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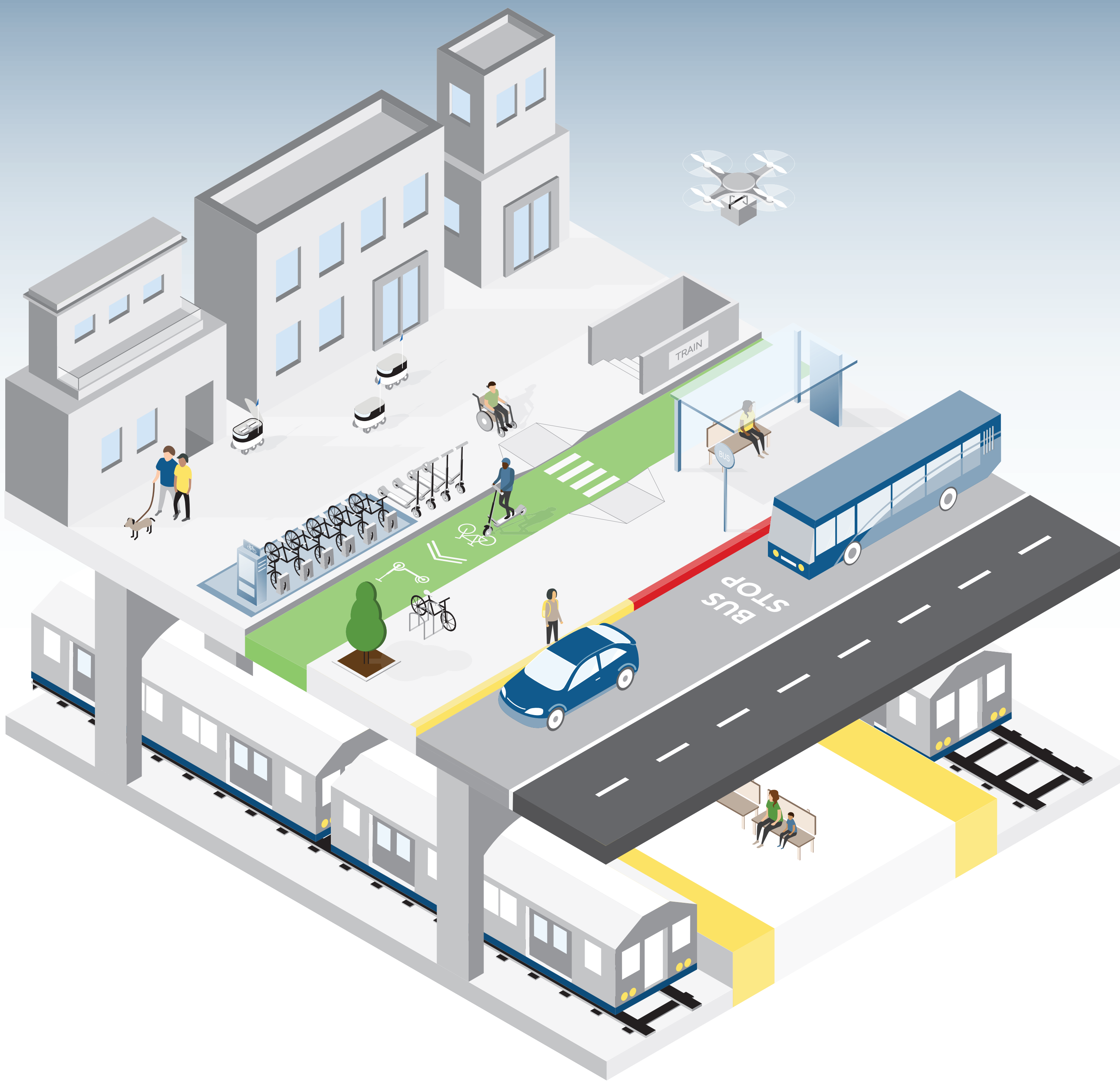

Shared Mobility Policy Playbook

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INTRODUCTION

Shared mobility - the shared use of a vehicle, bicycle, or other travel mode - is an innovative transportation strategy that enables short-term access to transportation modes on an "as-needed" basis. Sharing can include sequential sharing (i.e., different users share the same transportation vehicle or equipment, one after the other) or concurrent sharing (i.e., sharing of the same transportation vehicle or equipment by multiple non-household users for the same trip). Shared mobility can also include core services such as: shuttles, taxis, public transit, pedicabs, and paratransit. Although important to the shared mobility ecosystem, policies for these modes are not included in this toolkit. Please see Figure 1.1 below for the shared mobility ecosystem.

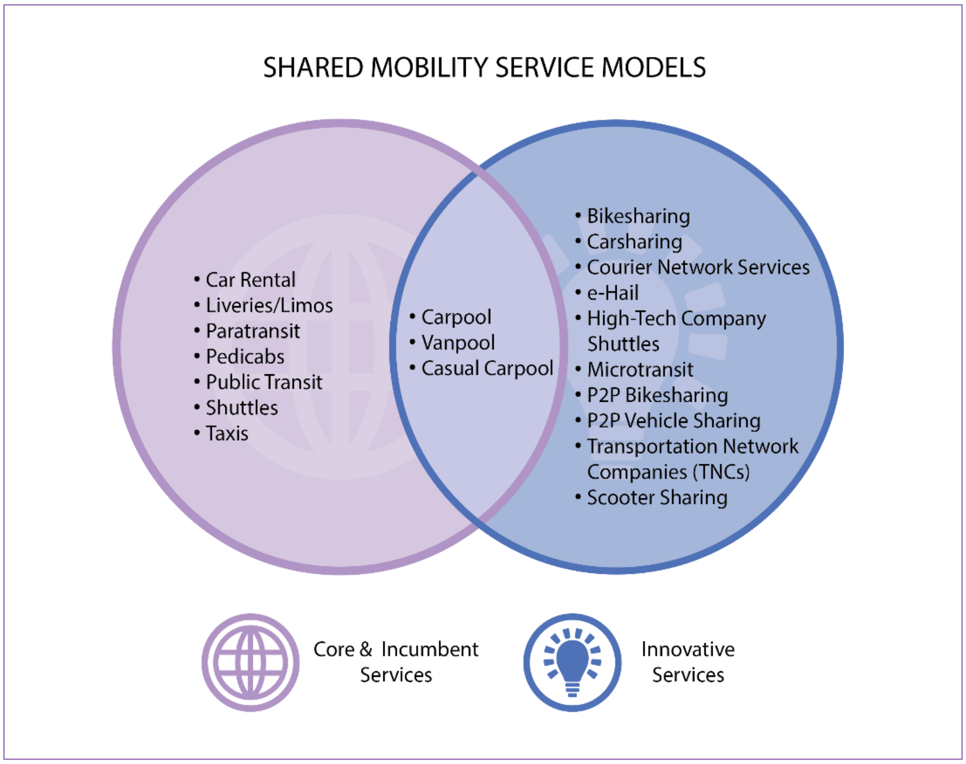

Figure 1.1 Shared Mobility Service Models. Adapted from Shaheen et al., 2016

Shared mobility can include roundtrip services (a vehicle, bicycle, scooter, or other mode is returned to its origin); one-way station-based services (a vehicle, bicycle, scooter, or other mode is returned to a different designated station location); and one-way free-floating services (a vehicle, bicycle, scooter, or other mode can be returned anywhere within a geographic area). To help manage free-floating services, cities and shared mobility operators may use technologies like geofencing. Geofencing is a technology that uses GPS or RFID technology to create a virtual boundary, enabling cities to determine when and how often vehicles or equipment cross predetermined boundaries, as well as alert riders who operate in restricted areas.

A number of environmental, social, and transportation-related benefits have been reported from the use of shared mobility. Several studies have documented reduced vehicle use, ownership, and vehicle miles/kilometers traveled. Cost savings and convenience are frequently cited as popular reasons for using a shared mode. Shared mobility can also make it easier for users to connect to public transportation, potentially helping to bridge gaps in existing transportation networks and encouraging multimodality by addressing the first-and-last-mile connections to public transit.

Studies indicate that shared mobility users are typically young and have higher levels of educational attainment, higher income, and are less diverse than the general population. However, there is anecdotal evidence from some cities that indicates the user base of shared modes (e.g., bikesharing and scooter sharing) may be more diverse than other shared modes, as dockless bikes and scooters may have greater success reaching underserved areas of communities. Shared mobility presents an opportunity to provide additional mobility to populations who may be underserved by traditional transportation options or who may be unable to afford the high cost associated with vehicle ownership. Shared mobility can provide numerous economic benefits to communities, such as cost savings for users and increased economic activity near multimodal hubs.

Development of this playbook was made possible by the public and private stakeholders who participated in workshops and webinars, small group discussions, and surveys throughout the development of this document. It is important to note, however, that shared mobility is rapidly evolving, and this playbook represents current understanding at the time of publication.

This *Shared Mobility Policy Playbook* provides an introduction and definitions of shared mobility services, mode-specific resources for agencies looking to develop policies in their community, and policy-focused tools demonstrating case studies and best practices for shared mobility.

How to Use This Playbook

This *Shared Mobility Policy Playbook* has been designed for individuals and practitioners who want to know more about shared mobility and to communities interested in incorporating shared mobility into their transportation ecosystem. This playbook is a practical guide with resources, information, and tools for local governments, public agencies, and non-governmental organizations seeking to incorporate and manage innovative and emerging shared mobility services.

The following are suggested uses of this playbook:

- Access shared mobility resources including: opportunities, lessons learned, and best practices for deploying shared mobility across the United States.
- Use this playbook as a guide for strategic transportation planning and incorporating shared mobility into transportation plans and models.
- Reference best practices, lessons learned, and case studies to aid public policy development.

Figure 1.2. Protected bike lane and loading zone in a city street. Photo Courtesy of Flickr/Sergio Ruiz

Policy Playbook Overview

This playbook presents an overview of current practices, lessons learned, and guiding principles for public agencies to advance shared mobility policy and planning. The playbook is organized into three distinct sections: 1) Shared Mobility Definitions, 2) Mode-Specific Tools, and 3) Policy-Specific Tools, outlined below:

- **Shared Mobility Definitions**

- **Mode-Specific Tools:**

  Carsharing

  Microtransit

  Ridesharing (Carpooling and Vanpooling)

  Shared Micromobility (Docked and Dockless Bike and Scooter Sharing)

  Transportation Network Companies (TNCS, also known as ridesourcing and ridehailing)

  Shared Automated Vehicles (SAVs)

  Last-Mile Delivery

- **Policy-Specific Tools:**

  Shared Mobility and Public Transit Integration

  Shared Mobility and Equity

  Rights-of-Way for Shared Mobility

  Shared Mobility and Incentive Zoning

  Shared Mobility and Data Sharing

  Incorporating Shared Mobility into Planning and Modeling

  Multimodal Tools and Trip Planners

  Shared Mobility and Electrification

SHARED MOBILITY DEFINITIONS AND KEY CONCEPTS

Shared mobility - the shared use of a vehicle, motorcycle, scooter, bicycle, or other travel mode - provides users with short-term access to a transportation mode on an as-needed basis. Shared mobility includes various travel modes and service models that meet the diverse needs of users including: carsharing, bikesharing, transportation network companies (TNCs, also known as ridesourcing and ridehailing), and others. The following section, Travel Modes, provides U.S. Department of Transportation, American Planning Association, and SAE International definitions of the most common shared mobility models. Following these definitions, this tool defines two evolving mobility concepts: Mobility on Demand (MOD) and Mobility as a Service (MaaS). Next, the tool outlines four categories of smartphone applications impacting transportation. The tool concludes with descriptions of shared mobility service models and business models (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a; Shaheen et al., 2017).

Travel Modes

BIKESHARING provides users with on-demand access to bicycles at a variety of pick-up and drop- off locations for one-way (point-to-point) or roundtrip travel. Bikesharing fleets are commonly deployed in a network within a metropolitan region, city, neighborhood, employment center, and/or university campus (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016). Bikesharing systems can be further categorized by their operational models: station-based, dockless, and hybrid. In a station-based bikesharing system, users access bicycles via unattended stations offering one-way service (i.e., bicycles can be returned to any station). In a dockless bikesharing system, users may access (unlock) a bicycle and park it at any location within a predefined geographic region. In a hybrid bikesharing system, users can check out a bicycle from a station and end their trip by either: 1) returning it to a station or a non-station location or 2) users can pick up any dockless bicycle and either return it to a station or a non-station location within a designated geographic (or geofenced) area.

CARSHARING offers members access to vehicles by joining an organization that provides and maintains a fleet of cars and/or light trucks. These vehicles may be located within neighborhoods or near public transit stations, employment centers, universities, etc. The carsharing organization typically provides insurance, gasoline, parking, and maintenance. Members who join a carsharing organization typically pay a fee each time they use a vehicle (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

Courier Network Services (CNS) (also referred to as flexible goods delivery) provides for-hire delivery services for monetary compensation via an online application or platform (such as a website or smartphone app) to connect couriers using their personal vehicles, bicycles, or scooters with freight (e.g. packages, food) (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

MICROTRANSIT is defined as a privately or publicly operated, technology-enabled transport service that typically uses multipassenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

PERSONAL VEHICLE SHARING is defined as the sharing of privately owned vehicles, where companies broker transactions between vehicle hosts and guests by providing the organizational resources needed to make the exchange possible (e.g., technology, customer support, driver and motor vehicle safety certification, auto insurance, etc.). This model also includes peer-to-peer (P2P) carsharing, P2P marketplace, hybrid B2C and P2P models, and fractional ownership (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

RIDESHARING (also known as carpooling and vanpooling) is defined as the formal or informal sharing of rides between drivers and passengers with similar origin-destination pairings. Ridesharing includes vanpooling, which consists of 7 to 15 passengers who share the cost of a van and operating expenses and may share driving responsibility (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

SCOOTER SHARING allows individuals access to scooters by joining an organization that maintains a fleet of scooters at various locations. Scooter sharing models can include a variety of motorized and non-motorized scooter types. The scooter operator typically provides charge or gasoline (in the case of motorized scooters), maintenance, and may include parking as part of the service. Users typically pay a fee each time they use a scooter. Trips can be roundtrip or one-way (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

Scooter sharing includes two types of services:

- **Standing electric scooter sharing** employs shared scooters with a standing design with a handlebar, deck, and wheels that is propelled by an electric motor. The most common scooters today are made of aluminum, titanium and steel; and
- **Moped-style scooter sharing** employs shared scooters with a seated design. Moped-style scooters can be electric- or gas-powered, and they generally have a less stringent licensing requirement than motorcycles designed to travel on public roads.

SHUTTLES are shared vehicles (typically vans or buses) that connect passengers from a common origin or destination to public transit, retail, hospitality, or employment centers. Shuttles are typically operated by professional drivers and many provide complimentary services to the passengers (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

TAXI SERVICES provide prearranged and on-demand transportation services for compensation through a negotiated price, zone pricing, or taximeter (either traditional or GPS- based). Passengers can schedule trips in advance (booked through a phone dispatch, website, or smartphone app); street hail (by raising a hand on the street, standing at a taxi stand, or specified loading zone); or e-Hail (by dispatching a driver on-demand using a smartphone app) (SAE International, 2018).

TRANSPORTATION NETWORK COMPANIES (also known as TNCs, ridesourcing, and ridehailing) are prearranged and on-demand transportation services for compensation in which drivers and passengers connect via digital applications. Digital applications are typically used for booking, electronic payment, and ratings (Cohen & Shaheen, 2016; SAE International, 2018; Shaheen et al., 2016a).

Micromobility

Bikesharing, scooter sharing, and other low-speed modes (both shared and personally owned) are sometimes collectively referred to as micromobility. This can include bicycles, bikesharing, electric bicycles/e-bikes, scooter sharing, and an array of light electric- powered modes such as: segways, hoverboards, skateboards/electric skateboards, and electric unicycles).

Figure 2.1. Examples of niche micromobility modes - Hoverboard (top left) (Smart Hoverboards, 2018), Unicycle (bottom left) (Best Electric Hoverboard, 2019; Segway, 2018), Segway (bottom right), Board (top right) (ZBoard Shop, 2018).

Digital Information, Fare Integration, and the Commodification of Transportation

Mobility on Demand (MOD)

In recent years, Mobility on Demand (MOD) has gained popularity among mobility consumers. MOD is an innovative concept based on the principle that transportation is a commodity where modes have economic values that are distinguishable in terms of cost, journey time, wait time, number of connections, convenience, and other attributes. MOD enables consumers to access mobility, goods, and services on demand by dispatching or using shared mobility, delivery services, and public transportation strategies through an integrated and connected multimodal network. MOD also includes the management of supply and demand across mobility services through an integrated transportation systems management and operations approach that is coordinated among the public and private sectors and the traveling public. As such, MOD encompasses decision support systems to: 1) aggregate real-time, historic, and predicted system condition information; 2) analyze alternative response strategies to address current or predicted problems; 3) assess the tradeoffs associated with strategies that support a number of operational objectives that vary dynamically; and 4) produce recommended strategies for implementation by system operators to guide and influence consumer choice (Shaheen et al., 2017). Figure 2.2 below visually depicts MOD's role in integrating multimodal transportation operations and management to optimize the supply and demand of the transportation network.

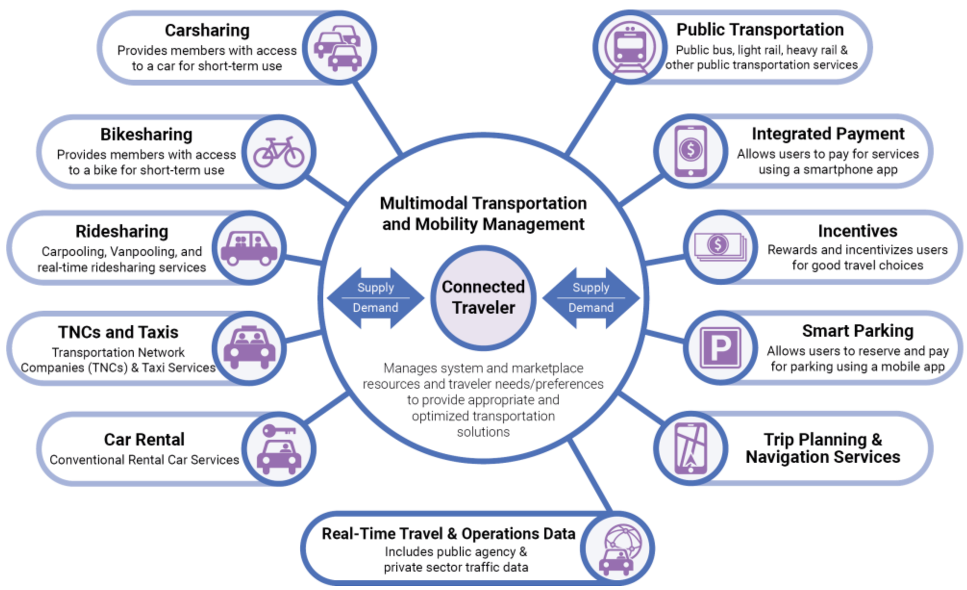

Figure 2.2. Mobility on Demand and Multimodal Transportation and Mobility Management (U.S. Department of Transportation)

Mobility as a Service (MaaS)

In Europe, an evolving concept known as Mobility as a Service (MaaS) is gaining popularity. Fundamentally, MaaS restructures the mobility distribution chain by integrating the products and services of mobility providers and supplying them to users as a single service. Typically, a digital platform creates and manages trips that users can pay for via a single account. A distinguishing feature of MaaS is giving users the option to purchase MaaS products, such as a monthly subscription plan that includes a bundle of transportation services that best fit a user's or household's travel needs. These subscriptions can include a certain amount of each transportation service (e.g. public transportation, bikesharing, carsharing, taxis, etc.) and are similar to other service bundles, such as mobile phone plans, where the user pays one price for the combination of multiple service elements (e.g., talk, text, data, roaming, long distance, etc.) (Durand et al., 2018; Matyas & Kamargianni, 2018).

Differences between MOD and MaaS

MOD differs from MaaS in that MOD focuses on the commodification of passenger mobility, goods delivery, and transportation systems management, whereas MaaS primarily focuses on passenger mobility aggregation and bundling services. Figure 2.3 illustrates the similarities and differences of MOD and MaaS. Specifically, MaaS is about integrating existing and innovative mobility services into one single digital platform where customers purchase mobility service packages tailored to their individual needs. In contrast, MOD leverages an integrated multimodal network to enhance access to services and improve system operations. Transportation network managers balance supply and demand to match changing conditions across the transportation system.

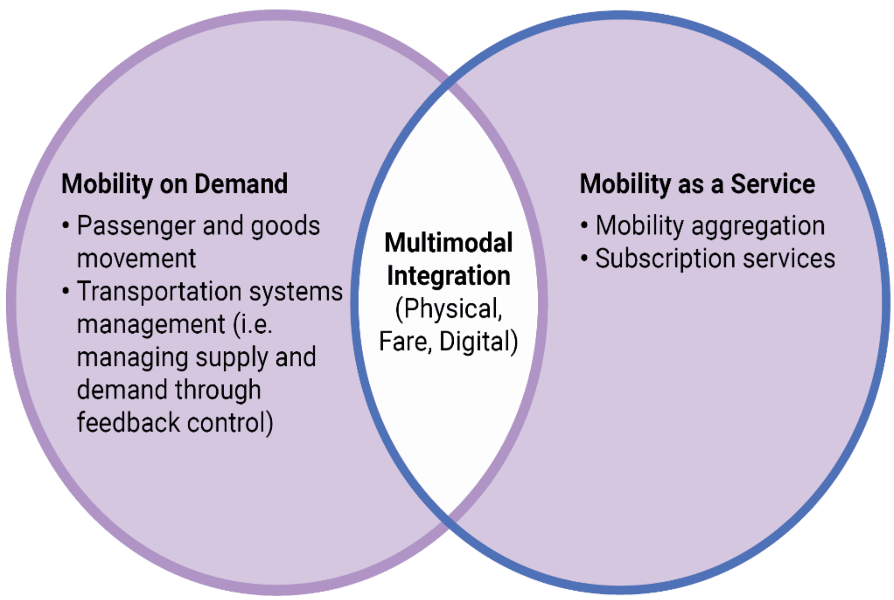

Figure 2.3. Similarities and Differences of MOD and MaaS. Shaheen and Cohen, 2019

Smartphone Applications

Increasingly, smartphone applications are assisting users in planning or understanding their transportation choices and may increase their access to alternative modes (SAE International, 2018; Shaheen et al., 2016b). There are four broad categories of apps impacting transportation. These categories are delineated by the apps' primary function. The categories are: 1) mobility apps, 2) vehicle connectivity apps, 3) smart parking apps, and 4) courier network services (CNS) apps (Shaheen et al., 2016b).

Mobility Apps

Mobility Apps are apps that assist users in planning or understanding their transportation choices and may enhance access to alternative modes. The eight sub-categories are:

Business to Consumer (B2C)

Business-to-Consumer (B2C) Sharing apps sell shared transportation services from a business to an individual consumer including: carsharing, bikesharing, and scooter sharing among other modes (Shaheen et al., 2016b).

Mobility Tracker Apps

Mobility Tracker apps track the speed, direction, and elapsed travel time of a traveler. These apps often include both wayfinding and fitness functions that are colored by metrics, such as caloric consumption while walking (e.g., GPS Tracker Pro) (Shaheen et al., 2016b).

Peer to Peer (P2P) Apps

Peer-to-Peer (P2P) Sharing apps enable private owners of vehicles to share them peer-to-peer, generally for a fee (e.g., Turo) (Shaheen et al., 2016b).

Public Transit Apps

Public Transit apps enable the user to search public transit routes, schedules, near-term arrival predictions, and connections. These apps may also include a ticketing feature, thereby providing the traveler with easier booking and payment for public transit services (e.g., Washington, DC's Metrorail and Metrobus) (Shaheen et al., 2016b).

Real-Time Information Apps

Real-Time Information apps display real-time travel information across multiple modes including: current traffic data, public transit wait times, and bikesharing and parking availability (e.g., Snarl) (Shaheen et al., 2016b).

Transportation Network Company Apps

TNC apps provide a platform for sourcing rides. This category includes "ridesplitting" services in which fares and rides are split among multiple strangers who are traveling in the same direction (e.g., UberPOOL and Lyft Shared rides) (Shaheen et al., 2016b).

Taxi e-Hail Apps

Taxi e-Hail apps supplement street hails by allowing location-aware, on-demand hailing of regulated city taxicabs (e.g., Flywheel) (Shaheen et al., 2016b).

Trip Aggregator Apps

Trip Aggregator apps provide users with trip planning and routing information incorporating multiple transportation modes and provide the user with travel times, connection information, distance, and trip cost (e.g., Transit App) (Shaheen et al., 2016b).

Vehicle Connectivity Apps

Vehicle connectivity apps allow remote access to a vehicle through an integrated electronic system that can be used in times of emergencies (e.g., locked out of a car, asking for help when in an accident, etc.). Vehicle connectivity apps are generally developed by auto manufacturers (e.g., General Motor's OnStar) (Shaheen et al., 2016b).

Smart Parking Apps

Smart parking apps provide information on parking cost, availability, and payment channels. These apps are often paired with smart parking systems. These apps can be grouped as follows (Shaheen et al., 2016b):

1. **e-Parking** describes the integration of technologies to streamline the parking process–from real-time information on space availability to simplified payment methods. e-Parking apps provide important information regarding real-time parking cost and availability (e.g., Park Whiz) and accessible payment channels for parking (e.g., Parkmobile).
2. **e-Valet** describes a for-hire parking service where drivers use an app to dispatch valet drivers to pick-up, park, and return vehicles. In addition to parking, some of these apps offer fueling, cleaning, and other vehicle services. e-Valet provides the ease of on-demand valet parking with flexible drop off and return locations (e.g., Luxe and Zirx, both now defunct).

Courier Network Service Apps

Courier Network Service (CNS) Apps provide for-hire delivery services for monetary compensation using an online application or platform (such as a website or smartphone app) to connect couriers using their personal vehicles, bicycles, or scooters with packages

(Shaheen et al., 2016b).

Service Models

These service model definitions describe how each mobility service is delivered to the traveler. Shared mobility service providers may offer more than one service type (SAE International, 2018; Shaheen et al. 2016a). Similar service models may evolve in a driverless vehicle future.

Membership-Based Service Models

Membership-based service models require that an individual or group of users sign up for membership to use a service. Examples include carsharing and membership-based bikesharing access.

Non-Membership-Based Service Models

Non-membership service models do not require a membership to use a service. Examples include: casual bikesharing access, car rental, and casual carpooling.

Peer-to-Peer (P2P) Service Models

In P2P service models, private companies manage transactions (for a fee) between hosts and guests of an asset (e.g., a vehicle, bicycle, or other mode) by providing the organizational resources needed to make the exchange possible (i.e., customer support, driver and motor vehicle safety certification, auto insurance, and technology, etc.). One way that P2P services differ from membership-based services is that an individual owns the private asset being shared rather than a business or organization.

For-Hire Service Models

For-hire service models transport passengers for a fare, which either is predetermined by distance or time traveled or is dynamically priced based on a meter or similar technology. For-hire services include TNCs, taxis, limousines, liveries, or pedicabs. The fundamental basis of for-hire services involves a passenger hiring a person operating an asset (e.g., a driver or cyclist) for a ride. For-hire services can be prearranged through a reservation or they can be booked on-demand through phone dispatch, street hail, or e-Hail using a website or smartphone app.

Public Transit Services

Public transit services include a variety of public transportation modes such as: buses, subways, ferries, light and heavy rail, high speed rail, and alternative transportation services.

Business Models

Shared mobility includes a variety of business models that are characterized by the different methods of commercial transactions used (SAE International, 2018; Shaheen et al., 2017).

BUSINESS TO CONSUMER SERVICES (B2C)

B2C services provide individual consumers with access to business-owned and operated transportation services such as: a fleet of vehicles, bicycles, scooters, or other travel modes. These services are typically provided through memberships, subscriptions, user fees, or a combination of pricing models (SAE International, 2018; Shaheen et al. 2016a).

GOVERNMENT TO CONSUMER (B2G)

B2G services offer business-owned and operated transportation services to a public agency. Pricing may include a fee- for-service contract, a per-transaction option, or some other pricing model (SAE International, 2018; Shaheen et al. 2016a).

BUSINESS TO BUSINESS SERVICES (B2B)

B2B services allow businesses to purchase access to business-owned operated transportation services, either through usage fees or a fee-for-service. This type of service is typically offered to employees to complete work-related trips (SAE International, 2018; Shaheen et al. 2016a).

PEER TO PEER (P2P)

P2P services offer a marketplace, usually an online platform, that facilitates transactions among buyer and sellers of personally owned and operated mobility services in exchange for a transaction fee. These can also include courier network services (SAE International, 2018; Shaheen et al. 2016a).

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CARSHARING

Carsharing is a service in which individuals gain the benefits of private vehicle use without the costs and responsibilities of ownership. Individuals typically access vehicles by joining an organization that maintains a fleet of cars and light trucks. Fleets are usually deployed within neighborhoods and at public transit stations, employment centers, and colleges and universities. Typically, the carsharing operator provides gasoline, parking, and maintenance. Generally, participants pay a fee each time they use a vehicle (Shaheen, Cohen, & Zohdy, 2016). Carsharing includes three types of service models, based on the permissible pick-up and drop-off locations of vehicles. These are briefly described below:

- **Roundtrip** - Vehicles are picked-up and returned to the same location.
- **One-Way Station-Based** - Vehicles can be dropped off at a different station from the pick- up point.
- **One-Way Free-Floating** - Vehicles can be returned anywhere within a specified geographic zone.

This toolkit is organized into seven sections. The first section reviews common carsharing business models. The next section summarizes research on carsharing impacts. The remaining sections present policies for parking, zoning, insurance, taxation, and equity. Case studies are located throughout the text to provide examples of existing carsharing programs and policies.

Carsharing Business Models

Carsharing systems can be deployed through a variety of business models, described below:

Business-to-Consumer (B2C) – In a B2C model, a carsharing providers offer individual consumers access to a business-owned fleet of vehicles through memberships, subscriptions, user fees, or a combination of pricing models.

Business-to-Business (B2B) – In a B2B model, carsharing providers sell business customers access to transportation services either through a fee-for-service or usage fees. The service is typically offered to employees to complete work-related trips. Typically, B2B carsharing services are provided by B2C service providers.

Business-to-Government (B2G) – In a B2G model, carsharing providers offer transportation services to a public agency. Pricing may include a fee-for-service contract, per-transaction basis, or other pricing models. Typically, B2G carsharing services are provided by B2C service providers. In the United States, the General Services Administration (GSA)—an independent agency of the federal government that manages and supports the basic functioning of federal agencies—has authorized carsharing use as means to help reduce government expenditures for vehicle fleet ownership and management. At the local level, cities such as Berkeley and Philadelphia have become carsharing customers to reduce municipal vehicle fleet costs (GSA, 2018).

Peer-to-Peer (P2P) – In a P2P model (sometimes referred to as personal vehicle sharing), carsharing providers broker transactions among vehicle owners and guests by providing the organizational resources needed to make the exchange possible. Members access vehicles through a direct key transfer from the host (or owner) to the guest (or driver) or through operator-installed, in-vehicle technology that enables unattended access. Pricing and access terms for P2P carsharing services vary, as they are typically determined by vehicle hosts listing their vehicles. The P2P carsharing operator generally takes a portion of the P2P transaction amount in return for facilitating the exchange and providing third-party insurance. Examples of P2P carsharing providers in the U.S. include: Turo (formerly RelayRides) and Getaround. For example, Turo takes 15 to 35% of the commission in the U.S. (depending on the vehicle protection plan a host enrolls in), and Getaround takes 40% from the host for its services. As of January 2017, 2.9 million members shared 131,336 vehicles as part of a P2P carsharing program in North America (Shaheen, Martin, Bansal, 2018b).

