# TRAVEL BEHAVIOR

## SHARED MOBILITY AND TRANSPORTATION EQUITY

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# EXECUTIVE SUMMARY

Transportation equity is key to ensuring broad-based access to opportunities such as jobs, healthcare, goods and services, and social connection by all Americans. The geographic, economic, and socio-demographic diversity of the United States can create challenges to ensuring transportation equity, requiring coordination among federal, state, local, and private sector stakeholders. While much progress has been made at all levels to remove barriers and improve access to transportation, equity challenges still persist. Moreover, current challenges coupled with changing demographic trends, such as an aging population, may create additional equity challenges in the future.

Shared mobility—the shared use of a motor vehicle, bicycle, or other low-speed transportation mode that allows users to obtain short-term access to transportation on an as-needed basis—has the potential to help address some transportation equity challenges. While more land use, infrastructure, and policy changes are needed, these opportunities may be expensive or have long-time horizons for implementation. In the near to medium term, shared mobility offers opportunities to bridge equity gaps in a rapid and cost-efficient manner. Shared mobility has the potential to increase mobility for users who are unable to access private vehicles and enable those who own cars to drive them at higher occupancy, for fewer trips, or forego ownership altogether, potentially reducing household transportation expenditures while providing more transportation options.

While increasingly becoming more mainstream, the demographics of shared mobility users often differ from the general population. In general, users tend to be younger, have higher levels of educational attainment, have higher incomes, and are less diverse than the general population. Older adults, low-income individuals, rural communities, and minority communities have historically been less likely to use shared mobility. Additionally, access to the Internet, smartphones, and banking services—a pre-requisite for many shared mobility modes—tends to be lower among many of these groups.

In an effort to categorize the myriad of transportation equity barriers facing transportation system users, this primer proposes a *STEPS to Transportation Equity* framework including: Spatial, Temporal, Economic, Physiological, and Social barriers. For each barrier category, shared mobility opportunities and challenges are explored along with policy recommendations. The supporting content for this primer reflects a literature review and discussions with 11 experts from the public, private, and non-profit sectors that were conducted by researchers at the Transportation Sustainability Research Center (TSRC) between January and February 2017. Wherever the term “expert/s” appears in the text, it is in reference to content gathered from these discussions. A more complete description of the discussion questions and methodology is included in Appendix B: .

## STEPS Findings

*Spatial*

Shared mobility may provide a low-cost solution for bridging transportation gaps, providing both a first-and-last-mile (FMLM) connection to public transit and serving as a stand-alone service option. Shared modes such as bikesharing, carsharing, and ridesourcing/transportation network companies may be deployed in underserved areas in less time at lower cost than traditional projects by leveraging private sector investment and operation of these services. However, the need to achieve full cost recovery (or make a profit) can limit the deployment of privately operated shared mobility services in lower-density and low-income communities.

Policy Opportunities:

- Require shared mobility operators to locate services in neighborhoods with gaps in the transportation network as conditions for operation in the public rights-of-way
- Risk sharing partnerships between municipalities and shared mobility providers for locating vehicles in potentially less profitable areas

*Temporal*

Shared mobility may provide temporal benefits over traditional service models, such as reduced wait time and increased travel-time reliability, advance booking options, and reduced travel time. For users without access to automobiles in areas with limited public transit, shared mobility may significantly reduce temporal barriers.

Policy Opportunities:

- Require self-service shared mobility (e.g.,carsharing) to be available 24 hours per day
- Facilitate off-peak commuting partnerships between employers and shared mobility operators for late-night workers
- Expand high occupancy vehicle (HOV) lane approach to surface streets for approved pooled services during peak period travel times

*Economic*

Shared mobility services can offer new travel options to users that may have lower operating cost and fares compared to existing paratransit and fixed-route transit service, particularly during off-peak and late-night hours. However, the lack of smartphone data access and credit/debit cards may be a barrier for disabled, low-income, and older adult users.

Policy Opportunities:

- Reduce taxes and fees for shared mobility services with a clear benefit to low-income users
- Subsidize access to shared mobility for qualifying users
- Provide pre-tax commuter benefits
- Deploy shared mobility access kiosks to address access for users without smartphones
- Offer alternative access modes (e.g., telephone concierge service, SMS text access, etc.) that do not require a smartphone
- Switch public transit payment systems from card-based to account-based systems that allow users to transfer transit subsidies to other services

*Physiological*

Shared mobility has the opportunity to lower the cost and diversify the range of assisted modes to users with cognitive and physical challenges. However, rapid technology change can create unforeseen access challenges for disabled users, if specific needs are not taken into account.

Policy Opportunities:

- Define multiple tiers of accessible vehicles to expand services for users with special needs
    - Wheelchair accessible for users in wheelchairs
    - Assissted ride for users who can ride as passengers in standard vehicles but need assistance at either end of a trip
    - Ambulatory for users who can ride as passengers without assistance

*Social*

Shared mobility services have increased awareness and interest in multi-modal travel, but many have faced challenges in addressing barriers and marketing to low-income communities, minorities, and users with limited English proficiency. Despite these criticisms, shared mobility providers, advocacy groups, and researchers are continuously trying to address barriers to ensure that shared mobility services improve social accessibility through community engagement, improved product design, and marketing.

Policy Opportunities:

- Shift from prescriptive outreach and engagement requirements to performance-based community engagement metrics that allow for flexibility in ensuring broad participation
- Require ongoing evaluation and refinement of services until equity goals are achieved

**Role of Government**

The government has many roles within shared mobility equity as a facilitator, funder, regulator, and evaluator of services.

*Parternship Facilitation/Knowledge Transfer*

- Federal government can facilitate partnerships among state and local government and private sector operators
- Federal government can facilitate knowledgede transfer activities about lessons learned and best practices from pilot evaluations among various local and regional public agencies

*Funding*

- Direct subsidies for qualified users (e.g., low-income individuals, users with disabilities, and older adults) of shared mobility services
- In-kind subsidies for shared mobility operators (e.g., access to rights-of-way and parking, permit streamlining, tax and fee waivers, joint marketing)
- Grants for new pilot projects

*Regulation/Legislation*

- Test innovative shared mobility legislation and programs as pilots with robust evaluations to increase the understanding of potential impacts and needed mitigation measures
- Craft proactive legislation that guides shared mobility toward social, environmental, and economic goals as opposed to reactive legislation that primarily seeks to counter perceived negative impacts

- Shift from prescriptive requirements (e.g., number of wheelchair accessible vehicles required in fleet) to performance-based metrics (e.g., customer satisfaction for users with disabilities, wait time and travel time reduction) that measure progress toward social, environmental, and economic goals
- Careful examination of which level of governance is best suited to regulate shared mobility services based on market and service characteristics and existing regulatory capabilities
- Apply minimum standards to all shared mobility operators regarding working conditions, impact fees, and accessibility

*Data and Metrics*

- Develop consistent data sharing requirements for all shared mobility services as a precondition of approval
- Provide guidance to state and local government in developing robust equity metrics

**Future Research Needs**

Most experts agree that more research is needed to fill gaps in knowledge about users and non-users, understand the impacts of shared mobility partnerships, and identify existing policy barriers to piloting and implementing equitable shared mobility services.

*Demographics*

- National transportation surveys (e.g., National Household Transportation Survey, American Community Survey) should include wider range of shared mobility modes

*Shared Mobility Partnerships*

- Research on regulatory implications of public-private shared mobility partnerships is needed

*Policy barriers*

- More research is needed on existing policy barriers to shared mobility that also achieve community goals

# CHAPTER 1. INTRODUCTION

## WHAT IS SHARED MOBILITY?

According to the U.S. Department of Transportation (U.S. DOT), shared mobility is defined as "the shared use of a motor vehicle, bicycle, or other low-speed transportation mode" that "enables users to obtain short-term access to transportation on an as-needed basis, rather than requiring ownership" (Shaheen et al., 2016). The first carsharing and bikesharing programs in North America launched in 1994, with other shared mobility services expanding rapidly since then (Shaheen et al., 2016). Its recent growth has been attributed to advances in technology, economic changes, and evolving social perspectives toward car ownership and urban living. Figure 1 shows both incumbent service models that have been available for many years, as well as more recent service innovations that leverage technological innovations, such as smartphones, GPS, and mobile payment. Specific service model definitions are included in the glossary of this document.

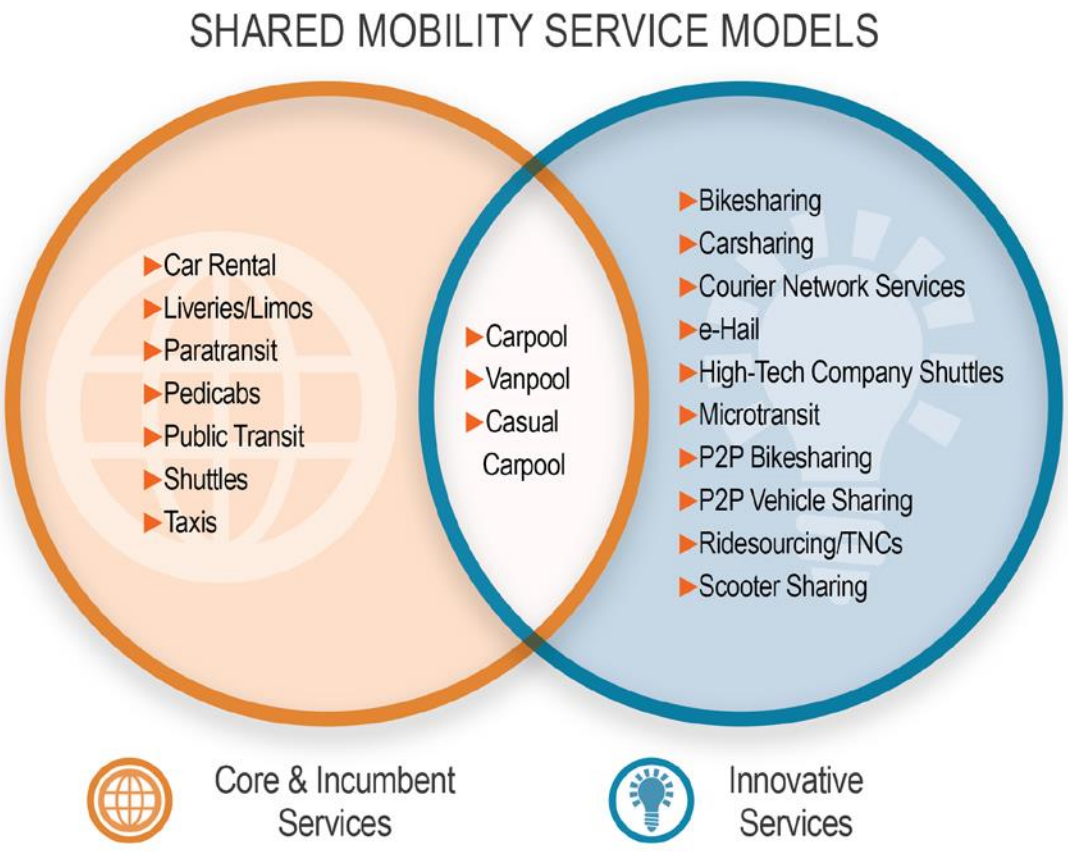



*Figure 1: Shared Mobility Service Models (Source; Shaheen, Cohen, and Zohdy 2016)*

Within the umbrella term of shared mobility, there is a broad array of modes with different use cases, business models, and travel behavior impacts. Deploying a range of shared mobility options in conjunction with reliable public transit service can facilitate optimal as-needed transportation access, providing a range of direct and indirect benefits to users and society at large. Shared mobility has the potential to increase mobility for users who are unable to access private vehicles and allow users who own cars to drive them at higher occupancy, for fewer trips, or forego ownership altogether, potentially reducing household transportation expenditures while providing more mobility options.

## SHARED MOBILITY IN THE CONTEXT OF TRANSPORTATION EQUITY

Transportation is consistently cited as one of the most important quality of life factors and economic mobility indicators for households. A 2015 study conducted by Harvard researchers found that longer household commute times are associated with lower wages and socioeconomic status for younger generations within the household (Chetty and Hendren 2015). The availability of transportation can impact a household's ability to access education, health services, jobs (Ihlanfeldt and Sjoquist, 1989) and maintain social ties with friends and family (Frank et al., 2006). On top of the macroeconomic benefits of transportation infrastructure, the association between transportation and quality of life has lead policy makers and governmental agencies to devote considerable resources to building and maintaining an extensive multi-modal transportation network.

