at home and wheelchair at events. | • COVID-19 is not a concern.<br>• Not vaccinated, and decisions did not change other than masking in public. |
| 10 | • Cannot drive but wishes they could (gave up license about 10 years ago).<br>• Neighbor helps with trips to groceries and uses paratransit as needed.<br>• Moved to be closer to medical care when previous transportation option was suspended due to COVID-19. | • COVID-19 caused the suspension of trips to medical care.<br>• Fully vaccinated and boosted, therefore not very concerned about transmission during travel—wears a mask and sometimes a face shield. |

During the research team's conversations with focus group participants, three clear themes emerged: (a) barriers to accessing SAVs, (b) challenges or concerns related to using SAVs, and (c) opportunities presented by SAVs or ways to improve SAV service offerings. The following subsections summarize focus group findings from each of these three themes.

## Barriers to Access SAVs

After reviewing the concept of SAVs with participants and answering any clarifying questions they presented, the researchers noted that most participants saw clear barriers to using such transportation options. The barriers identified by participants included the following:

- Rural operations/availability—How can people with disabilities benefit from SAVs in areas where residential density is low and infrastructure is not uniform? Unlike urban areas with relatively uniform street design/pavement quality and a higher density of residents, participants explained that rural areas consist of a mixture of road types (including gravel), limited or nonexistent signage, private access roads (requiring either a difficult/impossible walk/roll for riders or SAV operations on private property), and long distances between travel destinations.

- Accessibility for wheelchair users—How can multiple people who use wheelchairs be accommodated in a vehicle, and who will help with securement? Current paratransit vehicles feature van chassis cutaways with seating for around 14 people, typically accommodate at least two people using wheelchairs (including very heavy/large power chairs) and have a vehicle operator on hand to assist with securing a rider's wheelchair. All participants, including those individuals who do not use mobility devices, expressed concern about SAV capacity due to evidence that current SAVs are smaller than paratransit vehicles and because an operator will not be present to secure their wheelchairs if needed.
- Affordability—Will the service, which seems like a premium option, be excessively expensive or have a variable fare? Participants were all familiar with current paratransit fare structures and know that they are affordable and predictable, which helps them budget for their transportation when using these shared modes. SAVs seem to offer a premium service because they operate on-demand, have shorter wait times, and implement new technology. Therefore, participants expressed concerns about their ability to afford SAV service. Additionally, participants quickly connected possible SAV service models to those of TNCs and expressed concerns that a variable fare would preclude them from using SAVs due to the fear of being responsible for a fare that exceeds their budget.
- Fare payment option—Will riders be required to pay with credit cards? Some participants prefer cash since it helps them budget their expenses (e.g., they set aside certain amounts for certain expenses, such as transportation or groceries, and when the set-aside amount is exhausted, they curtail that activity for the month). The participants agreed that a stored value concept, such as a tap card, is a good substitute for cash payments, but without this accommodation, they cannot ride SAVs.
- Technology requirements—How can people with certain disabilities (e.g., visual or cognitive) request trips if a smartphone is difficult/impossible to use or if they simply do not have such a device? According to the service models discussed, SAV trips will typically be requested via smartphone apps, with a customer service center available as a backup. Multiple participants stated that they will not regularly or easily be able to use SAVs without the ability to request trips via either phone or website due to challenges with their disabilities.
- Technology trust—How can riders be sure the SAV is safe on the road and will get them where they need to be, and that they will not be left alone with strangers? The idea of trusting an SAV to transport them safely was difficult for some participants. All participants also expressed concern that without a human operator on board to intervene, there was a risk that the SAV might somehow fail and leave them stranded, or that they would experience increased risk associated with exposure to strangers. Without the minimum availability of a direct connection to a human operator via an onboard call button (e.g., like those on some elevators), participants would not be comfortable using SAVs. A secondary option that some participants said might help them trust the technology is a customer service call center available in emergencies, which can also help with trip planning and general customer service.
- Vehicle design—Beyond accommodating people who use wheelchairs and mobility devices, how can the vehicles be designed to accommodate other needs, such as issues with balance or dizziness that require forward-facing travel? During the review of vehicle

types, the participants noticed that some SAVs include seats that require some people to travel backward. Multiple individuals expressed concern about traveling in this configuration and would not ride SAVs with this design even if there were some forward-facing seats due to the chance they might not get to choose where they sat.
- Pickup/drop-off proximity—How can the service be operated so that SAVs pick up or drop off as close to the rider's origin or destination as possible? Many participants have challenges traveling far by walking or rolling and expressed concerns that some SAV service models might require a quarter-mile walk between the vehicle and their origin or destination. If the service cannot pick up and drop off as close as possible, many participants will not use SAVs.

### Challenges or Concerns Related to SAV Use

Other feedback collected during the focus group conversations dealt with perceived challenges with SAVs or concerns about SAV service operation—issues that, while not identified as significant enough to bar participants from using SAVs, can make the SAV experience better if addressed. Challenges or concerns according to participants were as follows:

- Ownership and liability should be clearly explained to the customer so that riders and the community understand what they are paying for.
- Travel training programs need to be adapted so that people with disabilities and service animals understand how to interact with SAVs.
- Low-speed vehicles should be given their own lane to make sure they do not impede other traffic or cause crashes due to unexpected slowness.
- SAVs should have a method of communicating with other road users beyond turn signals and brake lights (e.g., a sign that tells pedestrians they are seen and can cross) to be considered a safe addition to the roads.
- The service should be advertised in a way that helps people easily understand what it is and how they can use it or benefit from it.
- The idea of sharing a ride with others on an AV caused all participants to hesitate when compared with a dedicated ride on an AV because a human operator would not be on board to address social infractions, and the participants believe that a higher-cost service implies that sharing would not be required.
- Some participants expressed concerns that the cost of the SAVs and/or SAV maintenance might limit their availability and that low-quality local infrastructure might dissuade investments in SAVs.

### Opportunities

Despite the barriers, challenges, and concerns that the participants identified, some clear opportunities emerged during the conversations:

- Participants noted that transitioning current paratransit operators to a customer service steward position on SAVs will be helpful because the stewards can focus entirely on the customer experience, helping riders board and alight from vehicles and acting as an official third party in instances of intimidating interactions with other riders.
- About half of the participants stated that SAVs would improve their level of independence if they were made available in their areas.

- While using a local sidewalk, one participant who uses a power wheelchair was harassed by passersby—this person imagined that having access to an SAV might limit this type of exposure.
- All participants believed that the short informational video viewed during the focus group was useful and that providing this type of detail to others would help them understand the concept of SAVs and how they might be able to use them. The participants also suggested that a social media campaign (specifically TikTok) would help people like them learn more about SAVs.
- An ideal SAV service, according to the focus group participants, will include the following elements:
  - Larger vehicles to accommodate multiple wheelchair users.
  - A customer service representative (steward) on board the vehicle.
  - An emergency stop/human intervention feature.
  - On-demand door-to-door service.
  - Fares similar to or less expensive than paratransit, with fare-free options for eligible populations.
  - Vehicles that are affordable to procure in large quantities to facilitate rural adoption.
  - Vehicles that can operate in all weather and rural areas with diverse road infrastructure.

# APPENDIX D

# UNDERSERVED POPULATION SURVEY

Appendix D presents findings from a descriptive analysis of a survey of historically underserved populations regarding their current, COVID-19-influenced, and potential future travel behavior.

The purpose of the online survey was to gather information directly from members of the underserved populations about their use of new mobility services, existing barriers to use, and potential solutions. The survey was designed to provide answers to the following research questions:

1. What is the current local (not long-distance) travel behavior of underserved populations?
2. How did COVID-19 influence the ways in which underserved populations travel?
3. What barriers exist that make it difficult for underserved populations to use new mobility services?
4. What are potential policy or planning solutions to those barriers?
5. If barriers were removed, would underserved populations use new mobility services?

## SURVEY METHODS

### Survey Sample

Survey respondents were drawn from the Qualtrics online panel. An online panel is a group of people who have been pre-recruited to respond to surveys. Using a panel makes finding people in specialized population groups economically feasible. It also provides faster data-collection turnaround and higher-quality data. Qualtrics (2014) uses niche panels created through specialized recruitment campaigns to access hard-to-reach groups. Panel respondents are compensated based on the length of the survey, their specific panelist profile, and the difficulty of acquiring a target.

The following quotas were set to ensure that a minimum number of people in key target groups completed the survey:

- People with low incomes = 200.
- People with disabilities = 500 (across four disability types).
- People who live in rural areas = 200.
- People age 70+ = 200.
- People who speak little or no English = 150.

The setting of quotas was done with certain assumptions that people could belong to more than one underserved population group (e.g., older adults could include people with disabilities; people who spoke little or no English could include people with low incomes).

### Survey Instrument

The conducted focus groups yielded valuable insights into the barriers and potential strategies related to the access and use of transformation technologies considered in this project, particularly among specific population groups. These insights, in conjunction with data gathered

from other tasks such as the literature review, informed the design of an online survey instrument.

A draft online survey questionnaire was submitted for review to the TCRP Project B-47 panel with the interim report in June 2020. It was revised based on feedback received during an interim webinar in July 2020. In October and November 2020, eight virtual focus groups were conducted to elicit information to finalize the online survey questions. The online survey questionnaire was revised based on the focus groups' findings. The final survey instrument was translated into Spanish. Approval was received for both English and Spanish surveys from the Texas A&M University Institutional Review Board in January 2021.

The survey contained 103 questions, which were organized into the following topic areas:

- Quota-related demographics.
- Communication and other assistive technology use.
- COVID-19-influenced travel behavior.
- Current travel behavior.
- Use of new mobility services.
- Attitudes, opinions, barriers, potential solutions, and likely use pertaining to ridehailing, bikesharing, e-scooter sharing, carsharing, app-based carpooling, and self-driving vehicles.
- Household demographics.
- Personal demographics.

### Survey Execution

The questionnaire was programmed using the Qualtrics software platform. The survey was reviewed and revised using the Qualtrics Check Survey Accessibility feature that ensures the online survey meets accessibility standards.

The English language survey was executed in March 2021; the Spanish language survey was executed in April and May 2021. The average survey length was around 25 minutes. The median survey length was around 18 minutes.

Upon completion of data collection, the research team conducted a detailed data review and then cleaned and processed the data for analysis. A total of 1,275 people provided a usable survey sample, which constituted the data used for the analysis. Because of the overlapping of characteristics (e.g., people being counted as both low-income and rural residents), the sum of all groups is greater than the 1,275 respondents who completed the survey.

## SURVEY SAMPLE DEMOGRAPHICS

This section presents descriptive statistics about the demographics of 1,275 survey respondents. The survey was not designed to be a probability (i.e., representative) sample of the population of the United States. It was designed to sample according to quotas to ensure that underserved populations were included in sufficient numbers to permit reliable analysis of the data. While the survey data may not be generalizable to the entire population, it serves as a valuable resource for understanding the behaviors and characteristics of the specific groups under investigation and provides a complementary perspective when considered alongside other research methods employed as part of the project.

Many of the figures and tables are organized according to the five target groups with sampling quotas described above.

## Residence Location

### *Region*

Reflective of the population of the United States, most survey respondents were in the South (38%). Twenty-three percent resided in the Midwest, 22% in the Northeast, and 17% in the West. With this distribution, the survey was able to capture people who travel in various types of environments and weather conditions.

### *Community Types*

The survey sample included 509 people who resided in rural communities (40% of total); this resultant sample was more than double the quota of 200 rural residents due to the aforementioned overlapping count concept. Since rural areas are often ignored in studies on the impact of new mobility services, this robust sample size enabled detailed analyses.

As shown in Figure D-1, there were consistent proportions of rural residents among older adults, people with low income, and people with disabilities, though the distribution was skewed toward urban for those who spoke little or no English.

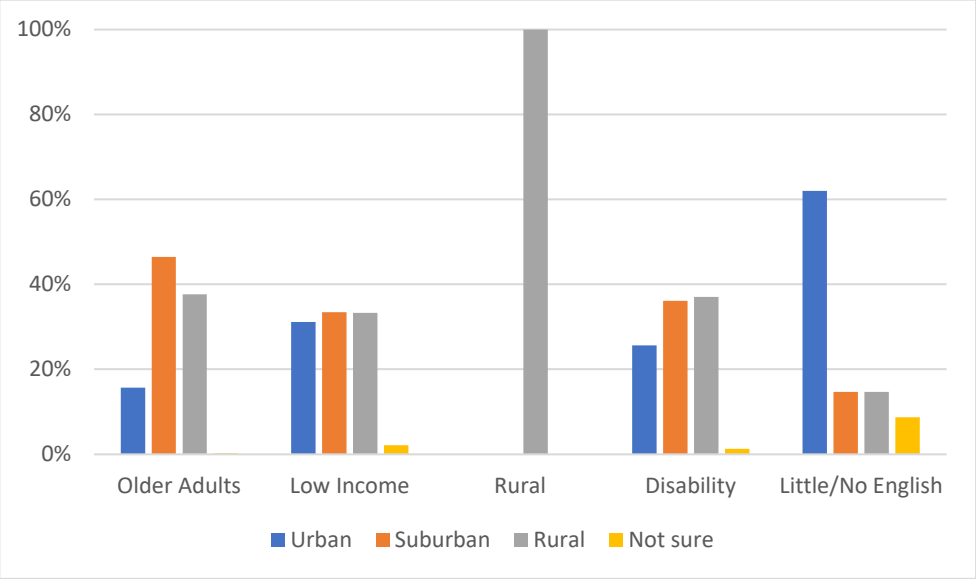


**Figure D-1. Distribution of community types by underserved population groups.**

## Personal Characteristics

### *Gender*

In terms of gender categories, around 99% of survey respondents self-identified as male or female. The sample had more females (67%) than males (33%) (see Figure D-2).