Impacts of Carsharing

Studies have examined the impact of roundtrip, one-way, and P2P carsharing on travel behavior and vehicle ownership. The extent to which carsharing impacts travel behavior and vehicle ownership decisions varies according to the methodological differences and geographic locations of the studies. Table 3.1 below on the following page provides an overview of North American studies that examine carsharing impacts. These impacts are summarized as follows:

Reduced household vehicle holdings – Carsharing services offer members the benefits of vehicle access without the costs of private vehicle ownership. Canadian studies and member surveys suggest that between 15 to 29 percent of roundtrip carsharing participants sold a vehicle, while 25 to 61 percent delayed or had foregone a vehicle purchase. Studies and surveys in the U.S. indicate that 11 to 26 percent of roundtrip carsharing members sold a vehicle, and 12 to 68% postponed or avoided a vehicle purchase (Cohen & Shaheen, 2016). A reduction in vehicle ownership may result in lower vehicle miles traveled (VMT)/vehicle kilometers traveled (VKT), reduced traffic congestion and parking demand, and an increase of other transport modes (such as biking and walking) in lieu of car travel.

Reduced Vehicle Miles Traveled (VMT) – Carsharing is thought to lead to lower VMT or VKT by emphasizing variable driving costs, such as per hour and/or mileage charges. Studies in Table 3.1 indicate that members of carsharing organizations decrease VMT/KMT from three to eighty percent; however, trial members of City CarShare experienced increases in VMT/VKT.

Increased use of active transit modes – The reduction of vehicle ownership, by members selling or avoiding purchasing a vehicle, opens up a turn toward multimodality. As noted in Table 3.1, studies indicate that people walk or take public transit more after joining a carsharing service.

Change in public transit use - The impacts of carsharing services on public transit are less certain. Several studies show that participants were taking public transit less since joining a carsharing service, including members of one-way carsharing services (see Table 3.1). However, other studies report that participants took public transit more often.

Reduced greenhouse gas (GHG) emissions - Carsharing may reduce GHG emissions by decreasing vehicle ownership and encouraging use of active modes. Although there is a slight increase in emissions by providing automobile access to those who did not own one, an analysis of the aggregate GHG impacts suggest net emissions decrease among carsharing members (Martin & Shaheen, 2010).

Table 3.1 Summary of Carsharing Impacts

Operator and Location	Authors, Year	Number of Vehicles Removed from the Road Per Carsharing Vehicle	Members Selling Personal Vehicle %	Members Avoiding Vehicle Purchase %	VMT/VKT Change % Per Member	Average Monthly Cost Savings per Member	Participants Walking More %	Participants Taking Public Transit More %
ROUNDTRIP CARSHARING STUDIES								
Short-Term Auto Rental *San Francisco, CA*	(Walb & Loudon, 1986)		15.4	43.1				
Arlington Carsharing (Flexcar and Zipcar) *Arlington, VA*	(Price & Hamilton, 2005)		25.0	68.0	-40		54.0	54.0
	(Price, DeMaio, & Hamilton, 2006)		29.0	71.0	-43.0		47	
Carsharing Portland *Portland, OR*	(Katzev, 1999)		26.0	53.0		154 USD		47.0
	(Cooper, Howe, & Mye)		23.0	25.0	-7.6		25.8	13.5
City Carshare *San Francisco, CA* — *Year 1*	(Cervero, 2003)		2.5	60.0	-3.0a/-58.0b			
Year 2	(Cervero & Tsai, 2004)	6.8	29.1	67.5	-47.0a/73.0b			
Year 4	(Cervero, Golub, & Nee, 2007)				-67.0a/24.0b			
PhillyCarshare *Philadelphia, PA*	(Lane, 2005)	10.8c	24.5	29.1	-42.0	172 USD		
TCRP Report – Surveyed Members of More Than Nine Carsharing Companies *North America*	(Millard-Ball, ter Schure, Fox, Burkhardt, & Murray, 2005)				-63.0		37.0	40.0
Surveyed Members of Eleven Carsharing Companies *U.S. and Canada*	(Martin & Shaheen, 2010)	9.0-13.0	33.0	25.0				
	(Martin, Shaheen, & Lidicker, 2010)				-27.0		12.0	22.0d
Zipcar *U.S.*	(Zipcar, 2005)	20.0	32.0	39.0	-79.8	435 USD	37.0	40.0
Modo *Vancouver, Canada*	(Namazu & Dowlatabadi, 2018)	5.0		55.0				-41.0--55.0 d
ONE-WAY CARSHARING STUDIES								
Car2Go *U.S. and Canada*	(Martin & Shaheen, 2016)	7.0-11.0	2.0-5.0	7.0-10.0	-6.0 to -16		-2.0-25.0	-43.0-3.0
Car2Go *Vancouver, Canada*	(Namazu & Dowlatabadi, 2018)	6.0		55.0				-41.0--55.0d
Car2go *San Diego, CA*	(Shaheen, Martin, & Bansal, 2018a)						25.0	-12.0
P2P CARSHARING STUDIES								
Getaround, RelayRides (Turo), and eGo Carshare *U.S.*	(Shaheen, Martin, & Bansal, 2018b)		.14	.19			13.0	1.0-2.0
Getaround *Portland, OR*	(Dill, McNeil, & Howland, 2017)			.44				-20.0e

Adapted from Shaheen et al., 2016.

[a]Reflects existing members' reduction in vehicle miles traveled/vehicle kilometers traveled (VMT/VKT).
[b]Reflects only trial members' reduction in VMT/VKT.
[c]Reflects vehicles removed by members who gave up a car.
[d]Reflects percentage of users for which carsharing was an alternative to public transit.
[e]Reflects percentage of users for which a carsharing trip replaced a public transit trip

Parking Policies for Carsharing

Dedicating parking for shared vehicles is a way public agencies can support carsharing. Some common policy considerations may include:

Parking Allocation: Carsharing parking can be allocated through a combination of formal and informal processes. Formal process include established policies that are written, codified, and/or negotiated through a formal request for proposal (RFP) process. An informal process includes approving parking through variances, special permits, and case-by-case approvals from administrative staff or an elected council. Methods for allocating parking include:

- Designating zones for on-street parking,
- Allocating parking spaces for carsharing vehicles, and
- Providing parking permits that allow parking within a specific parking zone or the use of a specific parking spot.

Parking Caps: Cities may cap the number of parking spaces. The number of parking spaces for carsharing can be limited by category (on- or off-street), operator, particular location, or service use (i.e., one parking space per every 100 members). To foster diverse carsharing business models, cities can allocate an equal number of station-based parking spaces and parking permits for free-floating services.

Public Involvement: Cities that seek to mitigate potential community concerns can incorporate public involvement in parking decisions. For example, some public agencies require public operators to work with local neighborhoods or community organizations before approving the location of carsharing parking.

Fees and Permits: Removing general-use parking may result in a loss of parking meter or permit revenue. Cities may choose to provide free parking or make up for the lost revenue by charging operators for parking. A city can charge a yearly fee to carsharing operators in return for parking permits or dedicated parking zones. The fee can be assessed based on costs associated with: 1) the price of a residential parking permit, 2) lost or foregone meter revenue, 2) costs associated with providing parking (e.g., operations, administrative cost, overhead, and maintenance); or 4) the market cost of the parking spaces provided.

Signage: Special signage may be needed to indicate carsharing parking. Public agencies can regulate signage to conform to local requirements. Maintenance of signage may be formally negotiated through real estate lease agreements or informally with the operator on an as-needed basis.

Parking Enforcement: To ensure that spaces are available for carsharing use, cities may consider parking enforcement. Cities may need to create provisions for unique license plates or ticketing/ towing authority of carsharing vehicles and carsharing parking spaces.

Impact Studies: Public agencies may require carsharing operators to conduct impact studies documenting the transportation, social, and environmental impacts of their system before allocating carsharing parking.

Case Studies

San Francisco, CA - Station-Based Carsharing

The San Francisco Municipal Transportation Agency (SFMTA) established a pilot for carsharing parking. To participate, eligible carsharing companies had to:

- Make vehicles available to members by reservation on an hourly basis or in smaller intervals at rates based on time or time and distance.
- Make vehicles available to members on a 24-hour, seven day a week basis.
- Make vehicles available to members at least 75% of the time during any given month when the vehicle is parked in a designated on-street carsharing parking space.
- At least 15% of the total fleet had to be located in an On-Street Car Share Zone 2 and at least 15% in an On-Street Car Share Zone 3 (See Figure 3.1).
- Provide SFMTA with quarterly reports on the number of members by zip code, vehicle location, trip duration, VMT, usage rate, and other operational metrics.
- Provide SFMTA with data from member surveys on travel behavior, vehicle ownership, and carsharing use.

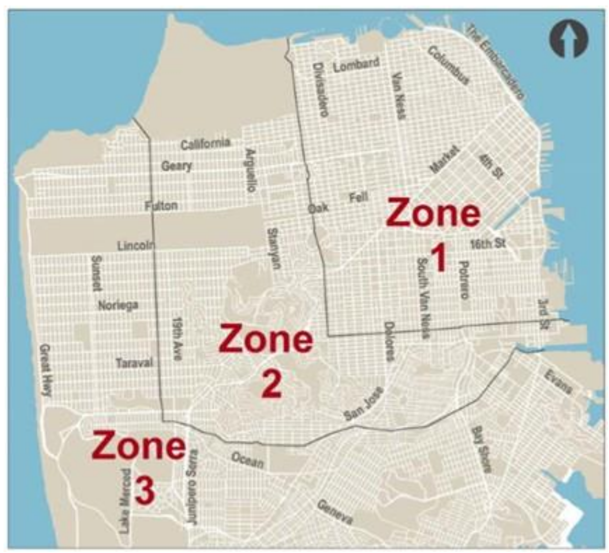

Figure 3.1. On-Street Carsharing Permit Pricing Zones. Photo Courtesy of SFMTA On-Street Car Sharing Pilot Program Evaluation Report

Three entities were chosen for the pilot program: City CarShare, Zipcar, and Getaround. Each operator proposed 150 parking space locations, which were reviewed by SFMTA and other city agencies. Parking space proposals were brought to the SFMTA Board of Directors for deliberation and approval. During the pilot program, 215 on-street parking spaces were dedicated for carsharing. At the completion of the pilot program, SFMTA found that on-street parking increased shared vehicle access, convenience, and visibility (SFMTA, 2017).

Following the pilot, San Francisco approved an On-Street Shared Vehicle Permit Program in July 2017. Under the program, permits are issued only to qualified Vehicle Sharing Organizations who provide fleets of shared vehicles and meet the following requirements:

- Conduct outreach when selecting locations for parking spaces,
- Provide ongoing usage data to the SFMTA,
- Provide a sufficient share of vehicle locations in areas throughout the city, and
- Satisfy other requirements specified in the permit.

Unlike the pilot program, permits are no longer available for P2P carsharing services (SFMTA, 2019). As of early 2019, SFMTA has evaluated permit applications for: City CarShare (now powered by Getaround), Maven, Zipcar, and UhaulCarShare. Fees for the on-street spaces will be applied using the same three-zone system used during the pilot (Figure 3.1) and cost $59 to $300 per month, depending on the zone. To ensure geographic equity, SFMTA requires permittees to place a minimum of 15% of their vehicles in Zone 2 and a minimum of 15% of their vehicles in Zone 3. Participants must share the following data every month:

- Number of reservations per space,
- Number of unique users per space, and
- Length of trip (miles/time) per space.

SFMTA will also work with permitted carsharing programs to develop a member survey that asks members about their travel behavior, vehicle ownership, and vehicle use (SFMTA, 2017).

Seattle, WA - Designated Space Parking and Free-Floating Carsharing

Seattle provides parking permits to carsharing through either a free-floating permit or designated space permit. Under the Designated Space Car Share Permit program, operators can apply for a permit that allows vehicles to be parked in designated on-street or private parking areas. Permits cost $300 annually for unpaid parking spaces or $3,000 annually for paid parking spaces.

Under the free-floating carsharing permit program, operators can apply for permits to park vehicles at any legal paid parking space in the city without payment or time restrictions. Each free-floating carsharing permit costs $1,730 annually.

Permit holders for both programs must meet the following requirements:

- Demonstrate within two years of beginning operations that they serve the entire city (operators may be requested to provide documentation on the number and location of vehicles);
- Annually report information regarding their fleet, membership (including demographics), and on- and off-street locations;
- Conduct an annual membership survey during the first two months of each permit year and submit the summary results to the city; and
- Provide vehicle data to the Transportation Data Collaborative (TDC) at the University of Washington through an API. Data shall include point location, vehicle identification numbers, vehicle types, fuel level, and engine type (Seattle Department of Transportation, n.d.).

Zoning Policies for Carsharing

Local zoning and codes may have unintended consequences on carsharing success. For example, a zoning ordinance may not permit commercial activity in residential zones (preventing the parking of carsharing in residential neighborhoods). Zoning can also be used to encourage carsharing services and mitigate the parking costs through a strategy known as “incentive zoning.”

Zoning Strategies

Incentive zoning consists of an array of policies that cities may implement to ease zoning regulations and parking minimums. Incentive zoning policies can be applied in both new and existing developments. For example, parking substitutions allow developers to substitute general- use parking for shared modes, such as carsharing parking. Additional information and strategies related to zoning can be found in the Shared Mobility and Incentive Zoning Toolkit.

Case Studies

Seattle, WA - Parking Substitution

Seattle’s municipal code allows developers to reduce a development project’s required total parking up to five percent by providing parking for a city-recognized carsharing program. The ordinance reduces the number of required spaces by one space for every parking space leased by a carsharing program. For developments requiring 20 or more parking spaces, the number of required spaces may be reduced by the lesser of three required parking spaces for each carsharing space or 15 percent of the total number of required spaces (Seattle Municipal Code, § 23.54.020). To qualify for the 15 percent reduction, the code stipulates that there must be an agreement between the property owner and carsharing operator, and the agreement must be filed and approved by the city and recorded with the deed.

Insurance and Liability Policies

Insurance regulations can make carsharing cost prohibitive. In the early 2000s, North American carsharing operators confronted substantially higher premiums (often more than $2,500 per vehicle). It was also common for providers to carry $1 million (per accident, per claim) single-limit policies (Cohen & Shaheen, 2016). However, insurance is becoming increasingly affordable as the industry grows. Carsharing operators are protected from vicarious liability claims (i.e., they are protected from the negligence of the user to whom the vehicle has been rented).

In some states, insurance laws have not kept pace with the introduction of P2P carsharing models. It may be unclear when a vehicle owner's policy ends and a P2P carsharing operator's commercial policy begins. Some states do not have P2P insurance legislation, and owners may be held liable for loss or injury when their vehicles are used for carsharing. They may also face premium spikes or non-renewal of personal insurance policies (Cohen & Shaheen, 2016).

Insurance Strategies

Revise Insurance Laws. A number of states have enacted laws to create insurance standards and a regulatory framework for P2P carsharing programs. For example, California requires the insurance coverage offered by the P2P carsharing program to be at least three times the minimum requirements for a private vehicle. This law protects participants' insurance policies from being canceled, voided, terminated, rescinded, or nonrenewed solely on the basis that the vehicle has been made available for P2P carsharing.

Taxation Policies

Carsharing services may be subject to state and local taxes that can increase service costs (e.g., rental car taxes). Four types of taxes can be levied on carsharing modes:

- State, county and municipal sales taxes applied to shared mobility (percentage-based tax on sales or receipts from sales),

- Rental car taxes (state and local percentage-based taxes on transaction value of a vehicle rental),
- Transaction fees and per-use excise tax (fixed-rate tax or fee applied to a transaction), and
- Miscellaneous taxes applied to shared mobility (percentage-based or fixed-rate taxes used to fund public transit and special projects).

Municipal governments with the highest tax rates charge between 34.44% and 61.89% on an hourly carsharing reservation. Hourly rentals are often charged a higher tax rate than 24-hour reservations and significantly higher than the average tax rate for other goods and services (Schwieterman, 2017).

Taxation Strategies

To reduce the impact of taxation on carsharing services, municipalities can:

- Amend codes to exempt carsharing from rental car taxes or transaction taxes,
- Revise transaction fees to only occur on annual membership contract (rather than each rental transaction),
- Lower per-use excise taxes, and
- Switch to a tax that is per-hour instead of a flat rate for short-term use.

Equity and Accessibility Policies

Carsharing services can increase accessibility for low-income populations by reducing the expenses associated with vehicle ownership. However, older adults, low-income households, rural communities, and minorities have been less likely to use shared mobility (Tyndall, 2017), and they tend to have lower access to the Internet, smartphones, and banking services. In addition, people with disabilities may face barriers to accessibility, if vehicles do not contain adaptive equipment, such as hand controls or swivel seats, or are not wheelchair accessible.

Strategies to Promote Equity

Strategies to improve equity in carsharing services overlap with those of other shared mobility modes; these strategies include providing low-income subsidies, accessibility to the unbanked and those without smartphones, and developing inclusive services. Strategies to improve equity can be reviewed in depth in the Social Equity Toolkit.

Mobility for People with Disabilities. Cities can require that carsharing operators adopt measures that enhance accessibility for those with disabilities. Measures can include providing adaptive technology in vehicles or wheelchair accessible vehicles. Cities can also subsidize fares for carsharing services that provide additional services to ensure that rates are equitable for these populations. For example, Zipcar provides the following services for members with disabilities (Zipcar, 2019):

- Installation of hand controls in vehicles with advanced notice of 72 hours. Zipcar will try to accommodate within 48 hours of notice;
- Service animals are exempted from Zipcar's rule of requiring pets in a carrier;
- The $3.50 assistance fee for reservation-related activity is waived for members who self- identify as disabled; and
- Members have an option of a household account, if disabilities prevent them from driving; this allows another person to drive for them.

Case Studies

Los Angeles, CA - Carsharing for Low-Income Residents

The California Air Resources Board partnered with the City of Los Angeles (LA) and the Shared Use Mobility Center to launch a carsharing pilot project aimed at serving low-income residents in LA. The pilot program is funded with $1.6 million in state cap-and-trade revenues and $1.82 million in EV infrastructure rebates, fee waivers, and in-kind support from the City of LA. Goals of the program include: 1) recruiting a minimum of 7,000 new carsharing users, 2) avoiding purchase or sale of 1,000 private vehicles, and 4) reducing GHG emissions by 2,150 metric tons of carbon dioxide (CO2) (Lee, 2016).

In December 2016, the city announced a contract with BlueLA, a subsidiary of Bolloré Group, to run a five-year long electric carsharing program. BlueLA is investing $10 million in a 100-car electric fleet and 200 charging stations. As of April 2019, BlueLA has deployed 80 electric vehicles and 26 charging stations. (Gray, 2019) The vehicles and charging stations are located in disadvantaged neighborhoods throughout Central LA (Ohland, 2016). Currently BlueLA offers three membership plans:

- Standard - Annual membership for $5/month with a usage fee of $0.20/minute. Minimum price per trip is $3.00;
- Community – Annual membership for $1/month with a usage fee of $0.15/minute. Minimum price per trip is $2.25; and
- Trial – Free for one month with a usage fee of $0.40/minute. Minimum price per trip is $6.00.

Key Takeaways

- Carsharing offers members access to vehicles by joining an organization that provides and maintains a fleet of cars and/or light trucks. The carsharing organization typically provides insurance, gasoline, parking, and maintenance. Members who join a carsharing organization typically pay a fee each time they use a vehicle.
- Carsharing encompasses a variety of service models including:
  - Roundtrip - Vehicles are picked-up and returned to the same location.
  - One-Way Station-Based - Vehicles can be dropped off at a different station from the pick-up point.
  - One-Way Free-Floating - Vehicles can be returned anywhere within a specified geographic zone.
- There are four types of carsharing business models:
  - Business-to-consumer (B2C): Individual consumers gain access to a business-owned fleet of vehicles through memberships, subscriptions, user fees, or a combination of pricing models.
  - Business-to-business (B2B): Carsharing providers sell business customers access to transportation services either through a fee-for-service or usage fees.
  - Business-to-government (B2G): Carsharing providers offer transportation services to a public agency. Pricing may include a fee-for service contract, per-transaction basis, or some other pricing model.
  - Peer-to-Peer (P2P): In a P2P model (sometimes referred to as personal vehicle sharing), carsharing providers broker transactions among vehicle owners and guests by providing the organizational resources needed to make the exchange possible.
- Studies have documented that carsharing can reduce vehicle ownership and VMT/VKT, contributing to a reduction in GHG emissions and the use of alternative forms of transportation, such as walking and cycling.
- Public policies, such as allocating rights-of-way for carsharing parking, can be important tools to enhance carsharing access and encourage use.

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MICROTRANSIT

Microtransit is a privately or publicly operated, technology-enabled transport service that typically uses multi-passenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing (Cohen & Shaheen, 2016; SAE International, 2018). Route and scheduling possibilities for microtransit are described in Table 4.1 below.

Table 4.1 Forms of Microtransit Operations

	Fixed Route	Dynamic Route
Fixed Schedule	The service operates on a schedule and fixed route similar to fixed route transit service. However, additional routes may be created using crowdsourced information from a service's users.	The service can adjust its route, but the pick-up and drop-off times are fixed.
Dynamic Schedule	The service operates on a fixed route but may offer demand-responsive passenger pick-up and drop-off.	The service can dynamically adjust to its routes and schedules according to the origins and destinations of its users.

Different microtransit service models are introduced in the following section. This toolkit identifies potential use cases for microtransit and provides case studies of pilot programs, public-private partnerships, and permit programs for private operators. The toolkit concludes with a summary of opportunities and challenges for microtransit services.

Microtransit Services

Microtransit services can be further classified by their business model and relationship to the public sector:

- **Private Microtransit** – Private microtransit services operate without a public-sector subsidy and are intended to make a profit. Jurisdictions can choose to regulate private microtransit services to achieve goals, such as safety and social equity. A discussion of private microtransit operator Chariot (now defunct) is available in the case study section.
- **Public-Private Partnership** – Governments may pursue partnerships with microtransit providers to achieve specific goals, such as expanding coverage or increasing efficiency. In these partnerships, microtransit companies may provide vehicles and software expertise (Lucken, Frick, & Shaheen, forthcoming) or operate the entire microtransit service through a turnkey operation.
- **Public Microtransit with Third Party Vendor** – The public agency takes the main role as an operator of the microtransit service and contracts with a vendor to provide particular components of the service, such as vehicles or software through a technology license.

Why Implement Microtransit?

There are a variety of potential use cases for microtransit such as:

- **First- and Last-Mile Connections –** Microtransit services can fill gaps in existing public transit systems, enabling users to connect to high-capacity public transportation.
- **Transit Replacement –** Microtransit services can replace underperforming routes, such as lower-density built environments, that may be more cost effectively serviced with right-sized and demand-responsive services.
- **Paratransit** – Microtransit can be a cost-effective solution for providing demand-responsive paratransit service for public agencies.
- **Peak Shedding** – Some high performing public transit routes may experience overcrowding during peak hours. Microtransit can provide an opportunity for “peak shedding” to relieve the stress on these crowded routes by providing additional capacity during peak hours.
- **Late Night Service** – Microtransit can provide a late-night transportation option.

Case Studies

The Kansas City Area Transportation Authority (KCATA) RideKC Pilot

In March 2016, Kansas City Area Transportation Authority (KCATA) began a pilot program to test how on-demand services could be integrated into the suite of transportation options available in the Kansas City region. The partnership between Bridj, KCATA, and Ford was the first U.S. public-private collaboration to bring together a major U.S. public transit system, an automaker, and an urban technology company to enhance existing mass transit by providing greater mobility options. The pilot was designed to share lessons learned, inform future project/programs decisions, and provide a demonstration project to public transportation providers relating to how service adaptations are required to meet the needs of an ever mobile, connected populace (KCATA, n.d.).,

Researchers at the Transportation Sustainability Research Center at the University of California, Berkeley conducted an evaluation of the pilot program to assess the service impacts (Shaheen, Stocker, Lazarus, Bhattacharyya, 2016). Key findings from the pilot evaluation include:

- Price affordability and convenience were the most common reasons for using microtransit, with 57 percent of respondents saying they used microtransit because it was cheaper and 39 percent saying it was more comfortable than other modes. A third of respondents said that microtransit offered them greater flexibility.
- A majority (89%) of users walked to or from their microtransit stop from a workplace or residence.
- More than half of the survey respondents used the service in the afternoon only. This may have occurred because a service area surrounding a hospital had many workers with shifts that fell outside of the pilot's operating hours.
- While all respondents said they would "maybe," "probably," or "definitely" use the microtransit service for $2.00, 23 percent said they would not use it for $3.00.
- Interviews with experts involved in the pilot project found that the microtransit service would need to expand operating hours and geographical coverage to achieve a critical mass of users.

Public-Private Partnership – West Sacramento

In May 2018, the City of West Sacramento, California launched a public-private partnership with microtransit operator, Via. The year-long pilot is intended to test a service model that would provide more efficient transportation in certain areas and potentially replace underperforming public transit routes. The pilot program cost approximately $749,000, with most of the funds coming from state and local transportation funding, including a $149,000 grant from the Sacramento Area Council of Governments (Yoon-Hendricks, 2018).

Via operates a fleet of ten, six-passenger Mercedes vans for a flat user fee of $3.50 ($1.75 for seniors) or a $15 weekly pass allowing for up to four rides a day. The service operates weekdays 7:00am to 10:00pm and Saturdays 9:00am to 10:00pm within city limits. Via allows users to request rides through either a smartphone application or a phone call. Users with disabilities can request a wheelchair or mobility device-accessible vehicle, as well as assisted door-to-door service. Additionally, while the service does not accept cash, users can load cash onto pre-paid credit cards to pay for services.

The city of West Sacramento released an update on the program after nine months of operation. As of February 2019, over 50,000 rides had been completed. Normalizing over nine months, the service cost the city around $11 per ride. In comparison, the Sacramento Regional Transit estimates that it spends $8.11 per passenger ride for bus service (SACRT, 2019). Ridership averaged around 350 rides per day on weekdays and 250 rides on Saturdays. These findings are almost double the original estimates projected for average daily ridership. Similarly, over 60% of the rides were pooled (i.e., two or more passengers). The City Council is considering a contract renewal for another year (City of West Sacramento, 2019a and 2019b).

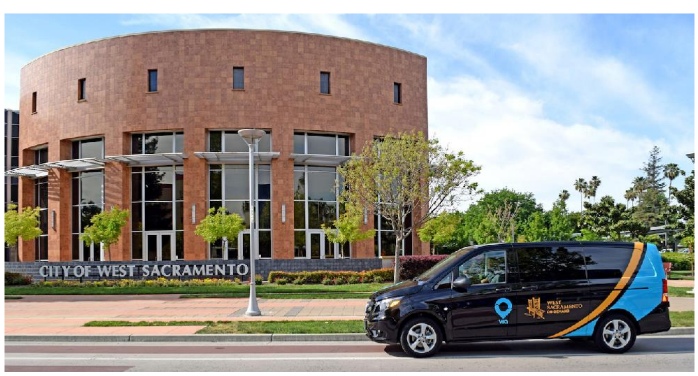

Figure 4.1. A Via Van in West Sacramento. Photo Courtesy of Via

Private Microtransit Operations – SFMTA's Private Transit Vehicle Permit

In the past, private jitney services were a popular transport mode in San Francisco. However, jitney services lost popularity in the city by the 1970s, and in 1978, voters passed Proposition K outlawing the sale of jitney permits. When a jitney operator retired or died, the city absorbed the permit and it was never reissued. The existing regulations for jitneys remained in place until 2011, when the SFMTA Board of Directors repealed them to leave a placeholder for new regulations. With the emergence of technology-enabled microtransit, the city became concerned about unsafe or illegal stops by microtransit and shuttles and the operational impacts of frequent stops on public transportation operations. In October 2017, the San Francisco Municipal Transportation Agency (SFMTA) approved the Private Transit Vehicle (PTV) permit program (DeNike, 2016; Jose, 2017).

SFMTA requires microtransit and shuttle providers to apply for a PTV permit. With this permit, the SFMTA ensures that stops are located at designated passenger loading zones. The operator is required to share GPS and ridership data with the agency and pay an annual permit fee to cover administrative and enforcement costs. Chariot was the first microtransit service to receive a PTV permit and the agency assisted Chariot in relocating over 100 stops throughout the permitting process (SFMTA, 2017). Chariot was acquired by Ford Motor Company in September 2016. However, Chariot announced the end of its microtransit operations, and the service ended in March 2019.

Figure 4.2. Chariot Microtransit Van. Photo Courtesy of Wikimedia Commons

Public Microtransit Operations with Third Party Vendor – AC Transit Flex Pilot

In 2015, AC Transit released a Request for Proposals (RFP) for a vendor to develop and implement a technology platform that would enable the agency to operate an on-demand microtransit service for two of its lower ridership routes in the San Francisco Bay Area. This pilot was meant to allow riders to schedule pick-up and drop-off locations. DemandTrans Solutions was selected as the technology vendor and was responsible for integrating the software and providing the hardware for AC Transit vehicles.

AC Transit decided to operate their own microtransit service and hire a vendor for support for a variety of reasons. First, the labor union was concerned that a private vendor might replace current AC Transit labor with contract labor. Second, the agency was concerned that a contract solution would not be accessible to disadvantaged communities. Finally, AC Transit had already procured 14-passenger transit vehicles before the development of the project.

In 2016, operation of AC Transit Flex began in two zones. One microtransit route replaced a low performing bus route that connected the cities of Newark, Fremont, and Union City. Another Flex service zone in Castro Valley complements two existing bus lines. The pilot was intended to address declining ridership, improve service quality, and reconfigure networks in low-density communities. AC Transit also wanted the pilot to be cost neutral.

Figure 4.3 provides a description of the booking and travel experience for users of AC Transit Flex. By 2017, the pilot had approximately 700 unique users with 23,000 annual trips. On-time performance improved from 70 to 85 percent, with 94 percent of riders preferring the Flex service over fixed route transit service. However, Flex served just three passengers per revenue hour on average, less than half of the previous fixed route that averaged seven passengers per revenue hour. For AC Transit Flex the service cost $72 per passenger in comparison to $25 per passenger for fixed route service. In November 2017, AC Transit recommended the continuation of Flex for routes with less than seven passengers per revenue hour. Ultimately, the success of AC Transit Flex will depend upon its ability to provide coverage, while enhancing the frequency and ridership of high-capacity fixed route service (AC Transit, 2019; Goodman, 2018; Hursh, 2017; Eno Center for Transportation, 2018; Urgo, 2018).

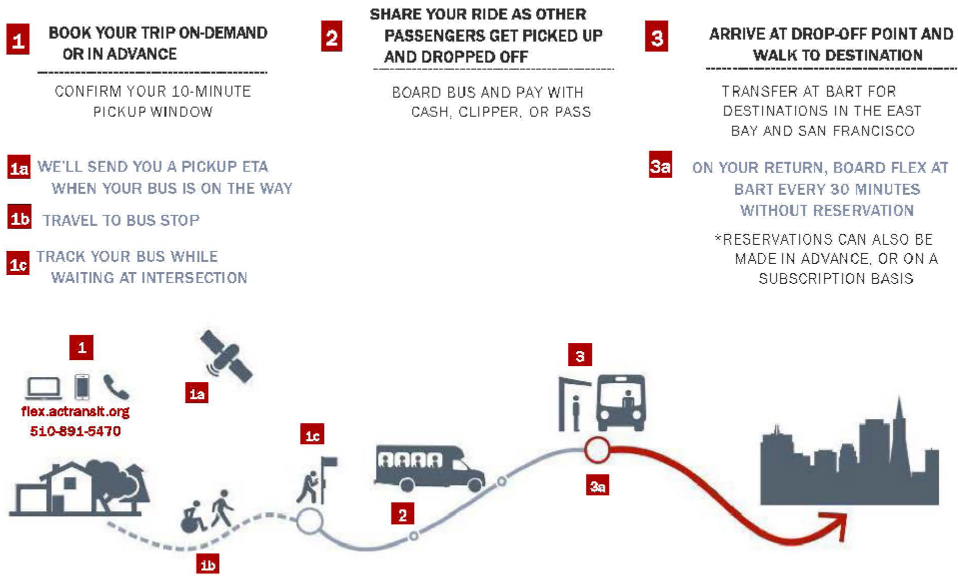

Figure 4.3. Illustration of an AC Transit Flex trip from booking to arrival at destination. Photo courtesy of John Urgo.