At a basic level, equity refers to the fairness with which benefits and costs are distributed (Litman, 2015). Transportation has been the subject of equity analysis for many decades, with research focusing on a range of issues including the local impacts of large transportation infrastructure projects (e.g., highway construction in low-income urban neighborhoods); equity assessment of how transportation is subsidized and taxed (e.g., the use of local sales taxes versus tolls to fund roadway projects); and how underlying land use and transportation planning decisions affect accessibility for various demographic groups (e.g., lower-density auto-dependent development impacts on senior, disabled, and low-income mobility). Transportation equity has become ingrained in the transportation planning and funding process, starting with the anti-discrimination provision as part of Title VI of the Civil Rights Act of 1964, impact assessment and public participation requirements as part of the National Environmental Policy Act (NEPA), and the expansion of protected classes with Executive Orders 12898 and 13166. Currently, U.S. DOT has incorporated transportation equity as part of its plans and programs to identify and mitigate disparate impacts and enhance access and mobility for all federal and federally funded transportation programs (Martens et al., 2012).

The recent proliferation of shared mobility services has disrupted the existing transportation marketplace. New service models can create opportunities and challenges with respect transportation equity. Shared mobility has the potential to increase access to opportunities for

many underserved populations, but it may also jeopardize access by not providing accommodations for vulnerable users and by reducing the viability of existing options they rely on ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016). While many shared mobility services are perceived as privately owned and operated, the public sector is involved in many aspects of their operation ranging from regulation of publicly owned rights-of-way, risk-sharing partnerships, service procurement, subsidies, and funding.

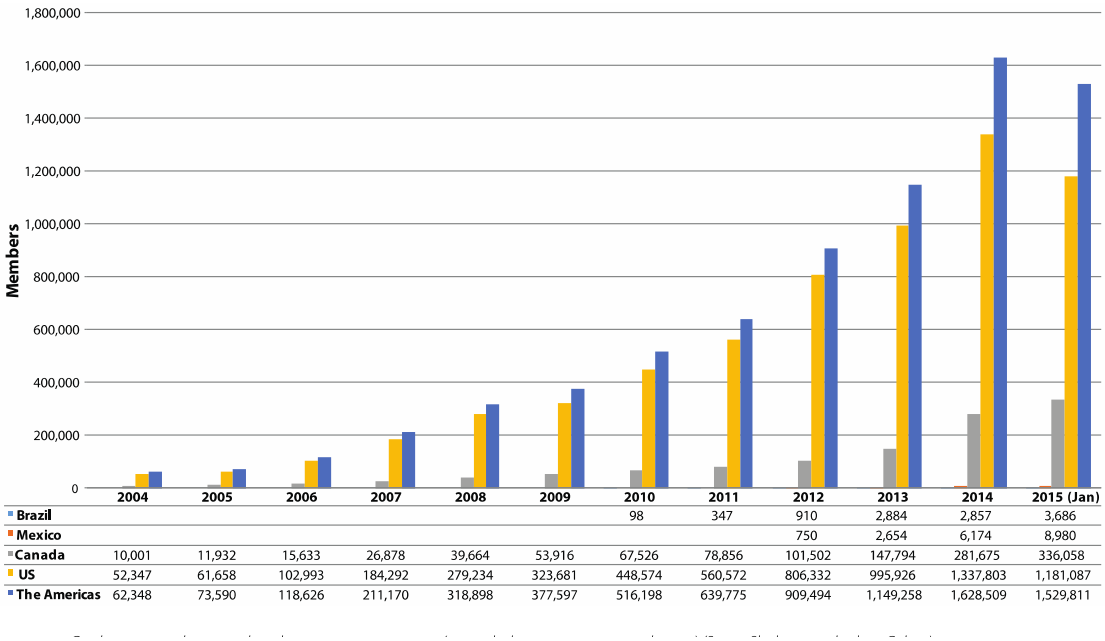
The evolving business models and partnerships of many shared mobility services makes determining responsibility for equity outcomes difficult to assess. Since many shared mobility operators receive direct or indirect monetary support from agencies receiving federal funding (e.g., subsidies from public transit agencies to ridesourcing companies) non-discrimination requirements could extend to shared mobility operators (Shaheen, Cohen, and Zohdy, 2016). According to the Federal Transit Administration, equity requirements established under the Americans with Disabilities Act (ADA) can still apply to projects that do not receive federal funding, if they meet certain definitions, such as fixed route, general public demand responsive, and paratransit services (Federal Transit Administration, 2016).

# CHAPTER 2. SHARED MOBILITY USERS

## WHO USES SHARED MOBILITY?

In the past, carpooling users engaging in more informal arrangements were more likely to have lower incomes and to be the non-primary income earner of a household. Ridesharing was also more prevalent among longer-distance commuters to compensate for higher commute costs (Teal, 1987). Although ridesharing and carpooling represent a declining share of commute travel from 20.4 percent in 1970 to 9.2 percent in 2014 (Cohen and Shaheen, 2016), data from the American Community Survey have shown that 10.4 percent of African Americans, 13.6 percent of Asians, and 15.3 percent of Hispanics carpool to work compared to 8 percent for Whites (Murakami and Long, 2011). A study of carpoolers in Houston, Texas found carpooling behavior differed by demographics, with younger carpoolers that had no children being more likely to engage in "casual carpooling." Casual carpooling is defined as informal carpooling among strangers (Shaheen et al., 2016), whereas high occupancy vehicle (HOV) lanes users tended to belong to larger households with fellow carpoolers more likely to be family members (Burris and Winn, 2006). A study of casual carpooling in the Bay Area found convenience, time savings, and monetary savings to be the primary motivators for carpooling (Shaheen et al., 2016).

As of July 2015, there were 22 active carsharing programs in the United States with over 1 million members, and as of October of 2015 there were 87 IT-based bikesharing systems with 30,750 bicycles in total (Shaheen et al., 2016). See Figure 2 for growth in carsharing members in the Americas (roundtrip and one-way models). Past North American studies on business-to-consumer (B2C) and peer-to-peer (P2P) carsharing and bikesharing have shown that shared mobility users are more likely to be White, male, between the ages of 20 to 35, and have higher levels of education than the broader population (Shaheen et al. 2014) (Dill et al., 2015). A Transportation Research Board report on shared mobility suggests that some of the race/ethnicity differences could be due to a lack of geographic availability of services, the association between income and race/ethnicity and differences in modal preferences ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016). Studies have also shown that the majority of carsharing users live in households without access to a car, showing carsharing's role in filling an important mobility gap for carless households (Millard-Ball et al., 2005). Some studies have shown carsharing users have a higher proportion of female users, although the reason for this has not been determined (Dill et al., 2015). Dill et al. found that without a P2P rental, 31% of users would not have made the trip, suggesting that access to the service has expanded the mobility of these users.




| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 (Jan) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brazil | | | | | | | 98 | 347 | 910 | 2,884 | 2,857 | 3,686 |
| Mexico | | | | | | | | | 750 | 2,654 | 6,174 | 8,980 |
| Canada | 10,001 | 11,932 | 15,633 | 26,878 | 39,664 | 53,916 | 67,526 | 78,856 | 101,502 | 147,794 | 281,675 | 336,058 |
| US | 52,347 | 61,658 | 102,993 | 184,292 | 279,234 | 323,681 | 448,574 | 560,572 | 806,332 | 995,926 | 1,337,803 | 1,181,087 |
| The Americas | 62,348 | 73,590 | 118,626 | 211,170 | 318,898 | 377,597 | 516,198 | 639,775 | 909,494 | 1,149,258 | 1,628,509 | 1,529,811 |

*Figure 2: Carsharing Growth in the Americas (Source: Cohen and Shaheen 2016)*

A recent poll conducted by the Pew Institute on participation in the sharing economy, showed similar results for ridesourcing, with use concentrated among those with college degrees, with above median household incomes, under the age of 45, and living in urban and suburban areas (Smith, 2016). Results from another national poll conducted by Morning Consult (2015) suggest that minorities may use ridesourcing in higher proportions, with 25 percent of Caucasian respondents reporting having used ridesourcing apps compared to 49 percent of Hispanics and 41 percent of African Americans (Morning Consult, 2015). This could be due to a combination of lower automobile ownership rates among minorities and the prevalence of ridesourcing in urban areas where they live, although does not capture frequency of use.

While there are similarities in who uses shared mobility, each mode has a different set of potential use cases, with bikesharing having the shortest range, and ridesourcing accommodating a larger geographic coverage, although at higher per mile/per trip costs. This highlights the need to understand the specific opportunities and limitations for each shared mobility service, as well how well they work in conjunction as a complete multi-modal system.

The general consensus among experts was that widespread demographic data on users of shared mobility is lacking. Making generalized statements about the impacts of shared mobility is difficult due to the specific use cases of different models and differences in study methodologies that can produce inconsistent results (Cohen and Shaheen, 2016). Private sector operators collect

detailed trip origin and destination information, which is important in determining the geographic and temporal distribution of such services. However, public agencies have struggled to gain access to this data from many operators because of concerns over user privacy and proprietary information. Despite the initial lack of data sharing, some operators may be opening their data for public use. For example, New York City's Taxi and Limousine Commission adopted a data sharing agreement ridesourcing operators to report intersection-level pick-up and drop-off data (Marshall, 2017). Some experts mentioned anecdotally that the shared mobility user base seems to be broadening in terms of income, race/ethnicity, particularly for ridesourcing. Underlying urban characteristics such as population density, public transit service quality, and vehicle ownership were cited as factors that could yield very different shared mobility user characteristics within and between urban areas. Experts from the private sector noted that while the user base was broadening, regulation and subsidies are likely needed to ensure full access for special needs users such as low-income, older, and disabled individuals.

## WHO IS NOT USING SHARED MOBILITY AND WHY?

While the user base of shared mobility services is growing, it still represents a small fraction of the US population and total trips. As of May 2016, only 15 percent of Americans had used ridesourcing apps, and 30 percent had never heard of them (Smith, 2016). While the number of carsharing and bikesharing markets and membership numbers continue to grow, they are still mostly confined to dense urban areas and represent a small percentage of regional travel.

Despite potentially providing disadvantaged communities with additional service offerings, shared mobility has failed to gain traction among these groups, with shared mobility surveys showing user bases that under represent low-income and non-white users. The lower rates of shared mobility use among the poor have many plausible explanations including lack of availability in low-income neighborhoods and limited Internet, smartphone, and credit/debit card access.

### Geographic Placement

Of the shared mobility services, bikesharing has the most demographic research documenting an income and race/ethnicity gap between users and non-users (Schmitt, 2012). Some articles cite a lack of stations in low-income neighborhoods since bikesharing stations are typically located in densely populated, higher income, mixed-use areas with good bicycle infrastructure to ensure adequate ridership and revenue to cover operating expenses (Schmitt 2012). Moreover, bikesharing networks operate most effectively when they form a tight contiguous cluster of stations. While many systems have made an effort to place some stations in low-income neighborhoods, if these stations are not fully integrated with the main contiguous cluster of stations they provide fewer accessible destinations, limiting their usefulness for adjacent users (Schmit, 2012). Carsharing vehicles are often located in higher-income central neighborhoods

for similar reasons, leaving many communities without access to these vehicles despite potential need and interest.

### Unbanked

Many shared mobility services require debit/credit cards for payment and, in some cases, collateral for vehicles or equipment. This can be a barrier for the 15 percent of US consumers who are under banked or unbanked, raising equity challenges as a disproportionate share of minorities are under and unbanked (Pew Research Center, 2016). Furthermore, bikesharing typically requires an equipment deposit hold on a bank account or credit card. This can be cost prohibitive for users that could otherwise afford the membership and usage fees.

### Social Barriers

A more elusive reason given for lack of shared mobility use among low-income households and minorities are social barriers. Community-based organizations (CBO) and public sector experts highlighted a lack of culturally inclusive marketing and outreach when shared mobility services launch in a particular market. There is a sentiment among low-income communities and minorities that despite being technically able to access shared mobility, the services have not been designed with their needs in mind (Schmitt, 2012). For limited English proficiency users, lack of outreach in the appropriate language is often cited as a reason these users are less likely to access shared mobility (Snyder, 2014).

## Digital Divide

Existing literature and expert perspectives on who is not using shared mobility are similar to surveys tracking the demographics of those left out by the "Digital Divide," defined as those who do not have access to the Internet. Since many shared mobility services require access to the Internet, especially through mobile devices, understanding who does not use the Internet helps identify groups that may have special needs when it comes to shared mobility access. According to Pew Research, as of 2016, 13% of U.S. adults did not use the Internet. Lack of Internet access is predominant among those over the age of 65, with incomes below $30,000, without a high school diploma, and living in rural areas. See Figure  for a synopsis of the demographics on non-Internet users.

Non-Internet users had the following reasons for not going online: 34 percent had no interest in doing so or did not think it was relevant to their lives, 32 percent said it was too difficult to use, and 19 percent said accessing Internet service or a computer was too expensive (Anderson and Perrin, 2016). Since many non-Internet users reported difficulty using the Internet, it is important to consider providing better education and more universal interfaces to facilitate access. Although still significant, the share of the U.S. population without Internet access has declined substantially from 48 percent in 2000 to 13 percent in 2016. See Figure  for the rate of decline in non-Internet use in the U.S. from 2000 to 2016. Some of the non-use among older Americans can be explained by the difficulty in adopting new technologies in older age, especially for those that had already retired at the time of widespread Internet adoption, highlighting the need to maintain transportation access interfaces, such as land lines and feature phones that are more compatible with the current cohort of older adult users.