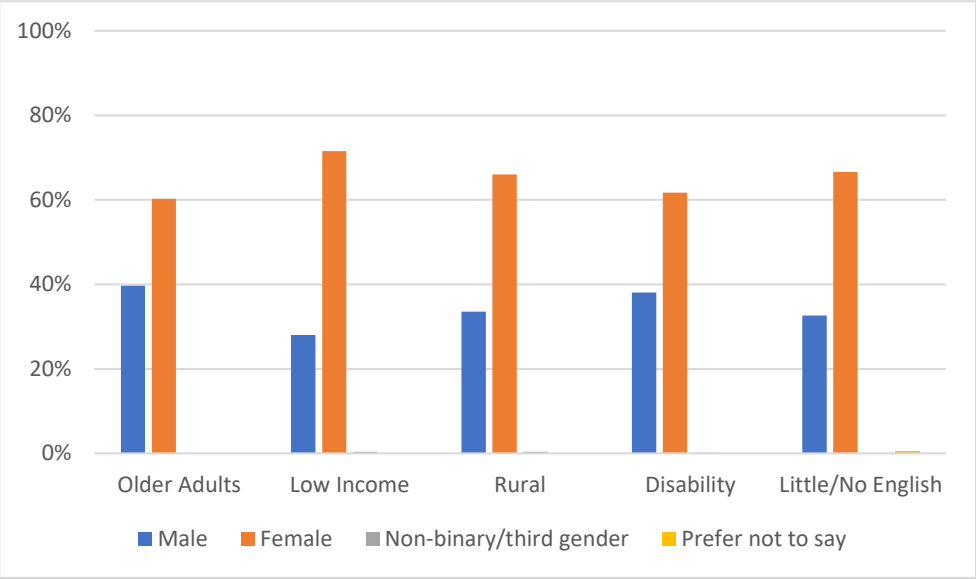


**Figure D-2. Gender distribution by underserved population groups.**

The uneven gender split of respondents is more pronounced than in the general population. The largest proportions of men were in the people with disabilities and older adult samples. Two people from each of the low-income, disability, and rural groups self-identified as nonbinary/third gender. One person in the group that spoke little or no English preferred not to comment on their gender.

### *Age*

The sample skewed toward older people, mainly due to the quotas set for people age 70+, residing in rural areas, and people with disabilities. Nearly 70% of the sample was age 55+, and about 30% was younger (see Figure D-3). On the other hand, adults who spoke little or no English tended to be younger, which might be an indication of many immigrants coming to the United States at younger working ages for employment opportunities.

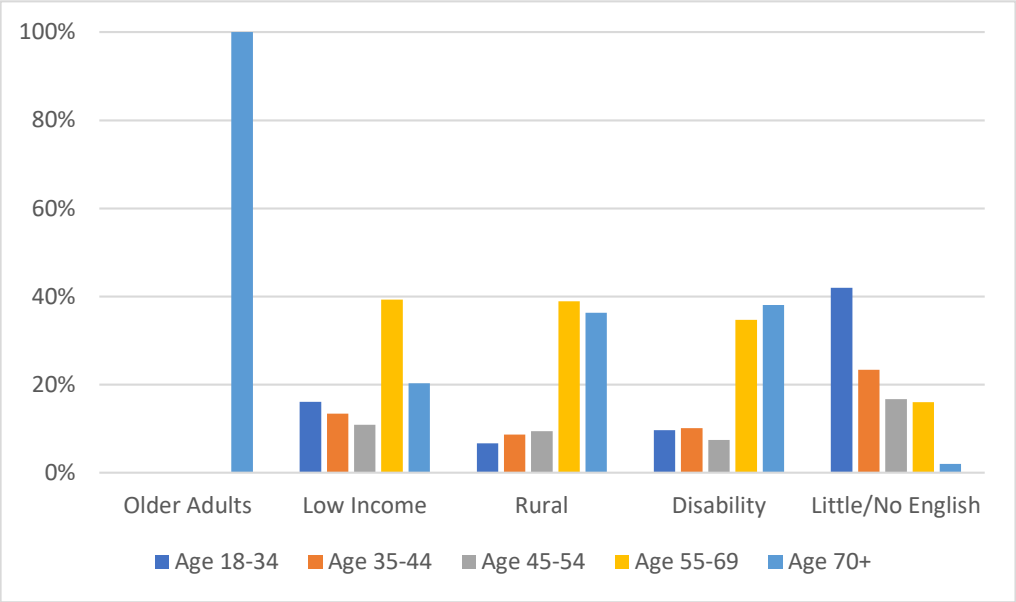


**Figure D-3. Age distribution by underserved population groups.**

### *Race, Ethnicity, and Country*

The majority of survey respondents (82%) self-identified as being White when asked for their race. Around 9% of survey respondents indicated being African American, while 5% preferred not to self-identify their race. Given the quotas on adults who spoke little or no English, 15% of the sample self-identified as Hispanic.

The survey also asked respondents for their citizenship status and the country in which they were born. Ninety percent of the sample noted being a citizen of the United States. The share was lower among those who spoke little or no English, with 65% indicating not being a citizen. Similarly, 86% of the overall sample indicated that they were born in the United States. Among the respondents who spoke little or no English, 93% indicated they were born in another country.

### *Disabilities*

The survey specifically targeted people with disabilities. A total of 643 people self-identified as having some type of disability, with around 16% having more than one. Ambulatory disabilities (i.e., serious difficulty walking or climbing stairs) were most frequently cited, pertaining to 26% of the sample (see Figure D-4).

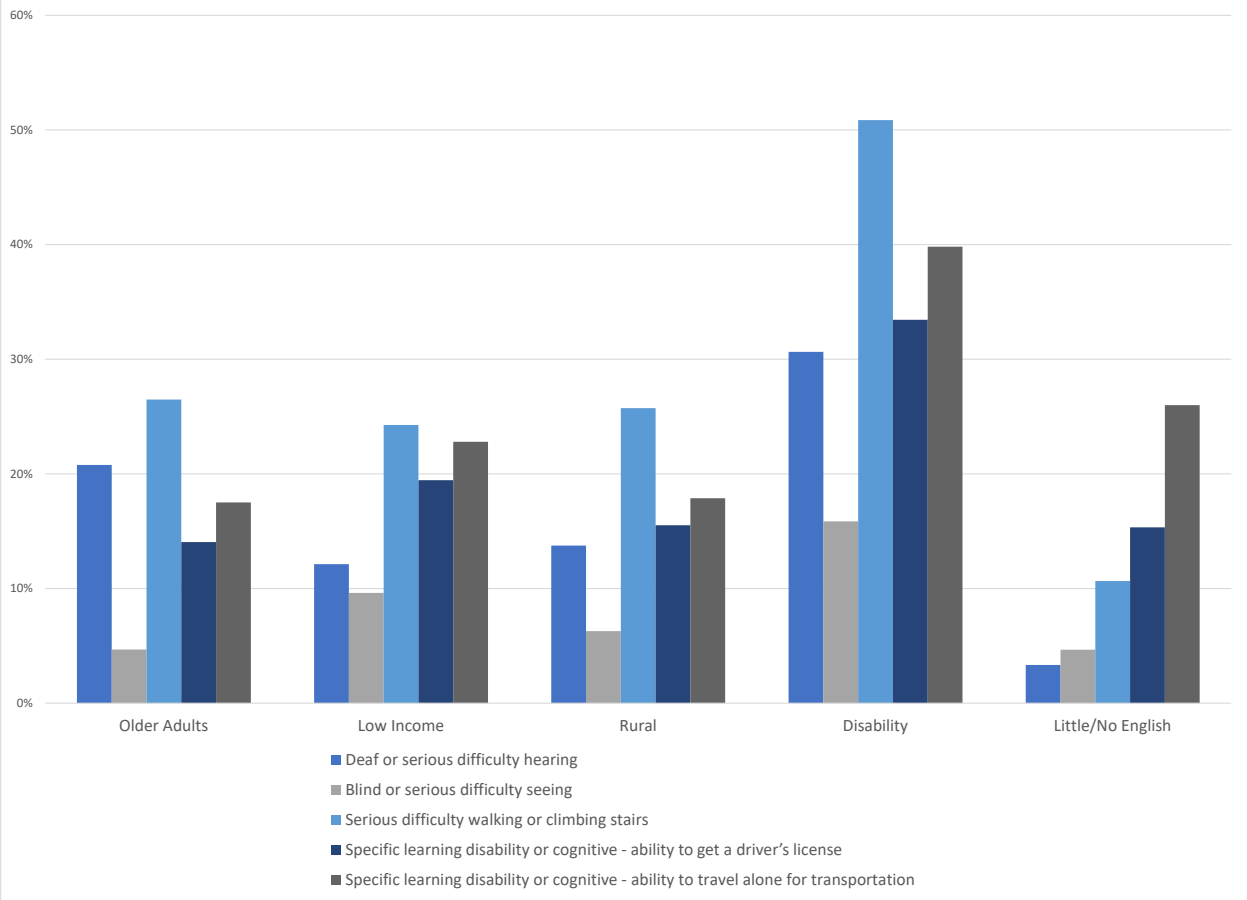


**Figure D-4. Distribution of disabilities among underserved population groups.**

Cognitive disability was reported by almost one-fourth of respondents. Specifically, 17% reported having a specific learning disability or cognitive disability that affects getting a driver's license, and 20% reported a disability or impairment that affects being able to travel alone for school, work, medical, or shopping purposes. Being deaf or having serious difficulty hearing was reported by 16%. Being blind or having serious difficulty seeing was the least reported disability (8%). Many of the older adult, low-income, and rural respondents reported disabilities.

Older, low-income, and rural groups had a similar distribution of mobility disabilities while hearing difficulties were more pronounced among older adult respondents, and visual and cognitive disabilities were more frequently noted among respondents with low incomes and those living in rural areas. The most prevalent type of disability among the group that spoke little or no English was cognitive disability, comparable to the group of people with low incomes. People with disabilities were of various ages, though most were older than age 55.

## Technology Use

### *Assistive Technology*

People who indicated certain disabilities were asked about their use of assistive technologies. A variety of assistive technologies were used, with the most common being hearing aids for people with hearing disabilities, smartphone GPS speech navigation for people with visual disabilities, and orthopedic support canes for people with mobility disabilities (see Table D-1).

**Table D-1. Assistive technologies used by individuals with disabilities.**

| Assistive Technology | Percent |
|---|---|
| **Deaf or Serious Difficulty Hearing (N = 197)** | |
| Hearing aids | 58% |
| Closed captioning on media devices | 24% |
| Lipreading | 19% |
| Speech to text or speech recognition software | 7% |
| Assistive listening devices to amplify sounds | 5% |
| Cochlear implants | 3% |
| Specialized smartphone applications | 2% |
| Specialized computer programs | 0.5% |
| None | 26% |
| **Blind or Serious Difficulty Seeing (N = 102)** | |
| Smartphone GPS speech navigation | 21% |
| Low vision optical devices | 15% |
| Text to speech or screen reader software | 13% |
| Long white cane | 8% |
| Service dog | 7% |
| Aira services | 5% |
| Braille printers or translators | 3% |
| Specialized computer programs | 1% |
| Specialized smartphone applications | 0% |
| None | 55% |
| **Serious Difficulty Walking or Climbing Stairs (N = 327)** | |
| Orthopedic support cane | 36% |
| Walker/rollator | 25% |
| Wheelchair | 15% |
| Companion for assistance | 13% |
| Motorized mobility scooter | 10% |
| Orthotic device/braces | 7% |
| Modified motor vehicle | 4% |
| Crutches | 3% |
| Prosthetic device | 2% |
| None | 33% |

### *Communication Technology*

Most survey respondents reported regularly using smartphones, laptops, tablets, or desktop computers (see Figure D-5). There were consistent percentages for smartphone use across older adults (72%), people with low incomes (80%), people residing in rural areas (79%), people with disabilities (81%), and people who spoke little or no English (85%). This finding is important since many new mobility services rely on smartphone apps. People who spoke little or no English reported relying on regular cell phones far more than all other groups.

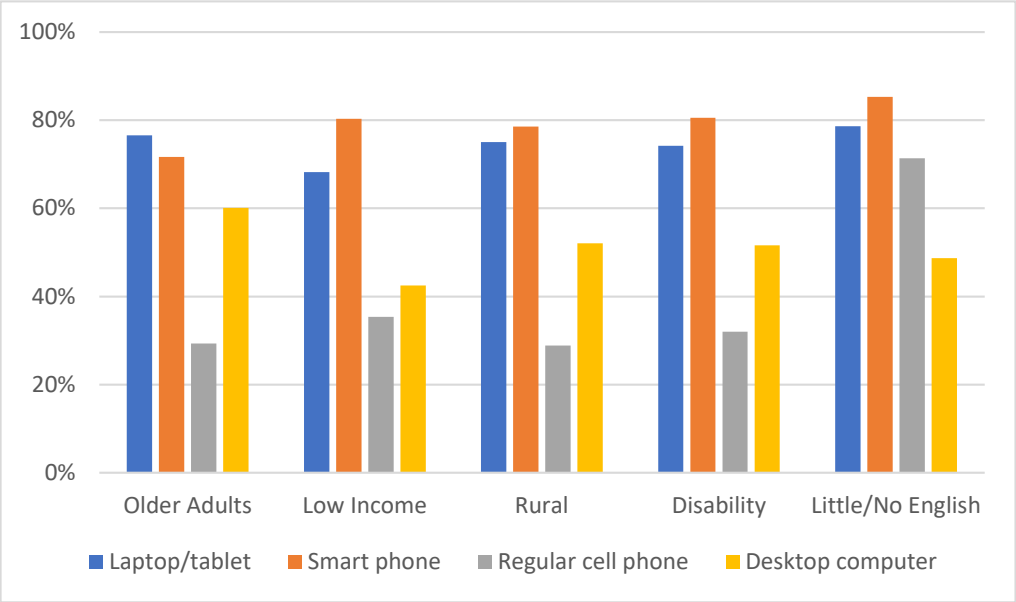


**Figure D-5. Regular use of communication technologies by underserved population groups.**

The high amount of reported smartphone use is consistent with data from other studies. The Pew Research Center reported in 2020 that the share of Americans who owned a smartphone was 85%, up from just 35% in 2011 (Pew Research Center 2021). In the Pew survey, smartphone ownership was reported by 80% of people who lived in rural areas, 76% of people with low incomes (making less than $30,000/year), and 61% of older adults (65+). Data were not provided for people with disabilities.

Of the people in this study who regularly used the aforementioned communication technologies, most had reliable access to high-speed internet when using them (see Figure D-6).