Opportunities and Challenges for Microtransit Partnerships

Microtransit can present a number of opportunities and challenges such as:

- **Marketing Microtransit Services Effectively –** Since these services typically operate differently than traditional public transportation, microtransit depends on effective communications and marketing to explain the operational differences and how to use the service.
- **Operations and Labor** – Agencies pursuing microtransit service may encounter challenges such as: procuring smaller vehicles, providing employee training, and managing potential issues with union contracts.
- **Social Equity** – The technology used by microtransit to provide dynamic routing and scheduling could create challenges for disadvantaged communities (See Social Equity Toolkit). Title VI of the Civil Rights Act requires that agencies perform an equity analysis, if they are replacing fixed-route service with microtransit to make sure the services do not have a disparate impact on disadvantaged communities.
- **Integrated Payment** – While some microtransit services may have integrated fare payment with public transportation (such as AC Transit Flex and the Clipper

Card in the San Francisco Bay Area), this may not always be the case. Integrated fare payment can enhance rider convenience and help ensure that microtransit complements fixed-route public transit services. For more information on ticketing integration, see the Shared Mobility and Public Transit Integration Toolkit.

Key Takeaways

- Microtransit is a privately or publicly operated, technology-enabled transport service that typically uses multi-passenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing.
- Microtransit can serve a variety of potential uses cases, such as first- and last-mile connections to public transportation, replacement of underperforming fixed-route services, supplement late-night transportation services, and provide additional options to augment or replace paratransit services.

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RIDESHARING

Ridesharing allows travelers to share a ride to a common destination and can include several forms (Shaheen & Cohen, 2019; Chan & Shaheen, 2011; SAE International, 2018). Ridesharing differs from for-hire vehicle services (i.e., transportation network companies (TNCs), ridesourcing, and ridehailing) in its financial motivation. When a ridesharing payment is collected, it partially covers the driver's cost and is not intended to result in financial gain. Additionally, the driver has a common origin and/or destination with the passengers. Types of ridesharing include:

- **Casual Carpooling**, also known as "slugging" and "flexible carpooling," is a form of ad hoc, informal carpooling among strangers. Typically, no money exchanges hands or passengers pay a nominal amount to reimburse drivers for actual travel expenses (i.e., tolls, gas, etc.). In some regions, cities may designate casual carpooling locations where drivers can pick up passengers waiting for a shared ride.

Figure 5.1. Sign for a dedicated carpool lane. Photo Courtesy of Flickr/user lady madonna

- **Real-Time Carpooling**, also known as "app-based carpooling" and "dynamic carpooling," allows people to arrange ad hoc rides on-demand (or very short notice) using smartphone apps or a website. Typically, passengers are picked up at their current location or a mutually agreed upon pick-up location.
- **Vanpooling** typically consists of 7 to 15 passengers who share the cost of a van and may share driving responsibility.

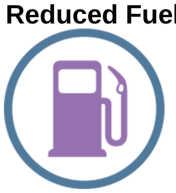
In this toolkit, readers will find a summary of the social, environmental, and behavioral impacts of ridesharing as well as a summary of user benefits. Following this material is an in-depth exploration of policy considerations for ridesharing that includes: incentive zoning, public-private partnerships, parking policies, road and curb pricing, ridesharing infrastructure, and tax incentives. Case studies of policies implemented for ridesharing are provided throughout the text.

Impacts of Ridesharing

A number of social, environmental, and behavioral impacts have been attributed to ridesharing, and an increasing body of empirical evidence supports many of these relationships, although more research is needed—as ridesharing is difficult for researchers to observe and record. Empirical and anecdotal evidence indicates that ridesharing provides numerous societal benefits.

Reduced Vehicle Miles Traveled (VMT) – Studies have shown that programs that encourage ridesharing can reduce VMT or vehicle kilometers traveled (VKT). For example, one study estimates that these programs can reduce VMT for workplace commutes by four percent to six percent (Boarnet et. al., 2014). While ridesharing has typically been associated with decreased VMT, it is important to note that ridesharing could lead to induced demand due to reduced travel times and costs. This should be considered in the net VMT impacts of any ridesharing policy.

Reduced Fuel Consumption – Ridesharing can be an effective strategy to reduce energy consumption (Noland, Cowart, & Fulton, 2006). For example, a study of ridesharing in the San Francisco Bay Area estimates an annual reduction between 450,000 and 900,000 gallons of gasoline. The majority of these savings are attributable to congestion reduction (Minett & Pearce, 2011).



Reduced Greenhouse Gas (GHG) Emissions – Studies have found that ridesharing can reduce GHG emissions by reducing fuel consumption. One study forecasts that individually carpoolers reduce personal commute GHG emissions by approximately four to five percent after joining an employer trip reduction program (Herzog, Bricka, Audette, & Rockwell, 2006).

Reduced Traffic-Related Emissions for Low-Income and Minority Households – Low-income and minority households commonly bear disproportionate exposure to vehicular emissions along congested roadways. Approximately four percent of Americans (11.3 million people) live within 500 feet of a major highway. Research indicates that certain populations (e.g., members of minority communities, foreign-born persons, and persons who speak a non-English language at home) are likely to be at a higher risk for exposure to traffic-related air pollution as a result of residential proximity to major highways. As such, ridesharing can serve as one primary prevention strategy to reduce traffic-related emissions to these communities.

Cost Savings for Public Agencies and Employers – By improving infrastructure capacity and person throughput, carpooling is a cost-effective strategy to mitigate congestion and reduce the need for additional roadway and public transit capacity. In Seattle, a Commute Trip Reduction Ordinance has contributed to an 11 percent reduction in single-occupant vehicle trips (City of Seattle, 2017). Another study found that casual carpooling has the potential to notably reduce energy consumption for 150 commuters equivalent to providing an express bus service for the same number of commuters but at a lower cost (Dorinson et al., 2009).

Reduced Need for Parking – By reducing the number of vehicle trips, public and private sector employees can reduce parking demand thereby saving capital costs of $15,000 to $45,000 per parking space (depending on design and land availability) and operational costs of approximately $360 to $2,000 annually per parking space (Shoup, 2011; Environmental Protection Agency, 2005).

Individual Benefits & Ridesharing Motivators

Ridesharing is a flexible commuting solution that yields a wide array of benefits and options for users.

- **Enhancing Accessibility and Economic Opportunity** – Long commutes and limited job access via public transportation can leave many jobs out of reach for carless households. Ridesharing may serve an important role in enhancing mobility in low-income, immigrant, and nonwhite communities where travelers are more likely to be unable to afford personal automobiles and obtain drivers' licenses (Liu & Painter, 2012).

- **Travel Time and Cost Savings** – Ridesharing can offer users cost and travel time savings through toll discounts, reduced wait times at toll plazas, and high occupancy vehicle (HOV) lane access.
- **Convenience** – Commuters who participate in ridesharing frequently have access to preferential parking and HOV lanes that contribute to ridesharing's convenience.

Policy Considerations for Ridesharing

A variety of stakeholders play crucial roles in supporting people who use ridesharing, ranging from specific programs at the employer and local government level to broader policy support at the state and federal levels of government. Local and regional support for people who use ridesharing can also include establishing travel demand management (TDM) or trip reduction ordinances.

These policies offer a complex combination of approaches to reduce single occupant vehicle trips, while also encouraging the inclusion of people who use ridesharing into residential, commercial, and mixed-use projects. Air quality districts that were failing to meet federal standards began implementing trip reduction and TDM policies in the 1980s, and they have continued to revise and implement new programs (see Table 5.1 below). Broadly, policy considerations for ridesharing typically include:

- Incentive Zoning,
- Public-Private Partnerships,
- Parking Policies,
- Road and Curb Pricing,
- Ridesharing Infrastructure and HOV Priority, and
- Tax Incentives.

Table 5.1 Examples of Transportation Demand Management Strategies in the U.S.

Jurisdiction	Key Policy Components	Application
Bellevue, WA	Earned incentives and lotteries	Commuters can earn coupons and enter drawings for additional rewards.
Indianapolis, IN	Minimum parking reductions for developers for the inclusion of carpooling and other infrastructure supportive of alternative modes	Developers can earn a 35% cumulative minimum parking reduction for the inclusion of TDM measures, such as carpooling parking.
Maricopa County, AZ	Mandated employer commute trip reduction program	Employers with 50 or more employees are required to implement trip reduction measures such as: ridematching, carpooling subsidies, and preferential parking for carpooling.
Pima County, AZ	Mandated employer commute trip reduction program	Employers with 100 or more employees are required to implement trip reduction measures such as: ridematching, carpooling subsidies, and preferential parking for carpooling.
Redmond, WA	Lotteries	Commuters taking alternative modes can enter a lottery for gift cards.
Seattle, WA	Mandated employer commute trip reduction program	Employers with 100 or more employees are required to implement trip reduction measures such as: ridematching, carpooling subsidies, and preferential parking for carpooling.
South Coast Air Quality Managemen t District (SCAQMD)	Average vehicle ridership (AVR)	Worksites with 250 or more employees must implement an annual commute trip reduction program that achieves an average vehicle ridership performance requirement of 1.3 to 1.75 depending on the geographic zone.
Sunnyvale, CA	Required transportation demand management (TDM) program for multifamily residential developments	TDM programs are required of all new developments of 10 or more residential units. Each development must achieve a certain number of points to receive approval. Points earned vary by TDM strategies including: site design options (proximity to public transit, development density, affordable housing) and ongoing TDM techniques (bike and pedestrian pathways, public transit pass programs, bike lockers) (City of Sunnyvale, 2016).

Source: (Shaheen, Cohen, & Bayen, 2018)

Seattle, WA Metro Area – Commute Trip Reduction Ordinance

Seattle's Municipal Code requires that employers implement at least two trip reduction programs, which can include ridematching services for employees, subsidies for carpool participation, and preferential parking and reduced parking fees for carpool and vanpool vehicles. The Seattle Department of Transportation (SDOT) estimates around 250 employers with over 187,758 daily commuters participate in the city's trip reduction program. SDOT estimates that the drive alone rate for the city has fallen from 39% in 2007/2008 to 34% in 2015/2016 (City of Seattle, 2017; Seattle Department of Transportation, 2017).

A number of other Washington municipalities have implemented trip reduction programs, including some paired with monetary incentives. The City of Redmond offers a monthly gift card lottery for people taking alternative modes at least four days per month. The City of Bellevue offers a benefits program where commuters can earn monthly coupons to local retailers and be entered into a monthly gift card drawing.

Statewide Trip Reduction Laws

Similar to local trip reduction ordinances, states can pass legislation or issue regulatory mandates requiring commute trip reduction benchmarks (see Table 5.2 below).

Table 5.2 Examples of Statewide Trip Reduction Laws in the U.S.

State	Requirements	Applications
Arizona	Major employers must provide employees with information on alternative commute options, participate in a mode choice and VMT survey, designate a transportation coordinator, and implement trip reduction measures such as: • providing ridematching and vanpooling services, • subsidizing carpooling and vanpooling, • allowing the usage of company vehicles for carpooling, and • offering preferential parking for carpooling among other applicable measures.	All major employers with 100 or more full-time employees (50 or more employees in select areas) working at or reporting to a single work site during any 24-hour period for at least three days per week during at least six months of the year
Massachusetts	Facilities must offer carpool matching using a designated coordinator or carpool-matching service and set aside preferential spaces for carpools.	Businesses that employ 250 or more daytime employees and educational institutions with 1,000 or more applicable commuters
Oregon	Employers must offer commute options to employees designed to reduce single occupant vehicle commute trips; incentives must have the potential to reduce commute trips by 10% from an established baseline.	Employers with 100 or more employees at a single worksite
Washington	Employers must develop their own trip reduction plans and submit them for approval.	All employers with 100 or more full-time employees at a single worksite with a scheduled start between 6 to 9AM on weekdays; employers located in urban growth areas or counties with populations exceeding 150,000

Source: (Shaheen et. al., 2018)

Incentive Zoning

In addition to mandating trip reduction, local and regional governments can integrate provisions within building codes to encourage carpooling. For example, the city of Indianapolis revised its zoning and subdivisions ordinance in 2016 to permit developers a cumulative reduction in required parking up to 35 percent for the inclusion of TDM measures. One of the measures that helped developers qualify for this parking reduction is the inclusion of carpool and vanpool parking spaces. Indianapolis allows developers to reduce off-street parking by four spaces for each carpooling parking spot developed, and the city also allows each carpool parking spot to count toward the minimum number of required spaces (City of Indianapolis, 2018) (Please see the Shared Mobility and Incentive Zoning Toolkit for more information).

Public-Private Partnerships

San Diego, CA - San Diego Association of Government's (SANDAG) iCommute Program

TDM is a key component of the San Diego 2050 Regional Transportation Plan (2050 RTP). SANDAG's TDM efforts are branded as iCommute (www.iCommuteSD.com) and are managed as part of the regional 511 transportation information program. iCommute provides a regional vanpool program, public transit support, bicycle encouragement programs, a Guaranteed Ride Home program, SchoolPool, and ridematching through private-sector technology partnerships. iCommute provides a comprehensive Commuter Benefit Program Starter Kit that outlines a simple, three-step process to help employers identify their commute needs, design a custom program, and roll it out to their employees. iCommute staff are available to work one-on-one with employers to survey employees, map employee commute routes, and develop custom TDM plans that makes business sense. SANDAG has provided free ridematching services with a variety of vendors continuously since the 1980s. From 2015 to 2018, iCommute provided a free ridematching service using RideAmigos at an annual cost of approximately $50,000 to SANDAG. SANDAG terminated its contract with RideAmigos (which provides more than just ridematching) because the system saw low and declining usage. Through SANDAG's in-person carpool outreach events, staff found that customers expect to have access to an on-demand app that they can download to find a carpool.

iCommute partnered with Uber and Lyft during the Rideshare Corporate Challenge 2016 to offer discounted and free pooled rides (UberPOOL and Lyft Line (now Lyft Shared rides) or pooled TNC rides, known as ridesplitting) to employees during designated time periods. The Guaranteed Ride Home program, a partnership between SANDAG and Uber, provides enrollees a free trip home up to three times per year in the event of emergency. Uber plans to subsidize this program up to $20,000 annually through 2022.

In 2017, SANDAG issued a request for a technology partner to provide on-demand carpooling through an app, leading to a partnership with Waze Carpool. SANDAG has received mostly positive feedback since the transition to Waze. Waze provided its own funding for carpool incentives ($2.00 per driver from February through April 2018), marketing, and promotion. This pilot program provided an incentive of 10 free trips over a 90-day period through the Waze Carpool app. New carpool drivers that participate are rewarded with a $50 gift card. In addition to their carpooling partnership, SANDAG is launching a vanpool pilot in partnership with Waze to help fill open vanpool seats using their application (Shaheen & Cohen, 2018).

Figure 5.2. A shared ride in a vehicle. Photo Courtesy of Unsplash/David Emrich

Parking

In most U.S. cities, parking is typically free. The oversupply of free parking can distort the transportation marketplace and modal choice. Employer parking policies can help employees shift preferences toward ridesharing such as:

- **100 percent commuter choice** involves employers providing all employees an equal tax-free transportation allowance equal to or less than what an employer charges for parking. If a commuter needs to drive alone to work, they use the 100 percent commuter choice allowance provided by the employer to pay for parking. Other employees might choose to move closer to work, walk, use public transit, cycle, carpool, or vanpool to work (Lew Pratsch, unpublished paper, 2017).
- **Parking Cash Out** is an employer-funded program where employees are offered a cash allowance equivalent to the parking subsidy that an employer would otherwise pay to provide the employee with a parking space. Parking cash-out programs can also be implemented through mandates by local or state governments. Parking cash outs make the true cost of parking more transparent to drivers and can encourage commuters that drive to work alone and park for free to use ridesharing.

Road and Curb Pricing

Road and curb pricing are also strategies that can encourage higher occupancy modes (Forscher & Shaheen, 2018). Road and curb pricing are direct charges that are levied for the use of roads and curb frontage such as: road tolls, distance or time-based fees, congestion charges, and fees. These charges are designed to discourage certain vehicles or behaviors, including higher polluting vehicles and lower occupancy vehicles, respectively. In the context of pooling, pricing can be applied to discourage single occupant vehicle travel. Refer to the Shared Mobility and Pricing Toolkit for more information.

San Francisco Bay Area Toll Authority

In the San Francisco Bay Area, the Bay Area Toll Authority is responsible for administering regional bridge tolls and provides discounts for carpools during commute times. Toll discounts for carpoolers vary from approximately 30 percent to 60 percent depending on the bridge and if electronic toll collection is used (Bay Area Toll Authority, 2019). The Toll Authority's toll pricing as of March 2019 is displayed in Table 5.3 below.

<table>
<tr><th colspan="6">Table 5.3 Bay Area Toll Authority Rates for Single-Occupant and Carpool Vehicles</th></tr>
<tr><th rowspan="2">Bridge</th><th colspan="2">Toll Rates During Commute Times</th><th>Carpool Requirement</th><th colspan="2">Commute Hours Monday to Friday</th></tr>
<tr><td>Regular</td><td>Carpool</td><td></td><td>Morning</td><td>Afternoon</td></tr>
<tr><td>Golden Gate
Regular Toll with FasTrak</td><td>$8.20
$7.35</td><td>$5.35</td><td rowspan="7">3 or more people, FasTrak required</td><td>5 to 9 am</td><td>4 to 6 pm</td></tr>
<tr><td>San Francisco Oakland Bay</td><td>$7.00</td><td rowspan="8">$3.00</td><td rowspan="8">5 to 10 am</td><td rowspan="8">3 to 7 pm</td></tr>
<tr><td>Antioch</td><td rowspan="7">$6.00</td></tr>
<tr><td>Benicia - Martinez</td></tr>
<tr><td>Carquinez</td></tr>
<tr><td>Richmond - San Rafael</td></tr>
<tr><td>Dumbarton</td><td rowspan="2">Two or more people, FasTrak required</td></tr>
<tr><td>San Mateo - Hayward</td></tr>
</table>

Source: (Bay Area Toll Authority, 2019)

Ridesharing Infrastructure and HOV Priority

A number of ridesharing infrastructure and priority policies can be implemented individually or collectively to provide priority to HOVs, such as carpools and vanpools. Ridesharing infrastructure typically includes:

- **HOV highway and arterial lanes** that provide carpools and vanpools a network of HOV lanes on highways and high-volume corridors and surface streets, and
- **Park-and-ride facilities** that provide parking for travelers to leave their vehicles and transfer to a carpool, vanpool, or public transportation for the remainder of

their journey.

HOV Lanes - The availability of HOV lanes is critical to supporting ridesharing. Studies indicate that HOV lanes can reduce vehicle trips by four percent to 30 percent. HOV lanes are most effective at reducing single occupant vehicle use on congested highways to large employment centers in large urban areas with high frequency bus service during peak periods, where public transit provides time savings of at least five to 10 minutes per trip (Turnbull, Levinson, Pratt, & Bhatt, 2006). Best practices for implementing effective HOV facilities include:

- A minimum threshold of approximately one million people in a metropolitan region;
- High levels of traffic congestion along a corridor;
- Access to an employment center with more than 100,000 workers;
- Supportive TDM programs and policies with ongoing marketing;
- Visible HOV or automated HOV enforcement; and
- Institutional, local, and regional support for ridesharing.

HOV lanes can be implemented by adding new road capacity designated for HOVs or converting an existing lane to HOV use. HOV lanes have a number of varying design and operational characteristics such as:

- Separation from regular traffic using signs, markings, painted buffers, or physical barriers; and
- Operational hours varying from peak hours only to 24 hours. Some facilities may use reversible lanes for areas with high levels of directional traffic.

Park-and-Ride Facilities – Park-and-ride facilities are parking lots, typically located in the suburbs or outskirts of metropolitan areas, that allow commuters to park their vehicles and participate in ridesharing or take public transit to their destination (Turnbull, Pratt, & Levinson, 2004). The average park-and-ride typically contains between 30 and 250 parking spaces, and some larger facilities can have more than 2,000 parking spaces. While research on the impacts of park-and-ride lots is limited, anecdotal evidence indicates that these facilities support ridesharing because they provide a safe and convenient meeting location for travelers to form a match. Additionally, these facilities can shift parking and congestion out of existing urban areas to lower density, less congested areas (Turnbull et al., 2004; Victoria Transport Policy Institute, 2014).

Other Ridesharing Infrastructure Policies - In addition to HOV lanes and park-and-ride facilities, a number of policies can encourage ridesharing through travel time savings. These policies include:

- Queue jumping where HOV lanes can by-pass ramp meters and enter immediately while SOV lanes must use the meters,
- Signal prioritization for HOV lanes on surface streets, and
- Preferential parking or parking discounts for ridesharing vehicles.

Each of these policies can help reduce travel times for HOVs. HOV priority effectiveness will typically depend on maintaining notable travel time savings over single occupant vehicle trips. As such, this policy should target corridors with congested general-purpose lanes where maximum travel time savings may be achieved (Victoria Transport Policy Institute 2014).

Tax Incentives and Commuter Tax Benefits

Tax incentives and commuter tax benefits provide a way for employers to provide parking, public transit, vanpool, and bicycle expenses on a tax-free basis. This can be done on a pre-tax basis, through employer subsidies, or both of these approaches (Section 132(f) U.S. Internal Revenue Code).

- With pre-tax public transit benefits, employees can elect to withhold funding from their paycheck. Those funds are used to purchase fares for public transit or vanpools. The employee is not taxed on the funding withheld, and the employer does not pay employment taxes on those funds.
- Through subsidies, employers can provide public transit or vanpool fares in addition to salary. With subsidies, the employee is not taxed on the value of these funds nor does the employer pay employment taxes on those funds.
- Employers can subsidize a portion of an employee's commute expenses, and the employee can withhold an additional amount based on need on a pre-tax basis (Internal Revenue Service, 2019).

Previously, employers could deduct the subsidy portion of a commuter's expenses that were paid for by the employer; however, this tax benefit was eliminated with the passage of the Tax Cuts and Jobs Act of 2017. While employers can still subsidize these expenses, they can no longer deduct the subsidized portion of their commuters' expenses. A number of states have implemented tax incentives and commuter tax benefits. See Table 5.4 below for examples.

Table 5.4 State Tax Incentive and Commuter Tax Benefits

State	Incentive Beneficiary	Incentive Amount
Maryland	Employer	50% of the eligible costs of providing commuter benefits to employees
Georgia	Employer	$25 for each employee using a federal qualified transportation fringe benefit at least 10 days per month
Washington	Employer and Property Managers	$60 per employee per a year, up to $100,000 per an employer/property manager annually

Source: (Shaheen et al., 2018)

Key Takeaways

- Ridesharing allows travelers to share a ride to a common destination and can include several forms of sharing a ride, such as casual carpooling, real-time carpooling, and vanpooling.
- Ridesharing provides a variety of social, environmental, and behavioral benefits that governments leverage through policies that encourage pooling.
- Users can benefit from ridesharing through increased convenience, enhanced accessibility, and cost savings.
- Local and regional governments can support ridesharing by implementing parking reforms, incentive zoning, pricing strategies, TDM ordinances, and infrastructure (e.g., HOV lanes and park-and-ride facilities).
- State governments can also support ridesharing through tax incentives and state transportation demand management laws.

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SHARED MICROMOBILITY

Shared micromobility – the shared use of a bicycle, scooter, or other low-speed mode – is an innovative transportation strategy that enables users to have short-term access on an as-needed basis. Micromobility includes various service models and transportation modes that meet the diverse needs of travelers, such as station-based bikesharing (a bicycle picked up from and returned to any station or kiosk) and dockless bikesharing and scooter sharing (a bicycle or scooter picked up and returned to any location) (Shaheen & Cohen, 2019). Micromobility can also include the sharing of e-bikes and other electric-powered modes such as: segways, electric skateboards, and electric unicycles. This toolkit begins with definitions of common shared micromobility modes and service models. Next, it presents a summary of the potential impacts of shared micromobility and policies for shared micromobility management including: rights-of-way and curb space management, data sharing, planning and expansion, and equity programs.

Bikesharing provides users with on-demand access to bicycles for one-way (point-to-point) or roundtrip travel. Bikesharing fleets consist of traditional bicycles and/or electric bicycles that are commonly deployed in a network within a metropolitan region, city, neighborhood, employment center, and/or university campus. Bikesharing typically includes one of three common service models.

- **Station-based bikesharing systems** where users access bicycles via unattended stations offering one-way station-based service (i.e., bicycles can be returned to any station).
- **Dockless bikesharing systems** where users may check out a bicycle and return it to any location within a predefined geographic region. Dockless bikesharing can include business-to-consumer or peer-to-peer systems enabled through third-party hardware and applications.
- **Hybrid bikesharing systems** where users can check out a bicycle from a station and end their trip either returning it to a station or a non-station

location or users can pick up any dockless bicycle and either return it to a station or any non-station location.

Scooter sharing provides individuals access to scooters by joining an organization that maintains a fleet of scooters at various locations. Scooter sharing models can include a variety of motorized and non-motorized scooter types. The operator typically provides gasoline or electric charge (in the case of motorized scooters), maintenance, and may include parking as part of the service. Users typically pay a fee each time they use a scooter. Like bikesharing, trips can be roundtrip or one-way (SAE International, 2018). Two common types of scooter sharing services include:

- **Standing Electric Scooter Sharing** using shared scooters with an electric motor. The scooter includes a handlebar, deck, and wheels. The scooter is propelled by an electric motor, and it is usually made of aluminum, titanium, and steel.
- **Moped-Style Scooter Sharing** using seated-design scooters that can be either electric or gas-powered. They generally have less stringent licensing requirements than motorcycles and are designed to travel on public roads.

Figure 6.1. Photograph of a Moped-Style Scooter. Photo Courtesy of Scoot

Service Models

Shared micromobility services are usually deployed through one of the following business models:

- **Business-to-Consumer (B2C) services** provide individuals with access to business-owned and operated micromobility services. Individuals pay for the service through memberships, subscriptions, short-term passes, user fees, or a combination of pricing models.
- **Peer-to-Peer (P2P) services** allow micromobility owners to rent their equipment to other individuals. A third-party enables the transactions by providing the hardware and applications needed to make sharing possible (e.g., a locking mechanism or online platform).

Figure 6.2. Photograph of a Lime bicycle. Photo Courtesy of Mike Licht

Growth of Dockless Micromobility around the U.S.

In recent years, bikesharing and scooter sharing has grown notably in the United States. Figure 6.3 and Figure 6.4 below show the number of dockless bikesharing bikes and standing electric scooters across major U.S. cities, as of Summer 2018.

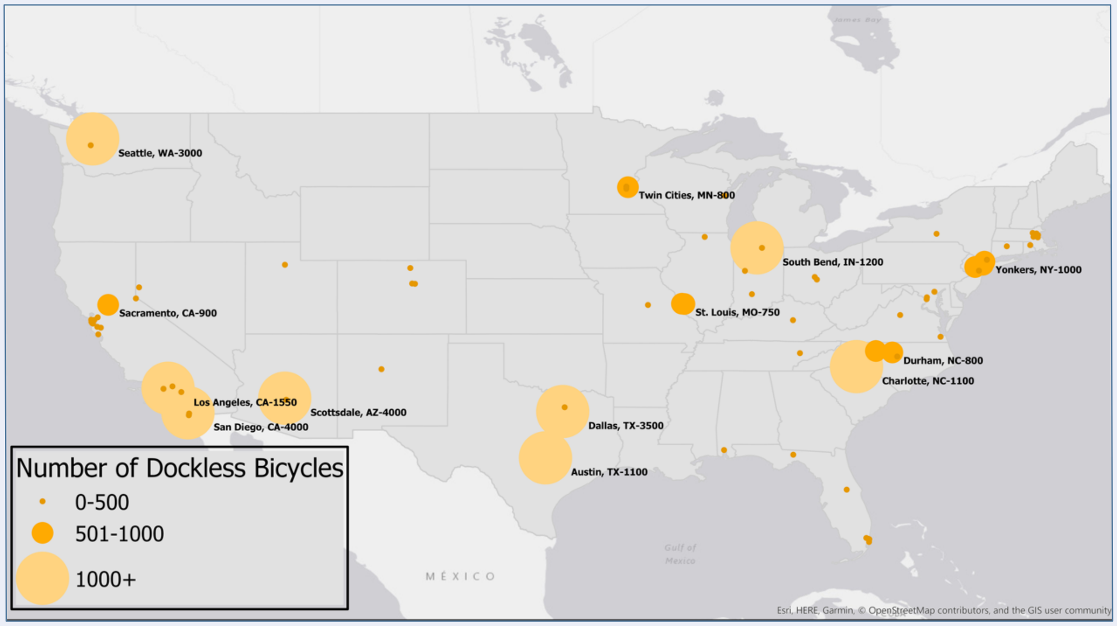
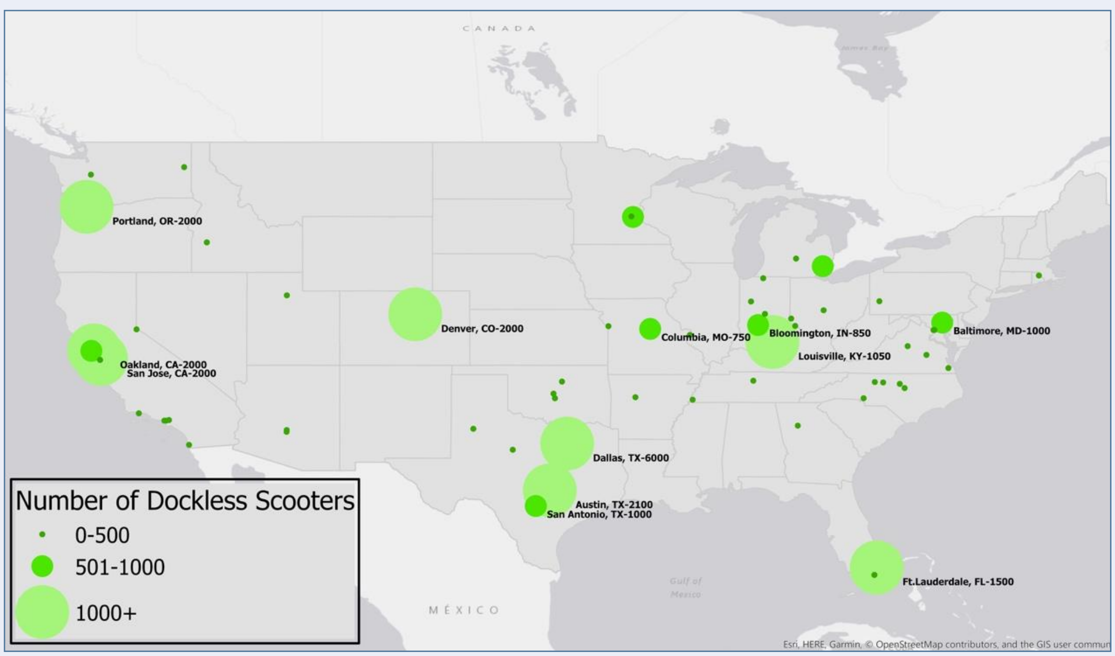


Figure 6.3. Map of Dockless Bikesharing in the U.S. Created by Mingyuan Yang



Impacts of Shared Micromobility

This section summarizes the impacts of shared micromobility (station-based and dockless) on modal use, the environment, health, and safety. Table 6.1 below provides a summary of impact studies.

Environment

The impacts of shared micromobility on the environment can vary based on a variety of factors. Several studies indicate that shared micromobility reduces greenhouse gas (GHG) emissions by replacing personal vehicle trips. However, total energy use for bicycle and scooter rebalancing may affect net environmental impacts of shared micromobility programs. Additional environmental considerations may include lifecycle impacts associated with recycling devices and batteries.

Mode Use

Mode replacement of shared micromobility systems appears to vary by service model, device, and location of the study. However, studies are limited for some forms of shared micromobility, such as dockless bikesharing. Table 6.1 below summarizes modal impacts due to station-based bikesharing, dockless bikesharing, and dockless scooter sharing

Health

Few studies in the U.S. have examined the health impacts of shared micromobility. A study of station-based bikesharing in Washington, D.C. and Minneapolis-St. Paul indicates an increase in physical activity. A four-month pilot program of standing electric scooter sharing in Portland found that scooter sharing attracted new people to active transportation. For example, 42% of scooter users had never bicycled before the pilot (Portland Bureau of Transportation, 2019).