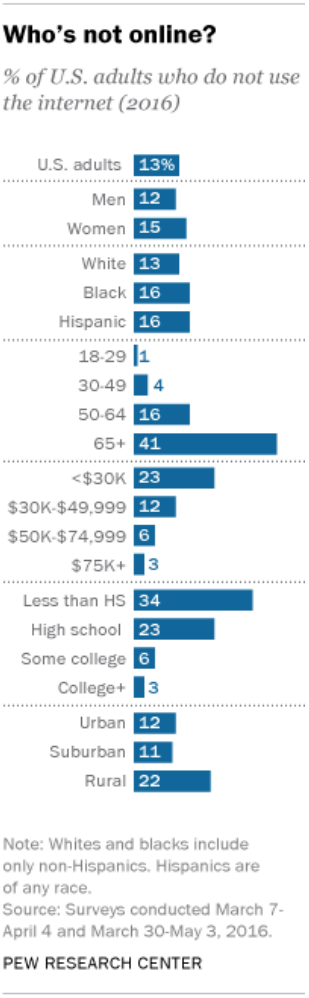



*Figure 3: Demographics of Non-Internet Users (Source: PEW Research Center)*

While many services also require a smartphone to access services, as of November of 2016, 77 percent of U.S. adults owned one, up from 35 percent in 2011 (Street et al., 2017). However, there are still discrepancies in use across demographics with use lowest among those 65 years and older (42 percent), without a high school diploma (54 percent), with incomes below $30,000 (64 percent), and those living in rural areas (67 percent) (Street et al., 2017).

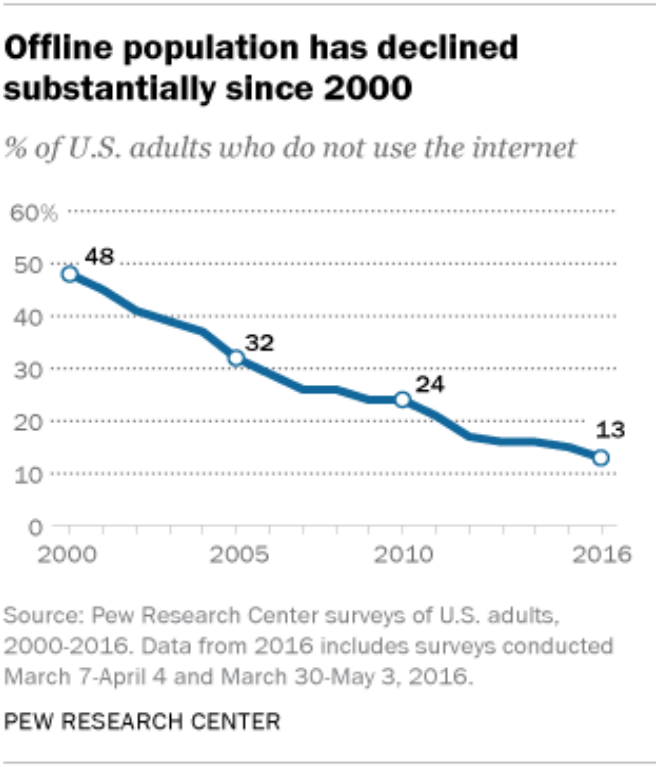



*Figure 4: Percent of U.S. Adults Who Do Not Use the Internet ((Source: PEW Research Center)*

# CHAPTER 3. OPPORTUNITIES, CHALLENGES, AND LESSONS LEARNED

## BARRIERS TO ACCESS AND USE

Many users may experience transportation barriers throughout the day. The impact of these barriers may be associated with spatial, temporal, economic, physiological, and social barriers, as noted earlier. Table 1 below provides a summary of the STEPS (Spatial, Temporal, Economic, Physiological, and Social) framework to transportation equity. STEPS offers a framework for categorizing equity barriers to accessing transportation. While there are numerous approaches to addressing these barriers, including building denser, mixed-use communities or expanding the coverage of existing public transit systems, shared mobility may provide some advantages. For instance, shared mobility options might provide lower cost, quicker deployment, flexibility, and enhanced convenience in contrast to longer-term infrastructure and development project approaches (e.g., construction a new rail line).

*Table 1: STEPS to Transportation Equity*

| Transportation Barriers | Definition | Shared Mobility Opportunities | Shared Mobility Challenges |
|---|---|---|---|
| Spatial | Spatial factors that compromise daily travel needs (e.g., excessively long distances between destinations, lack of public transit within walking distance) | • Public transit operators and ridesourcing first- and last-mile partnerships<br>• Microtransit for lower-density areas | • Higher operating costs in lower-density exurban and rural settings<br>• Limited curb space for increasing variety of mobility services |
| Temporal | Travel time barriers that inhibit a user from completing time-sensitive trips, such as arriving to work (e.g. public transit reliability issues, limited operating hours, traffic congestion) | • Dynamic microtransit<br>• Late-night ridesourcing and shuttle services<br>• Commuter carpooling services | • Wait-time and travel-time volatility on congested roadways<br>• Unpredictable wait times due to supply fluctuations |

| | | | |
|---|---|---|---|
| Economic | Direct costs (e.g., fares, tolls, vehicle ownership costs) and indirect costs (e.g., smartphone, Internet, credit card access) that create economic hardship or preclude users from completing basic travel | • Shared mobility subsidies for low-income users<br>• Multiple payment options for shared mobility services<br>• Multi-modal hubs with Wi-Fi access | • Credit/Debit Card payment<br>• High cost for longer distance and peak-demand trips<br>• Maintaining affordability, while providing livable wages |
| Physiological | Physical and cognitive limitations that make using standard transportation modes difficult or impossible (e.g., infants, older adults, and disabled) | • Older adult-focused shared mobility services<br>• Voice activated mobility app features | • Maintaining legacy technology access<br>• Ensuring adequate driver training |
| Social | Social, cultural, safety, and language barriers that inhibit a user's comfort with using transportation (e.g. neighborhood crime, poorly targeted marketing, lack of multi-language information) | • Ridesourcing app interface that minimizes sociodemographic profiling<br>• Targeted outreach to low-income and minorities<br>• App information in user's native language | • Attracting marginalized groups<br>• Driver prejudice against riders<br>• Providing security at un-manned vehicle stations |

## SPATIAL

### Barrier Description

Spatial distance becomes a transportation barrier when it impedes a user's ability to access opportunities in a timely and affordable manner. Since a lot of U.S. cities are designed around auto-oriented urban form, spatial barriers can be one of the most important for users without access to the automobile including youth, older adults, people with disabilities, carless households, and low-income households. More dispersed land-use patterns commonly associated with auto-oriented development can create challenges for public transit riders trying to make "First Mile Last Mile" (FMLM) connections, where the origin and destination of a trip are just far enough from a public transit line that completing the entire trip becomes a challenge. Communities that are far from the urban core with lower population densities also tend to have longer trip distances and fewer mobility options, which generally require a heavier reliance on

private vehicle use. The 2009 National Household Transportation Survey found that 97 percent of rural households had access to at least one motorized vehicle compared to 90 percent for urban households. At the same time, only 13 percent of the rural population has access to public transit (NCTR, 2014).

Access to jobs can become another equity challenge for Americans. Between 2000 and 2012, residents in major metropolitan areas saw the number of jobs within a typical commute distance fall by seven percent (Kneebone and Holmes, 2015). The decline in job accessibility was twice as large for suburban residents compared to city residents at seven and three percent, respectively. The decline in job accessibility was even more pronounced for low-income and minority communities. The decline over this period was 17 percent for Hispanics, 14 percent for Blacks, and 17 percent for low-income communities. It should be noted that this study period coincides with an economic expansion and the following Great Recession, which complicates the findings. While dense urban areas may benefit from shorter trip distances and generally more transportation options, 63 percent of jobs in the largest 100 metropolitan areas in the U.S. are in suburban areas (Plumer, 2012), often with limited public transit accessibility. Additionally, there may be a jobs-housing affordability mismatch (e.g., the jobs available in denser urban areas may require educational attainment, a degree, or other qualifications that residents in lower-income neighborhoods may not possess).

Experts representing public transit agencies highlighted the difficulty of providing adequate transit coverage for an entire region with fixed-route bus service. Many U.S. metropolitan areas have a land use and density composition, coupled with urban form, which is not well suited for fixed-route service. One expert involved in equity planning at a state DOT mentioned the lack of basic infrastructure in some disadvantaged communities, such as sidewalks connecting neighborhoods to schools and public transit facilities. Given the difficulty of changing land use patterns and major transportation infrastructure in the near to medium term, these challenges are likely to persist. Shared mobility may be able to bridge service gaps within the existing transportation network.

### Shared Mobility Opportunities and Challenges

Shared mobility may be able to address spatial inequality in areas with limited alternatives to private vehicle ownership by providing additional mobility options for an entire trip or first-and-last mile connections to public transportation. Strategic placement of shared mobility in communities underserved by public transportation may reduce the effects of spatial inequality by providing innovative modes that have greater geographic reach than existing options.

While shared mobility has the potential to enhance accessibility for people with spatial barriers, private services are still subject to market forces (e.g., cost recovery and profit). Lower densities create challenges to providing a high-quality, cost-effective service. Experts from metropolitan planning organizations (MPOs) said they struggle to integrate shared mobility and transportation demand management (TDM) measures in areas outside of the urban core. These experts

indicated that lower-density areas in many cases represent the majority of the population, land area, and travel demand. One expert mentioned that the presence of shared mobility often coincides with changing neighborhood demographics and displacement. While innovative services are coming to low-income neighborhoods that could benefit from increased accessibility, the increasing cost of housing is pushing lower-income residents to more peripheral "public transit deserts," lacking high quality transit service.

Not surprisingly, mobile service and high-speed data may be more limited in rural areas, making access to shared mobility services that rely on Internet access and smartphones more difficult. Many shared mobility apps require high-speed data connections to provide real-time data and location services to both users and providers. Slow Internet speeds can create challenges when locating a user and processing real-time transactions. One potential solution is to design "lite" versions of shared mobility apps that use less data and can supplement downloaded data through Wi-Fi connections (Shaheen et al., 2016).

*Bikesharing*

Bikesharing can provide a more convenient and faster alternative to bus access for shorter trips, while also acting as a FMLM access mode for longer distance public transit services, such as commuter rail (Martin and Shaheen, 2014). This can improve access for users in areas that currently lack high levels of public transit accessibility.

Despite the potential for increasing access, bikesharing systems tend to be located in densely populated mixed use areas that may be correlated with higher-income central neighborhoods (Schmitt, 2012). Bikesharing systems are typically placed in higher density urban areas to ensure high farebox recovery. Lower-income neighborhoods may lack supportive cycling infrastructure and perceived as a higher risk for system vandalism. While the goal of higher farebox recovery may limit bikesharing access in some low-income neighborhoods, there is a growing effort to improve the geographic coverage of systems, even if it requires more subsides (e.g., New York City's Citi Bike expansion into additional boroughs) (Rivoli, 2016) ("About Us," 2017).

*Carsharing*

Placing carsharing in a neighborhood with poor transit accessibility allows users to have access to a private vehicle on an as-needed basis. Roundtrip carsharing can provide the benefits of automobility for non-work trip purposes, such as grocery shopping, which may require carrying goods and are not well served by the existing public transit infrastructure. In contrast, one-way carsharing can serve as a commute or FMLM access mode as long as both ends of the trip are within defined service areas.

Carsharing operators may be sensitive to perceived vandalism risk and lower revenue potential in lower-income communities. Carsharing service deployments have generally focused on upper- and middle-income neighborhoods with good accessibility to public transportation. However, some non-profits have focused on serving low-income communities. San Francisco's

CityCarShare's *CommunityShare* program provided carsharing access to low- and moderate-income families in partnership with affordable housing and social service agencies. Additionally, Buffalo CarShare established a neighborhood storefront to serve a low-income community (Lynch, 2016).

### California's Electric Carsharing Program in Disadvantaged Communities

- In 2014, Governor Brown signed Senate Bill 1275, the Charge Ahead Initiative, with the goal of deploying one million electric vehicles by the year 2023. As part of SB 1275, the California Air Resources Board (ARB) was directed to create electric vehicle sharing pilot projects in low-income and moderate-income communities. Low-income communities in California often face disproportionate exposure to air pollution and may reside in areas that are poorly served by public transportation. While electric vehicles have many benefits, including lower tailpipe emissions and more affordable fueling costs, the higher upfront vehicle and charging station costs pose a barrier for low- and moderate-income households. By combining electric vehicles with carsharing, California policymakers hope to simultaneously improve low-income transportation access, while mitigating climate change and reducing local air pollution.
- The Greenlining Institute, an environmental equity organization, in conjunction with the TSRC, published a report with recommendations for the pilot program's success based on interviews with carsharing experts. According to the report, to address charging station costs, pilot projects should seek to partner with charging station installation companies and utilities to take advantage of economies of scale to lower the cost of implementation in lower-income neighborhoods. Moreover, since low- and moderate-income individuals disproportionately live in multi-unit dwellings, pilot projects should seek to partner with property managers and developers to ensure convenient and affordable access for low-income users. While the pilot program's main intention is to deploy electric vehicles, experts recommend including a range of plug-in hybrid vehicles to make the fleet more accessible to users without electric vehicle experience and to provide more flexibility to users that need to refuel quickly (Espino and Truong, 2015). Los Angeles is one of the first cities to make use of the funds from ARB's program by deploying 100 electric vehicles and 200 charging stations in lower-income neighborhoods surrounding downtown. The LA pilot project is receiving funding from ARB, the City of Los Angeles, and a French carsharing company Bolloré group (Lee, 2016).