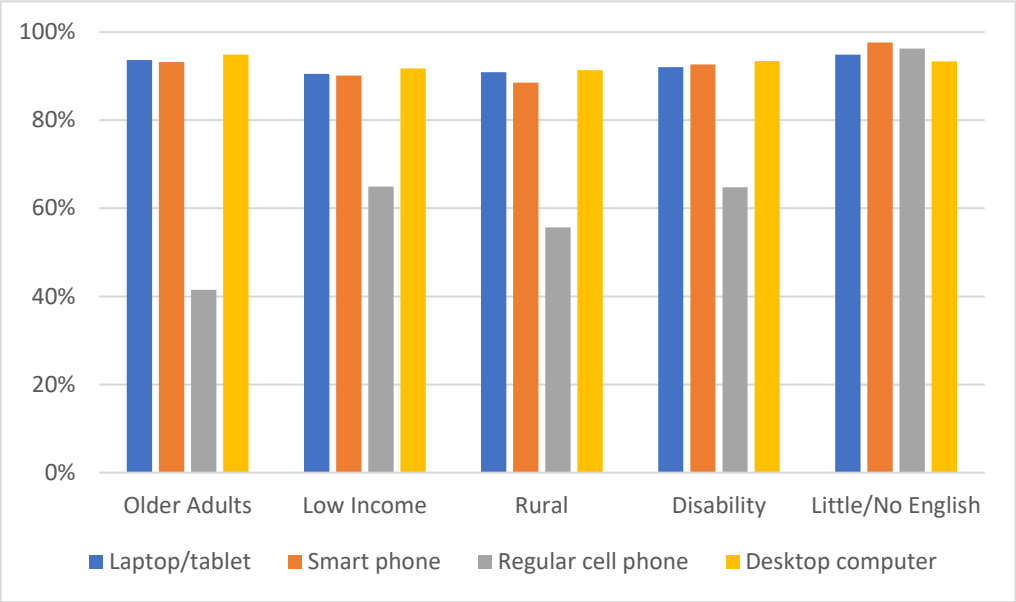


**Figure D-6. Access to population groups using communication technologies reliable high-speed internet by underserved.**

## Household Characteristics

### *Household Size*

The average household size for the survey sample was 2.36 people; it was slightly lower for individuals with low incomes (2.13 people) and older adults (1.88 people) and higher for people who spoke little or no English (4.19 people), rural residents (2.28 people), and people with disabilities (2.29 people). Older adults and people with low incomes were more likely to live alone than people living in rural areas and people with disabilities (see Table D-2). People who spoke little or no English had the largest household size compared to the other segments. This was particularly true for individuals with visual disabilities, with almost two-thirds indicating the need for a caregiver for travel.

**Table D-2. Household (HH) size by underserved population groups.**

| HH Size | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| 1 | 33% | 44% | 22% | 28% | 2% |
| 2 | 56% | 29% | 51% | 42% | 9% |
| 3 | 6% | 11% | 12% | 14% | 15% |
| 4 | 2% | 9% | 8% | 10% | 41% |
| 5 | 1% | 3% | 3% | 4% | 17% |
| 6+ | 2% | 4% | 3% | 2% | 15% |
| | 100% | 100% | 100% | 100% | 100% |

The presence of other people in the household presents the opportunity to ride as a passenger in the household member's vehicle, as well as have a travel companion. Almost one-third of people with disabilities reported that they needed a caregiver to help them travel outside of their home (see Table D-3).

**Table D-3. Need for caregiver when traveling outside the home by underserved population groups.**

| Frequency of Need | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every time | 4% | 6% | 5% | 9% | 5% |
| Almost every time | 2% | 6% | 2% | 6% | 5% |
| Sometimes | 5% | 11% | 7% | 14% | 17% |
| Rarely | 7% | 9% | 8% | 12% | 11% |
| Never | 82% | 69% | 77% | 60% | 62% |
| | 100% | 100% | 100% | 100% | 100% |

### *Children*

Using some of the new mobility services is more challenging if traveling with children. In the aggregate, 19% of survey respondents reported having children between the ages of 0 and 17 living in their household. A substantially higher percentage was reported among people who spoke little or no English (see Table D-4). Most people with children in the household reported that the children were under age 12.

**Table D-4. Presence of children in the household by underserved population groups.**

| Children Present | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Yes | 4% | 18% | 15% | 18% | 75% |
| No | 96% | 82% | 85% | 82% | 25% |
| | 100% | 100% | 100% | 100% | 100% |

### *Income*

The survey sample in general reported low household incomes. More than half of the respondents in each of the underserved groups reported total household incomes of less than $50,000 (see Table D-5). In addition to the low-income segment, those who spoke little or no English reported experiencing substantial income challenges. This finding places the responses on barriers to using new mobility services relating to affordability and cost in context.

**Table D-5. Total household income by underserved groups.**

| Household Income | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Less than $25,000 | 20% | 100% | 31% | 37% | 39% |
| $25,000 to $49,999 | 33% | 0% | 34% | 31% | 41% |
| **Subtotal** | **53%** | **100%** | **65%** | **68%** | **80%** |
| $50,000 to $74,999 | 21% | 0% | 17% | 15% | 11% |
| $75,000 to $99,999 | 10% | 0% | 9% | 7% | 2% |
| $100,000 to $149,999 | 8% | 0% | 5% | 5% | 0% |
| $150,000 or more | 4% | 0% | 2% | 2% | 0% |
| Prefer not to answer | 4% | 0% | 3% | 3% | 7% |
| | 100% | 100% | 100% | 100% | 100% |

## COVID-19 INFLUENCED AND CURRENT TRAVEL BEHAVIOR

### Travel Frequency during COVID-19

Most survey respondents reported that they traveled less during COVID-19 compared to before March 2020 (see Figure D-7). This finding is consistent with other data on travel behavior during COVID-19.

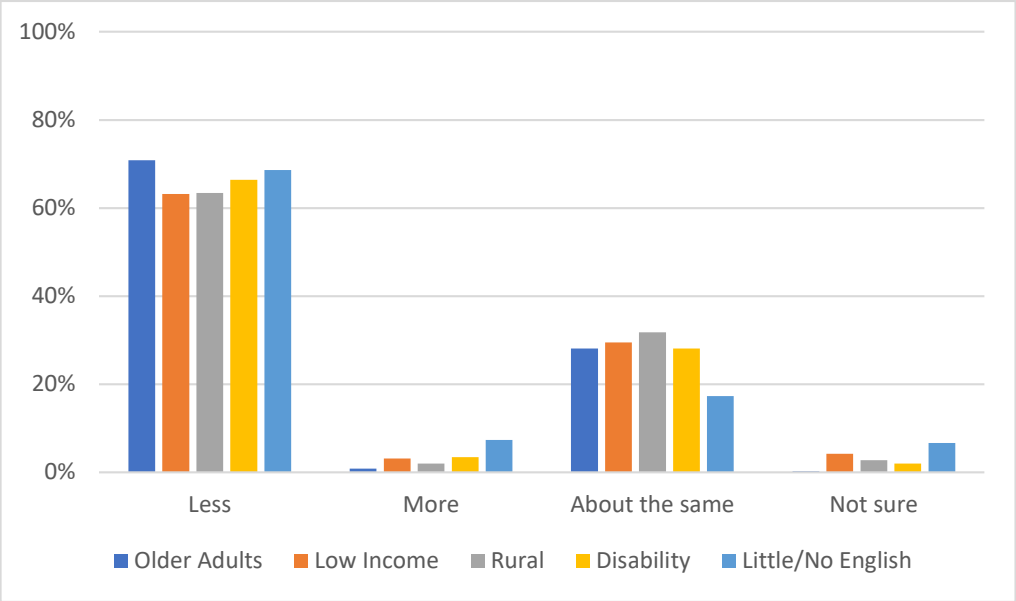


**Figure D-7. Travel frequency during covid-19/before march 2020 by underserved population groups.**

Another way to illustrate the decrease in travel during COVID-19 was in response to a question on how many days per week out of seven days people left home to travel for work, medical care, shopping, school, therapy.

As shown in Figure D-8, around 18% of people with low incomes and people with disabilities and around 15% of older adults and rural residents did not leave home at all on average. Almost half of the older adults only left home one to two days per week, while around 42% of the remaining groups (except those who spoke little or no English) left home one to two days per week. The proportion of people traveling six to seven days a week was nearly halved. Those who spoke little or no English were the most frequent travelers before and during COVID-19.

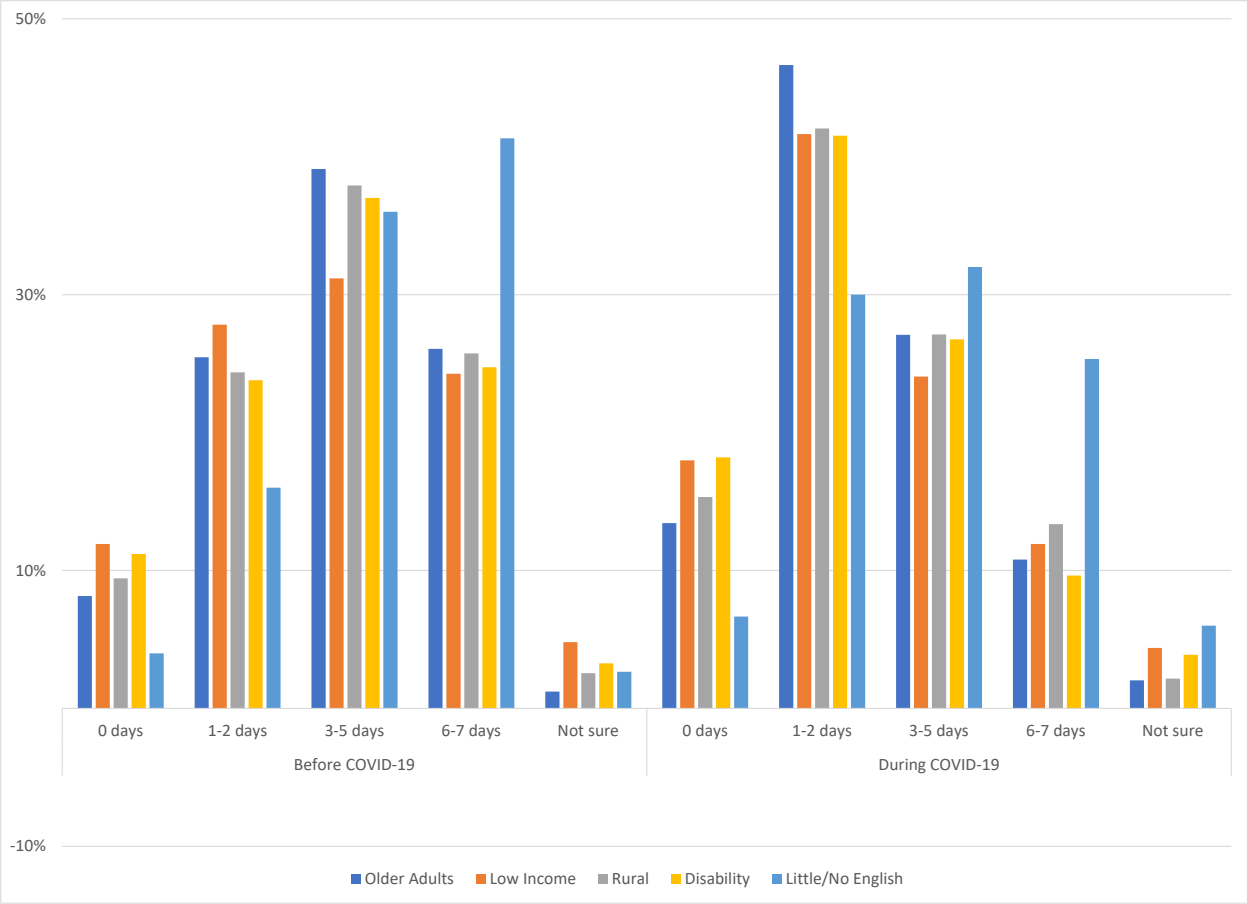


**Figure D-8. Number of days per week of travel by underserved population groups.**

When asked why they traveled less, most respondents indicated health concerns and the desire to keep a safe social distance from other people (see Figure D-9). Economic and work-related factors were more likely to be mentioned by those who spoke little or no English and those with low incomes than other underserved population groups. People who spoke little or no English were also more likely to say that transportation safety was a barrier.

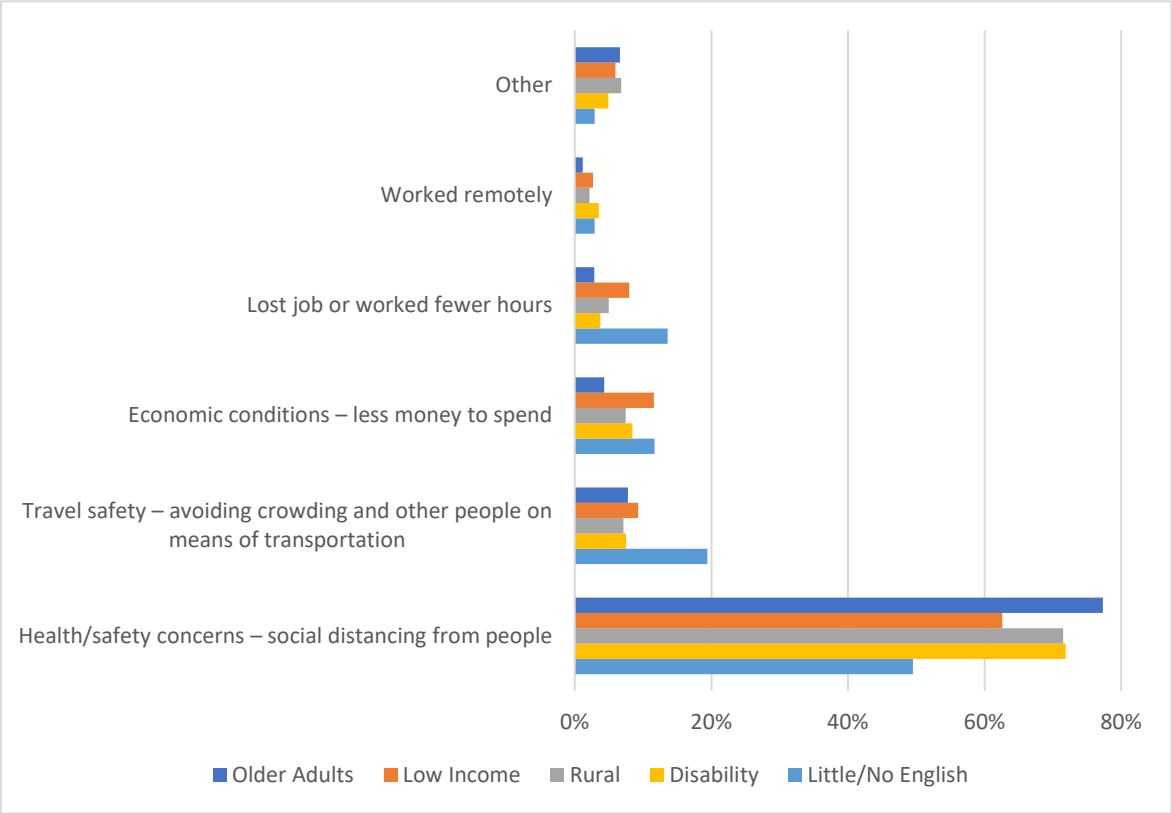


**Figure D-9. Reasons for less travel outside the home during covid-19 by underserved population groups.**

## Employment and Education Level

Generally, the main reason for travel outside of the home is to commute to work or school. Except for the group that spoke little or no English, the majority of the sample was retired or on disability, as shown in Table D-6. Only about 22% of respondents were employed full-time or part-time during the time of the survey. Compared to older and low-income groups, people with disabilities were more likely to be employed, followed by rural residents.