Safety

Studies indicate that shared micromobility users often do not wear helmets. However, uncertainty exists if these modes are more dangerous than other modes of transportation. Recently electric standing scooters have gained publicity for an increase in scooter-related emergency room visits. More research needs to be conducted to better understand risky riding behavior, speeds, and riding locations that can contribute to injury for electric standing scooters.

Table 6.1 Summary of Shared Micromobility Impacts in the U.S.

Study Name *Location*	Authors, Year	Mode Use	Environment	Health	Safety
Station-Based Bikesharing					
Capital Bikeshare Member Survey Report *Washington, D.C.*	LDA Consulting, 2013	**After joining bikesharing:** · 54% of respondents started or ended a bikesharing trip at a Metrorail station in the last month · 50% drove a car less often · 60% used a taxi less often · 61% ride Metrorail less often and 52% ride a bus less often · 52% decreased walking*	**After joining bikesharing:** · ¼ of respondents reduced their driving miles · On average, driving was reduced by 198 miles per year		45% of respondents never wear a helmet
Bikeshare's impact on car use: Evidence from the United States, Great Britain, and Australia *Washington, D.C. and Minneapolis-St. Paul*	Fishman et al., 2014	**Washington, D.C.:** · 45% replaced public transit · 31% replaced walking · 7% replaced driving a vehicle · 6% replaced personal bicycle · 6% replaced taxi · 4% generated new trips **Minneapolis-St. Paul:** · 20% replaced public transit · 37% replaced walking · 19% replaced driving a vehicle · 8% replaced personal bicycle · 3% replaced taxi · 8% generated new trips**	**Estimated car travel reduction per bike of:** - 153 mi (247 KM) in Washington, D.C. - 83 mi (135 KM) in Minnesota		
Bikeshare's impact on active travel: Evidence from the United States, Great Britain, and Australia *Washington, D.C. and Minneapolis-St. Paul*	Fishman et al, 2015	**Bikesharing trips replaced sedentary modes by:** · 42% in Minneapolis-St. Paul. · 58% in Washington, D.C.***		**Bikesharing trips replaced sedentary modes by:** · 1.4 million minutes in Minneapolis-St. Paul · 13.8 million minutes in Washington, D.C.	
Prevalence of bicycle helmet use by users of public bikeshare programs. *Boston and Washington, D.C*	Fischer et al., 2012				Bikesharing users are four times less likely to wear a helmet than personal bicycle riders
Are bikeshare users different from regular cyclists? *Washington, D.C.*	Buck et al., 2013	**For annual members:** · 45% replaced public transit · 31% replaced walking · 7% replaced driving a vehicle · 6% replaced personal bicycle · 6% replaced taxi · 4% generated new trips **For short-term users:** · 53% replaced walking · 35% replaced public transit · 5% replaced taxi · 2% replaced personal bicycle · 2% generated new trips · 2% other · 1% replaced driving a vehicle			94% of short-term subscribers did not wear a helmet, compared to 63% of long-term subscribers

Table 6.1 Summary of Shared Micromobility Impacts in the U.S., Cont'd					
Study Name *Location*	Authors, Year	Mode Use	Environment	Health	Safety
Dockless Bikesharing					
Electric Bikesharing in San Francisco: An Evaluation of JUMP Electric Bikesharing during an Early Pilot Deployment *San Francisco, CA*	Shaheen et al., forthcoming	· 10% replaced driving a vehicle · 14% replaced transportation network company trip (TNC, e.g., Lyft, Uber) · 26% replaced public transit · 8% replaced walking · 24% replaced personal bicycle · 4% replaced a motorcycle or scooter · 1% replaced scooter sharing · 5% other+			
Dockless Scooter Sharing					
2018 E-Scooter Findings Report *Portland*	Portland Bureau of Transportation, 2019	· 37% replaced walking · 19% replaced driving a vehicle · 15% replaced a taxi or TNC · 5% replaced personal bicycle++	Estimated e-scooters prevented automobiles from emitting 122 metric tons of carbon dioxide during the four-month pilot, equivalent to removing nearly 27 average passenger vehicles from the road for a year.	E-scooter sharing attracted new people to active transportation. Before the scooter sharing pilot, 42% of users reported never bicycling.	Scooter-related emergency room visits increased from <1 a week to 10 a week during the pilot. · 83% did not involve another mode · 13.6% involved a motor vehicle · 3% involved a pedestrian · 90% of riders did not wear helmets. However, most electric scooter injuries were not serious enough to warrant emergency room visits.
Bikeposhare's impact on active travel: Evidence from the United States, Great Britain, and Australia *Washington, D.C. and Minneapolis-St. Paul*	Fishman et al, 2015				Of 249 studied patients with scooter-related injuries: · 31.7% had fractures · 40.2% had head injuries · 27.7% had soft-tissue injuries · 4.4% wore a helmet · 8.4% were non-rider pedestrians · 10.8% were younger than 18 The cause of injury: - 80.2% fell · 11% collided with an object · 8.8% were hit by a moving vehicle or object

* Respondents asked if they had changed their use of any five non-bicycle types of transportation.

** Thinking about your last journey on bikeshare, which mode of transport would you have taken had it not existed?

*** Respondents asked what alternative mode they would typically have used for that trip before bikesharing was introduced.

+ If JUMP were not available, how would you have made this trip instead?

++ Respondents thought about what mode they would have used for their last e-scooter trip, if the e-scooters had not been available.

Policy Considerations for Shared Micromobility

Micromobility has the potential to offer communities an array of individual and community benefits such as: increased mobility, greater environmental awareness, and increased use of active transportation and non-vehicular modes. With careful planning and policy implementation, it also has the potential to enhance accessibility and quality of life in cities. This section reviews the most common shared micromobility policies and practices with respect to: 1) rights-of-way and curbspace management, 2) data sharing, 3) planning and expansion, and 4) equity standards and programs.

Rights-of-Way and Curb Space Management

City curbs are becoming increasingly crowded as shared micromobility, carsharing, for-hire services (e.g., TNCs and taxis), and delivery services compete for parking space and pick-up and drop-off locations. Curb space management is a term used to describe a transportation design and policy approach that requires curb access to be planned, designed, operated, and maintained to enable safe, convenient, and multimodal access for all transportation users. The provision of curb space dedicated to shared micromobility is an important policy area confronting public agencies. Shared micromobility curb space management is typically allocated through a combination of formal and quasi-formal processes. Some cities establish formal policies that may be written, codified by local ordinances, or allocated through an application process, whereas others use quasi-formal processes including pilot programs and case-by-case approvals from administrative staff. Key elements of shared micromobility curb space policies often include: 1) fees, 2) device caps, 3) designated parking areas, 4) service areas and geofencing, and 5) equipment and operational requirements.

Fees

Many public agencies charge operators a variety of fees for allowing the placement of shared micromobility devices in the public rights-of-way. Fee structures can include:

- **Per device** – The operator pays the public agency for each device they have in operation in the jurisdiction.
- **Per month** – The operator pays the public agency for every month the operator provides service.

- **Daily per device/trip** – The operator pays the public agency for each device or trip made on a daily basis.
- **Annual fees** – The operator pays an annual fee for operating in the jurisdiction.

Public agencies can also waive fees (for parking, charging, or transferring services) to incentivize operators to bring service to a jurisdiction.

Device Caps

Device caps limit the number of bicycles, scooters, or other devices that can be deployed. Public agencies may limit the number devices in a category (e.g., dockless bikesharing, standing electric scooter sharing, etc.) or the number of devices per operator. Establishing device caps can be difficult for public agencies and operators because the number of devices needed to create an adequate network varies based on a number of factors such as the: service area, built environment, density, and frequency of use. Caps could also have unintended consequences of constraining demand or the size of the service areas (Zack, 2019).

Designated Parking Areas

A number of cities have created designated parking areas for shared micromobility. This can include: where to park a device on the curb, a requirement to lock or attach a device to bicycle rack or other piece of street furniture, or a condition to return a device to a designated station or corral (a painted or barricaded parking location for shared micromobility devices) (Shaheen & Cohen, 2019).

Seattle, WA - Curb Space Management and Dockless Bikesharing Parking Guidelines

The Seattle Department of Transportation (SDOT) has established curb space design and management guidelines intended to facilitate walking as a safe, attractive, and viable travel mode and allow pedestrians to access their destinations including: shared modes and micromobility, public transit stops, work places, recreation facilities, schools, and residences. Recognizing the need to manage the curb for a variety of users, SDOT has classified sidewalk frontage into three zones:

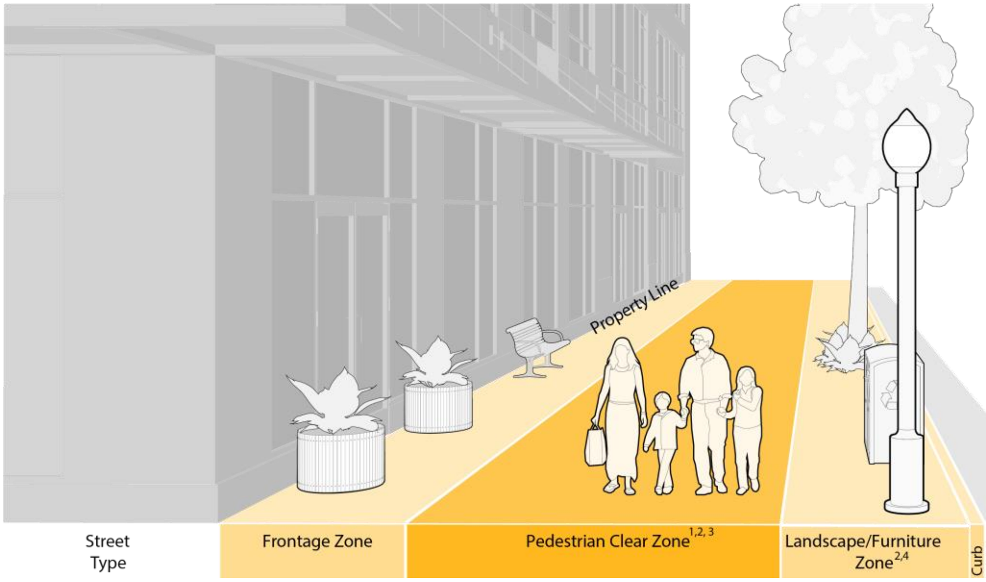


Figure 6.5. SDOT's classification of sidewalk frontage zones.

The **Frontage Zone** is the area between the property line and pedestrian clear zone. Depending on the size of the frontage zone, this area may be able to accommodate sidewalk cafes, store entrances, retail display, landscaping, public transit stop amenities, or other features that activate and enhance the pedestrian environment. Wider frontage zones provide more room for future tenants and residents to activate the public rights-of-way in a manner compatible with street trees and other required features between the frontage zone and curb. A minimum of two feet is recommended for the frontage zone to allow for sufficient distance from fixed objects.

The **Pedestrian Clear Zone** is the area of the sidewalk corridor that is specifically reserved for pedestrian travel. Street furniture, street trees, planters, and other vertical elements such as: poles, fire hydrants, and street furniture, as well as temporary signs and other items should not protrude into the pedestrian clear zone.

The **Landscape/Furniture Zone** (including the curb) is defined as the area between the roadway curb face and the front edge of the pedestrian clear zone. This zone buffers pedestrians from the adjacent roadway and is the appropriate location for street furniture, art, street trees, and vegetation. The landscape/furniture zone is also the preferred location for other elements such as: signage, pedestrian lighting, hydrants, and above and below grade utilities. In areas of public transit, this zone may be used for public transit shelters, stops, and platforms; boarding; lighting; trash cans, etc.

These zones form the foundation for Seattle's dockless bikesharing parking policy. Seattle's guidelines for dockless bikesharing parking instruct users to:

- Park a bicycle in any landscaping/furniture zone of the sidewalk that is more than three feet wide;
- Lock devices to a bicycle rack (as long as they do not block pedestrian access); or
- Park bicycles in designated parking zones (sometimes referred to as corrals, these are painted areas approximately the size of a vehicle parking space designated for micromobility parking). Additionally, SDOT instructs users to leave a clearance of at least six feet for pedestrians to pass and park equipment upright. SDOT does not allow operators/users to park equipment in a way that blocks corners, driveways, curb ramps, buildings, benches, parking pay stations, bus stops, or fire hydrants.

Santa Monica, CA - Shared Micromobility Corrals

Beginning in 2011, Santa Monica, California began planning bicycle corrals as part of the city's Bicycle Action Plan. In recent years, the concept has been expanded to include scooters, and the city has installed micromobility parking corrals to accommodate approximately eight to 14 bicycles or standing electric scooters. These corrals can be installed both on the curb or in the footprint of one automobile parking space. The corrals can also include a variety of markers and barriers to increase visibility and protect equipment (Linton, 2018).

Figure 6.7. Photo of a scooter corral in Santa Monica. Photo Courtesy of Rick Cole

Service Areas and Geofencing

Some public agencies have established access zones where operators can deploy devices. Access limitations can include permissible and prohibited operational areas, which may be enforced through virtual geographic boundaries (commonly referred to as a geofence) using GPS, RFID, or another technology.

Equipment and Operational Requirements

A number of cities have created designated parking areas for shared micromobility. This can include: 1) where to park a device on the curb, 2) a requirement to lock or attach a device to a bicycle rack or other piece of street furniture, or 3) a requirement to return a device to a designated station or corral (a painted or barricaded parking location for shared micromobility devices) (Shaheen & Cohen, 2019).

Data Sharing

Public agencies may require data sharing as a condition for shared micromobility providers to operate in a jurisdiction. Data sharing allows public agencies to understand micromobility impacts (and other transportation services); identify gaps in the transportation network; monitor equitable service standards; and offer multimodal, real-time transportation information through smartphone apps, websites, and other platforms. Two data standards have been adopted for shared micromobility.

General Bikeshare Feed Specification (GBFS)

Beginning in 2015, the North American Bike Share Association (NABSA) adopted an open data standard, known as the General Bike Share Feed Specification (GBFS). This makes real-time bikesharing operational data feeds publicly available in a standardized format. GBFS does not include historical usage data or other personally identifiable information (North American Bikeshare Association, 2019).

Mobility Data Specification (MDS)

MDS is a data and application programming interface (API) standard that allows a city to gather, analyze, and compare real-time and historical data from shared mobility service provider. An API enables the creation of a new application via access to data from another “app” or service. The specification also serves as a measurement tool that helps enable enforcement of local regulations. In addition, MDS allows service providers and public agencies to communicate with each other about their services because it consists of two APIs: a service provider API and a public agency API. MDS includes data such as: 1) mobility trips (and routes); 2) location and status of equipment (e.g., available, in-use, and out of service); and 3) service provider coverage areas (City of Los Angeles, 2019).

Shared Micromobility and Minors

A Southern California study found that 10% of patients admitted to the emergency room for scooter sharing were under the age of 18 (Trivedi et. al., 2019). The high number of injuries among minors indicates that more rigorous policies may be needed to enforce age restrictions. Most user agreements for shared micromobility services require a minimum age of 16 or 18 years to use devices, depending on the jurisdiction and type of device. However, minors may violate these restrictions without additional policies or penalties in place. Capital Bikeshare in Washington, D.C requires that minor users have an account sponsored by a parent or guardian (Motivate, 2016). Companies can also use the application to verify a user's age through their driver's license. In Los Angeles, scooter users are required to be at least 18 years of age and have a valid driver's license (Walker & Chandler, 2018). Requiring a driver's license to use scooters can be a popular public policy because it provides an enforcement mechanism for violations (users who do not follow the rules could have their licenses revoked). However, this policy can also prevent users without a driver's license from having access to shared micromobility. More public policies are needed that define permissible ages of operation and establish penalties for violations.

Planning and Expansion

The planning and expansion process are an important juncture for ensuring that shared micromobility services support transportation goals. As part of the permit process, public agencies can require that operators outline steps to achieve equity, sustainability, and safety goals. The planning process is also an important point to engage in community outreach and participatory planning. Before a service is deployed, planners can hold in-person meetings, workshops, and demonstrations to inform and engage residents. For station-based systems, planners can take advantage of technology such as public participation geographic systems (PPGIS), which allow residents to suggest sites where they would like docks to be placed. This type of technology encourages action-oriented, co-productive planning and produces useful data on mobility preferences. However, it should be noted that online-participatory tools exclude those without technological access or interest (Griffin & Jiao, 2019). On the following page are two case studies that illustrate unique strategies for micromobility planning.

Case Studies

San Francisco, CA

In April 2018, the San Francisco Municipal Transportation Agency (SFMTA) issued a competitive request for proposals (RFP) opportunity for standing electric scooter sharing providers to operate up to 1,250 scooters in the city. SFMTA's application process for permits invited proposals that prioritized the city's concerns around safety, equity, and accountability. Twelve applications were submitted and evaluated against seven key criteria, as seen in Figure 6.8 below (SFMTA, 2018). In August 2018, Skip and Scoot were selected as part of a year-long pilot and approved each for 625 scooter permits. As part of their agreement with SFMTA, the service providers agreed to provisions requiring them to serve low-income communities, share data, and implement user privacy protections. With the approval of SFMTA, operators have the option to double the number of scooters from 625 each to 1,250 after six months of operation. Both service providers are working with SFMTA to develop a locking mechanism to prevent scooters from blocking sidewalks (Said, 2018).

Scooter Share Pilot Program - SFMTA Application Assessments

AUGUST 30, 2018

Category	Standard	Bird	HOPR	JUMP	Lime	Lyft	Ofo	Razor	Ridecell	Scoot	Skip	Spin	Uscooter
Safety	Strategies to educate and train users should result in safe operations of scooters by riders.	F	F	P	P	P	P	P	F	S	F	F	F
Safety	Strategies to promote and distribute helmets should result in helmet use by riders.	P	S	P	P	P	P	P	P	S	F	P	P
Disabled Access	Strategies to ensure properly parked scooters, including any commitments to locking or tethering, should result in parking that does not block the right of way	F	S	P	F	F	F	F	P	F	S	S	F
Disabled Access	User penalties for poor compliance by users with laws governing scooter operation, including possibility of suspension by the applicant, should support appropriate operation and parking by users.	P	P	P	P	P	P	P	P	F	S	P	P
Equitable Access	Approach to providing service to low-income residents, including diverse payment options and fare discounts, should reduce barriers to participation.	P	P	S	P	S	F	P	P	P	S	F	P
Equitable Access	Service Area beyond the downtown core and commitment to rebalancing should ensure availability of scooters in underserved areas.	P	F	S	P	P	F	P	S	F	S	P	F
Community Outreach	Outreach approach should include strategies to ensure that low income residents are aware of service and how to participate.	P	P	S	F	F	P	P	P	S	F	S	P
Community Outreach	Approach to outreach should ensure that members of the public, including those that choose not to use scooter services, have the opportunity to be heard and to stay informed about program.	P	P	P	F	F	P	P	P	F	S	P	P
Labor	Should demonstrate understanding of operational needs and resource requirements to ensure service reliability.	P	P	S	S	S	S	P	S	S	S	S	F
Labor	Approach to hiring and training employees and/or contractors should ensure that staff have the knowledge and skills to ensure safe operational practices and knowledge of the communities in which they operate.	P	P	P	F	F	S	P	P	S	F	P	F
Sustainability	Approaches to operations and disposal should demonstrate commitment to environmental sustainability.	P	P	F	F	S	P	F	F	F	P	F	P
Experience & Qualifications	Applicant's experience in operating and maintaining shared mobility systems, in San Francisco and elsewhere as well as applicant's history, and the history of their users, in complying with city regulations should demonstrate their capacity to comply with the terms of the scooter share permit.	P	F	F	P	P	S	P	P	S	S	P	P

Rating Definitions

S — **STRONG** ratings were given to responses that included detailed, unique or innovative approaches demonstrating the highest level of commitment and ability to solving known challenges and concerns, and substantially exceeding the minimum requirements. The SFMTA evaluated these proposed approaches as highly likely to achieve the stated standard.

F — **FAIR** ratings were given to responses that included basic or typical, but unexceptional solutions, demonstrating a moderate level of commitment and ability to solving known challenges and concerns and meeting or somewhat exceeding the minimum requirements. The SFMTA evaluated these proposed approaches as moderately likely to achieve the stated standard.

P — **POOR** ratings were given to responses that at best met the bare minimum requirements established in the terms and conditions for holding a permit, and often lacked important details, demonstrating a low level of commitment and ability to solving known challenges and concerns. The SFMTA evaluated these proposed approaches as unlikely to achieve the stated standard.

SFMTA

Figure 6.8. SFMTA's RFP process rated 12 applicants across seven categories. Figure Courtesy of SFMTA

New York City, NY - Citi Bike

New York City is home to the largest operating bikesharing system in the U.S., Citi Bike, with around 12,000 docked bikes. The service was launched in May 2014. Citi Bike's planning and visioning process were extensive. As part of the planning process, the New York City Department of Transportation conducted 159 public meetings, presentations, and demonstrations between the Fall 2011 and Spring 2013. The outreach included two presentations in Spanish and one in Mandarin-Cantonese presentation. In addition to in-person outreach, the city conducted virtual outreach and received more than 10,000 station suggestions and 55,000 notices of support for proposed stations (Cohen & Shaheen, 2016). In August 2018, Citi Bike experimented with becoming a hybrid system by allowing dockless bicycles in a service area located in the Bronx; however, it received mixed results, and there are no current plans to pursue this service model (Fried, 2018).

Shared Micromobility Equity Standards and Programs

Shared micromobility can raise a number of potential equity concerns. Generally, many of these equity concerns can be summarized into five common areas of concern:

Un- and Under-Banked Households – Many micromobility services require debit/credit cards for payment and, in some cases, collateral (e.g., a debit or credit card hold) while the equipment is in- use. This can be a barrier for consumers who are under banked or unbanked. Providing alternative fare payment options (e.g., payment via prepaid cards and public transit fare cards) can help overcome this challenge. For example, Washington D.C. requires dockless bikesharing and scooter sharing programs to offer a cash payment option.

Low-Income Affordability - Pay-as-you-go (e.g., per-minute) pricing can be expensive and sometimes costlier than walking, private cycling, and public transportation. Discounted and subsidized programs for eligible low-income households can help overcome affordability challenges.

Digital Poverty – Shared micromobility may require a smartphone and high-speed data packages to access services. This can be a barrier to low-income and rural households who may not be able to afford or may lack data coverage. Alternatives such as digital kiosks, telephone/text services, and non-tech access (e.g., coin-deposit access) can help overcome these challenges. For example, Washington D.C. requires dockless bikesharing and scooter sharing programs to offer equipment that can be accessed without a smartphone.

Neighborhood Service Availability – The lack of service availability in a particular neighborhood can be an equity concern. Including minority and low-income neighborhoods in service areas and actively rebalancing equipment to ensure service availability can help overcome service availability concerns. For example, as part of its standing electric scooter sharing pilot program, Portland required a minimum of 100 scooters or 20 percent of an operator's fleet (whichever is less) to serve the city's disadvantaged east neighborhoods.

Figure 6.9 - Seattle transit at night. Photo Courtesy of Seattle DOT

Access for People with Disabilities – Shared micromobility can affect people with disabilities in a few different ways. The availability of adaptive devices—such as tricycles, hand pedaled cycles, recumbent cycles, and others—have the opportunity to enhance access for individuals with disabilities who otherwise rely on cars or paratransit for most of their transportation needs (Transportation 4 America, 2019). Public agencies may be able to expand access for people with disabilities by requiring a percentage of a fleet includes adaptive devices and establishing incentives for the addition of adaptive devices into shared micromobility fleets. For example, in Seattle, SDOT is using permit fees to partner with operators to increase the availability of adaptive bicycles. Additionally, operators that deploy adaptive bicycles as part of their fleets could be eligible for up to an additional 1,000 micromobility device permits. In

Figure 6.10. Scooters block sidewalk access. Photo by Emily Shryock

addition to increasing accessibility through adaptive devices, the placement of micromobility equipment in the public rights-of-way can present notable challenges for people with disabilities when bicycles or scooters block curb or ramp access. Prudent curb space management policies (e.g., designated parking areas, lock-to requirements) coupled with education, outreach, and proactive enforcement is key to protecting Americans with Disabilities Act (ADA) access.

Key Takeaways

- Shared micromobility is the shared use of a bicycle, scooter, or other low-speed mode. Shared micromobility includes various service models and modes including:
    - **Bikesharing** provides individuals access to traditional or electric bicycles for one-way or roundtrip travel. Bikesharing systems can be station-based (bikes are returned to stations), dockless (bikes can be returned to any location), or hybrid (combination station-based and dockless).
    - **Scooter sharing** provides individuals access to a fleet of scooters. Trips can be roundtrip or one-way. Two common types of scooter sharing include standing electric scooter sharing and moped-style scooter sharing.
- Existing studies indicate a net reduction in GHG emissions due to modal shift from personal vehicle trips to shared micromobility. Impacts on modal shift may vary based on the type of service (i.e., station-based or dockless systems) and mode. Research indicates that shared micromobility may increase active travel minutes, but users often do not wear helmets. More research is needed on impacts.
- Shared micromobility services require allocation of rights-of-way and curb space. To help manage these spaces, public agencies can consider: 1) placing fee structures on services that park devices in the rights-of-way; 2) caps on the number of devices; 3) establishing designated parking areas; 4) establishing permissible zones for operation; and 5) operational requirements, such as locking systems or designated corrals.
- Public agencies may consider requiring shared micromobility operators to share data as a condition for operating in a jurisdiction. These data can assist in planning and regulatory decisions.
- During the planning process, public agencies can outline important equity, sustainability, and safety goals for shared micromobility operators to incorporate in planning. Community outreach and participatory planning can help support these goals.

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TRANSPORTATION NETWORK COMPANIES (TNCs)

Transportation Network Companies (TNCs, also known as ridesourcing and ridehailing) provide prearranged and on-demand transportation services for compensation, connecting drivers of personal vehicles with passengers. Smartphone applications are used for booking, ratings (for both drivers and passengers), and electronic payment. These services are also referred to as ridesourcing or ridehailing. TNCs can provide pooled services, sometimes referred to as ridesplitting, and private services. In a pooled service, a TNC ride serves separate parties with similar routes. In a private service, a TNC ride serves only one party. TNCs differ from taxicab services in that taxis are permitted to pick up street hails, whereas TNCs are not permitted to pick up street hails in most jurisdictions (SAE International, 2018).

Figure 7.1. TNC rider is picked up by a driver. Photo Courtesy of Lyft

The TNC market is composed of a number of firms who provide on-demand services. Some of the largest TNCs operating in the U.S. market are listed in Table 7.1 below.

Table 7.1 Examples of TNCs in the U.S.

TNC	Highlights
Uber	• Operates in over 600 cities in 65 countries worldwide • Provides both pooled and private services • Variety of vehicle classes available
Lyft	• Operates in over 300 cities in the U.S. and Canada • Provides both pooled and private services • Variety of vehicle classes available
Via	• Operates in three U.S. cities and three European cities as a TNC • Provides pooled and private services • Core emphasis is on pooled services • Variety of vehicle classes available • In addition to its TNC service, Via partners with local public transit agencies or governments to offer on-demand microtransit services.

Services provided by TNCs vary in terms of the number of drivers available on the platform, geographic span, prices charged to customers, and available services. In addition to providing traditional for-hire services that connect customers requesting rides to drivers of cars, some TNC companies also provide services such as: bikesharing, scooter sharing, and courier network services/flexible goods delivery on their platforms. This toolkit focuses on for-hire passenger services offered by TNCs. For descriptions of shared micromobility and last-mile goods delivery services provided by TNCs, please refer to the Shared Micromobility Toolkit and the Last-Mile Delivery Policy Toolkit.

Figure 7.2. TNC user books a ride through an app. Photo Courtesy of Via

Impacts of Transportation Network Companies

As TNCs have gained popularity in recent years; policymakers, advocates, and researchers have sought to understand how these services change travel behavior and affect the environment. This section of the toolkit reviews TNC impacts on mode substitution, public transportation, and auto ownership and use.

Mode Substitution

A number of studies that assess the impact of TNC services on modal shift have found that passengers are either: 1) substituting a trip they formerly made with another transportation mode (public transit, driving, walking, biking, etc.) or 2) making a new trip they otherwise would not have made without the availability of TNC services (i.e., induced demand). There are conflicting conclusions regarding the extent to which TNCs compete with public transit. While some studies conclude that TNCs are largely not substituting public transit trips (Feigon and Murphy, 2016; Hampshire, Simek, Fabusuyi, Di, & Chen, 2017; Feigon and Murphy, 2018), several others suggest that a significant portion of travelers substitute TNCs for public transit, biking, and walking (Rayle, Dai, Chan, Cervero, & Shaheen, 2016; Henao, 2017; Clewlow and Mishra, 2017; Gehrke, Felix, Reardon, 2018; NYCDOT, 2018). Past surveys show that the degree to which TNCs substitute for other travel modes varies by city and the built environment. Denser cities like New York City, Boston, and San Francisco exhibited some of the highest proportions of passengers who would have used public transit for their last TNC trip, had TNCs been unavailable.

It is important to note that aggregated cross-city studies may obscure city-specific differences in TNC impacts. Also, studies frame questions aimed at parsing modal shift differently. Some ask in a more general manner what transportation mode travelers might have taken instead of a TNC, while others may ask what mode travelers would have used for their last TNC trip. Depending on how this question is presented, responses may be less representative. Additionally, one study (Alemi, Circella, Handy, & Mokhtarian, 2017) allowed respondents to select for more than one mode for how they would have completed their last trip if TNCs were not available. This method allows the percentages of the modes to add up to more than 100%, which makes it challenging to compare results across the studies. The results of existing studies on modal shift are shown in the table on the following page, along with the survey question asked in each study.

Table 7.2 TNC Mode Substitution Impacts								
Study Authors/ Location/Survey Year of Study	**Rayle et al.* San Francisco 2014**	**Henao* Denver and Boulder, CO 2016**	**Gehrke et al.* Boston 2017**	**Clewlow and Mishra† 7 U.S. Cities†† Two Phases, 2014–16**	**Feigon and Murphy‡ 7 U.S. Cities†† 2016**	**Hampshire et al.** Austin, TX 2016**	**Alemi et al. ‡‡ California 2015**	**NYCDOT ‡‡ New York City 2017**
Drive (%)	7	33	18	39	34	45	66	12
Public Transit (%)	30	22	42	15	15	3	22	50
Taxi (%)	36	10	23	1	8	2	49	43
Bike or Walk (%)	9	12	12	23	18	2	20	15
Would Not Have Made Trip (%)	8	12	5	22	1	-	8	3
Carsharing/Car Rental (%)	-	4	-	-	24	4	-	-
Other/ Other TNC (%)	10	7	-	-	-	42 (another TNC) 2 (other)	6 (van/ shuttle)	-

* Survey question: "How would you have made ***your last trip***, if TNC services were not available?"

† Survey question: "If TNC services were unavailable, ***which transportation alternatives would you use for the trips*** that you make using TNC services?"

‡ Survey crosstab and question, for respondents that use TNCs more often than any other shared mode: "How would you make ***your most frequent (TNC) trip*** if the TNC was not available?"

** Survey question: "How do you currently make trips like the last one you took with Uber or Lyft, now that these companies no longer operate in Austin?"

†† The impacts in these studies were aggregated across Austin, Boston, Chicago, Los Angeles, San Francisco, Seattle, and Washington, D.C.

‡‡ These studies allowed multiple responses to the question: "How would you have made your most recent TNC trip (if at all) if these services had not been available?" Therefore, the percentages add up to more than 100 percent, making it challenging to directly compare to the other studies

Public Transportation

Study findings on TNC impacts on public transportation ridership vary, possibly due to local differences in transit service, urban density, and the built environment. A few studies have investigated the effect that TNCs have on aggregate public transit ridership in U.S. metropolitan areas. Hall, Palsson, & Price (2018) examined the impact of Uber's entry on public transit ridership between 2004 and 2015 across the 196 U.S. Metropolitan Statistical Areas (or MSAs) where Uber was operating. This study found that Uber is a complement for the average public transit agency, increasing ridership by five percent after two years. A similar study by Feigon and Murphy (2018) examined TNCs and public transit ridership trends in Chicago, Washington, D.C., Los Angeles, Nashville, Seattle, and San Francisco from 2010 to 2016. The authors concluded there was no relationship between the peak-hour TNC trip share and changes in public transit ridership in these cities.