*Ridesourcing*

Ridesourcing has the potential to provide curb-to-curb service in areas that may be poorly served by public transit, taxis, or both. Pinellas Suncoast Authority (PSTA) in St. Petersburg, Florida was one of the first public transit agencies to offer subsidies, up to $5, for ridesourcing trips that begin or end at designated bus stops within defined zones (Cochran, 2016). The pilot was one of 11 programs selected as part of the Federal Transit Administration's (FTA) Mobility on Demand Sandbox evaluation. The pilot is intended to study the impacts of Lyft and Uber as a potential compliment or replacement for an existing paratransit service. One expert from a larger public transit agency did not think the model adopted by PSTA would work for the larger region they were serving, citing the potential for larger disparities in wait time between the ridesourcing and the more traditional cash-based services offered (e.g., taxis), the inability to ensure that all

neighborhoods would have equal access since drivers have discretion about which areas to serve, and the potential for pushback from equity stakeholders in the region.

The extent to which ridesourcing compliments or competes with public transit is not fully understood (Schaller, 2017). While there is less opportunity to explicitly discriminate geographically, its cost structure makes it unaffordable for longer trips for all but the wealthiest users. A ridesourcing expert mentioned that they may need subsidies to provide affordable service for areas with longer trips and lower-population densities. Small and rural communities could also make use of non-profit volunteer run models, such as Independent Transportation Network (ITN) America, a non-profit network of volunteer drivers that provide mobility services to older adults and people with disabilities. ITN America provides support to affiliate organizations and makes use of donated vehicles and volunteer drivers to keep costs to a minimum. Liberty Mobility Now has launched a rural ridesourcing service in Nebraska about two years ago an has expanded to Ohio and Colorado. The services charges $1.25 to book the ride service and $1 per mile.

*Courier Network Services*

Courier Network Services (CNS) have the potential to reduce spatial barriers by delivering goods to people instead of requiring them to travel to retail locations to access goods. While delivery is not a new concept, the use of technology to efficiently aggregate demand and route deliveries on an on-demand basis has the potential to reduce delivery cost and time. While this would be very useful for less dense areas where completing errands can require long driving distances, delivering in these areas may also require some form of subsidy to be affordable to low-income users. A public-sector expert envisioned that CNS combined with the virtualization of non-physical services (e.g., e-banking vs. physical banking transactions) could reduce the need to travel in the future, resulting in less isolation for users that are currently spatially constrained.

## Policy Opportunities

The primary policy opportunities to address spatial barriers include requirements and incentives to locate shared mobility services in underserved areas. For denser urban areas that have a large enough market to cross-subsidize less profitable vehicle placements, requirements to locate bikesharing and carsharing in poorly served neighborhoods as a condition of approval could be sufficient. San Francisco's on-street carsharing pilot is a an example of this, requiring carsharing vendors to locate 15 percent of vehicles in zones outside the central core (Cabanatuan, 2014), though this alone is not a guarantee that vehicles will be accessible to disadvantaged communities. Some public-sector experts described more flexible approaches to ensuring equitable access to services in their jurisdictions, such as by providing bonus parking spaces in higher revenue generating neighborhoods to carsharing vendors that locate in low-income neighborhoods. Other opportunities include risk sharing partnerships using a revenue guarantee where the carsharing organization values the monthly cost of vehicle placement and subtracts monthly revenue from that collected value and bills the shortfall to the risk partner (Dave Brook,

unpublished data, July 2005). Multiple experts emphasized the need for non-profit operators or governmental subsidies to provide affordable services outside of the urban core.

## TEMPORAL

### Barrier Description

Transportation systems can impose temporal barriers when users are unable to complete time-sensitive trips in a reliable and cost-effective manner. The most common source of temporal barriers faced in the U.S. include roadway delays due to fluctuations in normal traffic, traffic incidents, weather, and special events ("Traffic Congestion and Reliability," 2017) and public transit delays due to roadway congestion, boarding, and traffic signals (National Association of City Transportation Officials, 2016). For many transportation users, especially women with caregiving roles, certain activities are much more time sensitive than others (e.g., arriving at a job, children's activities, doctor's appointments). When transportation services experience consistent delays or are unreliable, users must devote more time to planning trips and rescheduling and less time engaging in their desired activity. According to a conference paper by Giuliano and Schweitzer, wage discrimination, gender segregation of the labor market, traditional household roles, and an increase in the uncertainty of auto travel time costs can have a disproportionate impact on women (Giuliano and Schweitzer, 2010).

For people who work second or third shifts, the lack of frequent public transit service can impose significant time costs. While travel by auto is often faster late at night, third-shift commuters are faced with significantly curtailed or nonexistent public transit service. In 2016 Boston's Massachusetts Bay Transportation Authority (MBTA) was challenged by the FTA for cutting its late-night service, which the FTA argued required an equity analysis to mitigate disparate impacts to riders dependent on late-night service (Dungca, 2016). Washington DC's Metro has recently increased fares and reduced late-night service to allow for critical repairs. An impact study, prepared as a requirement for Title VI, showed that service cuts would disproportionately increase travel times for low-income riders and minorities by increasing travel times for late-night and off-peak travel (Farley, 2017), but the need for repairs is seen as so critical by Metro's leadership that the service cuts are inevitable. Other cities with aging public transit infrastructure will likely face similar problems as they try to repair and upgrade their systems, while minimizing disruption to peak-hour commute riders.

### Shared Mobility Opportunities and Challenges

Shared mobility services can reduce temporal barriers by reducing combined wait- and in-vehicle travel times, providing trips when public transit is not available or has reduced service and providing the reliability of automobile access. Real-time arrival and travel-time estimate data for ridesourcing and real-time availability for carsharing and bikesharing allows users to make more informed mobility decisions, while the ability to reserve rides and vehicles provides more predictability than waiting for transit in areas where it is unreliable. Shared mobility services that

pool riders not only reduce the cost of providing service, but they can also take advantage of HOV lanes, potentially saving users time and improving travel-time reliability by providing access to less congested rights-of-way (ROW).

*Bikesharing*

For shorter trips in congested urban areas, bikesharing has the potential to provide more reliable travel times than public transit or automobiles, especially if dedicated bicycle lanes are present. Research suggests that bikesharing may provide faster, cheaper, and more direct connections than existing public transit services for short-distance trips (Martin and Shaheen, 2014).

In a station-based model, the main sources of temporal volatility stem from station rebalancing issues. Users may have to divert to another station, if their initial station is empty or, if at the end of their trip, the station is full with nowhere to dock the bicycles. These examples of rebalancing issues can add unplanned travel time to a bikesharing trip. Operators are experimenting with ways to improve rebalancing, with New York's Citi Bike even offering incentives to users who ride bikes to or away from unbalanced stations (Grabar and Canfield 2017).

*Carsharing*

With the ability to view availability in real time and book vehicles for a set amount of time, carsharing can provide the temporal reliability of auto ownership without the hassle of maintenance and insurance. However, unpredictable roadway conditions can make it challenging to properly estimate how long a trip will take, resulting in fines for the current user, if the vehicle is returned later than the designated reservation period and the next scheduled user has to wait for vehicle access.

*Ridesourcing*

Ridesourcing gained initial popularity as a more reliable late-night mobility option to public transit and taxis for travel to and from entertainment and bars, but it has since broadened its appeal for travel throughout the day. A study of ridesourcing use in San Francisco found that ridesourcing wait times tended to be substantially shorter than taxi wait times for matched trips (Rayle et al., 2015). Although as of October of 2014, 80 percent of taxis in San Francisco were using the e-Hail app Flywheel, bring taxi wait-times much closer to those of ridesourcing (Sachin Kansal, upublished data) (Shaheen, Cohen, and Zohdy 2016). Along with Direct Connect discussed in the Spatial Barriers section, PSTA also provides free grant funded ridesourcing rides between 9pm and 6am for low-income workers (Cochran, 2016). The partnership with Uber allows employers to set up an Uber for Business account that enables low-income workers to access rides with only an email address and a mobile phone.

While ridesourcing services provide users with wait-time and travel-time estimates, they are still subject to any reliability issues that affect single-occupant vehicles and often bus transit. Moreover, temporal spikes in demand or shortages of supply can result in unreliable wait times

and surge pricing. The co-founders of Lyft recently released an opinion piece calling for an expansion of dynamically priced "smart lanes," typically limited to highways, that would provide a free option for vehicles with three or more passengers as a way to reduce congestion on city streets and improve travel-time reliability (Zimmer, 2017).

### Policy Opportunities

While guaranteeing wait and travel times is difficult, the public sector can help improve travel speeds and reliability for shared mobility by expanding HOV, or "smart lanes," to congested arterial surface streets that provide priority access to pooled shared mobility services, such as pooled ridesourcing and microtransit, during congested periods.

To address long commutes for transit dependent users, public transit agencies could consider providing subsidies for shared mobility services, if users can show their current transit commute time is beyond a given threshold, and shared mobility services would significantly improve travel time. This could be done on a zonal basis, but given how distributed households and jobs are in most regions, an individual approach may be more useful.

To address late-night transportation access, public agencies could follow similar models to PSTA's late-night employee ridesourcing pilot. Partnering with employers can help offset costs especially if businesses see benefits, such as reduced turnover and increased productivity and satisfaction in their employees. Furthermore, public agencies could require bikesharing and carsharing services be available 24 hours per day to ensure late-night users have full access to these modes.

## ECONOMIC

### Barrier Description

Economic barriers exist if basic travel costs (e.g., commute, errands, appointments, social interaction) preclude a user from spending on other basic goods or savings. According to the U.S. Department of Housing and Urban Development, housing should cost no more than 30 percent of a household's income. Using this metric, no two-bedroom rental unit in the United States is affordable to a worker making the prevailing minimum wage ("Affordable Housing - CPD - HUD" 2017). While it is possible to reduce housing cost by living farther away from jobs, this can effectively trade housing costs for transportation costs. After housing, transportation is the second largest expense for American households, taking up 19 percent of the average American family's income. For auto-dependent suburbs, this proportion climbs up to 25 percent ("Transportation and Housing Costs - Fact Sheets - Livability - FHWA" 2017). The Center for Neighborhood Technology (CNT) has combined these two factors in what it calls the Housing + Transportation (H+T) index, proposing an H+T affordability target of no more than 45 percent of income. Using this metric, CNT has found that only 26 percent of U.S. neighborhoods are affordable ("CNT Ranks Regions for Transportation Affordability with Updated H+T Index" 2015).

Individuals can save money on transportation by living in areas that have a higher development density, good access to jobs and amenities, and provide more affordable alternatives to automobile use. This is especially true, if a household is able to forego car ownership, which the American Automotive Association (AAA) estimated to be $8,500 in 2016 (Stepp, 2016). Car ownership can also increase housing costs in urban areas. As of 2012, the average construction cost for an above-ground and underground parking space in the U.S. is $24,000 and $34,000, respectively (Ison and Mulley, 2014). Despite the potential cost savings for car-free or car-lite households, the quality of existing public transit services can vary significantly by neighborhood, even in regions known to have good transit access overall (Gordon-Koven, 2015). At the same time, inadequate public funding for transit and the lingering impacts of the recession have coincided with service cuts and fare increases, disproportionately impacting low-income riders (White, 2015).

### Shared Mobility Opportunities and Challenges

By allowing users to pay for transportation on an as-needed basis and more efficiently using existing roadway capacity (when pooled), shared mobility has the potential to substantially decrease household transportation costs, while reducing the need for the public sector to invest in low-ridership public transit lines, roadway expansion, and new parking facilities. As a supplement to core public transit services, shared mobility has the potential to reduce the need for car ownership in many communities.

While showing initial signs of mainstreaming in dense urban areas with good public transit access, shared mobility services generally are more expensive for a longer duration and trip lengths potentially favoring private vehicle ownership depending on a household's needs and usage patterns. Although cost-burdened households could experience savings from shared mobility access, many services require payment with a credit or debit card, which can impose a barrier for the 15 percent of American consumers who are unbanked. This barrier has been somewhat mitigated by the recent introduction of general purpose reloadable (GPR) prepaid cards available in corner stores, as well as from more traditional financial institutions (Wolff, 2015).