**Table D-6. Employment status by underserved population groups.**

| Employment Status | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Employed full-time | 2% | 10% | 14% | 15% | 31% |
| Employed part-time | 5% | 9% | 8% | 9% | 21% |
| Retired | 88% | 44% | 58% | 55% | 5% |
| Student | 0% | 3% | 1% | 1% | 4% |
| Unemployed—looking for work | 2% | 16% | 7% | 7% | 25% |
| Unemployed—not looking for work | 3% | 20% | 15% | 16% | 17% |

People who spoke little or no English went from 69% employment before COVID-19 to 52% afterward, a decrease of 17%. Similarly, other groups saw a decrease in employment pre/during COVID-19 of almost 25%.

The survey also asked about any volunteer work outside the home or if respondents were enrolled in school, educational, vocational, or therapy programs. Older adults indicated the highest share of volunteer work (19%), followed by an equal distribution among people living in rural areas, people with disabilities, and people who spoke little or no English (16%). Respondents with low incomes had the least share of reporting regular volunteer work. In addition, around 7% of people with low incomes and people with disabilities indicated being part of educational, vocational, and therapy programs. The share was the highest among people who spoke little or no English, at 10%, and the lowest share was among older adults (2%).

There was a bi-modal distribution on educational attainment; about 30% reported attaining a bachelor's degree or higher, while about the same percentage reported being a high school graduate or less.

### *Essential Workers*

About one in four respondents was currently employed at the time of the survey. Of these, about 12% self-identified as essential workers. They worked in healthcare (17%), critical retail (15%), cleaning/janitorial (13%), critical trades (10%), and agriculture and food production (5%).

### *Remote Workers*

The results related to remote working revealed interesting insights. An important share of employment loss was reported among survey respondents. Table D-7 provides an overall distribution of the sample, while Figure D-10 reveals the differences across underserved groups.

Of those employed in the spring of 2021, the majority reported traveling to work each day. Older adults were most likely to work from home during COVID-19, and respondents who spoke little or no English were the least likely to work from home, at 3%. Over 40% of people with disabilities and older adults reported that they worked from home during COVID-19, followed by respondents with low incomes at 38% and respondents living in rural areas at 31%.

**Table D-7. At-home workers currently (as of spring 2021).**

| Work Location | During COVID-19 (as of Spring 2021) |
|---|---|
| Working remotely | 25% |
| Traveling to work each day | 62% |
| Hybrid—doing both | 13% |
| | 100% (N = 320) |

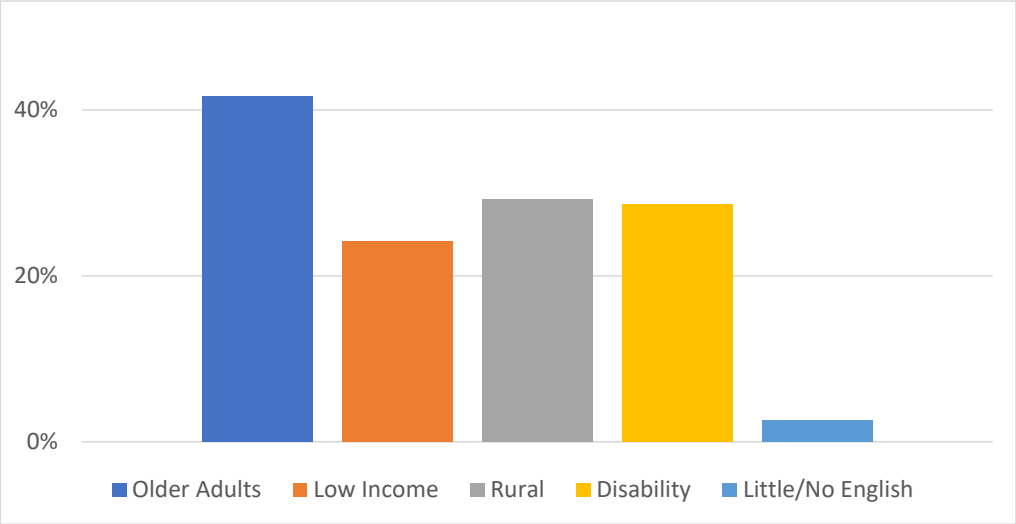


**Figure D-10. People working remotely during COVID-19 by underserved population groups.**

## VEHICLE OWNERSHIP/ACCESS

Nearly 9 of 10 sampled respondents owned or had access to a personal vehicle. This was highest among older people (92%) and lowest among people with low incomes (69%) and people who spoke little or no English (69%) (see Table D-8). Very similar percentages had a valid driver's license.

**Table D-8. Own or have access to a personal vehicle by underserved population groups.**

| Response | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| **Yes** | 92% | 69% | 90% | 82% | 69% |
| **No** | 8% | 31% | 10% | 18% | 31% |
| | 100% | 100% | 100% | 100% | 100% |

With substantial ownership or access to personal vehicles, it is not surprising that most people reported driving every day or almost every day (see Table D-9). The exception was people with low incomes, who also reported low ownership of or access to personal vehicles.

**Table D-9. Daily frequency of driving by underserved population groups.**

| Daily Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every day | 15% | 13% | 17% | 17% | 36% |
| Almost every day | 43% | 25% | 36% | 33% | 19% |
| **Subtotal** | **58%** | **38%** | **53%** | **50%** | **55%** |
| Sometimes | 26% | 25% | 28% | 22% | 15% |
| Rarely | 7% | 12% | 9% | 12% | 8% |
| Never | 9% | 24% | 10% | 16% | 22% |
| | 100% | 100% | 100% | 100% | 100% |

## USE OF TRADITIONAL TRAVEL MODES

Tables D-10 through D-17 present the trip frequency of modes used by respondents. As seen in Table D-10 and Table D-11, most respondents drove a personal vehicle or rode in the personal vehicle of someone they lived with or knew for most trips taken. The first was reported more by older adults and rural residents, while the latter was reported more by people with disabilities than other underserved populations.

**Table D-10. Trip frequency of driving a personal vehicle by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 56% | 40% | 53% | 44% | 42% |
| Almost every trip | 19% | 13% | 21% | 19% | 13% |
| **Subtotal** | **75%** | **53%** | **74%** | **63%** | **55%** |
| Sometimes | 10% | 13% | 11% | 12% | 17% |
| Almost never | 5% | 10% | 6% | 7% | 8% |
| Never | 8% | 17% | 7% | 14% | 15% |

**Table D-11. Trip frequency of riding in the personal vehicle of someone living with or know by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 11% | 12% | 13% | 16% | 19% |
| Almost every trip | 11% | 14% | 14% | 14% | 9% |
| **Subtotal** | **22%** | **26%** | **27%** | **30%** | **28%** |
| Sometimes | 32% | 28% | 30% | 29% | 25% |
| Almost never | 23% | 21% | 20% | 20% | 20% |
| Never | 14% | 16% | 15% | 14% | 15% |

Mode use is influenced by whether someone lives in an urban, suburban, or rural area. Among urban residents, 54% reported driving a personal vehicle for every trip or almost every trip, whereas 71% of suburban residents and 74% of rural residents drove for every trip or almost every trip.

Table D-12 and Table D-13 present the trip frequency by walking and biking, respectively. Walking, as a mode of travel, was most frequently reported by people who spoke little or no English, people with low incomes, and people with disabilities. Walking for every trip or almost every trip was mentioned more by people with cognitive and visual disabilities (18% and 15%, respectively) compared to people with mobility and hearing disabilities (9% and 8%, respectively).

**Table D-12. Trip Frequency of Walking by Underserved Population Groups**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 4% | 7% | 3% | 6% | 11% |
| Almost every trip | 4% | 9% | 3% | 5% | 7% |
| **Subtotal** | **8%** | **16%** | **6%** | **11%** | **18%** |
| Sometimes | 31% | 36% | 29% | 31% | 55% |
| Almost never | 33% | 25% | 27% | 27% | 19% |
| Never | 21% | 17% | 30% | 24% | 3% |

Compared to walking, and in general, the frequency of biking was quite low across all underserved population groups. Among urban residents, 23% walked for every trip or almost every trip, and 5% biked for every trip or almost every trip.

**Table D-13. Trip Frequency of Biking by Underserved Population Groups**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 1% | 1% | 1% | 2% | 1% |
| Almost every trip | 0% | 2% | 0% | 2% | 3% |
| **Subtotal** | **1%** | **3%** | **1%** | **4%** | **4%** |
| Sometimes | 18% | 21% | 18% | 17% | 27% |
| Almost never | 62% | 55% | 59% | 57% | 39% |
| Never | 16% | 14% | 16% | 14% | 11% |

Issues that both help and hinder walking and biking are whether infrastructure for safe walking and biking exists. Figure D-11 and Figure D-12 present responses to whether survey respondents' residential neighborhoods had sidewalks, bike lanes, or wide road shoulders in good condition to enable safe walking and biking, respectively.

For people who spoke little or no English and most other groups, infrastructure was reported to exist for safe walking, but less so for safe biking. However, this result needs to be interpreted with caution given the very low frequency of walking and biking since individuals may not be aware of any infrastructure issues in their neighborhood. Rural residents indicated a lack of infrastructure for safe walking or biking more than other groups.

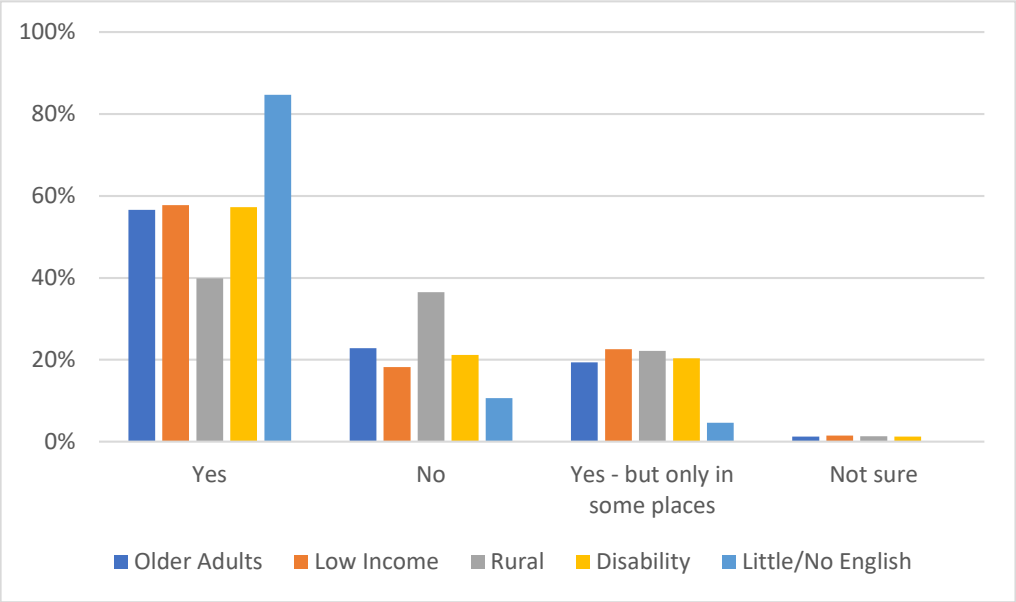


**Figure D-11. Infrastructure for safe walking in the neighborhood by underserved population groups.**

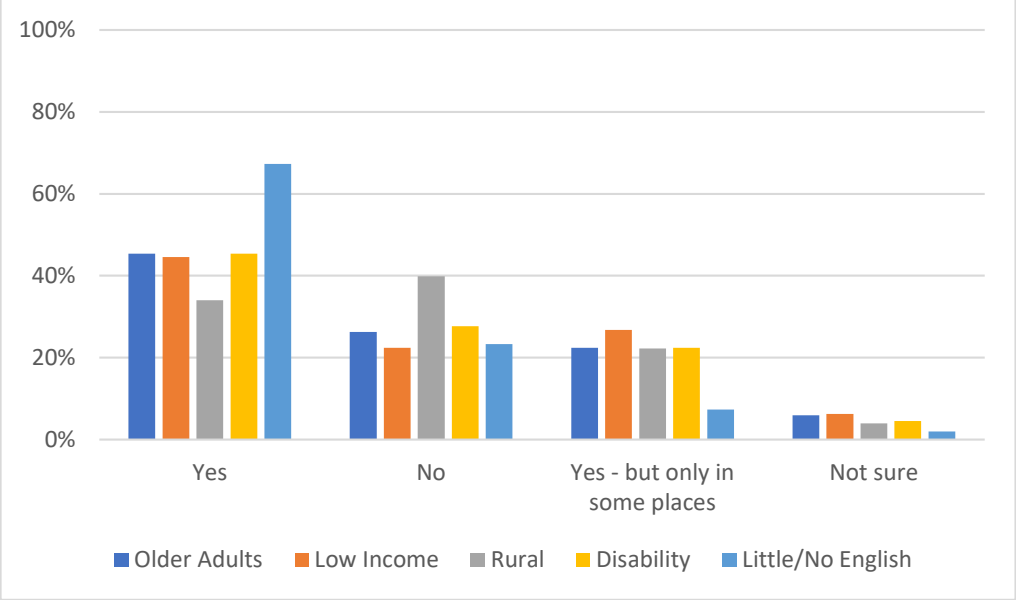


**Figure D-12. Infrastructure for safe biking in the neighborhood by underserved population groups.**

Table D-14 presents the trip frequency of demand-response public transit use, which was described to respondents as paratransit or other social services for people with disabilities and older adults, or general public demand-response service in rural areas. This service was used most frequently by people with disabilities, followed by people with low incomes.