In contrast, Graehler, Mucci, & Erhardt (2019) found that the entry and presence of TNCs cumulatively decreased heavy-rail ridership by 1.29 percent per year and bus ridership by 1.70 percent per year in a study examining data from 2002 to 2018. Gehrke et al. (2018) found that passengers with lower incomes and those who possess a weekly or monthly public transit pass were more likely to have substituted TNC services for public transit. In addition, relatively low TNC service costs, low TNC trip times, poor weather, and unavailability of public transit were also predictive of public transit substitution. Additional research is needed to assess TNC impacts on public transportation ridership, and it is important to account for both aggregate trends and individual modal choices when assessing TNC impacts on public transit.

Automobile Ownership

Research on TNC impacts on personal vehicle ownership (this includes the decision to either sell or forgo purchasing a personal vehicle) is limited. Clewlow and Mishra (2017) found that nine percent of respondents sold one or more household vehicles due to TNCs. Henao (2018) found that approximately 13 percent of respondents reported owning fewer cars due to TNC availability in Denver and Boulder, Colorado. Another study of rail transit users found that five percent of respondents in Atlanta, 12 percent in the San Francisco Bay Area, and 21 percent in Washington, D.C. either postponed a purchase, decided not to purchase, or sold a personal vehicle due to TNCs (Feigon and Murphy, 2018).

Hampshire et al. (2017) asked respondents about the effect of the mid-2016 Lyft and

Uber service suspension in Austin on their personal vehicle acquisitions. This study is unique because the Austin service suspension offered an opportunity to measure vehicle suppression using revealed preference survey data. It found that nine percent of respondents acquired a personal vehicle due to the Austin suspension, and another nine percent considered purchasing one but ultimately did not. Although Lyft and Uber were not operating in Austin from mid-2016 to mid-2017, other smaller TNC services continued to operate in their place. An even larger portion of respondents may have acquired a personal vehicle, if all TNC services had exited the region.

Impacts on Vehicle Miles Traveled (VMT)

A few studies have assessed TNC impacts on VMT and trip making decisions. The most comprehensive studies have employed trip-level TNC activity data in San Francisco (SFCTAb, 2017; SFCTA, 2018) and New York City (Schaller, 2017a; 2017b) to analyze mileage, trip metrics, and impacts. Schaller (2017a) conducted an analysis with publicly available taxi and for-hire vehicle trip and mileage data in New York City. This study found, after accounting for mileage declines in yellow cabs and personal vehicles, TNCs and other on-demand ride services (including Uber, Lyft, Via, Gett, and Juno) contributed 600 million additional miles of vehicle travel to the city's roads between 2013 and 2016. These additional miles equated to an estimated 3.5 percent increase in citywide VMT and a 7 percent increase in VMT in Manhattan, western Queens, and western Brooklyn in 2016. Another study conducted by Schaller (2017b) found that usage rates among taxis and TNC vehicles declined in New York City between 2013 and 2017, while the number of unoccupied taxi and TNC vehicles increased by 81 percent over this time period. Schaller (2017b) also found that total taxi and TNC weekday mileage in the central business district (or CBD) increased by 36 percent from 2013 to 2017.

The San Francisco Country Transportation (SFCTA) has conducted two studies of TNC impacts on the City of San Francisco. SFCTA collected TNC trip data from one month in late-2016 and found that TNC trips made up 15 percent of average weekday vehicle trips within San Francisco and nine percent of average weekday person trips within the city. In terms of mileage, this study found that TNCs represented 20 percent of the average weekday intra-San Francisco VMT (trips that originate and end within city limits only) and 6.5 percent of total VMT (including regional trips starting or ending within city limits) on an average weekday. SFCTA also found that around 20 percent of all TNC miles were deadheading miles.

The findings of these three studies are summarized in Table 7.3 below. However, these studies do have a few limitations. Schaller's two studies are largely based on TNC activity data (SCFTA used data scraped from an Uber API) without passenger surveys. Additionally, the three studies do not assess the impact of pooled TNC services.

Table 7.3 Key VMT and Trip Metrics from TNC Studies in San Francisco and New York City		
City *Study Author* Data Time Period	**Key Trip Metrics**	**Key Mileage Metrics**
San Francisco, CA *SFCTA* 1 month, late-2016	*TNC trips comprise…* - **15% of vehicle trips** (intra-SF, avg. weekday) - **9% of person trips** (intra-SF, avg. weekday)	*TNC mileage comprises...* - **20% of intra-SF VMT** (avg. weekday) - **6.5% of total VMT** (avg. weekday) - **10% of total VMT** (avg. Saturday)
New York City, NY *Schaller Consulting* Full year, 2016	*TNC trips comprise…* - **80 million vehicle trips** (in 2016) - **133 million person trips** (in 2016)	*TNC mileage comprises…* - **7% of total VMT** (in 2016) TNC mileage equates to an *estimated increase of…* - **3.5% citywide VMT** (in 2016) - **7% VMT** in Manhattan, western Queens and western Brooklyn (in 2016)
New York City, NY *Schaller Consulting* June 2013 and June 2017	*TNC/taxi trips increased by…* - **15% between June 2017 and June 2013** (Manhattan CBD, avg. weekday) - **133 million person trips** (in 2016)	*TNC/taxi mileage increased by…* - **36% between June 2017 and June 2013** (Manhattan CBD, avg. weekday)

Transportation Network Company Policy Considerations

In recent years, TNC growth has increasingly become a policy and regulatory issue. Key policy considerations for local governments include:

1) Placing taxes, caps, and fees on TNCs to limit and track their operations;
2) Ensuring minimum level of service and passenger and driver safety;
3) Managing curb space to minimize congestion and facilitate passenger pick-ups and

drop offs;

4) Enabling public-private partnerships to support existing public transportation networks;
5) Supporting access to TNCs for all populations; and
6) Preparing for a shared, automated, electric vehicle future.

Vehicle Caps, Registration, Fees, and Taxation

Local and state jurisdictions can enact TNC vehicle caps, registration fees, and taxes as a method for managing congestion and raising revenue (see Table 7.4 on the following page for examples of TNC service charges).

1) **Taxation:** A number of states and local governments are implementing TNC taxes to reduce TNC demand, mitigate congestion, and increase revenue for a variety of purposes. As of July 2018, municipalities in 12 states have implemented a TNC tax (Kim & Puentes, 2018).
2) **Vehicle caps:** Some public agencies have proposed or implemented caps on the number of TNC vehicles that can provide service in a jurisdiction. A cap is intended to limit the number of vehicles that can provide rides to mitigate potential concerns about congestion and encourage public transit use. Limiting the number of TNC vehicles could have unintended implications of increasing wait times and fares.
3) **Registration fees:** In some areas, TNCs are required to register with a regulatory agency (e.g., public utilities commissions, departments of insurance, parking authorities) to legally operate.

Table 7.4 Examples of TNC Service Charges around the United States		
Jurisdiction	**Policy Info**	**Description**
California	Registration Fee	- TNCs must file for a TNC Permit with the California Public Utilities Commission (CPUC). The permit costs $1,000 and is valid for three years. - A $100 annual fee is due thereafter to maintain registration. - The CPUC has not disclosed the amount of funds raised or where they will be used.
Chicago, IL	Taxation	- $0.67 per trip tax enacted in January 2018. - Funds are allocated between the city general fund, city business regulation department, rail maintenance, and the city's fund for improving accessibility for people with disabilities.
New York City, NY	Vehicle Cap	- In August 2018, the city enacted a one-year cap on the number of TNC vehicles allowed to operate. The regulation has since been extended indefinitely. - In August 2019, the city capped the number of vehicles that can cruise while empty in Manhattan at 31%.

Sources: CPUC (2016), Kim & Puentes (2018), and Reichert (2019)

Safety

Public agencies have implemented policies to protect consumer safety. A few safety issues that can be addressed through policy include (see Table 7.5 below for examples):

Driver standards and background checks: TNCs typically conduct internal screening procedures and some public agencies may have supplemental screening requirements, such as fingerprinting (Cohen & Shaheen, 2016). Public agencies and TNCs can partner to develop standards that ensure appropriate driver standards and vetting.

1) **TNC use by minors:** The use of TNCs by minors could raise a number of safety concerns. Potential policies could include: 1) ensuring minimum age requirements to use TNCs are followed, 2) requiring an adult chaperon, 3) dispatching specially trained and approved minor drivers, and 4) implementing background checks and policies that prohibit sex offenders from driving TNCs.

2) **Insurance:** TNC insurance is typically regulated at the state level. Regulators have typically required insurance coverage for the three periods of TNC use:

1) Phase 1: TNC driver is using the app and is available to accept passengers.
2) Phase 2: TNC driver has accepted a request from a passenger and is in route to pick up a passenger.
3) Phase 3: Starts when the passenger enters the vehicle and ends when the passenger fully exits the vehicle.

The American Property Casualty Insurance Association (2018) tracks state-level TNC insurance legislation. As of June 2018, 49 states and the District of Columbia have enacted legislation that require some type of primary insurance, generally during the time that the application is on and the driver is available. As of 2018, Oregon was the only state where draft legislation failed to advance.

3) **Vehicle inspections:** Public agencies can require TNC vehicles to undergo inspections additional to state vehicle inspections. Regulations in Massachusetts require TNC drivers to obtain a TNC vehicle inspection annually, which includes an evaluation of the brakes, suspension system, and an interior safety check (massDOT, 2019).

Table 7.5 Examples of Municipal TNC Safety Policies Implemented in the U.S.

Jurisdiction	Policy Info
New York City	- Vehicles used for TNC services must be inspected for safety every four months. - Drivers are required to take a defensive driving course. - TNC drivers are not allowed to drive more than 10 hours in a 24-hour period. - TNC drivers are required to undergo annual drug testing.
Boston	- TNC companies are required to conduct a multi-state criminal history check for drivers every six months.

Source: SFCTA (2017a)

Curb Space Management

Public agencies have identified the need for safe TNC loading zones that ensure TNC vehicles do not interfere with other modes. Some cities have implemented policies that designate TNC loading zones. These policies may also prohibit pick-ups or drop-offs at particular locations. Table 7.6 below includes selected curb space management TNC pilot projects.

Table 7.6 TNC Curb Space Management Pilot Projects in the U.S.	
Jurisdiction	**Policy Info**
Arlington County, VA	- The county established three TNC loading zones that are operational between 9PM and 3AM.[*]
Boston, MA	- Established six areas for TNC loading[**] - Customers near a pick-up zone requesting a ride are notified to walk to the designated location for pickup.[**] - Additional zones may be added pending program impacts.[**]
Fort Lauderdale	- Implemented three TNC unloading/loading zones[+] - Part of a six-month demonstration project[+] - TNC zones operational during designated hours during the week[+]
Washington D.C.	- The District Department of Transportation operates five loading zones for TNCs.[++] - Loading zones are operational 24 hours a day, seven days a week.[++]

Sources: County (2018)[*], Vaccaro (2019)[**], Las Olas (2018)[+], Cirruzzo & Goncalves (2018)[++]

Partnerships with Public Transit

TNCs have the potential to provide fill public transit gaps and/or public transportation replacement services, depending on the local context and public agency needs. Four examples of common partnership types include:

1) **First-Mile, Last-Mile Connections:** Many cities have begun to explore partnerships with TNCs to improve access to public transportation.
2) **Integration with Transit Apps:** Public agencies can partner with TNCs to integrate trip planning, fare payment, and booking into a single interface or smartphone app.
3) **Low-Density and Off-Peak Services:** Public agencies can partner with TNCs to offer gap-filling services for late-night transportation and low-density built environments. These partnerships typically offer discounts or subsidies for shared mobility services within a designated zone or time of day. These partnerships target times and locations that cannot support high-frequency public transit services.
4) **Paratransit:** Public agencies can partner with TNCs to offer on-demand ride services for passengers with disabilities. These partnerships often subsidize trips and provide same-day booking on wheelchair-accessible or Americans with Disabilities Act-compliant vehicles.

See Table 7.7 below for examples of TNC public-private partnerships.

Table 7.7 Examples of Public-Private TNC Partnerships with Public Transportation in the U.S.

Jurisdiction	Type of Partnership	Policy Info
Boise, ID	First-Mile/Last-Mile Partnership	- Valley Regional Transit subsidizes up to $6 of Lyft rides less than two miles in length to bus stops. - 18-month pilot program that commenced in late January 2019.[*]
Dallas, TX	Low-Density and Off- Peak Services	- Uber is partnering with Dallas Area Rapid Transit to provide pooled rides to customers within six zones of the agency's service area.[**]
Pinellas County, FL	Paratransit	- Pinellas Suncoast Transit Authority (PSTA) partnered with Uber, Lyft, United Taxi, and Wheelchair Transport to provide on-demand rides to and from selected locations. - The program runs seven days a week from 6:00 a.m. to 11:00 p.m. and offers $25 toward Wheelchair Transport rides.[***]
St. Louis, MO	Transit App Integration	- Metro Transit partners with Transit app to provide integrated booking services for public transit and TNC rides.[+]
Washington, D.C.	Low-Density and Off-Peak Services	- DC Metro has initiated requests for proposals for a TNC partner to provide late-night service during maintenance service periods. - Metro may subsidize up to $3 per trip between 11:30 p.m. and 1:00 a.m.++

Sources: Talerico, (2017)[*], Repko (2019)[**], Pinellas Suncoast Transit Authority (2019)[***], Descant (2019)[+], Siddiqui (2019)[++]

Accessibility for Disadvantaged Communities

TNC services can enhance access to transportation for a variety of users, such as carless households. However, barriers including a lack of wheelchair accessible vehicles, the requirement to use a smartphone, or the need to have a credit or debit card for payment can raise equity concerns. Potential policies to expand TNC service access include:

Table 7.8 Examples of TNC Equity Policies in the U.S.		
Jurisdiction	**Issue Addressed**	**Policy Info**
Puget Sound, WA; Los Angeles, CA	**Un- and Under-Banked Households:** Many TNC services require debit/credit cards for payment that can be a barrier for travelers who are unbanked.	As part of a pilot program with King County Metro and LA Metro, Via allows customers who do not have access to credit or debit cards to pay with pre-paid gift cards.*
Columbia, OH	**Low-Income Affordability:** TNCs and surge pricing can be expensive (and in some cases more expensive than other modes).	Columbia's public transit agency partners with TNCs to provide discounted rides to help low-income households travel to grocery stores.**
Puget Sound, WA; Los Angeles, CA	**Digital Poverty:** TNCs typically require a smartphone to access services that can be a barrier to low-income and rural house- holds.	As part of a pilot program with King County Metro and LA Metro, Via operates a telephone dispatch service that allows customers to register for accounts and book and pay for Via rides.*
New York City, NY	**Access for People with Disabilities:** Providing equivalent on-demand transportation services and/or removing barriers to TNC services for people with visual, auditory, cognitive, mobility, and other disabilities is critical.	All TNC drivers are required to complete wheelchair passenger assistance training before becoming a TNC driver. TNCs are required to provide equivalent fares and dispatch times for customers with disabilities.***

Sources: Cordahi et al. (2018), Trainor (2019)**, SFCTA (2017a)****

Preparing for Automation and Electrification

A number of service providers have expressed interest in developing automated and electric fleets that would remove human drivers. Several TNCs are piloting and continuing research on automation. As the industry prepares for shared automated vehicles (SAVs), public agencies may need to prepare for vehicle automation impacts.

1) **Electric Vehicle Infrastructure:** The transition to SAVs presents an opportunity to also transition TNC fleets to zero emission vehicles (ZEVs). California SB1014 (Clean Miles Standard) directs state agencies to enact stricter emission targets for TNCs to promote ZEVs by 2021. Expanding charging infrastructure for taxis and TNCs is one way in which public agencies can support the electrification of for-

hire vehicle services (Anair, 2018). For additional information on TNC electrification, refer to the Shared Mobility and Electrification Toolkit.

2) **Curb Space Management:** Public agencies will need to develop policies on how to manage curb space for SAVs and minimize modal conflicts (e.g., pricing, geofencing, and access management).

Key Takeaways

- TNC impacts are uncertain. Studies indicate that TNC impacts vary by built environment, density, and other local factors,such as the existing transportation network. Results from cross-city studies may obscure city-specific impacts.
- Public agencies can partner with TNC operators to fill service gaps and provide first- and last- mile connections to public transit.
- To manage congestion and raise revenue, public agencies can consider enacting TNC vehicle caps, registration fees, and taxes. Public agencies should also consider enacting policies to ensure passenger and driver safety including: supplemental screening requirements, minimum rider age requirements, additional insurance coverage, and additional vehicle inspection requirements.
- TNC loading zones can help ensure passenger safety and mitigate congestion between modes at the curb.
- Vehicle automation and electrification present new challenges for managing TNCs. Public agencies can support pilot programs and research to help prepare for automated and electric fleets.

RECOMMENDED READING

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SHARED AUTOMATED VEHICLES (SAVs)

The convergence of shared mobility, vehicle automation, and electric-drive technology has the potential to transform the way people travel and access goods and mobility. By automating driving tasks, shared, automated, electric-mobility services could become much more cost-effective, efficient, and convenient than human-driven, privately owned vehicles. In addition to leveraging opportunities for passenger mobility, automated vehicles (AVs) offer opportunities for unmanned on-demand delivery options. Automated deliveries (vehicles and drones) could support the e-commerce trend of reducing the size of brick and mortar storefronts, while simultaneously increasing the need for warehouses and urban logistics hubs to facilitate last-mile goods storage, dispatch, and on-demand delivery.

AV technologies will likely have a disruptive impact on traveler and consumer behavior (Cohen & Shaheen, 2016). As driverless vehicles become mainstream, policy makers will need to rethink traditional notions of access and auto mobility. This toolkit is designed to help policy makers understand the potential impacts and use cases of vehicle automation. This toolkit first defines SAE's five levels of automation and describes possible AV vehicle types and business models. Next, the toolkit presents potential use cases for shared automated vehicles (SAVs) and case studies of existing SAV services. To help policy makers understand the potential implications of vehicle automation, the toolkit also includes an analysis of the strengths, weaknesses, opportunities, and threats of AVs. It concludes with an overview of proposed policies to mitigate the impacts of vehicle automation on four key areas: the environment

Figure 8.1. Example of a delivery vehicle from Nuro. Photo Courtesy of Nuro (2018)

and land use, labor and the economy, social equity, and travel behavior.

Levels of Automation

SAE International, a global mobility standards organization, has established five levels of vehicle automation (see Figure 8.2 below). Level 1 describes vehicles that automate only one primary control function (e.g., self-parking or adaptive cruise control). Level 2 describes a vehicle with automated systems that have full control of specific vehicle functions such as: accelerating, braking, and steering. With Level 2, the driver must still monitor driving and be prepared to immediately resume control at any time. Level 3 allows the driver to engage in non-driving tasks for a limited time. With Level 3, the vehicle will handle situations requiring an immediate response; however, the driver must still be prepared to intervene within a limited amount of time when prompted to do so. With Level 4, a human operator does not need to control the vehicle as long as the vehicle is operating in the specific conditions in which it was intended to function. Level 5 describes vehicles capable of driving in all environments without human control.

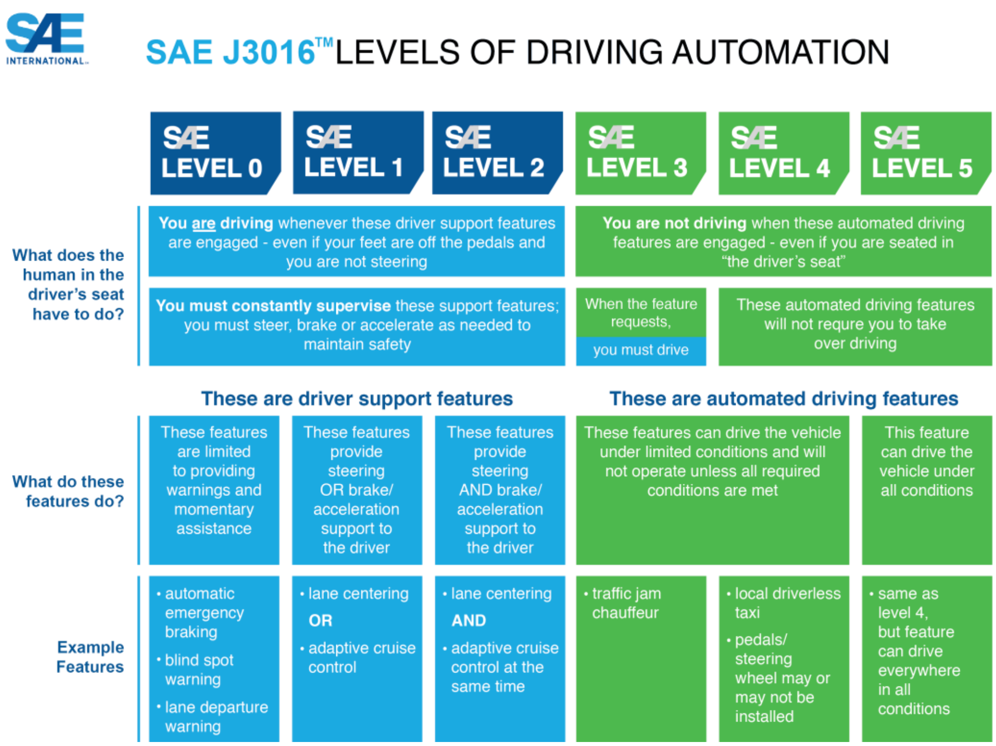

Figure 8.2. SAE's Five Levels of Automation. Illustration by SAE International

Automated Vehicle Types/Capacities and Business Models

The future of AVs – and how policy makers will regulate them – will depend on ownership, business models, and vehicle type/capacity. Automated technology could be applied to a variety of vehicles that range in the number of passengers they hold. The possible vehicle type/capacities include (Stocker & Shaheen, 2017):

- **Large vehicles** (20+ passengers) may provide high occupancy transit, such as shuttles and public transportation. Larger vehicles could operate on a fixed route similar to a bus or train but with potentially lower operational costs.
- **Mid-sized vehicles** (7 to 20 passengers) consist of smaller shuttles and vans that could be either privately or publicly operated. Mid-sized AVs could provide fixed route or demand-responsive service.
- **Small vehicles** (3 to 7 passengers) could be privately owned or operated by businesses similar to taxis and transportation network companies (TNCs, also known as ridesourcing or ridehailing).
- **Micro vehicles** (1, 2 or no passengers) could provide passenger mobility or last-mile delivery for short trips.

Additionally, AVs may be deployed in a variety of ownership and business models, similar to how shared mobility services and micromobility are provided today. Possible ownership and business models include:

- **Business-to-Consumer (B2C)** – A company owns or leases a fleet of SAVs that are accessible to riders via a membership or per-use fee.
- **Peer-to-Peer (P2P)** – A company provides the resources to facilitate the short-term use of a vehicle between a host (the owner) and a guest (the lessee).
- **Private Ownership** – An owner buys or leases an AV for personal use, similar to private vehicle ownership.
- **Publicly Owned and/or Operated** – A public agency owns and operates AVs similar to public transportation. This could include both large vehicles (e.g., buses) and smaller vehicles (e.g., shuttles and SAVs).

Potential Use Cases

SAVs have the potential to reduce vehicle ownership and provide innovative opportunities to lower cost and offer flexible public transportation systems. Potential SAV use cases include:

- **Closed Campus -** SAVs could provide short distance, point-to-point travel in closed campus environments that can be easily mapped by software. These locations include: theme parks, resorts, malls, business parks, college campuses, airport terminals, construction sites, downtown centers, real estate developments, gated communities, industrial centers, and others.
- **First-Mile/Last-Mile Connectivity -** Traditionally, public transit has been limited by fixed routes and fixed schedules. Due to these limitations, travelers may find it difficult to complete the first or last mile of their journey using public transit. SAVs may be able to help bridge first- and last-mile gaps in the public transportation network.
- **Low-Density Service -** SAVs have the potential to provide lower cost and more frequent or responsive public transit solutions in rural, exurban, and low-density suburban areas where low ridership and high labor costs often contribute to inefficient or cost prohibitive fixed route service.
- **Off-Peak/Late Night Service -** Similarly, SAVs may be able to complement public transit by providing service during off-peak times, especially late at night when service is challenging and costly to provide.
- **Paratransit -** Paratransit services could be provided by SAVs to meet the needs of people with disabilities; nevertheless, human assistance may still be required.
- **Urban Goods Delivery -** AVs and robots could also provide opportunities for last-mile delivery solutions (Last-Mile Delivery Policy Toolkit).

Table 8.1 below displays three potential AV scenarios with vehicle types/capacity, business models, and potential use cases.

Table 8.1 Potential AV Ownership, Occupancy, and Business Model Scenarios			
Automated Vehicle Scenarios	**Vehicle Types/Capacity**	**Business Models**	**Potential Use Cases**
Private vehicle ownership evolves into private AV ownership that could also support a combination of private use and for-hire services (similar to TNCs).	Micro Vehicles (1, 2, or 0 passengers), Small Vehicles (3 to 7 Passengers)	Private Ownership	Closed Campus, First-Mile/Last-Mile Connectivity, Low Density Service, Urban Goods Delivery
SAVs provide the majority of mobility services, operating similar to for-hire taxi and TNC services today.	Micro Vehicles (1, 2, or 0 passengers), Small Vehicles (3 to 7 Passengers), Mid-sized Vehicles (7 to 20 Passengers)	B2C, P2P, Publicly Owned and/or Operated	Closed Campus, First-Mile/Last - Mile Connectivity, Low Density Service, Off-Peak/Late Night Service, Paratransit, Urban Goods Delivery
High Occupancy Transit is provided by public and private sector entities for a combination of fixed-route and demand-responsive services.	Mid-sized Vehicles (7 to 20 Passengers), Large Vehicles (20+ Passengers)	B2C, Publicly Owned and/or Operated	Closed Campus, First-Mile/Last-Mile Connectivity, Paratransit

Public-Private Partnerships

Public-private partnerships can support early AV deployments and enable the testing of emerging technologies in the public rights-of-way. Two examples of public-private partnerships testing AV technology are included below:

DriveOhio and Smart Columbus

In 2016, the City of Columbus, Ohio won the Smart City Challenge, earning a $40 million grant from the U.S. Department of Transportation (USDOT) that funds the Smart Columbus Program. As part of this program, Columbus is operating an automated shuttle along a 1.5-mile route downtown. This pilot is made possible by DriveOhio, an initiative by the Ohio Department of Transportation to advance smart mobility technologies throughout the state (DriveOhio, 2019; Henry, 2018).

Waymo in Phoenix, AZ

Waymo has partnered with Lyft to place 10 self-driving minivans on its app in a handful of towns in the Phoenix metropolitan area. The partnership launched in June 2019. Each vehicle is operated with a safety driver behind the wheel. Waymo also operates two other services in the Phoenix area: Waymo One and Waymo One Early Rider. Waymo One is a commercial on-demand AV service that has carried over 1,000 riders to school, work, or shopping. The Waymo One Early Rider program is a confidential research program within Waymo One that requires riders to sign nondisclosure agreements (NDAs) before experiencing some of the company's latest updates. Waymo One is only available to former Early Rider participants, but they are not subject to an NDA (Hawkins, 2019; KTAR.COM, 2019).

Figure 8.3. Example of a Waymo AV. Photo Courtesy of Waymo Presskit

Strengths, Weaknesses, Opportunities, Threats (SWOT) Analysis

The SWOT analysis outlined in Table 8.2 and 8.3 below reviews potential strengths, weaknesses, opportunities, and threats associated with vehicle automation.

Table 8.2 SWOT AV Analysis - Strengths and Weaknesses

	Strengths	Weaknesses
Travel Behavior	Riders can perform other activities during travel. The use of SAVs may result in fewer personally owned vehicles.	AVs may be difficult for society to accept and may shift users away from higher-occupancy modes (e.g., public transportation). For SAVs, wait times may be unpredictable due to changes in supply and demand, as well as fleet rebalancing.
Environment and Land Use	SAVs could reduce parking demand. Vehicle rightsizing and platooning may also increase roadway capacity. Together, these potential impacts could open up space for infill development (e.g., housing). Automated driving systems may be able to provide data about traffic safety, curb space, and travel behavior for transportation planning.	Users may take longer trips or additional trips if they can perform other activities during travel. This could result in the growth of suburbs and exurbs. Additionally, vehicle automation may require new infrastructure or changes to existing infrastructure.
Labor and Economy	Automation may increase the efficiency of public transportation systems. If used as part of a P2P system, personally owned AVs can provide another source of income for vehicle owners.	AVs may disrupt existing transportation revenue, such as parking meters or traffic violations. Public transit operators may be reluctant to adopt AVs due to labor concerns and union contract issues. The public sector may have limited resources to invest in emerging technologies or lack workforce development to enable new technologies and processes.
Social Equity	AVs may improve accessibility and mobility for older adults and people with disabilities, and bridge gaps in the transportation network (e.g., underserved areas, first-and-last-mile connections).	AVs may be expensive to own and use. SAVs may also require smartphones and/or bank accounts to access mobility services. SAVs may not be accessible to all neighborhoods or all users (e.g., people with disabilities).
Safety	Driving may become safer and less stressful.	If vehicles are shared with strangers in absence of a driver, passengers may desire safety measures (e.g., separated compartments or an attendant).

Table 8.3 SWOT AV Analysis - Opportunities and Threats		
	Opportunities	**Threats**
Travel Behavior	SAVs may increase multimodality, connecting and integrating with other modes, such as shared micromobility and public transportation. Public-private partnerships may also enable a variety of demand-responsive services. Productive or recreational activities can be combined with travel time.	If costs are low enough, vehicle or fleet owners may send empty vehicles on errands or have vehicles drive around to avoid paying for parking or rent (e.g., a person living or operating a business in a roaming AV).
Environment and Land Use	SAVs could reduce GHG emissions and overall energy use. They also have the potential to enable increased density and infill development due to reduced demand for parking.	AVs could result in urban sprawl as commutes become more productive and less frequent (e.g., telecommuting). This could lead to an increase in per capita VMT and GHG emissions (depending on how the vehicles are powered).
Labor and Economy	Economic activity may increase due to increased mobility and accessibility. New jobs could be created, such as attendants, security personnel, and a high-tech workforce needed to maintain automated and electric fleets.	There could be notable job losses in industries dependent on human drivers.
Social Equity	AVs can integrate voice-activated app features for visually or physically impaired individuals. They may offer older adult, child-focused, and American with Disabilities Act services. Application programming interfaces (APIs) could minimize or eliminate sociodemographic profiling.	Personally owned AVs and SAVs (depending on the cost and access required, such as a smartphone or credit card) may exclude disadvantaged users.
Safety	Automation may increase vehicle safety by reducing or eliminating the potential for human error while driving.	A mix of automated and traditional vehicles could create unsafe traffic conditions.

Data Sharing and Automated Vehicles

Data sharing between the public and private sectors could be important to successful SAV deployments. Private operators may have important data on safety, curb space management, interactions with public transportation, and other operational characteristics important for transportation planning and management. Public agencies should work with the private sector to develop policies and standards to enable data sharing, while protecting user privacy and proprietary information. Third-party data platforms that aggregate and anonymize sensitive data could serve as an intermediary between public and private entities to facilitate secure sharing. For example, the California Department of Motor Vehicles (DMV) has a permitting process that requires AV companies to register vehicles and share data on traffic collisions and disengagements (when a vehicle can no longer be operated without human intervention) (California DMV, 2019).

Potential Impacts and Policy Responses

Automation will likely result in fundamental changes by altering the built environment and land-use costs, commute patterns, and modal choice. Public agencies can pursue a variety of policies to prevent and mitigate the potential impacts of vehicle automation. Impacts that public agencies may have to address include:

- **Environment and Land Use Impacts –** Reduced vehicle ownership due to SAVs could result in more compact urban centers and shorter commutes. However, the growth of telecommuting and AVs also make longer commutes more practical, which could shift consumer preferences in favor of suburban and exurban living.
- **Labor and Economic Impacts –** The impacts of vehicle automation on labor and the economy are uncertain. Automation reduces the costs associated with passenger transportation and creates new job opportunities associated with research and development, vehicular maintenance, and transportation security, supporting economic growth. However, vehicle automation could result in job losses in transportation operations and logistics.
- **Social Equity Impacts –** The impacts of vehicle automation on equity and access are uncertain. Vehicle automation could reduce transportation costs for low-income households and create new opportunities for healthcare and job access.