Many shared mobility providers require an Internet connection to request rides or make a reservation, which may leave these services out of reach for users without mobile Internet connectivity (Anderson and Perrin, 2016).

### Taxis and eHaling

- Taxis have long served as a critical mobility service for the older adults, youth, and low-income individuals without automobile access. Unlike technology-enabled shared mobility services, taxis can be reserved through street hailing and traditional telephones and the accept cash payment. These features are important for users that do not have access to smartphones or bank accounts, and may explain why low-income users may choose taxis over ridesourcing services despite higher average fares ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016)(Certify 2015). Moreover, significant price difference between taxis and ridesourcing is not universal. A study funded by Uber in New York City comparing differences in cost and wait-time between Uber and taxis did not find a statistically significant difference in cost (BOTEC Analysis Corporation 2015). This could be partially explained by New York City's open-entry system, allowing for taxi supply to more easily meet demand than in cities that limit the number of licensed taxis in their jurisdiction ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016).
- Since 2014, there has been a rise in the application of e-Hail applications that provide many of the benefits experienced from ridesourcing operators such as, internet-based dispatch, in-app reservation and payment, and more accurate wait-time and fare estimates. New York, Los Angeles, Washington DC, and Chicago all have programs to expand the use of e-Hail applications for taxis (Shaheen, Cohen, and Zohdy 2016). The wide deployment of e-Hailing could help taxis remain competitive with ridesourcing services while maintaining features, such as street hail and cash payment, that are more accessible to low-income and older users

*Bikesharing*

With its membership model that promises unlimited 30-minute rides for a fixed membership fee, bikesharing can be an attractive option for users. Bikesharing removes the financial burden of storing and maintaining a bicycle, while allowing users to link their trips to public transit. According to the 2009 National Household Transportation Survey, the bottom two income quartiles make up 61 percent of bicycle commuting (Anderson and Lauran, 2015), showing demand for practical bicycle solutions among low-income commuters. Despite the low per-trip cost, high upfront annual membership fees can be a barrier to low-income users. Many systems also require a credit hold or deposit to insure against theft of bicycles, which require a bank account or debit/credit card along with enough value stored to act as collateral. These upfront barriers prevent potential low-income users from benefiting from the free unlimited 30-minute rides that membership promises.

To overcome this challenge, Capital Bikeshare in Washington DC partnered with District Government Employees Federal Credit Union and United Bank to provide bank accounts and debit cards to previously unbanked users. To help defray the membership costs, previously unbanked users were awarded a $25 gift card toward their annual bikesharing membership (Shaheen et al., 2016). Indego BikeShare in Philadelphia provides $5 per month memberships to members that receive food assistance benefits and allows users to pay with cash by partnering with local retail outlets (Owens, 2016).

*Carsharing*

Many users have the potential to save money by paying for mobility on an as-needed basis in conjunction with other modes. This is due to high vehicle ownership costs of approximately $8,500 per year (Stepp, 2016), and vehicles sitting idle about 95% of the time. Moreover, peer-to-peer models, such as Getaround and Turo, provide a potential income stream for low-income car owners willing to share their vehicles with their neighbors. Studies of roundtrip carsharing have found that households that joined a carsharing organization save an average of $154 to $435 per month when compared to private vehicle expenses (Shaheen et al., 2012).

Similar to bikesharing, carsharing presents barriers to unbanked members and some members without Internet access (depending on an operator's vehicle telematics). Not surprisingly, a lot of the same solutions could apply to carsharing. Unlike most bikesharing services, hourly charges for use can add up quickly, especially if the vehicle is parked for a significant portion of a reservation. While most of the hourly price covers the operational cost, a study of taxes imposed on carsharing services across the United States discovered that carsharing transactions are being taxed at approximately double the rate of normal sales tax in the cities they operate (Schwieterman and Spray, 2016). Rental car taxes, popular among politicians for their perceived impact on visitors as opposed to residents, have been applied to carsharing vehicles despite the fact that these are overwhelmingly used by residents. In an effort to make carsharing more affordable, some states have revised their car rental taxes to reflect the difference between carsharing and car rentals (Shaheen et al., 2016).

Research by Dill et al. found that one of the most commonly cited reasons people chose to join a P2P carsharing organization as opposed to a business-to-consumer organization was the relatively lower-cost of P2P rentals. The lack of membership fees was also cited as an important factor to join (Dill et al., 2015). Both of these findings indicate that small differences in hourly rental fees, and elimination of an upfront membership fee could be an important incentive for price-sensitive users.

According to an expert from a community based organization, there is a business case for locating carsharing in low-income neighborhoods. With the right marketing and product-market fit, carsharing vendors can operate profitably by providing a valuable service that many low-income users would be willing to support. Non-profit Buffalo Car Share (BCS) was conceived to specifically target low-income users. Unlike most other carsharing operators, two thirds of BCS users came from households making less than the city median income of $30,000. Several effective strategies employed by BCS included allowing unbanked users to pay via money order and locating its vehicles on affordable housing properties (Snyder, 2014).

*Ridesourcing*

While generally competitive with public transit for shorter trips, ridesourcing is still not affordable to most users for routine commuting and longer non-work trips. Many regions, such as Denver (Proctor, 2016) and St. Petersburgh, Florida (Lazo, 2016a), are experimenting with

various subsidies to reduce the cost of using ridesourcing as a paratransit and FMLM access mode. With the combination of pooled rides and pre-tax commuter benefits now extended to qualifying vehicles, ridesoucing may become more affordable for commuting in some regions (BRiPulse, 2017). While ridesourcing can present a barrier to unbanked users, providers typically allow users to pay with GPR prepaid cards, providing a cash-based entry point for ridesourcing payment.

### Policy Opportunities

While shared mobility services can be more affordable than automobile ownership, they can still present an economic burden to low-income users. Public agencies can take a mixed approach of reducing costs on operators, by reducing taxes and fees where appropriate, subsidizing shared mobility use for those still unable to afford the market rate for the service, or both. Furthermore, expanding pre-tax commuter benefits to services like bikesharing, microtransit, and pooled ridesourcing could incentivize multi-modal trips and provide cost savings available to automobile owners and traditional public transit riders (Shaheen et al., 2016).

To better integrate means-based subsidies and multi-modal trips, private sector experts suggested switching from card-based payment, common in many public transit agencies to account-based payment used by most shared mobility vendors via smartphone apps. While account-based systems would allow users to reload their account value with cash, they would still be difficult to use without a smartphone. To address this, several public-sector experts discussed the potential role of strategically placed mobility hubs that would allow un-phoned users to hail a variety of shared mobility services. Some variants of this idea already exist, such as the linkNYC Wi-Fi kiosks in New York City (Mcgeehan, 2016). Although Wi-Fi kiosks have potential in denser urban areas, most users would still be better served by a mobile phone service. In an effort to address this gap, the Federal Communications Commission, through its Universal Service Fund (USF), offers Americans up to 135 percent of the poverty line a $10 subsidy to help pay for either Internet at home or a mobile phone service (Risen, 2016).

## PHYSIOLOGICAL

### Barrier Description

Transportation presents physiological barriers when a user has physical or cognitive difficulty navigating the transportation options available. All transportation users have a different combination of cognitive and physical abilities, which change over time. All people are born with limited cognitive and physical abilities that improve as they age, some develop a disability at a younger age, and most will experience declining cognitive and physical ability in older age. Along with these changes in physical and cognitive abilities come changes in mobility needs.

The growing American older adult population, along with its strong association to the disabled community, presents the single largest physiological challenge for the transportation system. According to U.S. Census projections, by 2050 the population of Americans older than 65 will

number over 83 million, almost double what it was in 2012 (Ortman et al., 2014). With old age comes a higher probability of developing a disability, with only eight percent of people under 15 reporting a disability, while that proportion grows to 71 percent of people 80 and older (U.S . Census, 2012). Moreover, as the population ages the prevalence of severe disability that require special assistance increases from five percent for those 15 to 24 years old to 25 percent for those 65 to 69 years old (U.S. Census, 2012). According to a Bureau of Transportation Statistics report, this was already impacting transportation access in 2000, with 12 percent of persons with disabilities stating they had difficulty getting the transportation they need, with the top reasons being no or limited public transportation (33 percent), do not have a car (26 percent), and disability makes transportation hard to use (17 percent) (Bureau of Transportation Statistics, 2002).

Public transit agencies have been successful in increasing ADA accessibility on vehicles and stations with 99 percent of buses and 67 percent of rail stations complying with ADA standards (Bureau of Transportation Statistics, 2012). Despite the progress made in providing ADA accessible vehicles, public transit agencies often do not have jurisdiction over local streets and sidewalks, making it difficult to guarantee that access routes to public transit stops will be ADA accessible. The inability to predict the accessibility of sidewalks and other infrastructure at either end of a public transit trip makes trip planning for disabled users extremely challenging. Combined with limited coverage and hours of operation, existing ADA compliant transit services can still pose significant barriers to disabled users.

While ADA compliance for public transit vehicles is relatively high and improving, transportation authorities have generally struggled to ensure taxi fleets have adequate wheelchair accessible vehicles. As of 2010, 1.8 percent of New York City taxis were wheelchair accessible. The number of wheelchair accessible for-hire livery vehicles was even lower at six out the 36,000 for-hire livery vehicles registered in New York City (Shaheen, Cohen, and Zohdy 2016). According to a survey of taxi regulators from cities across the United States the proportion of wheelchair accessible vehicles is nearly always less than 10 percent (Schaller 2015), although available studies show the proportion of trips completed in wheelchair accessible vehicles also tends to be less than 10 percent.

Although not physiologically burdened themselves, parents are burdened with physiological limits of newborn children. Research has shown that childbirth makes couples more likely to purchase a vehicle or increase the number of vehicles they own (Oakil et al., 2014). For low-income parents purchasing a vehicle may not be an option, leaving them with many of the same challenges faced by disabled users of public transit systems. The physiological needs of parents carrying infants and equipment (e.g., strollers, extra baggage, toys) and of the infants themselves can make public transit use difficult, highlighting a need for more services tailored to families with infants and young children.

## Shared Mobility Opportunities and Challenges

Shared mobility has the ability to address physiological barriers by allowing multiple means of accessing services, providing lower cost on-demand mobility options where providing conventional public transit and paratransit are too cost prohibitive, and by more efficiently dispatching a range of vehicles based on a user's specific needs.

A private sector expert with experience developing apps described how much progress has been made in providing a range of accessible communication technologies for shared mobility app users: native apps for iOS and Android popular with most users, short message service (SMS) functionality for users that still own feature phones, audio dial-in service for landline users and the visually impaired, and a desktop-friendly browser based version of their app for access from any computer with an Internet connection. Moreover, VoiceOver iOS compatibility allows the blind and visually impaired to have the text of an app dictated to them and allows them to speak commands back to the app (Flynn, 2015). Experts from senior mobility services stressed the importance of age-appropriate technology. Regardless of the service being provided, users need access technologies that are familiar or easy to learn.

### *Bikesharing*

Not surprisingly, bikesharing is not the most physiologically accessible mode, requiring both physical and cognitive abilities above other shared mobility services. However, research on the health impacts of bikesharing in Washington, D.C. show many benefits for those physically able to ride, with riders reporting reduced stress and weight loss (Alberts et al., 2012). Although not included in the initial plans of many bikesharing systems, there is movement toward providing more accessible bikesharing options. One expert from a municipality mentioned that they are including representatives and experts from the disabled community in the planning of their bikesharing system. Vendors, such as Zagster, have begun to offer accessible hand-cycles as part of their shared fleets to expand bikesharing opportunities to a wider range of users ("Zagster Brings Accessible Bike Share to Westminster, Colorado," 2017).

### *Carsharing*

Carsharing may not be directly accessible for those who are not cognitively or physically capable of driving, but it can be beneficial to disabled users with a family member or friend who can drive. CityCarShare, a non-profit carsharing organization that operated in the San Francisco Bay Area, had wheelchair-accessible vans available to members for $12 per hour. The accessible vehicles became unavailable when CityCarShare made their fleet exclusively accessible via Getaround in 2016, a peer-to-peer carsharing company. Stipulations in the grant that paid for the accessible vans prohibited other organizations from operating them (Said, 2016), underscoring the importance of managing shared mobility mergers carefully so as not to leave users stranded.

*Ridesourcing*

Ridesourcing may be an effective option to offer older adults another curb-to-curb transportation option (Maltz, 2016). However, ridesourcing drivers may not have specialized training or equipment to accommodate all types of trip. Additionally, each user's physiological barriers are unique, requiring some level of information sharing with operators to provide tailored service. This information may not currently be available because of the privacy rules in the Health Insurance Portability and Accountability Act of 1996 (HIPPA).

Ridesourcing operators are providing wheelchair accessible vehicles, requiring drivers to transport service animals (Lyft Inc 2017), and engaging in an increasing variety of partnerships with CBOs and non-profit medical facilities to provide more tailored transportation solutions for seniors and the disabled (Lazo, 2016b). Lyft has multiple partnerships with medical facilities to provide non-emergency medical transportation, with the medical facility acting as a centralized account and dispatch for patients. They have also partnered with Jitterbug, the makers of a senior-friendly mobile phone, providing seniors without a smartphone the ability to access a Lyft ride by connecting with an operator ("New Solutions to Keep Seniors Moving," 2016).