**Table D-14. Trip Frequency of Using Demand-Response Public Transit by Underserved Population Groups**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 1% | 4% | 2% | 5% | 4% |
| Almost every trip | 1% | 4% | 2% | 6% | 2% |
| **Subtotal** | **2%** | **8%** | **4%** | **11%** | **6%** |
| Sometimes | 4% | 8% | 6% | 8% | 11% |
| Almost never | 7% | 9% | 6% | 10% | 15% |
| Never | 87% | 76% | 84% | 70% | 67% |

Table D-15 and Table D-16 present the trip frequency results for public transit usage. While few people in the total sample reported using public transit buses, subways, or trains, 15% of urban residents used public transit buses for every trip or almost every trip and 8% of them used public transit subways/trains with that frequency. Those who spoke little or no English were most likely to use public transit buses and subways/trains compared to other underserved populations, likely due to their more urban residency. Taxi services were used very infrequently across the sample (see Table D-17).

**Table D-15. Trip frequency of using public transit buses by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 2% | 0% | 2% | 4% |
| Almost every trip | 1% | 5% | 1% | 3% | 8% |
| **Subtotal** | **1%** | **7%** | **1%** | **5%** | **12%** |
| Sometimes | 3% | 13% | 5% | 9% | 19% |
| Almost never | 10% | 14% | 9% | 13% | 23% |
| Never | 65% | 51% | 60% | 54% | 35% |

**Table D-16. Trip frequency of using public transit subways/trains by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 2% | 0% | 1% | 6% |
| Almost every trip | 0% | 1% | 0% | 2% | 3% |
| **Subtotal** | **0%** | **3%** | **0%** | **3%** | **9%** |
| Sometimes | 2% | 7% | 2% | 6% | 15% |
| Almost never | 12% | 14% | 7% | 13% | 19% |
| Never | 57% | 52% | 55% | 50% | 35% |

**Table D-17. Trip frequency of using taxi services by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 1% | 0% | 1% | 2% |
| Almost every trip | 0% | 1% | 0% | 1% | 2% |
| **Subtotal** | **0%** | **2%** | **0%** | **2%** | **4%** |
| Sometimes | 3% | 10% | 5% | 9% | 21% |
| Almost never | 12% | 14% | 9% | 16% | 25% |
| Never | 69% | 58% | 66% | 57% | 39% |

## USE OF NEW MOBILITY SERVICES

Tables D-18 through D-22 indicate current usage of new mobility services among the survey respondents. In general, the results indicated low usage, especially among older adults and rural population groups. Among various new mobility services, ridehailing usage (see Table D-18) was higher than other services, and the group that spoke little or no English used ridehailing services more than other underserved groups.

Table D-19 and Table D-20 provide results for micromobility services (bikesharing and e-scooter sharing, respectively). Except for individuals who spoke little or no English, the survey respondents had not used micromobility services very much, and most of them indicated that they were not aware of these services. Almost no one in the older adult group was aware of micromobility services or other services like carsharing (see Table D-21) or app-based carpooling (see Table D-22). At least 87% of any underserved group (except those who spoke little or no English) indicated not being aware of bike- or e-scooter sharing, carsharing, or app-based carpooling services. For the group that spoke little or no English, 70% or more indicated not being aware of those services.

**Table D-18. Trip frequency of ridehailing services by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 2% | 0% | 1% | 8% |
| Almost every trip | 1% | 2% | 1% | 2% | 1% |
| **Subtotal** | **1%** | **4%** | **1%** | **3%** | **9%** |
| Sometimes | 3% | 11% | 6% | 12% | 26% |
| Almost never | 9% | 14% | 9% | 13% | 31% |
| Never | 87% | 71% | 84% | 72% | 35% |

**Table D-19. Trip frequency of bikesharing services by underserved population groups**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 0% | 0% | 0% | 3% |
| Almost every trip | 0% | 0% | 0% | 1% | 1% |
| **Subtotal** | **0%** | **0%** | **0%** | **1%** | **4%** |
| Sometimes | 0% | 4% | 2% | 5% | 5% |
| Almost never | 2% | 6% | 5% | 7% | 21% |
| Never | 98% | 89% | 94% | 88% | 70% |

**Table D-20. Trip frequency of e-scooter sharing services by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 1% | 0% | 1% | 3% |
| Almost every trip | 0% | 1% | 0% | 1% | 0% |
| **Subtotal** | **0%** | **2%** | **0%** | **2%** | **3%** |
| Sometimes | 0% | 2% | 1% | 3% | 3% |
| Almost never | 1% | 6% | 3% | 7% | 18% |
| Never | 99% | 91% | 95% | 89% | 76% |

**Table D-21. Trip frequency of carsharing services by underserved population groups.**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 0% | 0% | 1% | 4% |
| Almost every trip | 0% | 1% | 0% | 2% | 2% |
| **Subtotal** | **0%** | **1%** | **0%** | **3%** | **6%** |
| Sometimes | 0% | 4% | 3% | 5% | 3% |
| Almost never | 1% | 5% | 3% | 5% | 11% |
| Never | 98% | 90% | 95% | 87% | 80% |

**Table D-22. Trip Frequency of App-Based Carpooling Services by Underserved Population Groups**

| Trip Frequency | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Every trip | 0% | 1% | 0% | 1% | 2% |
| Almost every trip | 0% | 1% | 0% | 1% | 1% |
| **Subtotal** | **0%** | **2%** | **0%** | **2%** | **3%** |
| Sometimes | 0% | 4% | 2% | 5% | 7% |
| Almost never | 1% | 4% | 3% | 4% | 15% |
| Never | 99% | 90% | 95% | 89% | 75% |

## BARRIERS AND SOLUTIONS FOR NEW MOBILITY SERVICES

Survey respondents highlighted the fact that while some barriers to new mobility access are shared across several modes, others are mode-specific. As shown in Table D-23, eight different types of barriers were identified as top barriers among the different population groups surveyed. Across most populations and modes, service availability was a top barrier. In addition, respondents had concerns about safety, affordability, liability, and usability of new mobility options. Lack of knowledge and lack of trust in new technology were also identified as barriers for some services, including e-scooters, carsharing, and self-driving vehicles.

**Table D-23. Top barriers to new mobility access by mode for underserved population groups.**

| Top Barriers | Ridehailing Services | Bikesharing Services | E-scooter Sharing Services | Carsharing Services | Carpooling Services | Self-Driving Vehicles |
|---|---|---|---|---|---|---|
| Lack of Service Availability | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Driver or Operational Safety Concerns | ✓ | | ✓ | | ✓ | |
| Affordability | ✓ | | | ✓ | | ✓ |
| Facility Limitations (lack of bike lanes, sidewalks) | | ✓ | ✓ | | | |
| Age/Impairment-Based Limitations (cannot use vehicles safely) | | ✓ | ✓ | | | |
| Lack of Operational Knowledge or Information | | | ✓ | ✓ | | |
| Burden of Responsibility | | | | ✓ | | ✓ |
| Lack of Trust in Technology | | | | | | ✓ |

The following sections identify barriers by population group for each new mobility service and summarize the types of solutions that most appeal to respondents. The discussions include the positive traits that respondents highlighted for each new mobility service they had used or were aware of.

### Ridehailing Services

The top positive traits of ridehailing identified by participants were (a) not having to drive, (b) convenience, and (c) not needing to own a car (see Table D-24). However, this order was different for the individuals who spoke little or no English; they indicated dependable service as the top positive trait, followed by not needing to drive and having the option of electronic payment.

**Table D-24. Top four positive traits of ridehailing services for each underserved population group.**

| Positive Traits | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Don't have to drive | 44% | 37% | 41% | 40% | 34% |
| Convenience | 38% | 33% | 34% | 33% | |
| Don't need to own my own car | 32% | 25% | 26% | 26% | |
| Cheaper than taxi | 29% | 25% | 25% | 25% | 28% |
| Electronic payment—no cash | | | | | 31% |
| Dependable | | | | | 45% |

The top three barriers for older adults, people with low incomes, people living in rural areas, and people with disabilities were (a) riding with unknown drivers perceived as unsafe, (b) lack of or limited amount of service in their area, and (c) not being able to afford the cost of the trip (Table D-25). For people who spoke little or no English, the top barrier was reported as having difficulty understanding some drivers. Difficulty traveling with young children in car seats was also identified as an important barrier by this latter group.

**Table D-25. Barriers to using ridehailing services for underserved population groups.**

| Barriers | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| No or limited service in my area | 29% | 23% | 49% | 25% | 11% |
| Riding with unknown drivers feels unsafe | 36% | 32% | 30% | 35% | 23% |
| Can't afford trip cost | 18% | 33% | 19% | 24% | 12% |
| Don't have smartphone | 15% | 9% | 11% | 10% | 1% |
| Can't use app | 9% | 9% | 8% | 8% | 9% |
| Updates to app make them difficult to use | 3% | 3% | 2% | 3% | 9% |
| Don't have a credit or debit card to pay | 3% | 6% | 4% | 5% | 5% |
| Service animal not allowed in vehicle | 1% | 1% | 1% | 2% | 5% |
| Longer wait times for those in wheelchairs and motorized scooters | 1% | 3% | 2% | 4% | 4% |
| Need assistance to safely enter or exit vehicle | 4% | 3% | 2% | 7% | 3% |
| Can't find drivers due to curbside confusion | 1% | 3% | 1% | 2% | 7% |
| Having to navigate busy and loud streets | 1% | 3% | 1% | 3% | 6% |
| Don't trust drivers to drop me off in a safe location | 8% | 11% | 9% | 10% | 9% |
| Drivers discriminate against people like me | 1% | 2% | 1% | 3% | 5% |
| Hard to travel with young children in car seats | 0% | 3% | 2% | 2% | 13% |
| Difficult to understand some drivers | 12% | 9% | 6% | 13% | 25% |
| Drivers not trained to serve people with disabilities | 5% | 7% | 6% | 10% | 5% |
| Weather conditions—snow and ice | 9% | 8% | 10% | 11% | 7% |

If solutions were implemented to ameliorate the identified deterrents, some respondents indicated they would use ridehailing more (Figure D-13). Specifically, around 60% of respondents who spoke little or no English, 30% of respondents with disabilities, 28% of respondents with low incomes, 17% of respondents living in rural areas, and 14% of older adult respondents indicated they would use ridehailing more frequently.

Furthermore, most of the underserved population groups indicated that if the following items were implemented, they would be more likely to use ridehailing services: (a) a list of safe drivers who have more extensive background checks, (b) drivers trained to ask a passenger's name and confirm the destination, and (c) a subsidized rate for people with disabilities. Respondents who spoke little or no English and those with disabilities also indicated the importance of drivers being trained to respect people with disabilities and non-English speakers.

Not all participants indicated facing barriers using ridehailing services; 30% of older adults, 26% of people living in rural areas, 24% of people with low incomes, 25% of people with a disability, and 23% of people who spoke little or no English reported that there were no issues.

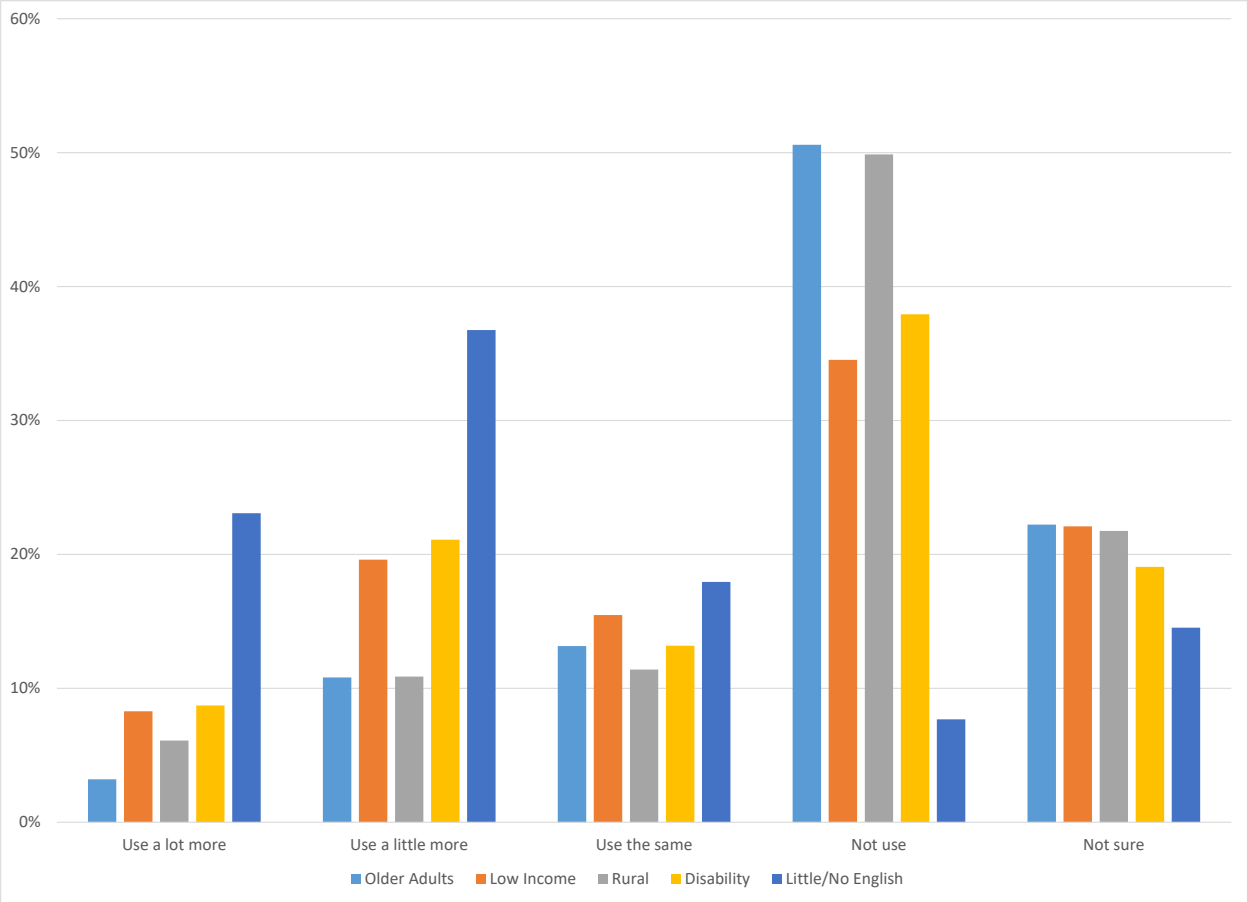


**Figure D-13. Potential use of ridehailing services by underserved population groups if solutions to significant issues were implemented.**

## Bikesharing Services

All five groups of participants attributed their primary use of bikesharing services to recreation/exercise, and subsequently, the top positive draws of bikesharing for the participant groups were that biking is good exercise, low cost, and fun, and they do not have to drive or own a car (see Table D-26).