However, if vehicle automation lacks services for people with disabilities or requires credit card or a smartphone to use services, some travelers may not be able to access mobility services.

- **Travel Behavior Impacts –** The impacts of vehicle automation on travel behavior are uncertain. Vehicle automation could result in either more or less congestion, depending on how vehicles are used (e.g., deadheading without passengers, single passenger use, or pooled use).

Table 8.4 provides a brief overview of potential policies for a driverless vehicle future and the types of impacts these policies could address.

Table 8.4 Policies for AVs

Policy	Description	Travel	Environmental and Land Use	Labor and Economy	Social
Comprehensive Equity Policy	Public agencies may consider developing a comprehensive equity policy that addresses access to driverless vehicle services for people with disabilities, low-income and underbanked communities, and people without access to a smartphone or high-speed data. Complying with an equity policy could be a precondition for vehicle registration, permitting, or access to the public rights-of-way.	x		x	x
Curb Space Optimization	AVs could provide data that support dynamic curb space management and related policies, such as curb space pricing.		x		
Expand EV Adoption	Public agencies may consider requiring zero-emission AVs and fund electric vehicle infrastructure to reduce the environmental impacts of vehicle automation.		x		
Infill Development and Parking Replacement	Vehicle automation could result in a reduction in parking demand. Zoning and development policies (e.g., reducing minimum parking requirements, streamlining permits for mixed-use developments, etc.) that allow for the conversion of parking to other uses could support infill development and affordable housing.		x		
Low Income Programs	Requiring low-income programs, such as subsidies and cash payment options, could reduce costs and enhance mobility access for low-income households.			x	x
Multi-Modal AV Planning and Policies	Policies that integrate with public transportation (e.g., mobility hubs and integrated fare payment) and encourage first- and last-mile connections could help ensure a complementary relationship between SAVs and public transportation.	x	x		x
Pricing	Pricing policies may help prevent and mitigate induced demand associated with and encourage higher occupancies and travel at off-peak times.	x	x		
Urban Growth Boundary	Land-use policies, such as urban growth boundaries and open space preservation, could help prevent suburban and exurban sprawl and encourage in-fill development within existing urban areas.		x		
Occupancy Requirements, Pricing, and Pooling Policies	In an automated future, minimum occupancy requirements, road pricing, and policies that encourage pooling could be important to prevent or mitigate potential increases in vehicle miles traveled.	x	x		
Workforce Development Programs	Local and state agencies could implement workforce development programs that include job training and placement services for former drivers and other workers adversely impacted by vehicle automation.			x	x

Key Takeaways

- Shared, electric, and AVs have the potential to provide more efficient, cost-effective, and convenient passenger mobility. Vehicle automation also offers opportunities for unmanned, on-demand delivery options.
- SAE International has established five levels of vehicle automation. In Levels 1 and 2, the driver must monitor driving and be prepared to immediately resume control at any time. With Level 3, the driver must be prepared to intervene within a limited amount of time when prompted to do so. Level 4 vehicles do not need a human operator to control the vehicle as long as the vehicle is operating in required conditions. Level 5 vehicles can drive in all environments without human control.
- SAVs may be deployed in a variety of use cases. The type and capacity of vehicle can vary from no passengers (for delivery vehicles) to 20+ passengers (for high occupancy transit). SAVs may be privately or publicly owned.
- The future impacts of AVs are unknown and will depend on future usage scenarios. Public agencies can mitigate potential harmful impacts through comprehensive policies that address equitable access to AVs, help cities plan for and manage AVs, and train the workforce to prepare for an automated future.

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LAST-MILE DELIVERY

In recent years, last-mile delivery services have grown rapidly due to technology advancements, changing consumer patterns, and a growing consumer recognition that goods delivery can serve as substitutes for person trips. Together these trends have transformed the retail sector from “just in time inventory,” where retailers order inventory and stock shelves on an as-needed basis to “just in time delivery,” with goods delivered direct to consumers on-demand. This toolkit provides an overview of recent innovations in last-mile delivery, followed by case studies and policy examples for: 1) lockers, 2) drone delivery services, 3) delivery robots, and 4) automated delivery vehicles.

Seven innovations in goods delivery that are impacting last-mile delivery (Shaheen & Cohen, 2018) are:

- **Advanced Algorithms** that optimize supply and delivery chains by identifying the least expensive or most efficient delivery route for merchants and logistics companies.
- **Subscription Delivery Services** that allow consumers access to on-demand, all-you-deliver consumption through typically low-cost flat-rate delivery subscription services (e.g., Amazon Prime and Shop Runner).
- **Courier Network Services (CNS)** are apps or online platforms that provide for-hire delivery services for monetary compensation. These apps match couriers– who use a personal vehicle, bicycle, or scooter for deliveries-with customers of the ordered goods (e.g., packages, food) (SAE International, 2018; Shaheen, Cohen, Yelchuru, & Sarkhili, 2017; Cohen & Shaheen, 2016).
- **Locker Delivery** allows consumers to order and ship items to a self-service locker at home, work, or an alternative pick-up location. Locker delivery can help consumers, merchants, and delivery providers overco
- me a variety of challenges, such as weekend and off-peak deliveries and enhanced security (i.e., in place of leaving a package at the door).

- **Delivery Drones** are unmanned aerial vehicles (UAVs) used to transport packages, food, or other goods.
- **Delivery Robots** offer short-range unmanned ground-based delivery of packages, food, or other goods using small machines.
- **Automated Delivery Vehicles** use driverless vehicles to deliver packages to consumers and businesses.

Delivery Lockers

Although locker delivery is not new, an increasing number of services are offering lockers for package delivery. Locker delivery has the potential to enhance customer convenience and package security for delivery. Additionally, delivery lockers can be paired with other automated delivery systems, such as delivery robots, vehicles, and drones to offer a seamless automated delivery chain. Examples of delivery locker services include the following.

Amazon

Figure 9.1. An Amazon locker. Photo courtesy of Flickr CC/Jeff Samsonow

As of 2018, there are over 2,800 lockers across over 70 major metropolitan areas in the United States. Typically placed at mobility hubs and commercial centers, Amazon lockers can receive packages up to 19” x 12” x 14” (Holsenbeck, 2018). Amazon provides two related services: 1) Amazon Key offers direct-to-consumer delivery, allowing couriers to remotely unlock vehicles, homes, and garages to provide in-home and in-vehicle delivery and 2) Hub, a locker delivery service designed for multifamily buildings that can be used by a variety of delivery vendors (Amazon, 2019a).

Three large libraries in West Sussex, United Kingdom have established a formal contract with Amazon to provide delivery lockers. The lockers are used by between 80 and 100 people at each library per week by both library patrons and non-library users (Department for Digital, Culture, Media & Sport, 2016). The libraries receive approximately £100 per month per row of lockers. As such, locker delivery services can serve as a revenue opportunity for public facilities and mobility hubs. Facility managers may consider developing real estate agreements to set out mutually agreed upon expectations.

Luxer One

Luxer One offers a variety of self-service locker delivery products targeted for multi-family developments intended to reduce the cost and responsibilities of delivery management for property managers. Products offered include technologies that provide residents one-time codes to access deliveries in a package room and a secure refrigerator that can accept perishable deliveries (Luxer One, 2019).

Drone Delivery Services

Delivery drones have the potential to complement delivery vehicles by offering low-cost, short-range, direct point-to-point delivery. Examples of companies providing drone delivery include:

- **Amazon Prime Air -** Planned service that delivers packages up to five pounds in 30 minutes or less using small automated drones. The Federal Aviation Administration (FAA) issued approval for the program in June 2019 (Amazon, 2019b; Hu, 2019).

Figure 9.2. Amazon Prime Air Drone. Photo courtesy of Amazon.

- **UPS-WakeMed Program -** UPS and Matternet are partnered to deliver medical samples via automated drones at WakeMed's hospital and campus in Raleigh, North Carolina. The drones carry up to five pounds on a predetermined flight path. This project is part of the FAA's Unmanned Aircraft System (UAS) Integration Pilot Program (IPP); see the highlighted text box on the next page for further details (UPS, 2019).
- **Uber Elevate Food Delivery -** As another IPP project, Uber Elevate and the city of San Diego plan to conduct small UAS operations for food package delivery (Nero, 2019).

The 1958 Federal Aviation Act delegated the safe and efficient use of the airspace to the FAA, requiring it to create and enforce federal regulations (under Title 14 of the Code of Federal Regulations). As such, the FAA has exclusive authority over the national airspace. With respect to UAS, the FAA issued its first rule governing commercial drone operations in 2016 (Serrao, Nilsson, & Kimmel, 2018). The National Aeronautics and Space Association (NASA) is conducting research on the development of Unmanned Aircraft System Traffic Management (or UTM). UTM could provide services such as: airspace design, corridors, dynamic geofencing, severe weather avoidance, congestion management, sequencing and spacing, and contingency management (NASA, 2019).

The Unmanned Aircraft System (UAS) Integration Pilot Program

In 2018, the FAA launched its Unmanned Aircraft System (UAS) Integration Pilot Program to develop new UAS rules that support low-altitude regulations. The program aims to:

- Identify ways to balance local and national interests related to the integration of drones into national airspace;
- Improve communications between local, state, and tribal governments;
- Address UAS security and privacy risks; and
- Accelerate the approval of UAS operations that currently require special authorization.

The City of San Diego was selected as one of nine participants for the pilot program. The city's proposal focused on border protection and package delivery of food, with a secondary focus on international commerce, automated vehicle (AV) interoperability, and surveillance (FAA, 2018). Local projects will include flying medical specimens from UC San Diego for quicker results and cost savings, testing food delivery with Uber Elevate, assisting first responders in emergency situations, and researching the integration of drones with AV technology. The city's Homeland Security Department was the lead applicant, with more than 20 private and public regional partners signing on to support the submission (Office of Mayor Kevin L. Faulconer, 2018).

Delivery Robots

A number of companies are pursuing last-mile delivery using small robots. Starship robots are devices that can carry items within a four-mile (6km) radius. Once a customer requests an order, the robots' entire journey and location can be monitored on a smartphone. The robots operate at pedestrian speed and weigh less than 100 pounds. For security, the cargo bay is mechanically locked throughout the journey and can be opened only by the recipient with their smartphone app. Delivery companies, such as FedEx and Amazon, are also developing their own delivery robots (Scott, 2019; Shaban, 2019).

Figure 9.3. A photo of Amazon's Scout Delivery Robot. Photo Courtesy of Amazon blog.

A number of cities and states are developing policies to regulate delivery robots. The policies from San Francisco and Florida are summarized below:

San Francisco Enactment 244-17

In December 2017, San Francisco passed an ordinance requiring permits to test "conveyance robots" on sidewalks. The ordinance is overseen by San Francisco Public Works and the San Francisco Police Department. Delivery robots are also required to (San Francisco Public Works, 2019):

- Travel at speeds limited to three miles per hour (mph),
- Emit a warning noise while operational,
- Have a human operator within 30 feet of the delivery robot to monitor operation,
- Test only on sidewalks in designated locations,
- Never transmit hazardous materials, and
- Be stored on private property when inactive.

Florida's House Bill 1027 - Personal Delivery Devices

In 2017, Florida enacted a statewide measure regulating unmanned devices and authorizing operations of personal delivery devices on sidewalks and crosswalks. Florida CS/HB 1027 establishes the following requirements (Yarborough, 2017):

- Personal delivery devices may not exceed 80 lbs. (excluding cargo) and 10 MPH while operating.
- Personal delivery devices must have a plate or marker with a unique identifying number and the name and contact information of the operator.
- Personal delivery devices must obey traffic and pedestrian control signals, not unreasonably interfere with pedestrians or traffic, and yield the right-of-way to pedestrians.
- Personal delivery devices must be equipped with a braking system that enables the device to come to a controlled stop.
- Delivery device operators must maintain a minimum damage liability insurance of $100,000.

Figure 9.4. Delivery robot. Photo courtesy of TSRC/Michael Randolph.

Automated Delivery Vehicles

Unlike smaller delivery robots that typically operate within the curbspace and crosswalks, automated delivery vehicles operate on public roads. Examples of automated vehicle last-mile delivery pilots are listed below.

Cruise

Cruise is partnering with DoorDash to provide food delivery using AVs in San Francisco (Hawkins, 2019a). For more information, please see the Shared Automated Vehicles Toolkit.

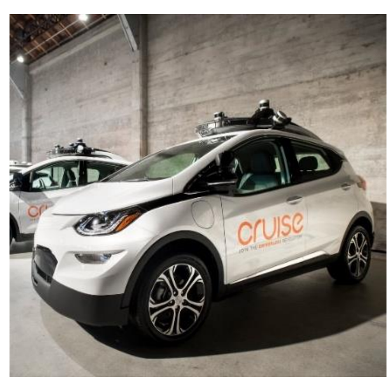

Figure 9.5. Cruise AV. Photo Courtesy of DoorDash.

Nuro

Nuro has concluded a pilot in Scottsdale, Arizona using a fleet of small automated electric vehicles to deliver groceries from Kroger. Another pilot has launched in Houston, Texas, also in partnership with Kroger (Redman, 2019; Wiles, 2019).

Figure 9.6. Nuro Delivery Vehicle. Photo Courtesy of Kroger.

Figure 9.7. Nuro Delivery Vehicle. Photo Courtesy of Kroger.

Udelv

In January 2019, Walmart announced a partnership with Udelv to deliver groceries to customers in Surprise, Arizona. The Udelv fleet consists of larger passenger vans capable of traveling up to 50 mph. Udelv also operates across the Peninsula of the Bay Area and in Houston, TX (Hawkins, 2019b; Udelv, 2019; Ward, 2019).

Figure 9.8. Photo of Udelv grocery delivery van. Photo courtesy of Udelv.

Key Takeaways

- Last-mile delivery innovations are changing traveler behavior and consumption decisions.
- Digital services and goods delivery may be substitutes for personal vehicle trips to commercial centers.
- More research is needed to determine the impacts of last-mile delivery innovations on travel behavior, the environment, and society.

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SHARED MOBILITY AND PUBLIC TRANSIT INTEGRATION

Multimodal integration - the seamless connection between different transportation modes - is recognized as a best practice to encourage the use of shared mobility and public transportation. Achieving multimodal integration typically involves public-private partnerships to pursue fare, information, and physical integration (Abrate, 2009; Shaheen, Cohen, & Zohdy, 2016):

Fare integration through a single card or account allows travelers to pay for multiple modes of transportation, including public transit and shared mobility services. These cards or accounts can be either fully integrated or semi-integrated. Fully integrated fare payment refers to systems where payments are deducted from the same card or account, and there is back-end integration between the different transportation modes.

Figure 10.1. Individual using bikesharing payment kiosk. Photo courtesy of Flickr/LADOT

Semi-integrated fare payment refers to a common fare payment card that is used for both public transit and shared mobility, but the two maintain distinct and separate payment accounts (Hernandez, Eldridg, & Lukacs, 2018). For example, the San Francisco Bay Area's Clipper Card allows users to access a variety of public transit networks and the region's Bay Wheels (formerly Ford GoBike) system with a common fare card.

Information integration, sometimes called digital integration, provides aggregated and seamless information on trip planning, fares, wayfinding, and modal connections. For example, the Tri-County Metropolitan Transportation District of Oregon (TriMet) has developed an Open Trip Planner app that allow users to plan multimodal trips using shared mobility and public transportation (TriMet, 2018).

Physical integration refers to the physical co-location of public transportation with shared mobility. This enables travelers to use shared mobility as a first- and last-mile solution. Mobility hubs that provide access to several transportation modes is one example of physical integration. The San Diego Association of Governments (SANDAG) developed a mobility hubs plan with eight prototypes that includes services, facilities, and infrastructure for carsharing, shared micromobility (scooter sharing and bikesharing), transportation network companies (TNCs, also known as ridesourcing or ridehailing), microtransit, electric vehicle charging, package delivery, and retail services (SANDAG, 2018).

The following sections provide an overview of how public-private partnerships can be harnessed to integrate public transportation and shared mobility, as well as three types of public-private partnerships. These include first- and last-mile integration connections to public transit, low-density and off-peak services, and paratransit partnerships. This toolkit concludes with a discussion of the potential impacts of automation on public transportation.

Public-Private Partnerships

Public-private partnerships can help integrate public transportation and shared mobility. The Federal Transit Administration (FTA) is conducting research on new mobility solutions that can provide travelers with flexible and convenient transportation, such as bikesharing, carsharing, and demand-responsive bus services. As part of this research, the FTA developed the Mobility on Demand (MOD) Sandbox Demonstration Program. The demonstration provides a venue through which integrated MOD concepts and solutions - supported through local partnerships - are demonstrated in real-world settings. Several of the partnerships showcase the integration of public transit with shared mobility. In one project, the Los Angeles County Metropolitan Transportation is providing discounted TNC services for trips originating and ending at select public transit stops.

Key objectives of the MOD Sandbox Demonstration include:

- Enhance public transit industry preparedness for mobility partnerships and integrate mobility services with existing public transit service,
- Validate the technical and institutional feasibility of innovative business

models and document best practices that may emerge from the demonstrations, and

- Measure the impacts of mobility services on travelers and transportation systems (Federal Transit Administration, 2016a; Federal Transit Administration, 2016b; Shaheen, Cohen, Yelchuru, & Sarkhili, 2017).

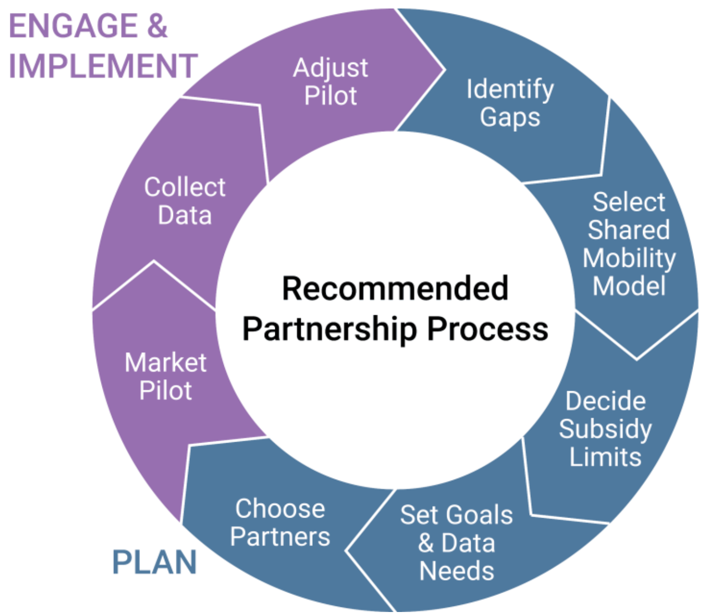

Figure 10.2. Recommended Partnership Process. Illustration by Emma Lucken

Common Shared Mobility Public-Private Partnerships

Three types of shared mobility public-private partnerships are being employed by public agencies across the United States. These include:

First- and Last-Mile Connections to Public Transportation

First- and last-mile connections refer to passenger travel to and from fixed-route public transportation. Shared mobility can provide an opportunity to bridge gaps in the transportation network and extend the reach of public transportation by providing first- and last-mile connections. For example, the Transportation Authority of Marin (TAM) is partnering with Lyft to provide subsidized pooled TNC rides to and from SMART rail stations in Marin County. In the first five months of service, roughly 1,000 TNC trips were completed through the program (Descant, 2018).

Low-Density and Off-Peak Services

Public agencies can also partner with shared mobility providers to offer gap-filling services for late-night transportation and low-density built environments. These partnerships typically offer discounts or subsidies for shared mobility services within a designated zone or time of day. These partnerships target times and locations that cannot support high-frequency public transit service. For example, Arlington, Texas has partnered with microtransit provider Via to replace public buses. Via charges a flat fee of $3 and is operational between 6am and 9pm, Monday through Saturday (Hanna, 2018). In Clearwater, Florida, the Pinellas Suncoast Transit Authority (PSTA) has launched TD (Transportation Disadvantaged) Late Shift, a program that allows economically disadvantaged riders to request up to 25 rides per month for their work commute in-between the hours of 10pm and 6am, as long as they are within county lines (Pinellas Suncoast Transit Authority, 2018). Programs such as these may be more cost-effective at providing demand-responsive and right- sized vehicles for low-density and off-peak services.

Paratransit

Paratransit partnerships involve the use of shared mobility (either technology or transportation services) to supplement or replace a public transit agency's existing paratransit service. In Las Vegas, the Regional Transportation Commission of Southern Nevada (RTC) is partnering with TNCs to provide rides for paratransit users enabling on-demand ride requests. TNC partners must educate their drivers on how to assist passengers with disabilities. RTC subsidizes the cost of the ride up to $15 (Lyft, 2018; Quigley, 2018).

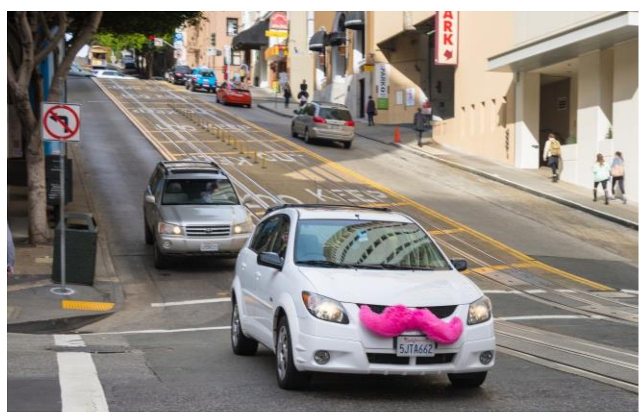

Figure 10.3. Lyft TNC Vehicle. Photo courtesy of Flickr/SPUR

Automated Vehicles and Multimodal Integration

A number of public agencies are exploring partnerships to leverage vehicle automation as first- and last-mile connection to public transportation, circulator shuttles, and replacements for existing fixed route services. A few examples of agencies exploring these types of services include:

San Ramon, CA

The Contra Costa Transportation Authority (CCTA) has formed a partnership with EasyMile to provide automated shuttles to connect Bishop Ranch to a Bay Area Rapid Transit (BART) station. The automated shuttle service was one of the first to receive approval by the California Department of Motor Vehicles to operate on public roads (Bloom, 2018).

Figure 10.4. CCTA Shuttle. Photo courtesy of CCTA.

Jacksonville, FL

The Jacksonville Transportation Authority (JTA) is planning to replace its monorail system with automated shuttles. The 2.5-mile elevated tracks of the monorail system will be re-purposed as a designated right-of-way for automated shuttles. The agency has formed a partnership with Florida Polytechnic University, and in late 2019, was awarded a $12.5 million grant from the U.S. Department of Transportation (Bortzfield, 2018; Robinson, 2018a; Robinson, 2018b).

Figure 10.5. Monorail System. Photo courtesy of Flickr/Jon Bell

Looking Forward

The Potential Impacts of Automation on Public Transportation

In the future, automation could be the most transformative trend to impact public transportation since the automobile. Automation will likely result in fundamental changes to public transportation by altering the built environment, transportation costs, commute patterns, and modal choice. Reduced vehicle ownership due to shared automated vehicles (SAVs) could result in changes in parking needs, particularly in urban centers. The repurposing of parking in urban centers has the potential to create new opportunities for increased density through infill development. While SAVs may compete with public transit ridership, infill development could also create higher densities to support additional public transit ridership and allow for the conversion of bus transit to rail transit in urban cores.

The growth of telecommuting and automated vehicles (AVs) may make longer commutes more practical, which could shift consumer preferences in favor of suburban and exurban living. If workers do not have to commute every day, and if those commutes are less expensive and more productive, today's time cost of commuting (and congestion) may be notably reduced (Shaheen & Cohen, 2018). As such, concerns that the introduction of AVs could reduce demand for public transit and encourage increased personal vehicle use are real. But just as AVs have the potential to reduce driving costs, automated transit vehicles have the opportunity to reduce operating costs and the potential to pass these savings on to riders in the form of lower fares, more routes, and increased service frequency. Reduced operational costs, lower fares, and improved service could make public transit more competitive than other modes and result in increased ridership (Shaheen & Cohen, 2018).

Looking to the future, technology has the potential to be both a key enabler and a "multimodal multiplier" for public transit operators. Technology can dramatically multiply the effectiveness of public transportation, allowing existing services to become automated and right-sized based on real-time demand and predictive analytics. While the precise impacts of automation are uncertain, it is clear that public transportation has the opportunity to leverage technology to become a more competitive alternative to private vehicle ownership today and private AV ownership tomorrow (Shaheen & Cohen, 2018).

Key Takeaways

- Multimodal integration is recognized as a best practice to encourage the use of shared mobility and public transportation. Multimodal integration can be achieved through public- private partnerships that pursue fare, information, and/or physical integration.
- Shared mobility public-private partnerships across the U.S. are providing first- and last-mile connections to public transit, filling service gaps for late night transportation and low-density built environments, supplementing paratransit services, and offering early-stage automated services.
- The impacts of automation on public transportation are unclear. Automated vehicles may reduce demand for public transit, but automation may also reduce operating costs and increase efficiency for public transit. Public transportation has the opportunity to leverage technology to become a more competitive alternative to private vehicles.

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SHARED MOBILITY AND EQUITY

The demographics of shared mobility users can differ from the general population. A number of studies suggest that users of shared modes tend to be younger, with higher levels of educational attainment, higher incomes, and less diverse than the general population. Older adults, low-income households, rural communities, and minority communities have historically been less likely to use shared mobility. Additionally, access to the Internet, smartphones, and banking services–a common prerequisite for many shared mobility services–tends to be lower among many of these groups. These equity barriers are explained in the context of the spatial, temporal, economic, physiological, and social barriers known as the STEPS framework (Shaheen, Bell, Cohen, & Yelchuru, 2017). This toolkit reviews the STEPS framework and then discusses common shared mobility equity challenges. This toolkit also provides examples of policies and programs to help overcome these challenges (see Table 11.2). This toolkit concludes with opportunities for public agencies to encourage equitable outcomes for shared mobility.

Figure 11.1. Residents crossing a street. Photo Courtesy of Flickr/Seattle DoT.

Table 11.1 STEPS to Transportation Equity

Transportation Barrier	Definition	Opportunity to Overcome Barrier
Spatial 	Spatial barriers include the lack of service availability in a particular neighborhood, excessively long distances between destinations, and the lack of public transit within walking distance. These factors can compromise daily travel needs.	Requiring or incentivizing shared mobility companies to serve underserved communities
Temporal 	Temporal barriers can inhibit a user from completing time-sensitive trips, such as arriving at work or completing travel due to lack of service availability at a particular time (e.g., late-night transportation services).	Facilitating off-peak partnerships to provide late-night transportation service using shared mobility
Economic 	Economic considerations include direct costs (e.g., fares, tolls, and vehicle ownership costs) as well as indirect costs (e.g., smartphone, Internet, credit card access) that create economic hardship or preclude users from completing basic travel.	Subsidizing access to shared mobility for qualifying low-income users and offering alternative access modes (e.g., telephone concierge service, SMS text access, etc.) that do not require a smartphone or high-speed data access
Physiological 	Physiological factors include physical and cognitive limitations that make using standard transportation modes difficult or impossible for certain individuals, such as children, older adults, and people with disabilities.	Expanding access for people with disabilities and older adults through wheelchair accessible vehicles (WAVs), personal assistance, and assistive technologies
Social 	Social considerations include social, cultural, safety, and language barriers that inhibit a user's comfort with using transportation modes and services. Examples of social barriers can include neighborhood crime, poorly targeted marketing, and the lack of multi-language information.	Conducting education and outreach to an array of potential users, such as low-income, minority, and immigrant households

Source: Shaheen et al. (2017)

Common Equity Challenges

Four common equity challenges associated with shared mobility include (Shaheen, 2018):

- **Un- and Under- Banked Households:** Services may require debit or credit cards for fare payment or may require a credit hold to use a service (Shaheen & Cohen, 2018).
- **Digital Divide:** Shared mobility services may require a smartphone or high-speed data packages to access services. Low-income and rural households may not be able to afford a smartphone or data access, or lack data coverage to access services.
- **Accessibility:** The Americans with Disability Act (ADA) provides accessibility guidelines for people with disabilities. Unfortunately, not all shared mobility services may be accessible for people with disabilities. In the context of shared mobility, this could include wheelchair accessible vehicles or accessible shared micromobility devices, accommodations for service animals, incorporating universal design into all modes and app-based services, and preventing shared mobility services from blocking ADA curbs and ramps.
- **Low-Income Affordability:** Shared mobility can be expensive in comparison to walking, cycling, and public transportation. It is important that low-income households and neighborhoods have affordable mobility options.

Table 11.2 provides sample policies and programs that can help overcome some of these challenges.

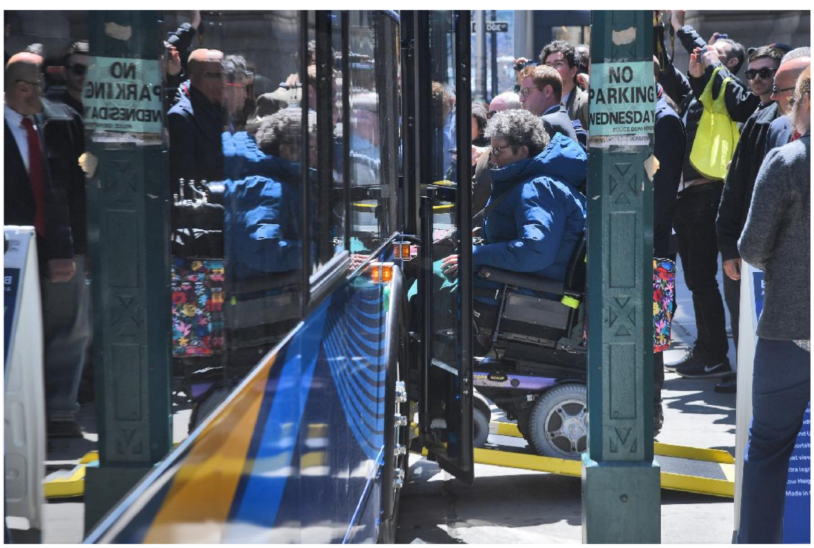

Figure 11.2. An individual uses an ADA ramp to access a public bus. Photo Courtesy of Flickr/New York MTA

Case Studies of Accessible Services and Equity Programs

Table 11.2 Programs for Overcoming Barriers to Shared Mobility	
Barrier	**Policies or Program Examples**
Spatial: Expansion to Low-Income Areas	**Our Community CarShare Program (Sacramento, CA)** In May 2017, *Our Community CarShare* was launched by the Sacramento Metropolitan Air Quality Management District (SMAQMD) at affordable housing locations and the Sacramento Valley Train Station. Funded by California's cap and trade program, this roundtrip carsharing program provides free access to zero emission vehicles (ZEVs) to low-income communities that would otherwise not have access to ZEVs and electric charging equipment due to their high capital cost. At housing developments, community leaders are trained as ambassadors to support the program, enroll fellow residents, and provide assistance in multiple language. Provided by Zipcar, the service is available to residents for up to nine hours per week (Sacramento Air Quality Management District, 2017; Mutual Housing California, n.d.).
Temporal: Late Night Services and Low-Income Programs	**Pinellas County Transportation Disadvantage Program (Pinellas County, FL)** The Pinellas County Transportation Disadvantaged (TD) Program provides reduced cost transportation services for households that have incomes less than 150 percent of the poverty level. Low-income households can purchase a 31-day unlimited bus pass for $11/month. In addition to reduced cost bus passes and door-to-door service, the program has a special TD Late Shift component. TD Late Shift provides late-night and early-morning rides to low-income households as part of a public-private partner- ship with Uber, United Taxi, or Care Ride. The program costs an additional $9/month for 25 on-demand rides between the hours of 10PM and 6AM (PSTA, 2019).
Economic: Unbanked and App-free Shared Mobility Programs	**Bay Wheels (San Francisco Bay Area, CA)** Bay Wheels (formerly Ford GoBike) is a station-based bikesharing program in the San Francisco Bay Area. Multiple plan options are available including: single rides, all day access, monthly membership, and annual membership. Bay Wheels offers a reduced-cost annual membership for low-income residents who qualify for local social service programs through the *Bikeshare For All* program. Participants of *Bikeshare For All* are offered 60 minutes of ride time before additional fees, compared with 30 minutes in the traditional membership. According to TransForm, 20 percent of all Bay Wheels memberships are discounted *Bikeshare For All* memberships. Additionally, users of the *Bikeshare For All* membership were more diverse than the general user population - 86 percent had an annual income of $25,000 or less, 97 percent were people of color, and 47 percent identified as female or "other" (compared to 34% of bikesharing members nationally) (Ford GoBike, 2018; TransForm, 2018).
Physiological: ADA Accessible Modes	**SilverRide** SilverRide is a TNC that offers seniors driver-assisted, door-through-door rides. Drivers for SilverRide are licensed, bonded, trained, and can accompany users during their trips. The cost of the ride is quoted in advance based on trip distance, time of day, and whether the rider requests that the driver accompany them during the trip. Rides can be booked online or through an app with 24-hour notice. The service is available in the San Francisco and Kansas City metropolitan areas (SilverRide, 2019).
Social: Outreach Programs and Multi-Language Applications	**Charge Ahead California Initiative** Launched in November 2013, the Charge Ahead California Initiative creates equity programs that increase access to clean transportation in low income communities. Programs include rebates for low- and moderate-income consumers that purchase electric vehicles (EVs), low-income financing assistance for EVs, and electric carsharing services in disadvantaged communities. Charge Ahead California programs are required to provide adequate outreach to disadvantaged, low-income, and moderate-income communities, including partnering with community-based organizations (De Leon, 2014; Espino & Truong, 2015).