## Services for Seniors

Despite the mobility challenges confronting older adults, a number ridesourcing partnerships and senior-specific services have emerged in recent years to fill the gap.

**Freedom in Motion:**

- Launched by the city of Gainseville, Florida in 2015, the Freedom in Motion partnership with Uber and a local eldercare network provides subsidized rides for residents aged 60 and older. The program is grant funded and limits participant fares to between $1 and $5 based on their income. As an added service, the program provides limited capacity smartphones to request rides to seniors who need them (Warren, 2015).

**Lyft and National Medtrans Network Partnership:**

- To expand non-emergency medical transportation for seniors, the National Medtrans Network partnered with Lyft in January 2016. The service allows healthcare providers to request rides for patients using a web-based dashboard as opposed to individual smartphone accounts (National MedTrans Network, 2016).

**SilverRide:**

- SilverRide, a for-profit ridesourcing provider licensed in the State of California, provides features not found from standard ridesourcing providers such as "door-through-door" service, drivers trained to provide physical assistance, additional insurance, and landline dispatch for non-smartphone users (Maltz, 2016). It is currently used by religious institutions, as non-emergency medical transportation, as a senior living vehicle replacement, and as a paratransit plus service.

**ITN America:**

- ITN America, a non-profit senior mobility provider allows seniors to trade their unused vehicles for future rides with the platform. Since labor is typically the most expensive cost component of any transportation service, ITN America's use of volunteer drivers provides considerable cost savings to its operation ("Helping Seniors Stay Mobile," 2017).

*Shared Automated Vehicles*

While AVs may provide advantages over conventional vehicles, more development may be needed to accommodate people with special needs. The ideal shared mobility technology for physiologically challenged users would allow for "passive use," removing all potential physical and cognitive barrier points, including entry and exit of the vehicle. Ideally, this principle would be important for very young children, as well older adults and the disabled. This would also extend outside of the vehicles to creating awareness among pedestrians and cyclists who are disproportionately involved in vehicles-related collisions and deaths.

## Policy Opportunities

To expand and mainstream the use of shared mobility for people with special needs, policymakers need to address a wide array of service accessibility questions, such as defining (or redefining) services, equivalency of service standards, and provision of access for people with disabilities. The Federal Transit Administration (FTA) Equivalent service standard (Se. 37.105) states the following:

> A fixed route system or demand responsive system, when viewed in its entirety, shall be deemed to provide equivalent service if the service available to individuals with disabilities, including individuals who use wheelchairs, is provided in the most integrated setting appropriate to the needs of the individual and is equivalent to the service provided other individuals with respect to the following service characteristics:
>
> (a) (1) Schedules/headways (if the system is fixed route);
>
> (2) Response time (if the system is demand responsive);
>
> (b) Fares;
>
> (c) Geographic area of service;
>
> (d) Hours and days of service;
>
> (e) Availability of information; and
>
> (f) Reservations capability (if the system is demand responsive); (g) Any constraints on capacity or service availability; (h) Restrictions priorities based on trip purpose (if the system is demand responsive).

According to a public transit agency expert, meeting this definition is incredibly difficult in the context of paratransit ridesourcing partnerships, where geographic service area, hours of service, fares, and response time are predicated on both user demand and driver supply within a dynamic marketplace. Most drivers in ridesourcing markets lease or own standard non-commercial vehicles and are less likely to lease or own a wheelchair accessible vehicle given the higher cost and smaller potential user base. Since the supply of wheelchair accessible vehicles is much lower than the supply of standard vehicles in open-entry ridesourcing markets, wheelchair users have a distinct response time disadvantage.

Minimum fleet standards requiring all services to be equally accessible may be an operationally ineffective approach. For example, in Washington, D.C., minimum wheelchair accessible fleet requirements have resulted in a surplus of unused accessible vehicles (Caro, 2017). Chicago uses a more flexible accessible shared mobility model by charging all users a fee that subsidizes the provision of wheelchair accessible vehicles through a pooled dispatch (Dardick, 2015). Despite the convenience of this fee for regulators, it may have unintended impacts. Low-income households use taxis more often than middle-income households ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016), while only about 28 percent of people with severe disabilities are poor (Renne and Bennett, 2014), highlighting the importance of designing subsidy programs that do not benefit one underserved group at the expense of another.

### Three Categories of Users

According to Jeff Maltz, the founder of SilverRide, senior and disabled mobility providers would benefit from more nuanced legal definitions for special needs users:

- *Accessible Vehicle* for those requiring wheelchair accessible vehicles
- *Assisted Ride* for those who can use standard passenger vehicle but need physical assistance at both ends of their trip
- *Ambulatory* for those that can ride as passengers without extra assistance (Maltz, 2016)

While the *Accessible Vehicle* category is generally well established, providing wheelchair access can be expensive for operators and may not be necessary for a large number of special needs users. The *Assisted Ride* criteria may open up service to the larger population of users who can ride as passengers in a standard vehicle but need physical assistance.

ITN America's 50 State Policy Project provides a massive database of policies by state, which either act as barriers or incentives to providing senior transportation. For example, the State of Maine enacted a policy that bars insurance providers from refusing to insure a driver solely because they volunteer for a non-profit mobility service ("50 State Policy Project" 2017). This policy is crucial to ITN America's business model since volunteer drivers are a key component in keeping costs down for its mobility service.

## SOCIAL

### Barrier Description

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of transportation services, laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of a transportation service, resulting from governmental and commercial transportation operations or policies. Meaningful involvement means that: 1) people have an opportunity to participate in decisions about activities that may affect their transportation, 2) the public's contribution can influence the regulatory agency's decision, 3) their concerns will be considered in the transportation decision-making process, and 4) policymakers will seek out and facilitate the involvement of people specifically affected. Some of the first attempts to address transportation equity, including Title VI of the Civil Rights Act of 1964 and subsequent Executive Orders 1316 and 12898 established protected classes based on ethnicity, skin color, national origin, and native language. While these policies have been successful in eliminating explicit discrimination in transportation provision, such as banning the segregation of service based on skin color, many social barriers still exist.

### Shared Mobility Opportunities and Challenges

Many experts that we consulted as part of this white paper highlighted the importance of addressing social barriers in making shared mobility accessible to disadvantaged communities.

1. Understanding the social context
2. Developing appropriate marketing and educational materials
3. Engaging with relevant CBOs
4. Creating meaningful avenues for community input and feedback

All of these factors are crucial to ensuring difficult to reach users feel that the services provided are truly for them.

While many public transit services only show wayfinding and user information in the most common languages, many app-based services allow users to view information in their native language minimizing language barriers for users with limited English proficiency. Some experts mentioned the importance of cultural differences with regard to transportation preferences. Research has shown that immigrants are more likely to carpool with people outside of their household (Blumenberg and Shiki 2008), showing potential for higher acceptance of pooled shared mobility services if they are properly targeted.

CBO experts that we interviewed talked about the need for *quality marketing and branding*, citing success of bus rapid transit (BRT) in not only making functional improvements to bus service, but also re-branding bus service into something low-income riders felt proud to use. They also stressed that it was not their role as CBO representative to sell shared mobility services

but to provide more neutral outreach so that communities can decide, if shared mobility services are truly serving their needs and provide feedback to adjust service accordingly.

*Bikesharing*

Despite providing potential cost and convenience benefits to low-income users without access to an automobile, the marketing of bikesharing has been critiqued as appealing to higher-income and already well-served social groups, leaving many low-income communities and minorities feeling that bikesharing is not for them (Jaffe, 2015). The lack of bikesharing use among minorities is especially pronounced given minorities have experienced a larger percentage growth in cycling as a share of personal trips when compared to Whites (Anderson and Lauran, 2015). While many minorities use a bicycle as a utilitarian means of transportation, it is often seen as a mode of last resort. The general perception of cycling as a signal of poverty in some neighborhoods can make bikesharing "un-cool" by association (Schmitt, 2012). For lower-income neighborhoods with higher crime rates, perceived personal safety risks can be a strong deterrent, especially for women, to accessing bikesharing stations alone late at night. Apart from crime risk, many users feel unsafe cycling on streets that have busy traffic. A report jointly published by People for Bikes and the Alliance for Biking & Walking found that minorities were more likely to respond that they would increase their bicycle use, if bicycle lanes were physically separated by a barrier ( Anderson and Lauran, 2015). Installing bikesharing stations without complementary improvements to the bicycle network may not be enough to get potential riders to embrace bikesharing.

Despite these challenges, bikesharing operators continue to refine and expand their outreach efforts in underserved communities. One bikesharing expert with a major U.S. operator? mentioned explicit attention to diversity in marketing campaigns by showing advertisements that reflect the diversity of the communities they are launching in. They also mentioned that their organization works closely with local CBOs and neighborhood groups to ensure community concerns are addressed in station siting and system design. In the San Francisco Bay Area, the CBO Transform is charged with community outreach and the development of an ambassador program to hire community members to ensure comprehensive outreach in communities that have historically experienced lower bikesharing usage.

### Better Bikeshare Partnership

- Given the challenge faced by bikesharing systems nationwide in providing access to underserved communities, the Better Bikeshare Partnership was founded to share lessons learned from existing systems to build more equitable and replicable bikesharing models. The partnership, funded by the JPB Foundation, is a collaboration among the City of Philadelphia, the Bicycle Coalition of Greater Philadelphia, the National Association of City Transportation Officials (NACTO), and the People for Bikes Foundation. As part of the partnership, People for Bikes will distribute $900,000 in grant funding to partnerships of cities, local nonprofits, and bikesharing operators to develop strategies that promote more equitable bikesharing access. On top of distributing funds, People for Bikes also manages communication of the successes and challenges of grantees, with the hope that all bikesharing stakeholders can learn from the program. (“About Us,” 2017)

*Carsharing*

In many cities, carsharing operators have struggled to attract a diverse user base (Martin and Shaheen, 2011). Non-profit carsharing organization Buffalo Carshare (now defunct) has been held up as a model for how social barriers may be overcome. Part of Buffalo CarShare’s success in attracting low-income members was attributed to its community-based marketing. The non-profit operated out of a storefront allowing curious customers to walk-in and learn about the service in person. Buffalo CarShare also made use of community outlets, such as neighborhood meetings and church functions to promote its service. These efforts helped Buffalo CarShare attract a membership, with more than half making less than $25,000 a year (Gottlieb, 2015).

*Ridesourcing*

Ridesourcing vendors use a wide range of marketing techniques, including web-based marketing such as social media, mobile advertising networks, organic search engine optimization, podcasts; more traditional marketing such as radio, television, billboards, transit facility advertising, event partnerships; and personal marketing through ambassador programs that reward people for enlisting people they know. While the marketing approach has been robust and varied, one ridesourcing expert mentioned that there is more work to be done reaching low-income populations. They also have no information on people who choose not to use their services for cultural reasons.

**Ridesourcing Marketing Strategies**

- Web Based
  - Social Media
  - Mobile Advertising
  - Search Engine Optimization
  - Podcast Advertisements
- Traditional Marketing
  - Radio
  - Television
  - Billboards
  - Public Transit Facilities
  - Event Partnerships
- In-person Marketing
  - Ambassador programs
  - User referral credits

A recent multi-university study raises equity concerns about involving race and gender with ridesourcing services. The study reported that male passengers with African American sounding names from low-density neighborhoods were three times more likely to have trips canceled, and female passengers were more likely to be taken for more expensive rides (Ge et al., 2016). While racial and gender prejudice in ridesourcing has been measured, a ridesourcing expert stated that their company was very conscious of the issue and had, to the extent feasible, removed opportunities within their app that allows driver discrimination. Nevertheless, drivers still need the ability to deny a ride when they feel their safety is threatened or if they have a legitimate reason not to pick up a passenger. This is also somewhat mitigated by requiring high passenger acceptance rates as a condition for receiving bonuses within the platform. Some journalists have suggested that ridesourcing services may reduce racial/ethnic discrimination when compared to traditional taxi services (Wortham, 2014), athough this article was based mostly on anecdotal experience.

## Policy Opportunities

Understanding social barriers requires policymakers to delve into sensitive user topics. While shared mobility providers struggle to get underserved riders to use their services, consistent efforts to monitor ridership and adapt approaches are hopeful signs that operators are serious about ensuring all potential users are comfortable with their services. Flexibility in choosing community specific outreach avenues is imperative to ensure appropriate community engagement methods are used. According to experts, mandating specific methods may be less effective than performance-based metrics that ensure a broad range of community members have been engaged.

Public sector experts stressed the importance of early, continuous, iterative community engagement for input in design, concept development, and project operation. Moreover, they

mentioned before and after surveys as a crucial component of testing shared mobility pilots. A robust variety of engagement methods including: telephone surveys, on-board transit rider surveys, community meetings, and public hearings across the region to ensure regional coverage are recommended. Several public-sector experts that we queried mentioned the use of web-based crowdsourcing to let community members comment on each other's concerns.