**Table D-26. Top four positive traits of bikesharing services for each underserved population group.**

| Positive Traits | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Good exercise | 50% | 58% | 54% | 51% | 73% |
| Low cost | 32% | 36% | 34% | 36% | 43% |
| Don't have to drive | 20% | 25% | 21% | 24% | |
| Fun | 18% | 26% | 21% | 23% | 54% |
| Don't need to my own car | | | | | 17% |

The older adult, low-income, rural, and disability groups cited the top three barriers to using bikesharing services as (a) a lack of bikesharing service in their area, (b) an inability to use

bicycles due to their disability or age, and (c) an absence of bike lanes in their area (see Table D-27). For the population that spoke little or no English, the top barrier was also related to the lack of service in their area; however, this group highlighted the difficulty of traveling with children as another important barrier.

**Table D-27. Barriers to using bikesharing services for underserved population groups.**

| Barriers | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| No bikesharing service in my area | 34% | 28% | 44% | 30% | 29% |
| No helmet and I won't ride without one | 10% | 8% | 6% | 9% | 11% |
| Not enough bicycles available in my area | 9% | 7% | 8% | 8% | 12% |
| Can't use bicycles due to my disability or age | 32% | 26% | 28% | 37% | 7% |
| Don't know how to ride a bike | 9% | 8% | 5% | 6% | 9% |
| Riding a bike in my area is not safe | 18% | 12% | 17% | 15% | 9% |
| Accessible bicycles are not available | 14% | 10% | 14% | 12% | 15% |
| Can't afford cost | 6% | 13% | 7% | 9% | 3% |
| No smartphone for accessing bikeshare | 8% | 4% | 7% | 5% | 1% |
| Don't have credit or debit card to pay for rides | 2% | 3% | 3% | 3% | 3% |
| No bike lanes in area | 23% | 16% | 26% | 22% | 10% |
| No paved roads in area | 3% | 3% | 7% | 4% | 3% |
| Too hilly in area | 12% | 9% | 16% | 13% | 5% |
| The weather is not good for biking in my city | 8% | 6% | 9% | 8% | 8% |
| Can't travel with child | 1% | 4% | 3% | 4% | 19% |
| No space for cargo | 14% | 14% | 15% | 15% | 13% |
| Don't like biking | 18% | 14% | 15% | 14% | 12% |
| Weather conditions—snow and ice | 18% | 14% | 18% | 15% | 12% |

If the corresponding barriers to use were removed, 49% of respondents who spoke little or no English, 19% of respondents with low incomes, 15% of respondents with disabilities, 10% of respondents living in rural areas, and 6% of older adult respondents self-reported they would use bikesharing more frequently (Figure D-14). Furthermore, all groups of participants cited the addition of modified three-wheel bikes for stability, motorized bikes, pedal-assist bikes, e-bikes for easier pedaling, and affordable or free helmet availability as ideas that would increase their chances of bikeshare use.

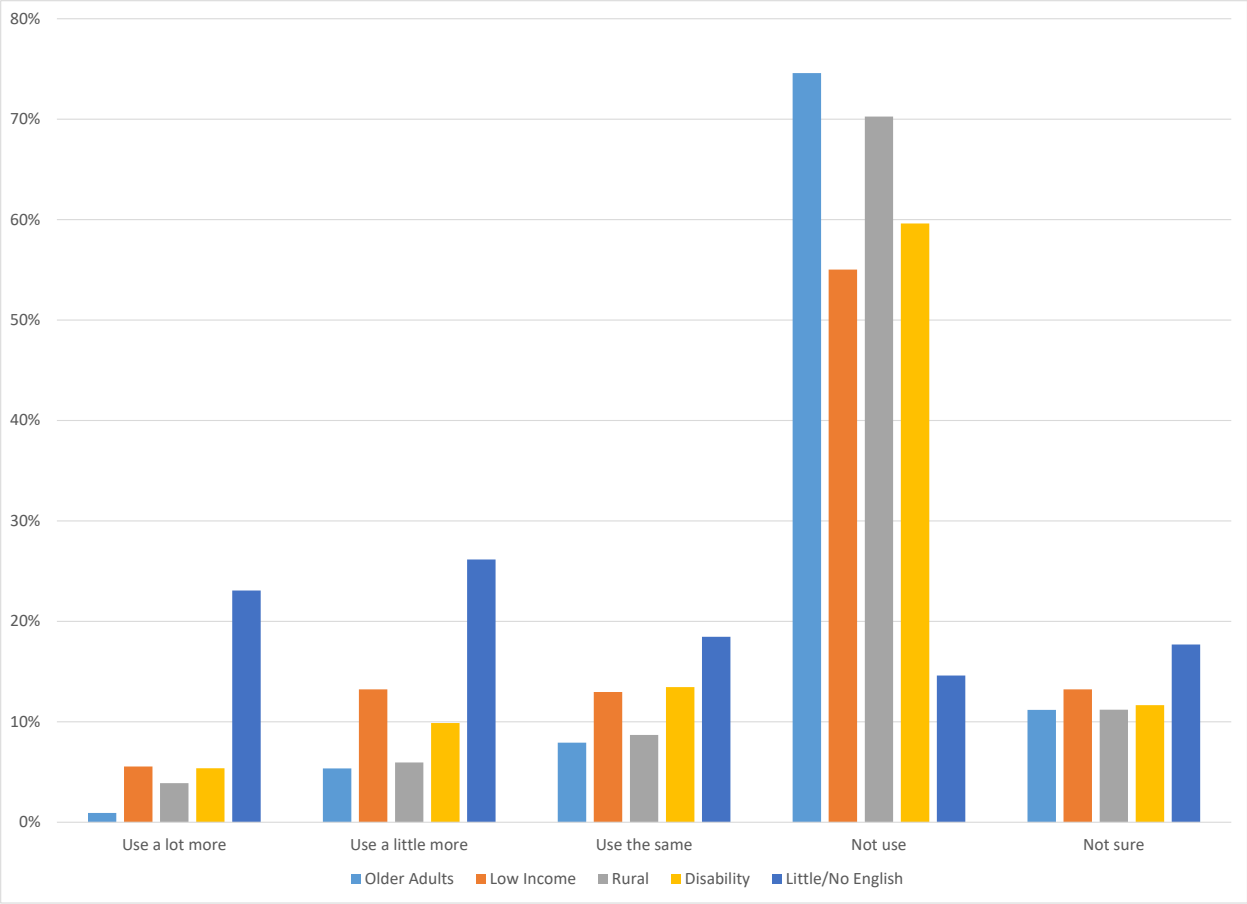


**Figure D-14. Potential use of bikesharing services by underserved population groups if solutions to significant issues were implemented.**

Compared to ridehailing, fewer participants reported having no issues that made it harder for them personally to use bikesharing services. Only 21% of respondents with low incomes, 14% of respondents living in rural areas, and 13% of older adult respondents, respondents with disabilities, and respondents who spoke little or no English cited a lack of issues regarding barriers to access.

## E-scooter Sharing Services

Although most study participants felt "neutral" or "somewhat positive" when asked about their attitude toward e-scooter sharing services, a significant share (25%) of older adults felt "extremely negative" toward the service. In contrast to other services included in the survey, the top positive trait of e-scooter services cited by all groups was that the service was fun (Table D-28). Low cost was another positive trait cited by all groups. Other positive traits included the service providing good exercise and being fast for the group that spoke little or no English and the benefit of not having to drive or own a car for other groups.

**Table D-28. Top four positive traits of e-scooter sharing services for each underserved population group.**

| Positive Traits | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Fun | 25% | 32% | 34% | 30% | 56% |
| Don't have to drive | 22% | 23% | 24% | 24% | |
| Don't need to own car | 20% | 20% | 20% | 21% | |
| Low cost | 17% | 26% | 25% | 25% | 35% |
| Good exercise | | | | | 35% |
| Fast | | | | | 28% |

The top two barriers to use identified across all groups included the absence of e-scooter sharing services in their area and a lack of knowledge on how to ride an e-scooter (Table D-29). Older adults, people with low incomes, and respondents living in rural areas also indicated the inability to use e-scooters due to their age or disability as an important barrier. Respondents living in rural areas further highlighted the lack of sidewalks as well as weather conditions (i.e., ice and snow) as barriers. Similar to other services, respondents who spoke little or no English identified the difficulty in traveling with a child as an important barrier.

**Table D-29. Barriers to using e-scooter sharing services for underserved population groups.**

| Barriers | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| No e-scooter sharing services in my area | 37% | 29% | 43% | 30% | 20% |
| No helmet | 14% | 12% | 10% | 14% | 19% |
| Not enough e-scooters in my area | 16% | 14% | 18% | 16% | 13% |
| Can't use e-scooters due to my age or disability | 30% | 21% | 24% | 30% | 9% |
| Don't know how to ride an e-scooter | 29% | 23% | 23% | 22% | 25% |
| Riding an e-scooter in my area is not safe | 25% | 18% | 21% | 20% | 13% |
| Can't afford cost | 8% | 17% | 9% | 13% | 7% |
| No smartphone for accessing e-scooters | 7% | 5% | 6% | 6% | 3% |
| Don't have credit or debit card to pay | 2% | 4% | 4% | 4% | 3% |
| No bike lanes in area | 17% | 12% | 22% | 16% | 11% |
| No sidewalks in area | 17% | 9% | 23% | 14% | 7% |
| No paved roads in area | 4% | 4% | 7% | 5% | 3% |
| Can't travel with child | 2% | 5% | 4% | 5% | 22% |
| No space for cargo | 17% | 14% | 16% | 16% | 11% |
| Don't like e-scooter clutter on sidewalks | 8% | 6% | 5% | 7% | 9% |
| Weather conditions—snow and ice | 19% | 13% | 23% | 17% | 10% |

If solutions to these issues were implemented, 39% of respondents who spoke little or no English, 18% of respondents with low incomes, 16% of participants with disabilities, 10% of respondents living in rural areas, and 6% of older adult respondents would use e-scooter services more frequently (Figure D-15).

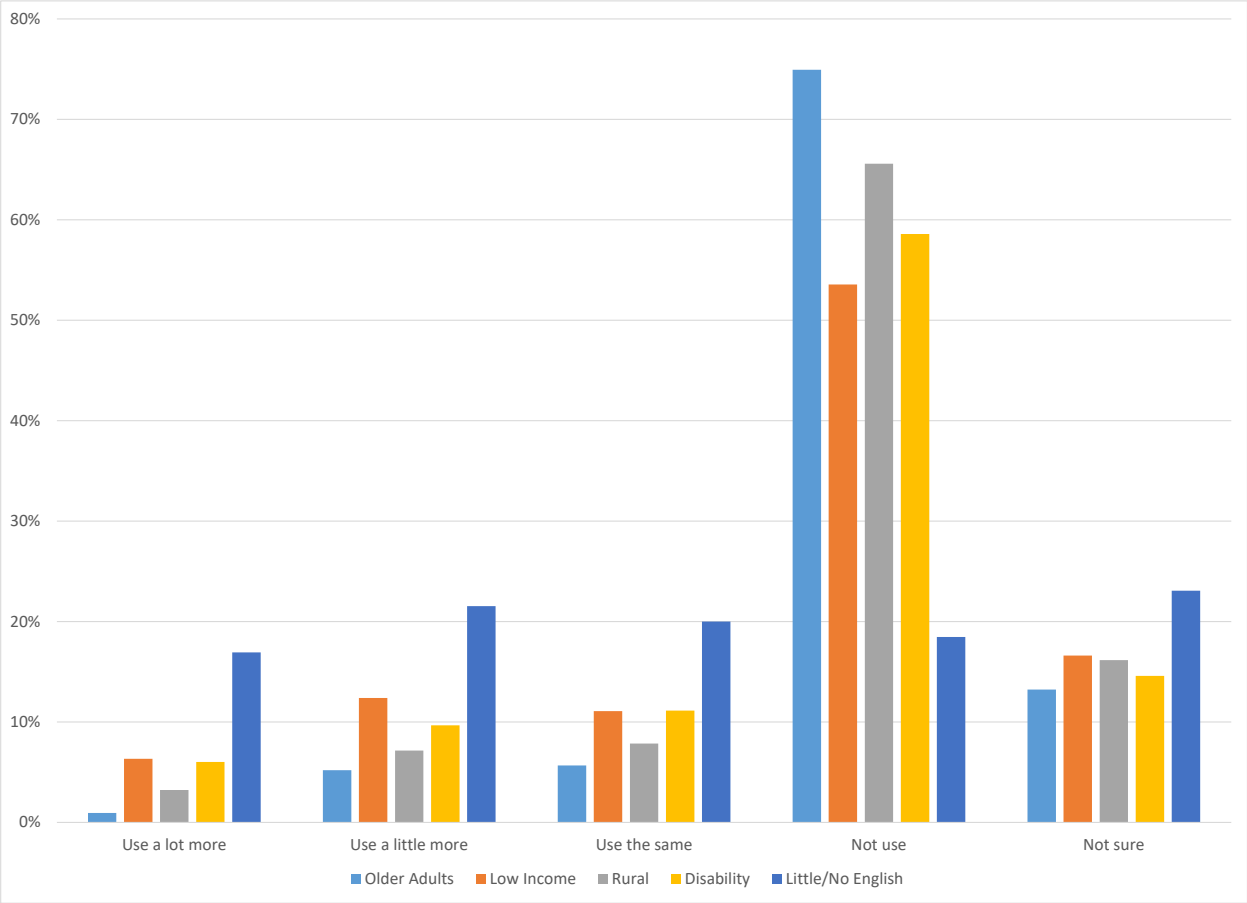


**Figure D-15. Potential use of e-scooter sharing services by underserved population groups if solutions to significant issues were implemented.**

As in the case of bikesharing, respondents were interested in e-scooter adaptations to make them easier to use, such as three-wheeled e-scooters for stability and a sit-down option. Information that would ease the use of these services as well as dedicated lanes and affordable and free helmets were cited among adaptations that would motivate the use of e-scooter services.