Role of Government

In addition to the examples in Table 11.2, the public sector can encourage shared mobility equity through:

Knowledge Transfer and Partnership Facilitation: Metropolitan Planning Organizations (MPOs) can facilitate equity programs and partnerships between lower levels of government and private vendors. MPOs can also facilitate knowledge transfer by integrating shared mobility vendors into the regional planning process as technical advisory committee members. Finally, MPOs can deploy pilot projects to identify how shared mobility can help regions achieve equity goals.

Funding: There are a number of funding opportunities that the public sector can pursue to encourage shared mobility use in disadvantaged communities. One example includes subsidies for shared mobility (e.g., first- and last-mile subsidies for paratransit and connections to public transit).

Enforcing Equity Through Regulation/Legislation: Government can help ensure equitable access to shared mobility through regulation and legislation. Many of these laws and regulations already exist, though guidance on how to apply them to shared mobility may be needed. A few examples include (Shaheen & Cohen, 2018):

- **Title VI of the Civil Rights Act of 1964** prohibits discrimination based on race, color, and national origin in programs and activities that receive federal financial assistance.
- **The Civil Rights Restoration Act of 1987** clarifies the earlier definition of “programs and activities” in civil rights legislation. Under this law, discrimination is prohibited throughout an entire organization or agency, if any part of that agency receives federal financial assistance.
- **Title 49 CFR Part 21** implements provisions of Title VI for any program or activity receiving federal financial assistance from the U.S. Department of Transportation.
- **Title 49 CFR 37.105** implements equivalent service provisions with the respect to schedules/headways, response time, fares, geographic area of service, hours and days of service, availability of information, reservations capability, constraints on capacity and service availability, and restrictions based on trip purpose.
- **National Environmental Policy Act (NEPA)** establishes a framework for environmental protection. Under NEPA, an environmental impact statement (EIS) is used by federal agencies to ensure a full and fair discussion of all the

significant environmental impacts of projects and informs decision makers and the public of reasonable alternatives that would avoid, minimize, or mitigate the adverse impacts or enhance the quality of the human environment.

- **The Rehabilitation Act of 1973** makes it illegal for government agencies, programs, or activities that receive federal financial assistance to discriminate against qualified individuals with disabilities under Section 504. Section 508 requires federal information technology and electronic systems be accessible to people with disabilities.
- **Americans with Disabilities Act (ADA)** prohibits discrimination against people with disabilities. Title III of ADA requires that private transportation businesses provide accessible-ready vehicles and facilities to persons with disabilities.

In addition to federal requirements, a number of states have implemented laws and regulations to support equitable access to transportation services. A few examples from California include:

- **The California Environmental Quality Act (CEQA)** requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.
- **The Unruh Civil Rights Act** prohibits discrimination against all persons and guarantees the right to full and equal accommodations, advantages, facilities, privileges, or services in all business establishments (Civ. Code, §§ 51, 51.5, 51.6).
- **The Disabled Persons Act** protects Californians from discrimination based on disability. California's law states that individuals with disabilities shall be entitled to "full and equal access, as other members of the general public" to the "privileges of all common carriers, airplanes, motor vehicles, railroad trains, motorbuses, streetcars, boats, or any other public conveyances or modes of transportation (whether private, public, franchised, licensed, contracted, or otherwise provided)" (Civ. Code, §§ 54.1).

Monitoring Equity Outcomes Through Data and Research: Data and research can be an important monitoring tool for public agencies to help understand if shared mobility services are meeting the needs of all users. To do this, public agencies should identify equity goals, translate these goals into evaluation hypotheses, define metrics to measure equitable outcomes, identify data sources, and both define and implement methods of analysis. Examples of potential equity metrics for shared mobility could include: 1) demographics of shared mobility users; 2) spatial distribution of locations served; 3) demographics of areas served; and 4) cost per trip or cost per mile.

Key Takeaways

- Common barriers to accessing shared mobility include serving un- and under-banked communities, access for people without a smartphone or data service, accessibility for people with disabilities, and low-income affordability.
- The STEPS framework explains equity barriers to shared mobility in the context of spatial, temporal, economic, physiological, and social barriers.
- Shared mobility equity can be supported with the following strategies:
    - Metropolitan Planning Organizations (MPOs) can facilitate knowledge transfer and partnerships between lower levels of government and private companies.
    - Public agencies can provide funding to support shared mobility use in disadvantaged communities.
    - Government can ensure equitable access to shared mobility through regulations and legislation.
- Public agencies can monitor equity outcomes through data and research. Equity goals should be identified and translated into evaluation hypotheses that can be evaluated using data.

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RIGHTS-OF-WAY FOR SHARED MOBILITY

Rights-of-way is a term used to describe the legal passage of people (and their means of transportation) along public and sometimes private property. Rights-of-way includes transportation infrastructure such as streets, bicycle lanes, and sidewalks for other public and quasi-public spaces. A number of local public agencies have developed a combination of formal and informal policies to allocate rights-of-way such as curb space, loading zones, and parking for shared mobility. Many of these policies focus on how rights-of-way space is allocated, how to determine the monetary value of that space, and how to address a variety of related administrative issues. Public agencies have also developed policies to manage demand for the rights-of-way among multiple operators and modes. This toolkit reviews the impacts of shared mobility on rights-of-way including: on-street parking, loading zones, and curb space management. Next, this toolkit discusses policy considerations for public agencies allocating rights-of-way for shared mobility. This is followed by example policies and strategies. This toolkit concludes with key takeaways and considerations for public agencies.

Figure 12.1. Example of a dockless bicycle corral. Photo Courtesy of Flickr

The Impacts of Shared Mobility on Rights-of-Way and Curb Space Management

A few academic and industry studies have documented the impacts of shared mobility on rights-of-way and curb space. Generally, these studies have shown:

- An increased use of parking, loading zones, and curb space by shared mobility can create competition among modes and operators for a limited amount of space;
- Unintended impacts on other modes and vulnerable travelers, such as shared modes interfering with public transportation operations (i.e., loading/unloading) and shared modes blocking bicycle lanes and Americans with Disabilities Act (ADA) access (i.e., ramps and curbs); and
- Potential reductions in private vehicle ownership and use that could reduce demand for on-street parking.

This section outlines the impacts of shared mobility on the rights-of-way, organized by impacts on parking, loading zones, and curb space.

Impacts on Parking

The impacts of shared mobility on parking are difficult to measure. On one hand, shared mobility can reduce the availability of parking spaces in the rights-of-way. Cities may allocate street space to kiosks and corrals for shared micromobility (e.g., bikesharing or scooter sharing) or designate parking for carsharing. On the other hand, shared mobility may reduce demand for parking. Studies of one-way and roundtrip carsharing have generally found that each carsharing vehicle can reduce the number of vehicles on the road, vehicle use, and vehicle ownership, which could reduce parking demand (Martin and Shaheen, 2016; Martin, Shaheen, and Lidicker, 2010).

Impacts on Loading Zones

Transportation network companies (TNCs), microtransit, shuttles, taxis, and last-mile delivery services may require frequent loading. Frequent loading or unloading of passengers or packages from a variety of shared modes can cause safety hazards; congestion; impact public transit operations; and block bicycle, pedestrian, and ADA access. Designated spaces for station-based micromobility services require a portion of the rights-of-way and thus may also impact the amount of space available for loading zones.

Impacts on Curb Space

Shared mobility modes could have unintended consequences for pedestrians, people with disabilities, and curb space. Shared micromobility (station-based and dockless) may be parked or operated on sidewalks, potentially blocking pedestrian and ADA access. Research in the impacts of shared micromobility on curb space management are limited; however, a number of studies are ongoing.

Policies Allocating Public Rights-Of-Way

When allocating public rights-of-way to shared mobility service providers, public agencies may have a number of policy questions to consider such as:

- What will be the process for allocating public space to shared mobility operators?
- Should there be limits on the amount of public space allocated (e.g., a specified amount of curb feet, number of parking spaces, square footage)?
- Will fees or permits be assessed for private use of the rights-of-way? If so, how will these costs be determined and assessed?
- Will special signage and marking be permitted to identify areas, such as special parking spaces and loading zones, and who will be responsible for their installation and maintenance?
- What type of enforcement mechanisms will be in place to prohibit unauthorized activities (e.g., ticketing, booting, towing)?
- What processes will be in place to ensure public involvement and compliance with environmental justice policies?
- Will documentation of social, environmental, and transportation impacts be required? Will future allocation and/or fees be based on program impacts?

Generally, the allocation of public rights-of-way is implemented through a combination of formal and informal processes. Some municipalities have established designated locations for permissible activities (e.g., carsharing parking zones; TNC, microtransit, shuttle, and last-mile delivery loading zones; and stations or corrals for shared micromobility). With the growth of shared mobility in many jurisdictions, public agencies may pursue a variety of competitive processes (e.g., requests for proposals, auctions, etc.) and non-competitive processes (e.g., permits, real estate agreements, etc.) to allocate rights-of-way among operators and modes.

Public agencies with multiple shared modes vying for rights-of-way may consider comprehensive approaches that allocates space to minimize modal conflicts and ensure multimodal access. Public agencies should carefully consider rights-of-way policies to ensure that they do not limit innovation and development of new operators or shared modes.

Strategies for Rights-Of-Way Management

The availability of rights-of-way for shared modes can have a notable impact on the growth and potential success of shared mobility. As noted previously, the allocation of rights-of-way for shared mobility can be classified into three types of policies:

- The allocation of parking for carsharing and moped-style scooter sharing;
- Loading zones for shared automated vehicles, some last-mile delivery services, microtransit, shuttles, taxis, and TNCs; and
- The allocation of curb space for shared micromobility (bikesharing and standing electric scooter sharing) and robotic delivery.

While there may be subtle differences between modes, the themes and policy considerations for policy development will be similar within these three policy categories.

Parking Policies

A number of public agencies have established policies to allocate on-street and publicly owned off-street parking for carsharing and moped-style scooter sharing. These jurisdictions typically have distinct policies for roundtrip and one-way free-floating shared mobility services due to differences between the operational models. Several sample policy approaches include:

San Francisco's Roundtrip Carsharing Parking Policy

San Francisco Metropolitan Transit Authority's (SFMTA) On-Street Shared Vehicle Permit Program allocates up to 1,000 on-street parking spaces for leasing by carsharing companies. Under the policy, carsharing companies can apply for a permit to obtain exclusive rights to parking spaces throughout the city at a cost of $50 to $285 per space per month, depending on where the space is located. Each approved carsharing vehicle is exempt from street sweeping, time limits, and other restrictions. To obtain a permit, carsharing vehicles are required to meet certain criteria such as, vehicles being available for reservation “on an hourly basis, at an unstaffed self-service location, twenty-four hours/seven days per week, without assistance or key exchanges, operator, lot, stations or garage or any other paid or contracted personnel.” Vehicles must also have insurance, be labeled, and have low emissions. The carsharing company must provide monthly reports on the number of reservations per space, number of unique users per space, length of trip (miles/time) per space, and new member outreach findings to SFMTA (SFMTA, 2017).

A review of the program noted that designated space programs (in which on-street space is reserved for carsharing vehicles only) can be expensive and cumbersome to operate, as well as difficult to scale-up and adapt. According to SFMTA, permitted spaces may take many months to be approved and can be quickly lost to construction activity. In addition, designated carsharing spaces can be vulnerable to vandalism and require material, labor, and routine maintenance (SFCTA, 2018).

SFMTA noted that if a carsharing vehicle is well utilized, then its parking space remains empty for much of the time and may not be usable for other purposes such as loading and unloading. Permit policies that enable carsharing vehicles to park anywhere within a given zone may be able to address some of these issues (SFCTA, 2018).

San Francisco’s Moped Scooter Sharing Parking Permit Program

San Francisco has implemented a Shared Electric Moped Parking Permit Program that exempts shared electric mopeds from Residential Parking Permit time restrictions, payment in metered motorcycle parking stalls, and payment in metered parallel parking spaces, if parked on the line between spaces, or in front of the parking meter (if there is no line). These permits are available to moped scooter

Figure 12.2. A Moped-style scooter. Photo Courtesy of Scoot

sharing operators that provide pre-approved members access to a citywide network of at least 100 shared moped-style scooters. Permits cost $325 per year and are used to administer the program. Permitted providers are required to share data on scooter usage and parking with the city to help prevent and mitigate issues such as crowding (too many scooters in a particular area) (SFMTA, 2017).

Seattle's Carsharing Parking Policy

Seattle allows roundtrip and free-floating one-way carsharing providers to apply for designated and free-floating carsharing permits, respectively. For free-floating parking, operators may apply for an annual permit that costs $1,730 per free-floating vehicle. Permitted vehicles can park at any legal paid parking space without paying at a pay station and without regard to time limits in on-street time-limited spaces.

For carsharing services that require designated on-street parking, the city charges $3,000 per space in paid parking areas and $300 per space in non-paid parking areas, annually. Seattle limits the number of dedicated carsharing parking spaces in paid areas (i.e., parking that typically requires a fee to park in). In areas of the city where parking is free, there are no predetermined limits. The city encourages carsharing providers to serve the entire city and to locate vehicles at mobility hubs (Seattle Department of Transportation, 2019).

Figure 12.3. Lime Carsharing vehicle. Photo Courtesy of Flickr/Kris Krug.

Loading Zone Policies

A number of public agencies are establishing loading zones for shared modes, such as employer shuttles and TNCs. See below for two examples.

SFMTA's Employer Shuttle Loading Zone Policy

SFMTA has established a program that enables employer shuttle services to pay to use loading zones if certain guidelines are followed, such as yielding to public buses and pulling to the front of the loading zone to make room for other vehicles. As part of this program, shuttle operators apply for a permit and pay $7.75 per stop in designated shared MUNI zones or commuter shuttle-only zones. The permit fee covers the city's costs for administering and enforcing the program. The program also requires shuttle operators to use clean fleets and provide real-time GPS tracking of vehicles (SFMTA, 2018).

Washington, D.C.'s Late-night Loading Zone Policy

In Washington, D.C., the District Department of Transportation (DDOT) has established nightlife loading zones for taxis and TNCs in response to growing late-night activity in areas with high concentrations of restaurants and bars. DDOT has designated these locations for passenger loading and unloading and prohibits parking from 10 pm to 7 am on Thursday, Friday, and Saturday (Lazo, 2018).

Curbspace Management Policies

The growth of shared mobility has led to an increased demand for curb space necessitating curb space management policies. A common issue for curb space management includes preventing shared micromobility devices from parking in inconvenient or dangerous locations that impede ADA, pedestrian, and bicycle access.

Cities can manage curb space by proactively developing policies to:

1) Identify locations where shared micromobility devices can be parked and other services are able to load and unload passengers and packages,
2) Develop agreements with private operators that indemnifies the public agency from liability for any loss or injury that could result from a service operating or parked on the public rights-of- way,
3) Implement enforcement procedures for illegally parked bicycles and scooters, such as fines or
   Impounding,
4) Develop a process for requesting access to the use the public rights-of-way (i.e., curb space),
5) Identify permits that should be issued or fees that should be charged for services to operate in the public rights-of-way,
6) Establish standards for shared micromobility parking signage and/or markings to identify proper parking areas, and
7) Develop data-sharing requirements and/or require impact studies as a condition for

allowing shared micromobility devices to use the public rights-of-way.

In addition to curbside and shared micromobility parking management, a number of cities also employ "geofencing" or the process of designating permissible and prohibited areas of operation. For example, dockless operators in San Diego use geofencing to prohibit cyclists from parking and leaving their bicycles on Coronado Island. Similarly, JUMP has geofenced San Francisco's Union Square to discourage bicycle parking in the pedestrian plaza.

Curbside Management in Seattle

Seattle has developed a policy for curbside management to guide where dockless bicycles should be parked in urban areas. Seattle's policy defines three key zones: 1) a landscape/furniture zone, 2) a pedestrian zone, and 3) a frontage zone. Seattle requires dockless bicycles to be parked in the landscape/furniture zone or at a Seattle Department of Transportation (SDOT) bicycle rack. Please see Figure 12.4 for an illustration of the three key curbside zones. Additionally, Seattle prohibits bicycles from being parked on corners, driveways, or curb ramps, or in a way that blocks access to buildings, parking meters, benches, bus stops, or fire hydrants. If dockless bicycles end up in prohibited locations and is an obstruction hazard, Seattle requires operators to move improperly parked bicycles and to correct parking violations within two hours of a problem being reported between 6:00 AM and 11:59 PM. If a device is reported outside of these hours and is an obstruction hazard, it must be corrected within four hours of receiving notice. If the device is not an obstruction hazard, the vendor must move the device 24 hours after receiving notice (Seattle Department of Transportation, 2018).

Figure 12.4. Depiction of three key curbside zones. Photo Courtesy of SDOT.

Key Takeaways

- Rights-of-way is a term used to describe the legal passage of people (and their means of transportation) along public and sometimes private property. Rights-of-way includes streets, bicycle lanes, and sidewalks as well as easements and other public and quasi-public spaces.
- Potential impacts of shared mobility on the public rights-of-way can include: increased use of parking, loading, and curb space; potential modal conflicts with public transportation and pedestrian and ADA access; and a potential reduction in private vehicle ownership and use (possibly reducing demand for on-street parking).
- Public agencies may pursue a variety of competitive processes (e.g., requests for proposals, auctions, etc.) and non-competitive processes (e.g., permits, real estate agreements, etc.) to allocate rights-of-way among operators and modes.
- Generally, the allocation of rights-of-way for shared mobility can be classified into three types of policies:
    - The allocation of parking for carsharing and moped-style scooter sharing;
    - Loading zones for delivery vehicles, microtransit, shuttles, taxis, and TNCs; and
    - The allocation of curb space for shared micromobility (bikesharing and standing electric scooter sharing) and robotic delivery.

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SHARED MOBILITY AND INCENTIVE ZONING

Parking can be a major expense for cities and developers, with spaces costing upwards of tens of thousands of dollars to construct. Likewise, surplus parking can be costly for developers, urban homeowners, and renters. Incorporating shared mobility into new and existing developments is one strategy to increase multimodal options and reduce the need for parking. Cities can implement an array of policies easing zoning regulations and parking minimums to promote the inclusion of shared mobility in new developments. Commonly referred to as incentive zoning for shared mobility, these policies can be categorized as (Cohen and Shaheen, 2016):

1) **Policies that enable reduced parking** such as parking reductions (i.e., reducing the required number of spaces in a new development) and parking substitution (i.e., converting parking into spaces for shared mobility, such as carsharing or shared micromobility).
2) **Policies that allow increased density** such as greater floor-to-area ratios, more dwelling units permitted per acre, and greater height allowances.

This toolkit describes policies that enable parking reductions and increased density. In addition, several case studies are introduced to illustrate how incentive zoning can be used to encourage shared mobility.

Parking Reduction and Parking Substitution

Parking reduction policies can be useful in urban areas with particularly high housing or parking construction costs. Reducing the number of required parking spaces for new and existing developments can make housing more affordable by reducing per-unit costs. Parking reduction policies can also encourage neighborhood redevelopment and revitalization by making it easier for investors to have positive cash flows and higher capitalization rates on real estate projects. Parking substitution can also be employed in new and existing developments. To encourage the use of shared modes, parking reduction and substitution strategies should be employed in high-density areas with robust public transit services (Cohen and Shaheen, 2016).

Examples of Incentive Zoning for Shared Mobility

Incentives can come in various forms and will often depend on the local customs and desired outcomes for a city. A city may proactively change its zoning code and model the code after other incentive mechanisms employed in the jurisdiction or after a zoning code of another city. Across the United States, a wide array of incentives are being employed by local governments, such as parking reductions and reduced transportation impact fees. The following sections describe three examples of incentive zoning from Seattle, Washington; Vancouver, Washington; and Indianapolis, Indiana.

Seattle, WA

Seattle's municipal code allows for reductions to parking requirements if alternative transportation programs are provided. These include parking reductions for properties located near frequent public transit service areas or properties that provide carsharing parking, ridesharing parking, transit passes, and parking for bicycles. Seattle's ordinance reduces the number of required spaces by one space for every parking space leased by a carsharing program. For developments that require 20 or more parking spaces and provide carsharing parking, the number of required spaces may be reduced by the lesser of three required parking spaces for each carsharing space or 15 percent of the total number of required spaces (Seattle Municipal Code, § 23.54.020). To qualify for the latter provision, the property owner and the carsharing operator must file an agreement with Seattle and receive approval. The agreement must also be recorded with the deed. The ordinance also allows for the reduction of minimum parking requirements by 1.9 spaces for each carpooling space, up to a maximum of 40 percent of the parking requirement. Every vanpool purchased or leased by an applicant for employee use (or equivalent vanpool fee purchase by a public agency), requirement can be reduced by six spaces, up to 20 percent of the requirement (City of Seattle, 2019).

Vancouver, WA

Figure 13.1. Parking in Vancouver, WA. Photo Courtesy of The West End

In Vancouver, Washington, the municipal government has implemented an incentive program to encourage development within the city's Transit Overlay District. In recognition of the potential reduction of vehicle trip demand that may result from an increase in shared mobility use, the city is implementing traffic impact fee (TIF) reductions along with residential density bonuses. TIF reductions are granted on a percentage basis for implementation of one or more alternative transportation measures. See Table 13.1 for the full list of TIF reductions offered for transportation demand management measures. Vancouver's ordinance allows a maximum total TIF reduction of 24 percent, if all alternative transportation strategies are implemented. Additionally, any development within the first tier of the city's Transit Overlay District receives a density bonus equivalent to the percentages, if five or more of the alternative transportation actions are implemented. Developments located in the second tier of the district are entitled to the incentive, provided that building orientation, frontage, and setback requirements for the tier are met (City of Vancouver, 2019).

Table 13.1 Alternative Transportation Measurers	
Traffic Impact Fee Reductions (Vancouver, Washington)	
Action	**TIF Reduction (%)**
Construction of direct walkway connection to the nearest arterial	1
Installation of pedestrian-convenient information kiosk, with maintained information	2
Installation of on-site sheltered bus stop (with current or planned service) or bus stop within a quarter mile of site with adequate walkways (if approved by C-TRAN, the county public transit agency)	1
Installation of Bike Lockers	1
Commercial development that would be occupied by employer subject to Commute Trip Reduction Ordinance	4
Voluntary compliance with Commute Trip Reduction Ordinance, where compliance is not required	5
Connection to existing or future regional bike trail (either directly or by existing, safe access)	1
Direct walk/bikeway connection: • To a destination activity (e.g., a commercial/retail facility, park, school) if a residential development or • To an origin activity (e.g., a residential area) if a commercial/retail facility	2
Construction of on-site internal walk/bikeway network	2
Installation of parking spaces that will become paid parking (by resident or employee)	3
Installation of preferential carpool/vanpool parking facilities	1
Regular distribution of transportation demand management information packets to all new tenants	1
TOTAL (ALL STRATEGIES IMPLEMENTED)	24

Indianapolis, IN

In April 2016, Indianapolis adopted a revised consolidated zoning and subdivisions ordinance (City of Indianapolis, 2018). Under the revised zoning code, developers are permitted to reduce the number of required parking spaces by up to 35 percent (Cohen and Shaheen, 2016). The code includes several parking reduction policies related to shared mobility, summarized by Cohen and Shaheen (2016) as follows:

- **Shared vehicle, carpool, or vanpool spaces:** The minimum number of required off-street parking spaces may be reduced by four for each shared vehicle, carpool, or vanpool space provided. Each shared space counts toward the minimum number of required parking spaces.
- **Electric-vehicle charging stations:** The minimum required off-street parking may be reduced by two parking spaces for each electric-vehicle charging station provided. Each charging station counts toward the minimum number of required parking spaces.
- **Bicycle parking:** For every five bicycle parking spaces provided in excess of the required bicycle parking spaces (or where no bicycle parking is required), the minimum number of required off-street parking spaces may be reduced by one or up to a maximum of five.
- **Proximity to public transportation:** The minimum number of off-street parking spaces required for any development may be reduced by 30 percent, if the developer builds within a quarter mile of a sheltered public transit stop or public transit corridor. The minimum number of off-street parking spaces required may be reduced by 10 percent, if the development is between a quarter mile and a half-mile of a stop or public transit corridor.

Key Takeaways

- Incentive zoning can support shared mobility, create an environment that reduces dependency on private automobiles, and encourage increased urban densities.
- Incentive zoning strategies include: reduced parking requirements, substituting general parking for shared mobility, dedicated charging stations for shared modes, and granting density bonuses or fee waivers for alternative transportation strategies implemented in developments.

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SHARED MOBILITY AND DATA SHARING

Data sharing is the exchange of information on shared modes and their operations and impacts. Data can be shared among operators, public agencies, researchers, or the public. Data can be an important tool for informing transportation decision-making. Information on shared mobility services can help public agencies understand the impact of shared mobility on users, traveler behavior, and the environment. This understanding can in turn be used for data-driven public policy and decision-making.

Shared Mobility Data Definitions and Formats

Shared mobility data sharing can include a variety of aspects such as:

- **Demographic Data** include user characteristics such as age, ethnicity/race, occupation, level of education, income, etc.
- **Financial Data** include payment information, discounts, subsidies, etc.
- **Fleet Data** include fleet or equipment information such as location, maintenance status, etc.
- **Spatial Data** include spatial distribution of equipment, users, trips, etc.
- **Survey Data** are a common method to collect data and can include basic information about travel behavior, impacts, user perceptions, and demographics.
- **Trip Data** include information on trip characteristics such as origins and destinations, trip lengths, routing, and trip duration.

Data sharing can take place in two formats (Bailey, 2018):

- **Real-Time Data** are data that can be queried at any time, allowing its users continuous access.
- **Historical Data** are data that is reported either once or in periodic intervals.

This toolkit presents common challenges for data sharing between private-mobility operators and public agencies. Next, this toolkit presents model policies and sample guidelines for handling shared mobility operator data. Next, readers are introduced to common data standards that can ensure consistency among data. The highlighted box in this toolkit reviews the data-sharing strategy of an automated vehicle pilot program. This toolkit concludes with guiding principles for developing data-sharing partnerships.

Common Challenges for Data Sharing

There are a number of challenges that can limit shared mobility data collection and use. These include:

Inconsistent and Incomplete Data Reporting

One common barrier associated with shared mobility data are either incomplete data or data that are not in a standard format. Data agreements and standards can help overcome inconsistent and incomplete data reporting. A public agency's data standards should establish the following (Shaheen, Cohen, Zohdy, & Kock, 2016):

- The type of data needed for the planning, design, operation, safety, and maintenance of the transportation network;
- The format and standards for publishing data sets should be consistent with industry and other public entities to ensure interoperability;
- Standards for classifying and updating data; and
- Standards for data dissemination.

Privacy Concerns and Proprietary Information

Protecting Individual Privacy. Data-sharing agreements should ensure that the privacy of shared mobility users is protected. Data-sharing agreements may include the sharing of sensitive personal information, such as demographic data or home addresses. Other information, such as trip data, may reveal daily routines or the residence of a specific user. To protect user privacy, data managers should "de-identify" data before it is shared or released. De-identification removes names and other personally identifiable information. Privacy concerns can also be addressed by aggregating data so specific users are not identifiable. Users should always be informed of how their data will be used and shared and all associated risks with such practices.

Protecting Proprietary Information. Some companies may be reluctant to share data if they believe it can reveal trade secrets. Data-sharing practices should take reasonable precautions to protect proprietary information from improper release.

Access to Public Records. Public entities may be required to release information if requested. Under the Freedom of Information Act (FOIA), private citizens may request disclosure of previously unreleased information controlled by the U.S. government. Many states have similar laws, known as "state sunshine laws," that govern access to public records. If private entities share data with public entities, they could make their data subject to release depending on state law. As a precaution, public entities should not request and private entities should not share sensitive records that could be subject to release.

Model Policies

Frameworks for Data Sharing

Public agencies have a variety of methods to request and enforce data sharing. Common methods can include:

- **Data Sharing as a Requirement for Permits** - A public agency requires shared mobility operators to share data as a condition for receiving an operating permit in the jurisdiction.
- **Open Source Data Sharing** - Mobility operators, either voluntarily or as part of data agreements, share data for public use online.
- **Third Party Data Sharing** - Third-party organizations can serve as an intermediary to manage and anonymize data before providing it to public agencies or the general public. This can help mitigate risks associated with public records laws and concerns about the release of user or proprietary data.

SharedStreets Data Dashboard

SharedStreets, which was established by NACTO and the Open Transport Partnership (NACTO, 2018), provides open source software to enable public-private collaboration and the exchange of transportation data. In one example project, SharedStreets provided data on TNC pick-ups and drop-offs in select cities. A key tenet of this project was establishing a non-proprietary standard for data as it relates to streets, so cities and private operators can avoid interoperability issues. A screenshot of a SharedStreets data dashboard charting TNC pick-ups and drop-offs in Washington, D.C. is available below.

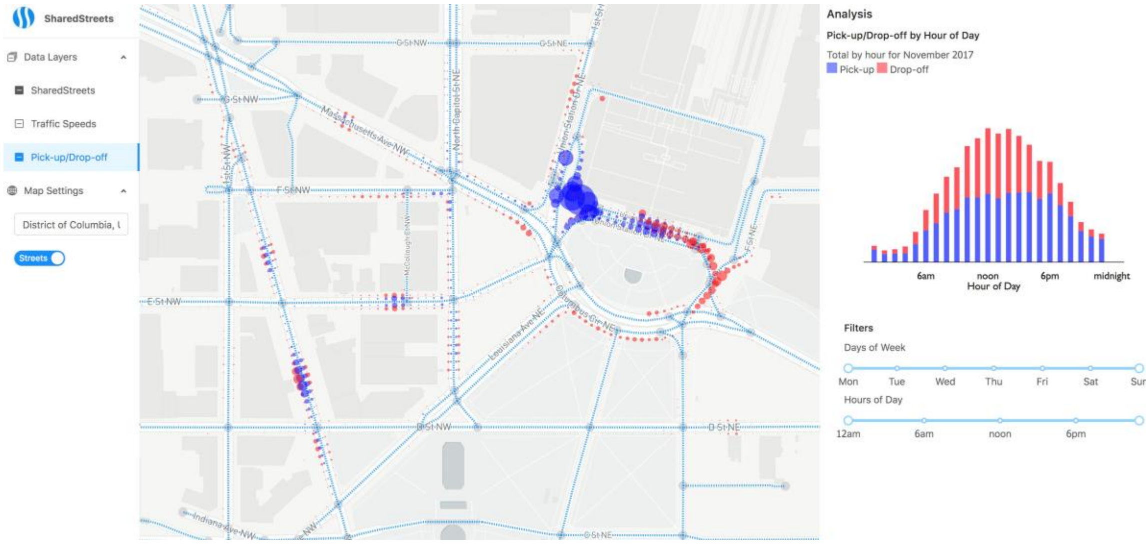

Figure 14.1. Screenshot of a SharedStreets data dashboard charting TNC pick-ups and drop-offs in Washington, D.C. Photo Courtesy of SharedStreets.