### Public Sector community engagement methods

- Telephone Surveys
- On-Board Public Transit Rider Surveys
- Community Meetings
- Public Hearings
- Web-Based Crowdsourcing Tools

### In-app Engagement

- Experts from the private sector stressed the importance of having in-app mechanisms for feedback, allowing users the ability to communicate directly with service providers at salient times. For app-developers this feature allows for an iterative process of continuous service refinement. Public sector experts we interviewed mentioned an interest in learning from the success of private sector apps as "platforms of participation," where users and providers can provide feedback and ratings of a service for continuous improvement, something relatively uncommon for the public sector.

## GOVERNMENT ROLE

The government has many potential roles within shared mobility equity as a facilitator, funder, regulator, and evaluator of services. Some experts from the public sector who were consulted as part of this white paper took great pride in the existing equity-related requirements enforced by governmental agencies, citing the progress that NEPA made for large infrastructure projects, the engagement benefits of community participation requirements as preconditions of grant funding, and the universal design improvements ADA has made for the disabled community. Others described the government's equity track record with mixed enthusiasm, citing a cumbersome and prescriptive approach that was slow to adapt to changing realities, such as ridesourcing, mobile payment, and AVs. While the public sector has generally been successful at ensuring public transit and paratransit is relatively affordable and accessible to a broad range of people, it has been less successful at ensuring the complete geographic coverage of services at all times of day. Moreover, the perceived inferiority of public transportation has brought with it social stigma that precludes many from using it. The following expert insights shed light on government's role moving forward.

*Table 2: Government Role*

| Government Roles | Key Points |
|---|---|
| Knowledge Transfer and Partnership Facilitation | • Higher levels of government can facilitate partnerships between lower levels of government and the private sector<br>• Government agencies at the same level can engage in public-public sharing of knowledge and experience |
| Funding | • Government agencies can attract private sector partners by providing in-kind subsidies in exchange for meeting community goals<br>• Direct subsidies and taxes were viewed more cautiously by public sector experts |
| Regulation/Legislation | • More pilots and evaluation are needed before standards and regulations are set<br>• The rapid evolution and varying impacts of the shared mobility services make developing general best practices difficult<br>• The public sector needs proactive goal-based policy instead of reactive mitigation-based policy |
| Data and Metrics | • Standard data sharing requirements for all shared mobility operators would ensure fairness between providers<br>• Equity metrics should strive for more than minimum legal requirements |

### Knowledge Transfer and Partnership Facilitation

One public sector expert from a municipality mentioned the importance of public-public partnerships and knowledge transfer to share experiences with shared mobility pilots and regulatory frameworks. They mentioned that cities across the country have shown interest in embedding staff in their agency to learn from the innovative policies and partnerships they are engaging in to better integrate a wide variety of shared mobility services into their existing planning and implementation processes.

At the regional level, a MPO expert mentioned that MPOs can help facilitate partnerships between lower levels of government and private vendors, as has been the case in the bikesharing expansion in both the San Francisco Bay Area and San Diego. In this way, MPOs can act as resources for public-public knowledge transfer for municipalities within their regions. While many actors engaged in innovative shared mobility partnerships complain about the opacity and

slow pace of the existing request for proposal (RFP) processes, the MPO expert felt that there was enough flexibility within current federal, state, and local procurement laws to craft special shared mobility RFPs and did not feel that any one policy would improve the process.

### Funding

While the public sector has already begun to subsidize shared mobility through direct subsidies (e.g., ridesourcing subsidies for paratransit and FMLM) and in-kind access to public ROW (e.g., bikesharing and carsharing vehicle placement), opinions differed on how governmental subsidies should be distributed. Private sector experts were open to receiving operating subsidies for special needs constituents, such as the older adults, the disabled, and low-income users with inadequate public transit access. This was especially true for lower-density communities outside of the urban core that are more difficult to serve profitably given current service provision costs.

Public sector experts showed interest in providing in-kind subsidies and incentives to operators that met agency goals. Many of the existing pilot programs are seen as ways public transit agencies and municipalities can reduce fiscal burden, such as by reducing the cost of providing paratransit and low-ridership transit lines through on-demand ridesourcing partnerships or by reducing the need for new parking facilities by providing on-street permits to carsharing vehicles. Despite excitement around the potential of these modes, public sector experts were more cautious and skeptical of their benefits, especially for ridesourcing, with multiple respondents stating that more pilots and evaluation are needed before embracing shared mobility as a completely in line with goals. Moreover, the source of funding for subsidies needs to be assessed carefully to ensure not disproportionately impacting one disadvantaged group in favor of another, as may be the case for fees charged to taxi trips to subsidize wheelchair accessible vehicle access ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016).

One expert from a non-profit organization felt that government funding should be focused toward grants to help start untested ideas, but funding should not be directed toward subsidizing existing business models. They stated that subsidies were not a substitute for removing regulatory and financial barriers, such as prescriptive vehicle requirements and excessive taxes, that made service provision difficult or expensive to begin with. They were also wary of the sustainability of private-sector business models that relied on subsidized operations.

### Regulation/Legislation

Public sectors experts consulted did not think standards for shared mobility policies should be adopted until adequate testing and pilots had been completed. One expert stated that the shared mobility market is changing too rapidly to establish standards, but equity should always be an integral part of the process. They also mentioned a need for resilient policies that could deal with the continuous changes not only within the shared mobility market but within the larger transportation industry and economy. For example, gasoline is relatively inexpensive today, but

it could become expensive again in the near future, affecting assumptions about which modes are most appropriate to achieve equity goals. Many experts also mentioned the uncertainty around AVs in the near future as a complicating issue when formulating plans and policies for the next several decades. Many current shared mobility business models could become obsolete as the declining cost of AVs challenge incumbent services.

With regard to current regulations, public transit agency experts identified two major regulatory barriers to testing shared mobility pilots: equivalent level of service (LOS) requirements for publicly funded transportation that requires wheelchair accessible vehicle wait times to be the same as non-wheelchair accessible vehicles and stringent drug and alcohol tests for shared mobility drivers. Both requirements were seen as impediments to pilots that could reduce wait times for people with disabilities even if not by as much as for non-disabled users. Calling into question the conflict between the intent and outcome of current equity and driver screening regulations. Despite current barriers, according to a public transit agency expert, the requirement for both of these provisions does not apply when there are multiple providers for a single service and at least one of the providers meets the wheelchair accessible and driver training criteria, which was the case for the PSTA ridesourcing pilot.

Because travel often crosses jurisdictional boundaries and shared mobility firms often operate in different regions around the country, there should be a careful examination of which level of government is best suited to regulate a given shared mobility service based on market and service characteristics and existing regulatory capabilities ("Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services" 2016).

Experts interviewed from non-profit organizations mentioned several policy changes needed to ensure shared mobility operators were acting in the public interest including: better minimum working conditions for drivers, licensing and training requirements, minimum service levels for all neighborhoods and users, and taxing mechanisms that ensure shared mobility providers are paying for external costs imposed by their services.

Finally, there is a need for the public sector to be proactive as opposed to reactive. If cities have a vision and a plan for how shared mobility can help achieve goals they are in a better position to negotiate with operators that come to their jurisdiction. The more streamlined and established the regulatory process is, the more likely operators are going to comply.

### Data and Metrics

Experts also mentioned there should be consistent data sharing requirements for all regulated shared mobility operators to ensure fairness, including agreement to share some form of origin and destination data to help cities plan for transportation.

When experts were asked how their organizations measured equity, most agreed that there was a need to develop more relevant, consistent performance measures that go beyond the minimum

legal requirements that currently exist. Experts from the public sector admitted that beyond complying with legal requirements such as Title VI, ADA, and directives from higher levels of government, there was no consistent performance measure used to determine whether their planning and services are equitable.

Experts from CBOs discussed looking at differences in travel time and access to transportation infrastructure as well as differences in outcomes, such as health by income quintiles. They also mentioned a need to make transportation equity a continuous process as opposed to a static metric. User needs are context specific, making the success of metrics and transportation solutions applied elsewhere difficult to guarantee in new settings. Experts also stressed a need to evaluate the impact of past investments once they are in operation.

Private sector experts did not feel that it was their responsibility to develop metrics or evaluate the equity of their services. They expressed a willingness to accommodate the goals and needs established by partner organizations whether they are CBOs, healthcare providers, public sector, or private partners.

## POTENTIAL AREAS FOR NEEDED RESEARCH

Most experts agreed that more robust nationwide research was needed to fill gaps in knowledge about users and non-users, impacts of innovative shared mobility partnerships, and existing policy barriers to piloting and implementing equitable shared mobility services.

*Table 3: Needed Research Areas*

| Research Areas | Key Points |
|---|---|
| User Demographics | • National transportation surveys should include wider range of shared mobility modes |
| Shared Mobility Partnerships | • Research on regulatory implications of public-private shared mobility partnerships is lacking |
| Policy Barriers | • More research is needed on existing policy barriers to shared mobility that work at cross purposes to community goals |

### User Demographics

Private sector experts stressed that they only had information on users of their systems and could not describe non-users with any specificity. Moreover, demographic data of users is limited to ad-hoc survey efforts conducted in conjunction with academic researchers, making comparisons across time and geography difficult. One expert recommended that the public sector devote more resources to research on understanding how shared mobility fits into the general population's

transportation profile. Of specific interest was the proportion of the general population using shared mobility services, a data point currently lacking in standardized national datasets on transportation.

One non-profit expert mentioned their organization focuses on user motivation and interest for using particular modes. They felt that public sector research focuses too much on the service providers (e.g., public transit agencies, private providers), leaving out key details about user preferences.

### Impact of Shared Mobility Partnerships

Experts from CBOs wanted more impartial information about the outcomes of newly implemented public-private partnerships to assess whether similar models would be appropriate in serving the needs of their communities. Experts from CBOs stressed the importance of funding for policy research on regulatory implications of shared mobility. Some of the data agreements required as part of regulatory approval are a good first step toward having the required data needed for more transparent research on the impacts of shared mobility services. One particular concern is the effect of user and driver ratings on acceptance rates and wait times for disabled users.

### Policy Barriers

Given the rapid change occurring in the shared mobility market, there will inevitably be a mismatch between existing policies and the operation of such services. According to experts, policies such as the application of car rental taxes to carsharing, limits to vehicle donation and volunteer driver compensation, and equivalent LOS service requirements for publicly funded shared mobility services have introduced challenges. Assessing existing policies for their unintended impacts on transportation equity should be a priority.

# CHAPTER 4. KEY STUDY TAKEAWAYS

While the current transportation equity barriers are significant across the STEPS framework, shared mobility offers many opportunities to fill existing transportation equity gaps. The diversity of services and business models, flexibility of deployment, and rapid feedback allows shared mobility providers to tailor services to user needs in ways not possible with more traditional transportation projects. Despite these advantages, shared mobility still has many challenges. Shared mobility operators often confront a complex regulatory environment that may limit innovation or misapply regulations not well suited for the service model, private sector services, or both. Private sector services also must balance shared mobility as a business with the need to address an array of equity issues.

*Table 4: Shared Mobility Key Takeaways*

| STEPS to Transportation Equity | Shared Mobility Key Takeaways |
|---|---|
| Spatial | • Can be a flexible and lower infrastructure cost solution to filling public transit network coverage gaps<br>• Can provide greater geographic coverage than a new transit project |
| Temporal | • Can reduce door-to-door travel time and increase travel time reliability<br>• Can provide on-demand service for late night users |
| Economic | • Can provide some of the benefits of car ownership with much lower upfront cost to users<br>• Can increase transportation accessibility at lower cost to the public sector<br>• Access and payment that requires internet, smartphones, and credit/debit cards impose barriers for low-income and older adult users |
| Physiological | • The user focus and market segmentation of private sector operators can provide a wider range of services tailored to specific physical and cognitive disabilities<br>• Technological innovation can provide both opportunities and barriers for disabled users |

| | |
|---|---|
| Social | • Marketing and community engagement have made multi-modalism more attractive to potential car owners<br>• Low-income and minority communities still feel excluded from decision making and implementation of shared mobility services |

## SPATIAL

Shared mobility provides a low-cost solution to filling spatial gaps in the near term as both a FMLM solution and to improve geographic coverage generally. While traditional public transit projects can take years, if not decades, to complete, shared mobility solutions like bikesharing, carsharing, and ridesourcing can deployed in underserved areas in much less time at lower cost to the public sector by leveraging private sector investment and operation of these services. Moreover, the possibility of origins and destinations tend to be much greater than existing fixed transit systems. The key role for the public sector is to ensure that services truly provide the geographic coverage necessary to alleviate spatial barriers, which has been a critique of current bikesharing deployment, for example.