The percentage of respondents that reported no issues related to personal use of e-scooter sharing services was low and comparable to values for bikesharing. Only 21% of respondents with low incomes, 15% of respondents living in rural areas and respondents with disabilities, and 14% of older adults and people who spoke little or no English reported no issues regarding barriers to use.

## Carsharing Services

All five groups of respondents found the top positive trait of carsharing service to be not needing to own a car (Table D-30). Various other positive traits were also cited by different groups, such

as the convenience of the service and the money saved from using the service compared to owning a car. However, in addition to availability, respondents had concerns about liability and lack of information about carsharing. Among all groups, the top barriers to carsharing use included (a) a lack of vehicles or service in their area, (b) being responsible for a vehicle that is not theirs, and (c) insufficient information about the service (Table D-31). For respondents with low incomes, affordability-related concerns were also listed among the top barriers.

**Table D-30. Top four positive traits of carsharing services for each underserved population group.**

| Positive Traits | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Don't need to own my own car | 67% | 56% | 48% | 51% | 32% |
| Convenience | 42% | 35% | 37% | 41% | 23% |
| Car can be driven by someone other than me who can drive | 35% | 29% | | 35% | |
| Drive when you need to | 34% | 29% | | | |
| Save money | | | 35% | 36% | 28% |
| Don't have to pay for parking | | | 30% | | |
| Independence | | | | | 27% |

**Table D-31. Barriers to using carsharing services for underserved population groups.**

| Barriers | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| I do not have a driver's license | 5% | 14% | 6% | 10% | 15% |
| No vehicles/service in my area | 36% | 27% | 49% | 31% | 24% |
| Not enough information about the service | 26% | 23% | 22% | 25% | 30% |
| Can't afford hourly cost | 14% | 25% | 16% | 19% | 11% |
| Can't afford annual membership fee | 14% | 24% | 17% | 19% | 13% |
| Don't have smartphone | 10% | 6% | 9% | 8% | 1% |
| Can't use smartphone app | 9% | 6% | 8% | 9% | 4% |
| Don't have a credit or debit card to pay for rides | 2% | 5% | 4% | 4% | 6% |
| Having responsibility for a vehicle that is not yours | 28% | 23% | 24% | 26% | 25% |
| My service animal is not allowed in the vehicle | 1% | 2% | 3% | 3% | 4% |
| Vehicles not accessible for people with wheelchairs or motorized scooters | 3% | 5% | 4% | 8% | 5% |
| Inability to travel with young children requiring car seats | 1% | 3% | 3% | 3% | 7% |
| Weather conditions—snow and ice | 12% | 10% | 12% | 12% | 5% |

If these barriers were ameliorated, 35% of respondents who spoke little or no English, 18% of respondents with low incomes, 17% of respondents with disabilities, 11% of respondents living in rural areas, and 8% of older adult respondents claimed their frequency of service use would increase (Figure D-16).

More specifically, implementation of the following ideas would make people's use of the service more likely: adding carsharing services to more convenient areas with multiple rental car options, offering discounted memberships and rentals for eligible users, and accepting cash.

Like ridehailing services, significant numbers claimed that they had no significant issues that made it hard to use carsharing. Twenty-four percent of respondents with low incomes, 23% of older adults and respondents living in rural areas, 21% of people with disabilities, and 17% of people who spoke little or no English cited no issues with carsharing service access.

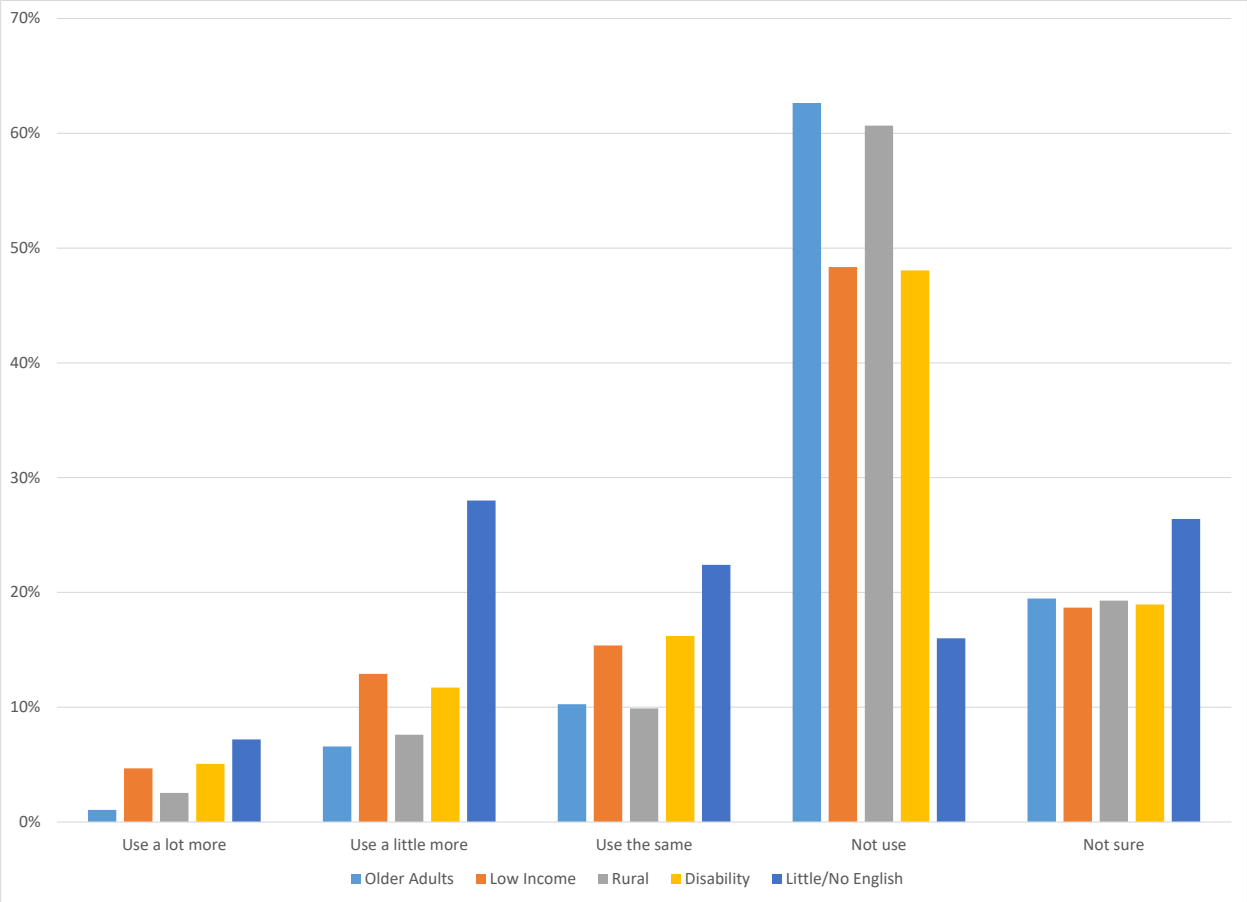


**Figure D-16. Potential use of carsharing services by underserved population groups if solutions to significant issues were implemented.**

## App-Based Carpooling Services

According to study participants, the top common positive traits of app-based carpooling services among all groups included not needing to own a car, saving money, and convenience (Table D-32). An interesting distinction was observed for people who spoke little or no English, they cited meeting new people as the top positive trait.

**Table D-32. Top four positive traits of app-based carpooling services for each underserved population group.**

| Positive Traits | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Don't need to own my own car | 17% | 18% | 19% | 17% | 41% |
| Save money | 16% | 17% | 18% | 22% | 44% |
| Convenience | 15% | 16% | 21% | 22% | 37% |
| Independence | 9% | 10% | | 15% | |
| Meet new people | | | 16% | | 54% |

The top barriers to using app-based carpooling included (a) safety concerns about riding with strangers, (b) wanting to know a driver's background and driving record, and (c) perceptions about the service being complicated (see Table D-33).

**Table D-33. Barriers to using app-based carpooling services for underserved population groups.**

| Barriers | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Seems complicated | 20% | 20% | 18% | 22% | 34% |
| Safety concerns riding with strangers | 45% | 41% | 42% | 42% | 40% |
| Need to know driver's background and driver record | 33% | 28% | 30% | 31% | 26% |
| Don't have smartphone | 15% | 9% | 12% | 10% | 3% |
| Can't use smartphone app | 11% | 9% | 8% | 9% | 4% |
| Question whether I can bring young children requiring car seats | 1% | 5% | 4% | 5% | 17% |
| Question whether service animal is allowed | 1% | 3% | 3% | 4% | 7% |
| Question whether vehicles are accessible for wheelchairs or motorized scooters | 4% | 5% | 5% | 8% | 8% |
| Question whether drivers would have concerns about people with disabilities | 6% | 10% | 8% | 14% | 7% |
| Weather conditions—snow and ice | 14% | 13% | 17% | 14% | 5% |

If solutions to these issues were implemented, 38% of respondents who spoke little or no English, 19% of participants with low incomes, 16% of respondents with disabilities, 9% of participants living in rural areas, and 6% of older adult participants claimed they would use app-based carpooling services more frequently (Figure D-17).

Participants cited the following ideas that, if implemented, would improve the likelihood of service usage: adding information about trip duration and trip stops to the app; adding the ability to match drivers and passengers from a trusted, shared network to the app; and adding information about pickup and drop-off order to the app.

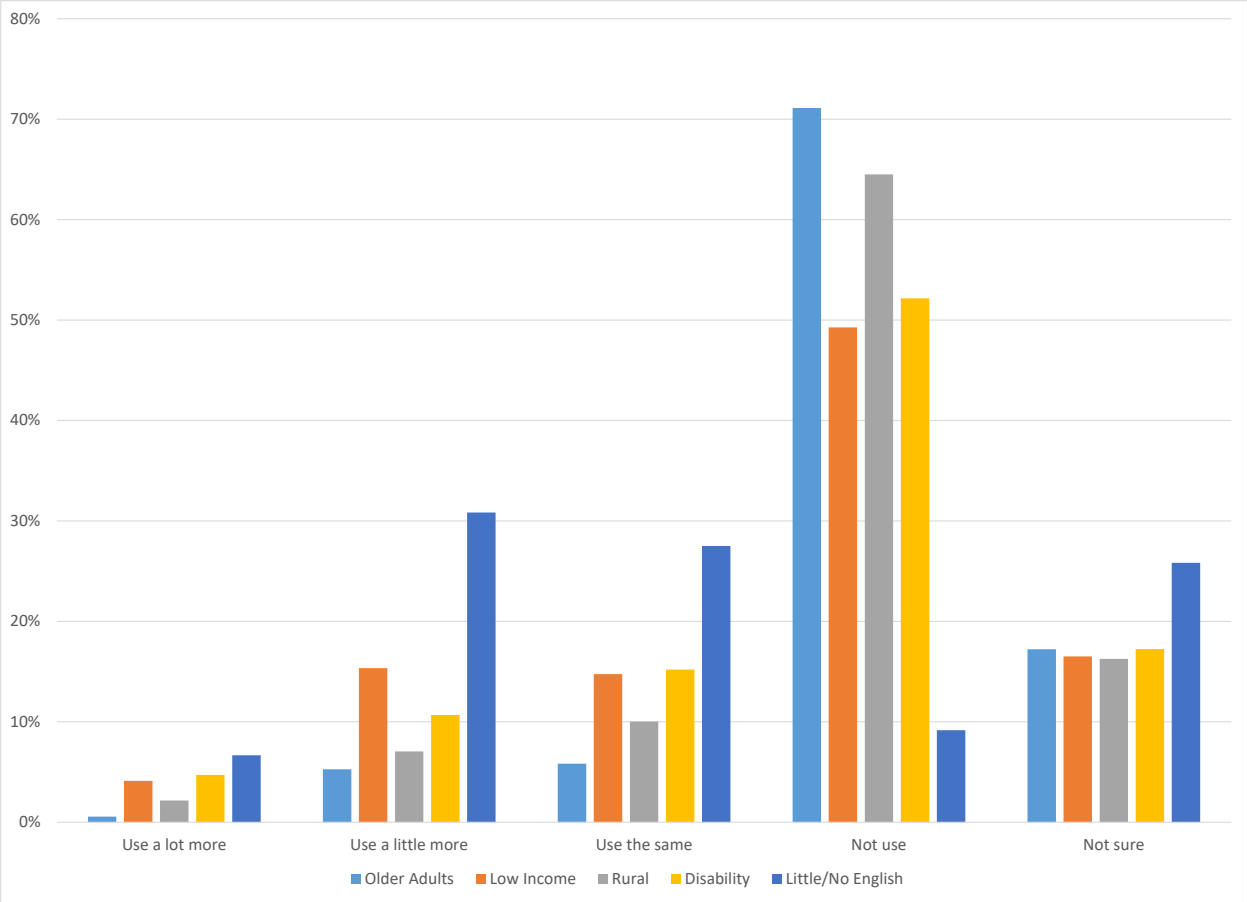


**Figure D-17. Potential use of app-based carpooling services by underserved population groups if solutions to significant issues were implemented.**

App-based carpooling services had a high rate of respondents claiming to have no issues that prevented them from using the service. Thirty percent of respondents with low incomes, 28% of respondents living in rural areas, 27% of older adult respondents, 24% of respondents with disabilities, and 21% of respondents who spoke little or no English reported having no issues regarding app-based carpooling services.