## TEMPORAL

Shared mobility provides many temporal benefits over incumbent services, such as increased wait and travel time reliability, the ability to book services in advance, and reduced travel times. Moreover, for users without access to automobiles in areas with no or minimal public transit service, shared mobility can significantly reduce temporal barriers for users. However, access to shared mobility is not a substitute for sound transportation planning and infrastructure management solutions, such as travel demand management and congestion management, that improve travel time reliability.

## ECONOMIC

Shared mobility services offer innovative travel options to users at capital and operating costs that are extremely competitive with existing publicly provided services, especially for paratransit and low-ridership bus routes. The reliance on private capital has led to rapid growth and lower fiscal burden for the public sector, although the need to operate at a profit pushes the price of services out of reach to many low-income users. Moreover, the requirement for associated technologies such as the Internet, smart phones, and credit/debit cards imposes additional barriers to the most vulnerable.

## PHYSIOLOGICAL

Shared mobility has the opportunity to more efficiently and effectively diversify the range of assisted modes to physiologically challenged users. Whether through subsidized for-profit models, such as SilverRide, or volunteer-operated non-profit models, such as ITN America, shared mobility has created innovative options for serving mobility needs beyond traditional paratransit service. Some of these technologies (e.g., smartphones, mobile payment) may present access barriers for users accustomed to legacy technologies.

## SOCIAL

Shared mobility has done much to make a car-ownership-free lifestyle socially desirable, but it has also had difficulty marketing this message in a manner sensitive to existing social stigma and barriers for minorities and low-income communities. Despite these criticisms, shared mobility providers are working to ensure users are comfortable with their services through continued community engagement and improved product design and marketing.

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# APPENDIX A: GLOSSARY

**Bikesharing:** Users access bicycles on an as-needed basis for one-way (point-to-point) or roundtrip use. Station-based bikesharing kiosks are typically unattended, concentrated in urban settings, and offer one-way station-based access (bicycles can be returned to any kiosk). Free-floating bikesharing offers users the ability to check-out a bicycle and return it to any location within a predefined geographic region. Bikesharing provides a variety of pickup and drop-off locations. The majority of bikesharing operators cover the costs of bicycle maintenance, storage, and parking. Generally, trips of less than 30 minutes are included within the membership fees. Users join the bikesharing organization on an annual, monthly, daily, or per-trip basis.

**Carpooling:** A formal or informal arrangement where commuters share a vehicle for trips from either a common origin, destination, or both, reducing the number of vehicles on the road (Shaheen et al., 2016).

**Car Rental:** A non-membership-based service or company that rents cars or light trucks typically by the day or week. Traditional rental car services include storefronts requiring an in-person transaction with a rental car attendant. However, rental cars may also employ "virtual storefronts," allowing unattended vehicle access similar to carsharing (Shaheen et al., 2016).

**Carsharing:** A program where individuals have temporary access to a vehicle without the costs and responsibilities of ownership. Individuals typically access vehicles by joining an organization that maintains a fleet of cars and light trucks deployed in lots located within neighborhoods, public transit stations, employment centers, and colleges/universities. Typically, the carsharing operator provides insurance, gasoline, parking, and maintenance. Generally, participants pay a fee each time they use a vehicle (Shaheen et al., 2016).

**Courier Network Services (CNS):** CNS provide for-hire delivery services for monetary compensation using an online application or platform (such as a website or smartphone app) to connect delivery drivers using a personal transportation mode with a package/item or food delivery requests. These services can also be used to pair package delivery with passenger trips, where for hire-drivers can deliver both passengers and packages, either together or in separate trips (Shaheen et al., 2016).

**Discrimination**: Any action or inaction, whether intentional or unintentional, in any program or activity of a federal aid recipient, subrecipient, or contractor that results in disparate treatment, Disparate Impact, or perpetuating the effects of prior discrimination based on race, color, or national origin (TriMet, 2016).

**Disparate Impact**: A facially neutral policy or practice that disproportionately affects members of a group identified by race, color, or national origin, where the recipient's policy or practice lacks a substantial legitimate justification and where there exists one or more alternatives that would serve the same legitimate objectives but with less disproportionate effect on the basis of race, color, or national origin (TriMet, 2016).

**Environmental Justice:** At the Federal Highway Administration (FHWA), this means identifying and addressing disproportionately high and adverse effects of the agency's programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens (Sandt et al., 2016).

**Executive Order 13166:** Executive Order 13166 mandated equal access to services and benefits for those individuals with limited English proficiency (LEP) ("Transportation Equity," 2017).

**Executive Order 12898:** Executive Order 12898 required federal agencies (and recipients of their financial assistance) to identify and address any disproportionately high adverse effects of their programs, policies, and activities on minority or low-income populations. ("Transportation Equity," 2017).

**Fixed Route and Fixed Schedule Microtransit:** Fixed route and fixed schedule microtransit occurs where the routing and arrival/departure times of the shared vehicles are fixed. The alignment of routes, however, can be "crowdsourced" (i.e., users can request origin-destination points on a tech-enabled platform that can inform the operators of which routes to introduce). This type of microtransit most closely mirrors public transit (Shaheen et al., 2016).

**Flexible Route and On-Demand Schedule Microtransit:** Users can request shared vans or buses real time through a tech-enabled application, and the vehicle will deviate from its route to somewhere within walking distance of the requester. These services can range in how dynamic they are—from routes that change over the span of a few days to fully dynamic routes that adjust in real time based on traffic and demand (Shaheen et al., 2016).

**High-Tech Company Shuttles:** Employer-sponsored shuttles that ferry employees between suburban
workplace and public transit stations(Shaheen et al., 2016).

**Limited English Proficiency**: Individuals who do not speak English as their primary language and who have a limited ability to read, speak, write, or understand English (Source: US Department of Justice) (Sandt et al., 2016)

**Limousines and Liveries:** A limousine or luxury sedan offering pre-arranged transportation services driven by a for-hire driver or chauffeur (Shaheen et al., 2016).

**Low Income**: A person whose household income (or in the case of a community or group, whose median household income) is at or below the US Department of Health and Human Services poverty guidelines. (Source: US Department of Health and Human Services (DHHS) Poverty Guidelines) (Sandt et al., 2016)

**Microtransit:** A privately owned and operated shared transportation system that can offer fixed routes and schedules, as well as flexible routes and on-demand scheduling. The vehicles generally include vans and buses (Shaheen et al., 2016).

**Minority**: Belonging to a minority racial or ethnic group including Black, Hispanic or Latino, Asian American, American Indian and Alaskan Native, and Native Hawaiian or Other Pacific Islander (Source: DOT & FHWA Environmental Justice Executive Order). Note that some people and organizations believe that the term "minority" is inappropriate and prefer terms such as "communities of color" or "people of diverse backgrounds." For this paper, the term "minority" is used to remain consistent with Federal definitions (Sandt et al., 2016)

**One-Way Carsharing:** A form of carsharing that enables members to pick up a vehicle at one location and drop it off at another. This is also called a point-to-point carsharing service. One-way carsharing can be station-based or free floating (Shaheen et al., 2016).

**Person with Disabilities**: A person with a disability is one who has a physical or mental impairment that substantially limits one or more major life activities of such individual, a record of such an impairment, or being regarded as having such an impairment (Source: The Americans with Disabilities Act (ADA) of 1990) (Sandt et al., 2016)

**Public Transportation:** Any mass transportation vehicle that charges set fares, operates on fixed routes, and is available to the public. Common public transportation systems include buses, subways, ferries, light and heavy rail, and high speed rail (Shaheen et al., 2016).

**Taxis:** A type of for-hire vehicle service with a driver used by a single or multiple passengers. Taxi services may be either pre-arranged or on-demand. Taxis can be reserved or dispatched through street hailing, a phone operator, or an “e-Hail” Internet or phone application maintained either by the taxi company or a third-party provider (Shaheen et al., 2016).

**Title VI:** This title declares it to be the policy of the United States that discrimination on the ground of race, color, or national origin shall not occur in connection with programs and activities receiving Federal financial assistance and authorizes and directs the appropriate Federal departments and agencies to take action to carry out this policy. This title is not intended to apply to foreign assistance programs. Section 601 – This section states the general principle that no person in the United States shall be excluded from participation in or otherwise discriminated against on the ground of race, color, or national origin under any program or activity receiving Federal financial assistance ("Civil Rights Act of 1964," 2017).

**Transportation Network Company (TNC)/Ridesourcing:** Ridesourcing services (also known as transportation network companies (TNCs) or ride-hailing) provide prearranged and on-demand transportation services for compensation, which connect drivers of personal vehicles with passengers. Smartphone mobile applications are used for booking, ratings (for both drivers and passengers), and electronic payment. There are a variety of vehicle types that can be offered by these services including: sedans, sports utility vehicles, vehicles with car seats, wheelchair accessible vehicles, and vehicles where the driver can assist older or disabled passengers (Shaheen et al., 2016).

**Vanpooling**: Consists of seven to 15 passengers who share the cost of the van and operating expenses and may share the responsibility of driving (Shaheen et al., 2016).

# APPENDIX B: METHODS

## LITERATURE REVIEW METHODS

Given the rapid evolution of shared mobility, providing good coverage of the issue requires inclusion of a wide variety of sources. The authors of this document have made a reasonable attempt to include all relevant literature from academic, think tank, and public sector, and consulting sources. To supplement basic literature with the most current information available, the authors included sources from news media, blogs, webinar presentations, and relevant organization web pages. All sources included in this paper are listed in the reference section with in-text citations.

## DISCUSSION METHODS AND QUESTIONNAIRE

Expert discussions were conducted by researchers at the Transportation Sustainability Research Center (TSRC) during the months of January and February 2017. Eleven discussions were held with expert from the federal, state, regional government, public transit agencies, and municipalities; private sector including bikesharing, multi-modal app, and ridesourcing operators; community based organizations including representatives from international policy and consulting, regional transportation advocacy, and senior mobility.

**Introduction Questions**

I am a research associate at the Transportation Sustainability Research Center, UC Berkeley. I would like to interview you regarding our research project on equity and Smartphone-enabled transportation services. I will ask questions about your organization's operations, how these operations impact transportation equity, and what measures your organization has taken to address transportation equity[1].

1. Thank you for your time. Have you reviewed the consent to participate in this research form that I emailed? [if not, review with them quickly]. If yes, do you understand the consent process, and do you have any questions about it [answer questions]? Do you agree to participate in this research project [you need a yes]. If no, thank them for their time and end the call.

[1] We are interested in transportation equity issues for following populations as defined under Title VI, which prohibits discrimination on the basis of race, color, religion, sex, or national origin; Executive Order 12898, which protects minority and low-income populations from disproportionate adverse effects of federally funded projects; Executive Order 13166, which protects populations with limited English proficiency; and non-protected classes including single parents, rural communities, and the digitally impoverished.

2. We are offering a $25.00 Amazon.com gift certificate in appreciation of your time. This is optional. You can participate and elect not to receive an incentive. If you do receive the gift certificate, this will be sent via email. Would you like to receive the gift card in appreciation for taking the time to interview today?

**Services Provided and User Characteristics (Bold for private sector only)**

4. What is your title and role with [name of organization]?
5. What type of services does your organization provide? Who are your target users/customers etc.?
6. What types of programs do you have to serve them?
7. Are you meeting the needs of your target users, or are there service gaps?
8. In your experience, does the demographic profile of shared mobility users (or users of the specific service in question for operators) differ from the general population (e.g., ethnicity, age, income, gender)? How?
9. If yes, what factors might be influencing these differences?
10. What specific access challenges does [the mode or service of vendor in question] present for various demographic groups (un-phoned, unbanked, visually impaired, limited English proficiency (LEP))?
11. **In what ways does your business model present challenges for various user groups (e.g., app-only model, requires credit/debit card payment, membership fees)?**

**Equity Measures**

12. How does [name of organization] measure equity?
13. What measures has [name of organization] taken to address equity concerns?
14. Which of these measures have been successful and which have been unsuccessful?
15. Do you know of measures that other [mode or service of vendor in question] vendors have taken to address equity? If yes, how were they successful or unsuccessful?
16. Does [the name of organization] face equity issues related to geography or specific neighborhoods? If yes, what types of measures are used to address geographic equity?
17. How does [the name of organization] do marketing and outreach for [the mode or service of vendor in question]?

18. How does [the name of organization] solicit public feedback for [the mode or service of vendor in question]?

**Interacting with Government**

19. Is [the name of organization] involved in any public-private-partnerships to address equitable access to [the mode or service of vendor in question]? If yes, which organizations are involved and what are the program details?

20. Are there any statutory provisions that require access and/or address equity? Are these helpful? Are they effective?

21. What types of policies and/or public support is needed?

**Tech Changes**

22. What technology changes are likely to have positive and negative impacts on equitable access to shared mobility modes and why?

**Wrap-Up**

23. Do you have any additional information (documents, reports, other sources) that you would like to share?

24. Would recommend anyone for us to contact?

25. Thank you for your time. Your input is very helpful. If I have any follow-up questions, may I contact you?

26. If not already very clear from previous communication, clarify if individual wants the gift certificate.