## Self-Driving Vehicles

### *Familiarity and Attitudes*

All participant groups were mostly "not familiar at all" with self-driving vehicles. In addition, all groups but one had an "extremely negative" attitude toward self-driving vehicles; the group that spoke little or no English was more neutral.

In general, the more familiar with self-driving vehicles someone was, the more likely it was that they would have a positive attitude toward them. This was especially true at the extremes: respondents who were extremely familiar with self-driving vehicles were most likely to have an extremely positive view of them. Respondents who were not familiar with self-driving vehicles at all were most likely to have an extremely negative view of them.

Older adult respondents had less familiarity with self-driving vehicles and a more negative attitude toward them compared to all respondents. Just 2% of older adult respondents were extremely familiar with self-driving vehicles, and just 4% had an extremely positive view toward them.

Respondents with low incomes also had less familiarity with self-driving vehicles compared to all respondents. However, they were slightly less likely to have a negative attitude toward them. Fifty-one percent of respondents with low incomes had a somewhat negative or extremely negative attitude toward self-driving vehicles, compared to 54% of all respondents. Twenty-eight percent of respondents with low incomes had a neutral attitude toward self-driving vehicles, compared to 24% of all respondents.

Respondents living in rural areas were less familiar with self-driving vehicles and more likely to have negative views toward them compared to all respondents. This finding could potentially reflect lower exposure to self-driving vehicles in rural areas compared to urban or suburban areas. Sixty-four percent of respondents living in rural areas were slightly familiar or not at all familiar with self-driving vehicles, compared to 61% of all respondents. Sixty-two percent of respondents living in rural areas had a somewhat negative or extremely negative attitude toward self-driving vehicles, compared to 54% of all respondents.

Respondents with a disability had a similar level of familiarity with self-driving vehicles as all respondents. They also had similar attitudes toward self-driving vehicles as all respondents.

Respondents who spoke little or no English were much less familiar with self-driving vehicles compared to all respondents. Three-quarters were slightly familiar or not at all familiar with self-driving vehicles, compared to 61% of all respondents. Respondents who spoke little or no English had more positive attitudes toward self-driving vehicles than did all respondents. One-third had a somewhat positive or extremely positive attitude toward them, compared to 22% of all respondents.

### *Positive Traits and Barriers*

Participants identified common positive themes about self-driving technology, including that the service relieved the stress of driving; enabled mobility for older adults, people with disabilities, or other people who are unable to drive; and allowed people to be productive while in the vehicle (Table D-34).

When asked about the most appealing use of self-driving vehicles, the majority of respondents claimed they did not know enough about self-driving vehicles to pick an option (71% of older adults, 69% of respondents living in rural areas, 65% of participants with low incomes, 63% of respondents with disabilities, and 47% of respondents who spoke little or no English). Apart from that, the most preferred type was self-driving personal vehicles.

**Table D-34. Top four positive traits of self-driving vehicles for each underserved population group.**

| Positive Traits | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Relieves stress of driving myself | 26% | 26% | 22% | 27% | 41% |
| Mobility enabler for older adults, people with disabilities, or other people who are unable to drive | 22% | 25% | 23% | 25% | 29% |
| Ability to be productive while in vehicle because not driving | 15% | 14% | 18% | 16% | 25% |
| Lower insurance cost | 14% | 13% | 13% | 16% | |
| Attractiveness of newest driving technology | | | | | 31% |

In terms of top barriers to self-driving vehicle use, participants in all five groups identified the following issues: (a) a lack of trust in technology (too new), (b) not being able to take over control in a potential crash situation, and (c) the service being too expensive (Table D-35).

**Table D-35. Barriers to using self-driving vehicles for underserved population groups.**

| Barriers | Older Adults | Low Income | Rural | Disability | Little/No English |
|---|---|---|---|---|---|
| Don't think vehicles will be accessible | 1% | 3% | 2% | 4% | 11% |
| Need help entering/exiting vehicle | 1% | 3% | 1% | 3% | 2% |
| No driver to help me when inside the vehicle | 2% | 5% | 4% | 4% | 5% |
| Don't feel safe or comfortable when riding with other people when there is no driver | 8% | 8% | 5% | 8% | 7% |
| Will not know when vehicle arrives or arrives at destination | 1% | 3% | 2% | 2% | 3% |
| Will not know how to enter or exit vehicle | 1% | 3% | 1% | 2% | 5% |
| Too expensive | 10% | 14% | 10% | 13% | 12% |
| Lack of information about self-driving vehicles | 8% | 7% | 6% | 7% | 13% |
| Lack of trust in technology (too new) | 14% | 12% | 11% | 12% | 17% |
| Privacy concerns and that my trips will be tracked | 3% | 3% | 3% | 5% | 6% |
| Insurance or liability concerns | 8% | 9% | 8% | 8% | 12% |
| Like to drive myself | 8% | 7% | 6% | 9% | 7% |
| I will not be able to take over control in a potential crash situation | 11% | 12% | 12% | 11% | 13% |

A high share of survey respondents indicated a high likelihood of using self-driving vehicles in the future if solutions to these issues were implemented (Figure D-18). Specifically, 72% of respondents who spoke little or no English, 60% of respondents with disabilities, 57% of

respondents with low incomes and those living in rural areas, and 54% of older adults claimed they would be more likely to use self-driving vehicles.

In particular, the implementation of on-demand human assistance via phone, a smartphone-enabled car detection feature, and on-demand human assistance via video call would improve the likelihood of participants using the service more frequently.

A stark 2% to 3% of all groups claimed they had no issues in terms of barriers to use, potentially reflecting the lack of familiarity toward self-driving cars.

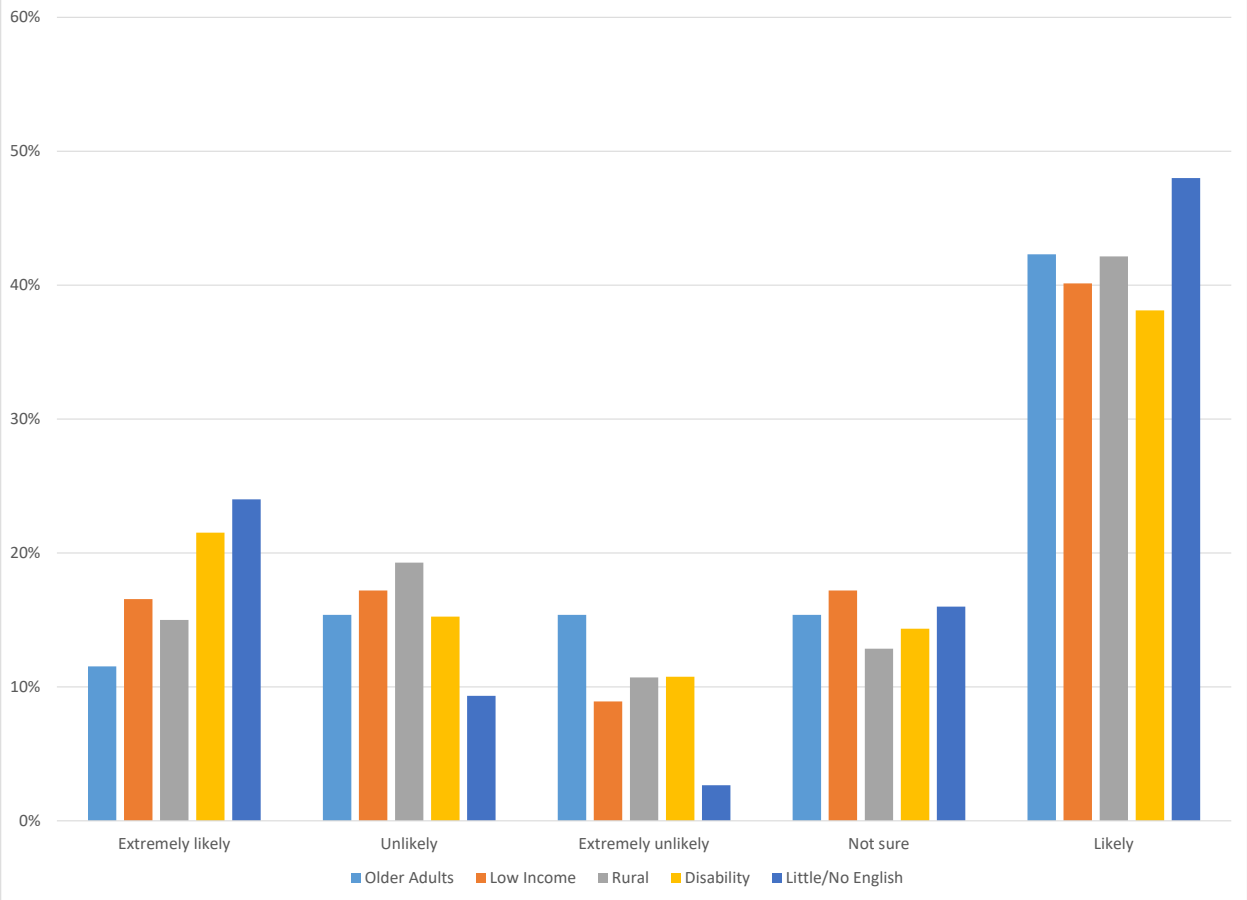


**Figure D-18. Potential use of self-driving vehicles by underserved population groups if solutions to significant issues were implemented.**

### *Most Appealing Uses of Self-Driving Vehicles*

Around 20% of all survey respondents found the idea of using a self-driving vehicle as their personal vehicle appealing. Far fewer respondents found using self-driving vehicles for ridehailing (7%), on-demand shuttle buses (5%), or regular fixed-route transit buses (4%) appealing.

Around 63% of all survey respondents did not know enough about self-driving vehicles to decide what would be most appealing. This number was lowest for those who spoke little or no English (47%). On the other hand, more than 70% of older adult respondents did not know enough about self-driving vehicles to choose the most appealing uses. This number was higher than that for the

remaining groups, indicating that older adult respondents were less likely to find any of the available options most appealing compared to all respondents (Figure D-19).

Respondents who spoke little or no English were more likely to find using self-driving vehicles as personal vehicles most appealing (31%) compared to other respondents (ranging from 17% to 22%). They were also more likely to find using self-driving vehicles for ridehailing (14% vs. 4% to 6%) and regular fixed-route transit buses (7% vs. 2% to 5%) most appealing. Compared to all respondents, this group was much less likely to find using self-driving vehicles as small on-demand shuttles most appealing (1% vs. 4% to 5%).

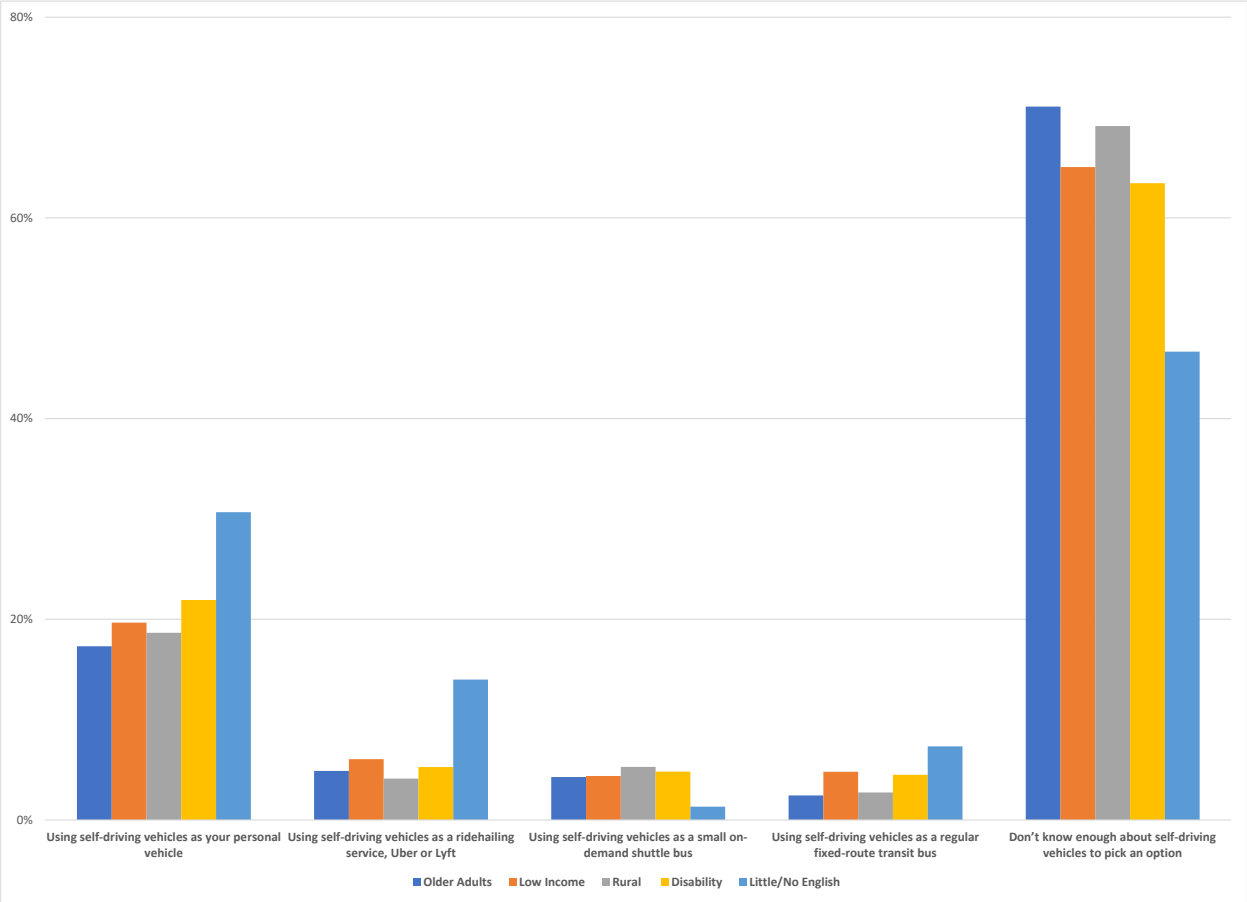


**Figure D-19. Most appealing self-driving vehicle form.**

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