OpenMobilityData

The software company TransitScreen announced in January 2019 that they are partnering with nonprofit MobilityData to develop an open-data platform for sharing global public transit and mobility information. The platform, OpenMobilityData, provides real-time feeds from public transit agencies across every continent. The platform will use General Transit Feed Specification (GTFS) data, which includes items like schedules and timing (Plautz, 2019).

Multimodal Data Sharing Policies in Seattle

Transportation Network Companies (TNCs)

Seattle requires TNCs to maintain records for two years and report:

- Total number of rides provided;
- Type of dispatch for each ride (phone, online app, etc.);
- Percentage or number of rides picked up in each ZIP code;
- Pick-up and drop-off ZIP codes of each ride;
- Percentage by ZIP code of rides that are requested by telephone or applications but do not happen;
- Number of collisions, including the name and number of the affiliated driver, collision fault, injuries, and estimated damage;

- Number of rides when an accessible vehicle was requested;
- Reports of crimes against drivers;
- Records of passenger complaints; and
- Any other data identified by the director of the Department of Finance and Administrative Services to ensure compliance (Seattle Finance and Administrative Services, 2019).

Dockless Bikesharing
Seattle requires dockless bikesharing vendors to report:

- Real-time data on deployments, removals, and available devices;
- Weekly updates of trip data;
- Trip waypoint data; and
- Collisions, injuries, or property damage.

Vendors must maintain parking and maintenance logs. Seattle uses the data for planning bicycle infrastructure improvements, monitoring intersection level of service for cyclists, and managing streets and its dockless bikesharing program (Seattle Department of Transportation, 2018).

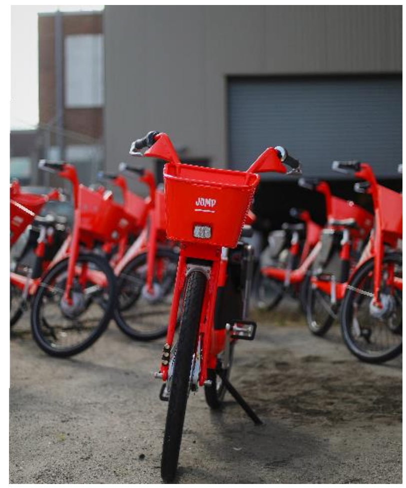

Figure 14.2. Dockless Bikesharing Vehicles. Photo Courtesy of JUMP Bikes.

Carsharing
A mobility company, Lime, and data strategies company, Populus, teamed up in December 2018 to provide data on Lime's new carsharing service, LimePod. Populus' platform collected real-time GPS-based data from the LimePod fleet, which Populus then made available to the city of Seattle. It is important to note that in September 2019, LimePod announced that it will end services in Seattle by the end of the year (Dickey, 2019; Pyzyk, 2018).

Los Angeles Department of Transportation Guidelines for Handling of Data from Mobility-Service Providers

The City of Los Angeles and the LA Department of Transportation (LADOT) have developed a set of guidelines for data handling in conjunction with the development of the Mobility Data Specification (MDS). These guidelines state (City of Los Angeles, 2018):

1. The City of Los Angeles ("City") and LADOT consider trip data, as defined in the Mobility Data Specification, as confidential data as defined in the City of Los Angeles information handling guidelines.

2. The City of Los Angeles and LADOT will collect, access, use, store, process, dispose of, and disclose confidential data in accordance with the aforementioned information handling guidelines, as may be amended from time to time.

3. To the extent that confidential data are used for transportation policy-making, it will be stored un-obfuscated for no less than two years and in accordance with the City of Los Angeles information handling guidelines.

4. If the City decides to publicly share confidential data, and to the extent permitted by law, LADOT will release the data as either aggregated, blurred or otherwise obfuscated to the point where primary identification risk is minimized while still retaining its usefulness for city planning or research functions.

5. If the City receives a public records request for confidential data, the City will not release un-obfuscated confidential data to the extent the City determines such data are exempt from release under the California Public Records Act, unless required to do so pursuant to a court order.

6. To the extent permitted by law, any tool that is commissioned to be built or licensed for use by the City and used in conjunction with the Mobility Data Specification shall comply with these guidelines.

7. The City of Los Angeles and LADOT reserve the right to amend this data handling policy from time to time.

8. The City of Los Angeles and LADOT encourage mobility service providers to inform their customers that vehicle data are being shared with the City of Los Angeles by sharing the following sample language: "Pursuant to our contract with the City of Los Angeles, vehicle data will be shared with the City of Los Angeles."

Data Standards

Data standards can be employed to ensure consistency among operator-provided data. A few common data standards include:

General Bikeshare Feed Specification. The North American Bikeshare Association (NABSA) has developed an open data standard for bikesharing that makes real-time bikesharing operational data feeds publicly available in a standardized format. The General Bikeshare Feed Specification (or GBFS) does not include historical usage data or other personally identifiable information (NABSA, 2019).

General Transit Feed Specification. The General Transit Feed Specification (or GTFS) defines a common format for public transportation schedules and associated geographic information. GTFS allows public transit agencies publish their public transit data and developers write applications that consume that data in an interoperable way (Google Developers, 2016).

Mobility Data Specification. The MDS is a data and application programming interface (API) standard that allows a city to gather, analyze, and compare real-time and historical data from shared mobility service providers. An API allows the creation of applications that access data from another service or application. The specification also serves as a measurement tool that helps enable enforcement of local regulations. In addition, MDS allows service providers and public agencies to communicate with each other about their services because it consists of two APIs: 1) a service provider API and 2) a public agency API (Bailey, 2018). MDS includes data such as: 1) mobility trips (and routes); 2) location and status of equipment (e.g., available, in-use, and out-of-service); and 3) service provider coverage areas. Cities currently using MDS as of October 2019 include Los Angeles, CA; Santa Monica, CA; Austin, TX; and Ulm, Germany.

Automated Vehicles and Data Sharing

As automated vehicle (AV) pilots are deployed, public agencies have begun to develop procedures for data sharing between the public sector and AV operators. For example, the California's Department of Motor Vehicles (DMV) regulates the testing of AVs on public roads and requires that permitted operators provide data on any traffic collision involving an AV within 10 business days of the incident. The DMV also requires that AV operators annually report on AV disengagements during testing. Disengagement is a term used to describe instances in which the AV can no longer operate without human intervention.

Boston has approved operators nuTonomy and Optimus Ride to test AVs. The city requires the operators to share data in quarterly reports that include:

- Miles driven,
- Locations driven,
- Conditions driven in,
- Crash reports,
- Failures with autonomous mode, and
- Disruptions while driving in an automated mode.

The companies must also provide a narrative description of the conditions related to vehicle disengagements and notify the city of any crashes within 24 hours (including a written crash report) (City of Boston, 2017).

Figure 14.3. A nuTonomy AV. Photo Courtesy of nuTonomy

Guiding Principles

Data sharing between public and private entities could improve shared mobility planning and operations. The following best practices can be used to guide robust data-sharing relationships (Shaheen et al., 2016):

Provide Open Data. Some guiding principles for open data include:

- **Data Accessibility**
  - Ensure that data made available are in an open format that can be downloaded, indexed, searchable, and machine readable to allow automated processing.
- **Open License**
  - Data are available to the public for use.
- **Data Quality and Timeliness**
  - Data are high quality and scrubbed for plug-and-play end use by developers without requiring extensive effort to make datasets usable.
  - Data are made available as quickly as possible and frequently enough to remain current and usable.

Data Exchanges. Public agencies can establish data exchanges to serve as a repository for datasets by:

- **Maintaining in-house capability** through a chief technology officer or chief data officer, for example, to oversee data standards and data exchanges.
- **Establishing Data Standards:**
  - Determine the type of data useful for public agency and private sector use for the planning, design, operation, safety, and maintenance of the transportation network and the development of third-party apps
  - Determine the format and standards for publishing data sets that are consistent with industry standards, other public entities, and address interoperability issues.
  - Require two-way data sharing, when possible. For example, apps must share self-reported incident data with public agencies in exchange for receiving their data.
  - Develop standards for aggregating these data and disseminating this aggregated data real time.
  - Develop standards for classifying and updating data.
  - Include metadata with key methodological information on how data were collected.

    - Require geocoding location-based data to make such data suitable for mapping functions.
    - Develop standards for data dissemination.
- **Establishing Conditions for Use:**
    - Require transportation service providers and apps to share data as a condition for offering services within a jurisdiction.
    - Require open access to trip aggregator apps (i.e., trip aggregator apps cannot provide exclusive access to one service provider on its app and exclude another).
    - Require that data sources filter and scrub their data, according to set standards, prior to uploading to a data exchange.
- **Establishing Data Management Platforms:**
    - Establish standard operating procedures to protect consumer privacy and proprietary data.
    - Establish user agreements, data upload, data storage, and data delivery (downloading) capabilities in conjunction with third-party organizations.
    - Timestamp and archive old data to ensure that historical data are made available on data exchanges.
- **Establishing a Data Dashboard (for internal use):**
    - Public agencies may consider establishing a data dashboard that assists local governments in tracking longitudinal data metrics against a baseline (e.g., modal split, app modal share, etc.).

Key Takeaways

- Shared mobility data sharing is the exchange of information about shared modes and their operations. Two types of data sharing include:
    - Real-time data that can be queried at any time; and
    - Historical data that are reported either once or in periodic intervals.
- There are two challenges to data sharing. First, shared mobility data may be incomplete or in an inconsistent format. Second, data sharing may be limited to protect user privacy and proprietary information.
- Data can be shared in a number of ways such as:
    - Public agencies requesting and enforcing data sharing as a requirement for shared modes operating within the public rights-of-way;
    - Mobility operators can share open-source data for public use; and
    - Public agencies and operators can work with third-party organizations to share and anonymize data.

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INCORPORATING SHARED MOBILITY INTO PLANNING & MODELING

Given the rapid growth of shared mobility and its potential impacts on communities, shared mobility can be an important consideration as part of the transportation planning process. McCoy, Andrew, & Lyons (2018) describe the planning process as a two-way relationship, displayed in Figure 15.1 below. First, the plans and decisions of Metropolitan Planning Organizations (MPOs) and their partners shape local and regional travel behavior. Similarly, MPO planning goals and products are shaped by traveler behavior and preferences. It is important for MPOs to incorporate shared mobility into the planning process as shared mobility may change user travel behavior. This relationship can also be applicable for planning at the local level.

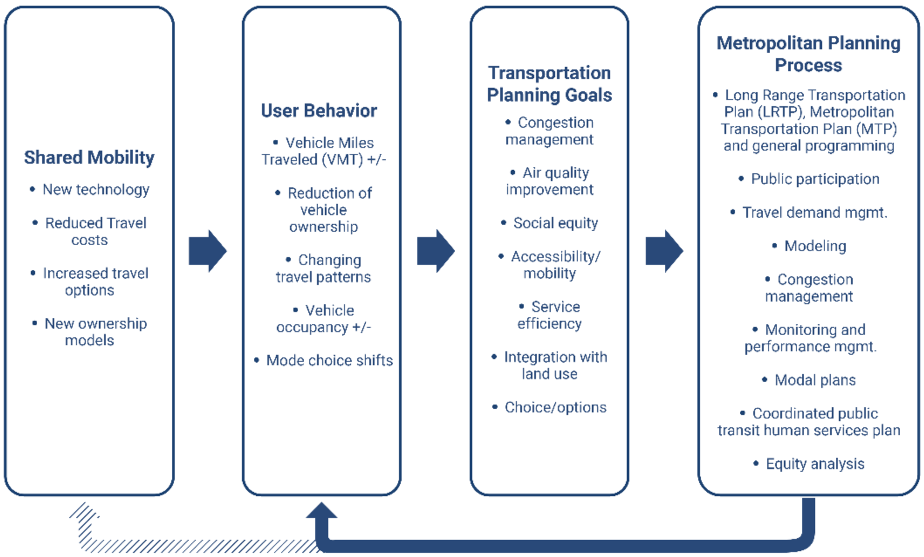

Figure 15.1. The Transportation Planning Process. Illustration courtesy of McCoy, Andrew, & Lyons (2018)

This toolkit describes the impacts of shared mobility on travel behavior. Next, the toolkit introduces readers to the state of practice for incorporating shared mobility into transportation planning and modeling. Finally, the toolkit outlines challenges and opportunities to modeling and the transportation planning process.

Travel Behavior Impacts of Shared Mobility

Understanding the impacts of shared mobility on travel behavior can assist public agencies who seek to achieve long-term goals for mobility, equity, and the environment. Preliminary research has shown that shared mobility may have impacts on modal choice, vehicle miles traveled (VMT), and greenhouse gas (GHG) emissions. Impacts on travel behavior may vary based on the type of shared mode a traveler uses and context-specific variations (e.g., public transit accessibility, built environment). For example, research indicates that shared mobility can reduce or replace private-vehicle trips; likewise, shared mobility can both complement and compete with public transit depending on the context in which it is deployed. Additional research on the impacts of shared mobility is needed as new modes and service models evolve (Circella, Lee, & Alemi, 2019; Cohen & Shaheen, 2016; Feigon & Murphy, 2016; Taylor et al., 2016).

State of Shared Mobility in Planning and Modeling

Transportation Planning and Shared Mobility

Planning allows public agencies to guide transportation network growth and future infrastructure development. Transportation planning is conducted at various levels (Cohen & Shaheen, 2016):

- **Comprehensive plans** are a set of long-term goals and policies that communities (typically larger geographical areas) use to guide development decisions around a specific issue, such as transportation.
- **Community plans** focus on smaller areas, such as a neighborhood. Community plans address specific issues in more detail, such as establishing the locations and availability of shared mobility services within neighborhoods.
- **Specific plans** are used to implement particular planning provisions in limited geographic areas. For example, a specific plan can be used to illustrate how shared

mobility can be deployed at a specific site.

Traditionally, transportation planning efforts have been driven by the public sector and characterized by incremental technological changes (e.g. expansion of highways and fixed route transit, followed by a focus on better operations and management of existing infrastructure) (McCoy et al., 2018). The fast pace of technological innovation and private sector deployments, coupled with rapidly changing traveler behavior, presents challenges in planning for shared mobility. These independent processes require that public agencies adapt to ensure that transportation planning remains both relevant and effective for traveler choices and infrastructure investments.

Transportation Modeling and Shared Mobility

MPOs develop travel demand models to anticipate how trends in regional population, employment, and land use can impact the transportation network, infrastructure investment, and programming. Travel demand models draw from user surveys of previous travel decisions to inform future activity; however, MPOs may not have sufficient information on shared mobility's impact on travel behavior due to the lack of shared mobility user surveys or shared private operator data, making existing data unreliable for forecasting purposes. For example, the lack of shared mobility data complicates our understanding of shared mobility's ability to complement or compete with public transportation. Innovative modes present novel opportunities for modeling, although unknown factors and assumptions about their system-wide implementation may present challenges to incorporating them into current transportation models.

Challenges Facing Shared Mobility in Planning and Modeling

Many challenges exist to incorporating shared mobility in planning and modeling efforts. These include: 1) the lack of formal definitions for shared modes, 2) competition or lack of cooperation among service providers and stakeholders, and 3) varying impacts that shared mobility can have in different built environments. As mentioned in earlier sections, the lack of consistent, reliable data also presents a challenge.

Challenges to Data Collection and Standardization Practices

Traditionally, public agencies have relied upon public transit data or self-reported survey data for planning and impact evaluation. The growth of shared mobility offers a new opportunity to understand the impacts of these services as they typically collect detailed information about trips, fleet operations, customer demographics, and travel behavior. However, public entities face challenges obtaining shared mobility data such as: 1) collecting data that might be viewed as proprietary by private operators, 2) complying with privacy concerns over user data, and 3) inconsistent data sharing across modes and service providers.

This reluctance to share data may make it challenging for MPOs to keep pace with an evolving marketplace. The impacts of shared modes on congestion, mode shift, and vehicle use are difficult to evaluate without actual data. Additionally, even if data are shared with the public sector, there can be challenges with data completeness, level of detail, and data fidelity. Data sharing across multiple operators may vary in the types of data and format provided, and at present there are not many incentives for operators to provide data consistently with the public sector.

Best Practices to Integrate Shared Mobility into Planning and Modeling

Given the rapid pace of development in shared mobility, local governments and cities may lack the data expertise to conduct thorough research. The following sections address opportunities to incorporate shared modes into planning and modeling.

Incorporating Shared Mobility into the Planning Process

Table 15.1 presents potential roles public agencies can undertake to incorporate shared mobility into the planning process. One such role is the collection, analysis, and dissemination of data. Public agencies can rely on established techniques to collect information about shared mobility traveler preferences and behaviors to advance understanding of shared mobility impacts. Additionally, public agencies can enhance data collection efforts by fostering partnerships with shared mobility operators. These partnerships can initially be deployed as pilots to determine how shared mobility can support planning goals. Partnerships can produce opportunities for learning, evaluation, public involvement, and future collaborative projects.

To ensure fair treatment of communities and meaningful involvement of the public during shared mobility pilot projects, public agencies can encourage public and stakeholder engagement during the planning process. Public involvement can provide public agencies and shared mobility providers with community and stakeholder concerns. With this information, public agencies can work to reduce opposition, provide opportunities that address public concern, and help jurisdictions comply with environmental justice requirements (Cohen & Shaheen, 2016).

Table 15.1 Potential Roles for Public Agencies in Shared Mobility Planning

	MPO	Local Government	Public Transit Agency	State DOT
Regulating shared mobility operations		X		X
Regulating the use of public rights-of-way and curb space		X	X	X
Data collection, analysis and dissemination	X	X	X	X
Partnerships with shared mobility providers to complement public transit or transportation demand management (TDM)	X			
Training and technical assistance for regional partners	X			
Thought leadership and research	X			X
Regional coordination and consensus building	X			
Integration into transportation plans and programs of projects	X	X	X	X

Adapted from McCoy et al. (2018), pp. 14

Incorporating Shared Mobility into Modeling

A number of public agencies are developing strategies to better incorporate shared mobility into their modeling and forecasting efforts. McCoy et al. (2018) identifies three emerging practices and strategies:

- **Incorporating shared mobility in travel surveys -** Public agencies can explicitly incorporate shared mobility modes into travel surveys.
- **Collecting data continuously -** The rapid evolution of shared mobility services limits the accuracy of travel surveys distributed periodically, as the questions will only reflect services available at the time of survey distribution. Public agencies can increase the frequency of data collection to more accurately reflect travel behavior.
- **Using off-model approaches to estimate shared mobility impacts -** “Off-model”

approaches refer to analyses conducted outside of transportation models to account for impacts that these models are not equipped to handle. Examples include sensitivity analysis, working with activity data, and developing new analysis methodology.

Key Takeaways

- The consideration of shared mobility is increasingly important for the transportation planning process. The growth of shared mobility services may impact travel behavior and preferences, which help determine public agency planning goals.
- Public agencies can enhance data collection efforts through partnerships with shared mobility operators. Partnerships can initially be deployed as pilot programs, producing opportunities for learning, evaluation, and future collaboration.
- Travel demand models draw on user surveys of previous travel decisions to help anticipate future travel activity. Public agencies may not have sufficient data on the travel behavior impacts of shared mobility. Three possible strategies to incorporate shared mobility into modeling and forecasting efforts include: 1) incorporating shared mobility into household travel surveys, 2) collecting data continuously, and 3) using off-model approaches to estimate the impacts of shared mobility (McCoy et al., 2018).

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MULTIMODAL TOOLS AND TRIP PLANNERS

Travelers are increasingly turning to smartphone applications for an array of mobility services. Recent technological advancements allow consumers to efficiently use multimodal smartphone apps. As a result, consumers are increasingly saving time and money by using apps to plan routes, seek departure information, and access or dispatch a travel mode. Multimodal apps can typically be divided into one of two services:

Multimodal aggregators combine various travel modes - such as carsharing, shared micromobility, microtransit, transportation network companies (TNCs, also known as ridesourcing and ridehailing), taxis, public transportation, etc. - into a single-digital platform that lists transportation options, provides real-time information, and enables multimodal booking and payment.

Trip planners help users navigate to their destination based on their travel preferences (i.e., to find the fastest route, find the least expensive route, or prioritize public transportation).

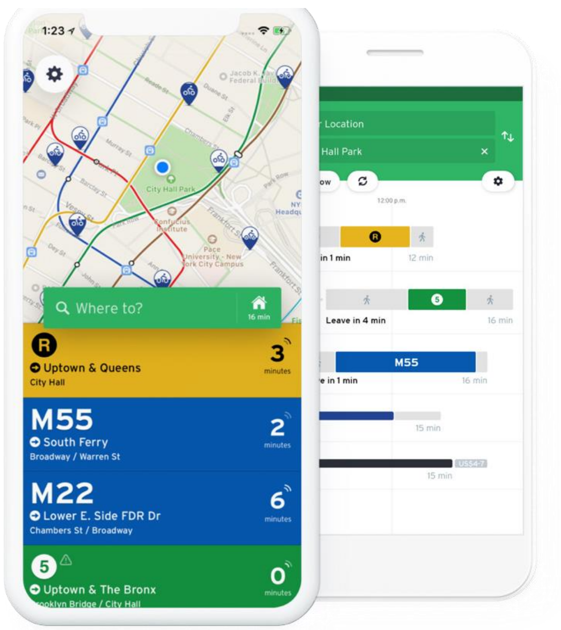

Figure 16.1. Transit is a smartphone based multi-modal trip planning app used in more than 175 cities worldwide. Photo Courtesy of Transit

For definitions of the types of smartphone apps impacting shared mobility, please refer to the Definitions Toolkit.

This toolkit provides policy considerations for fare integration, data sharing and interoperability, and equity concerns for app-based services. This toolkit concludes with case studies from public agencies that have deployed multimodal smartphone apps.

Policy Considerations for Multimodal Apps

Public agencies can facilitate multimodal services and enhance smartphone app capabilities through several policy considerations. This section discusses 1) fare payment integration, which allows users to plan and pay for an entire trip; 2) data sharing that supports the ability to provide real-time transportation system information to travelers; and 3) equity concerns for multimodal tools and trip planners.

Integrated Fare Payment

With a growing array of transportation apps, fare payment is becoming increasingly complex for users. A user may be able to plan an entire trip on a single app, but generally multimodal connections will require multiple fare payments. Smartphone apps offer an opportunity to integrate fare payment into a single interface where a user plans, executes, and pays for an entire trip. Integrated fare payment can make multimodal trips more affordable and convenient for users (Shaheen, Cohen, Zohdy, & Kock, 2016a).

The case studies below include: 1) a statewide initiative to institute integrated fare payment and 2) the development of an integrated payment platform for city-wide public transit services.

California

In 2018, California stakeholders formed the California Integrated Travel Project (Cal-ITP) to enhance integrated trip planning and fare payment (Capitol Corridor Joint Powers Authority, 2019). The group formed in response to escalating costs, increasing demand for paratransit, and the perceived need to develop new public sector business models to provide multimodal strategies. Cal-ITP plans to implement a single payment mechanism that would be valid across state-funded rail, public transit, and paratransit services. A pilot program is planned to launch in 2022 (Gradinger, 2018).

Columbus, OH

The U.S. Department of Transportation (USDOT) launched the Smart City Challenge, inviting mid-sized cities to develop ideas for an integrated, smart transportation system. As the challenge winner, Columbus proposed an integrated payment platform for the city's various public transit services as part of its smart mobility plan. When enacted in 2020, Columbus' Common Payment System (CPS) will enable users to pay for multimodal trips and parking options from a single account, linked to various payment media and user preferences. CPS intends to be integrated with the Central Ohio Transit Agency, providing users a shared account with access to existing fare products and fare payment equipment across the regional transit network (Bishop, 2019; Wolpert, Kavanagh, & Baker, 2018).

Data Sharing and Interoperability

Data sharing and interoperability facilitate the exchange of information between public and private operators, providing the foundation for multimodal apps and trip planners. Public and private entities can facilitate and define data sharing through public-private partnerships. Public agencies can also offer open data, providing the private sector with freely available, machine-readable public transit data. This allows public agencies to provide real-time public transit information to communities without the cost of developing mobile apps themselves. Public agencies should address the following items when providing open data (Shaheen et al., 2016a):

- **Data accessibility** - Ensure data are available in an open format that can be downloaded, indexed, searchable, and machine-readable to allow automated processing.
- **Open licensing** - Ensure data are available to the public for use at little to no cost.
- **Data quality and timeliness** - Ensure data are high quality and made available as quickly as possible and frequently enough to remain current and usable.

App-Based Services and Equity

The use of smartphone apps in shared mobility can raise a number of equity concerns such as:

- **Digital Poverty** – App-based services require a user to own a smartphone and subscribe to high-speed data.
- **Data Service Availability** – Gaps in data service coverage, such as rural communities,

may limit access to transportation services only available through an app.

- **Un- and Under- Banked Households** – Many apps require the use of a debit or credit card for payment, limiting access to households without certain types of banking products.
- **Accessibility and Universal Design** – Apps may not be accessible for people with disabilities.

Providing alternative forms of access and payment (i.e., digital kiosks, telephone services, and cash payment) may be able to help overcome barriers to payment. Incorporating universal design principles into app-based services is also key to ensuring access for people with disabilities. Providers can incorporate voice-activated mobility app features. For users who may face language barriers, providers can develop multi-lingual apps and marketing.

The following section reviews two pilot programs in which public agencies developed multimodal smartphone apps incorporating public transit data and private operator data.

Multimodal App Case Studies

Multimodal apps can bridge communication gaps between travelers, public transit, and shared mobility. Developing the app services, data structures, and interface may require substantial resources and coordination. The Federal Transit Agency (FTA) Mobility on Demand (MOD) Sandbox program provided funding for project demonstrations of innovative MOD concepts with the goal of improving transportation efficiency through enabling technologies and public-private partnerships. Two FTA MOD Sandbox demonstrations developed multimodal apps including:

Portland, OR

In 2018, Portland's public transit operator began partnering with bikesharing and TNC providers to test the new TriMet Trip Planner. The primary goal of the app is to allow riders to book and pay for trips within a single interface. Trimet's app is based on OpenTripPlanner, an open source software tool developed in Portland, which has since been adopted in dozens of cities worldwide (Descant, 2018; Cordahi, Shaheen, Martin, & Hoffman-Stapleton, 2018b).

Figure 16.2. TriMet Trip Planner app. Photo courtesy of TriMet.

Dallas, TX

Dallas Area Rapid Transit (DART) operates a variety of services, including public transit, paratransit, and vanpool services. DART has leveraged its GoPass ticketing app and application program interfaces (APIs) available through shared mobility providers to integrate first- and last-mile connections, such as carpooling, microtransit, taxis, and TNCs (Cordahi, Shaheen, Martin, & Hoffman-Stapleton, 2018a).

Figure 16.3. Images of the GoPass ticketing app. Photo Courtesy of DART.

Key Takeaways

- With the growth of mobile apps, public transit agencies are able to leverage multimodal and trip planning apps to provide integrated traveler services with shared mobility.
- Multimodal and trip planning apps can enhance traveler convenience, improve decision making, and streamline the payment process for users (Shaheen, Martin, Cohen, Musunuri, & Bhattacharyya, 2016b).
- Public agencies should consider policies that encourage integrated payment systems, data sharing, and data interoperability to enable the development of multimodal trip

planners and aggregators.

- App-based services can raise a number of accessibility and equity concerns. Providing alternative access methods, such as digital kiosks, telephone services, and cash payment may help overcome many of these barriers. Incorporating universal design principles into app-based services is also key to ensuring access for people with disabilities.

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SHARED MOBILITY AND ELECTRIFICATION

In the transportation sector, electrification refers to the transition from diesel- or gasoline-powered internal combustion engines (ICEs) to electric motors as the source of vehicle propulsion. Vehicles that use electricity as their sole source of power can run on renewable energy instead of energy from fossil fuels. Electric-powered zero emission vehicles (ZEVs) charged using clean energy sources support shared mobility goals by eliminating emissions produced by fossil fuels. Cities can support the electrification of shared mobility through policies that broaden the use of electric vehicles (EVs), expand electric charging infrastructure, and increase the generation of renewable energy to support EVs. This section presents policies and examples on vehicle (e.g., electric carsharing and transportation network companies (TNCs)) and shared micromobility (e.g., electric bikes and scooters) electrification from around the United States (U.S.). Policies specific to medium- and heavy-duty electric vehicles (e.g., freight trucks, buses, and trains) remain important to emissions reductions goals, however, they are not covered in this toolkit.

Figure 17.1. Electric Vehicles at a Charging Station. Photo Courtesy of Shutterstock

State of the Practice in Shared Fleets Electrification

Shared mobility services that use EVs and electric shared micromobility can expand access to affordable, clean transportation for all users. The adoption of electric shared mobility can reduce consumer costs associated with transportation services and reduce transportation-related emissions. Additionally, electric shared mobility can increase awareness and access to EVs and charging infrastructure. Current barriers to electrification of shared mobility include high vehicle costs, a lack of awareness around EVs, and limited charging infrastructure. Moreover, the lack of consistent and readily available charging infrastructure limits the ability of shared mobility providers to increase EVs in their fleets and generates "range anxiety" in users. This section presents policies and examples on EV and shared micromobility electrification from around the U.S.

Carsharing Fleet Electrification

Through partnerships with privately operated carsharing providers, municipalities have brought EV carsharing to areas otherwise underserved by carsharing providers. A 2015 report by the Greenlining Institute offers several essential policy considerations for designing a public-private carsharing program to support underserved communities. Suggested policies call for policy makers to:

- Create a "pooled risk" fund to offset the cost of deductibles faced by low-income drivers;
- Allow public transit subsidies to apply to carsharing services;
- Form partnerships among property managers, carsharing operators, utilities, and charging station companies to reduce costs and administrative burdens;
- Consider a carsharing operator's experience in serving low-income communities and incorporating EVs into their fleets before forming a partnership; and
- Consider EV vanpooling/carpooling as an alternative to carsharing in rural low-income areas (Espino & Truong, 2015).

Los Angeles and Sacramento, CA

The California Air Resources Board (CARB) has established a program using state Cap-and-Trade funding to fund electric and hybrid carsharing services for low-income communities. The Los Angeles "Leading by Example" program provides for EV carsharing and charging stations to over 7,000 residents previously unserved by this mode. In Sacramento, the "Our

Community Car Share Sacramento" program provides free shared electric and hybrid carsharing vehicles to residents of affordable housing projects (California Air Resources Board, 2016).

TNC Fleet Electrification

States and cities have adopted policies that require TNCs to adopt clean-air vehicles. One study estimates that if half of TNC and taxi drivers in New York and San Francisco converted to EVs, they would annually offset 1.5 billion pounds of carbon dioxide (CO2) from the atmosphere while improving local air quality (Li & Fitzgerald, 2018). California's Clean Miles Standard and Incentive Program (SB-1014) sets a timeline for reduction of greenhouse gas (GHG) emissions and a requirement to increase the number of EVs in TNC fleets (Anair, 2018).

The International Council on Clean Transportation's 2019 policy brief *Emerging Policy Approaches to Electrify Ride-Hailing in the United States* provides summaries of state policy actions (see Table 17.1) and city policy actions (see Table 17.2) that combine charging infrastructure, pricing, and rights-of-way policies to encourage the adoption of EVs by TNCs.

Table 17.1 Summary of State-Level Support Policies for TNCs

Action	Policy Overview
Fleet regulations	• Implement fleet-based ZEV regulations for commercial fleets (e.g., TNCs, taxis) to have increasing ZEV share to complement the automaker-focused ZEV regulation • Implement fleet-based CO_2 regulations to reduce emissions per passenger mile, incentivize electrification, and increase the percentage of shared rides
Financial incentives	• Incentivize with point-of-sale rebates, tax exemptions, or financing to reduce the upfront cost differential between electric and gasoline models for purchases and leases • Ensure commercial fleets are eligible for incentives, contingent upon submission of public data that verify high annual electric vehicle miles traveled
Public charger promotion	• Exempt taxes to partially reduce charging infrastructure installation costs • Direct funding for key fast-charging destinations including airports and urban transportation hubs
EV-friendly pricing schemes	Exempt electric cars in TNC fleets from existing state fees and registration taxes • Grant authority to city governments to implement pricing schemes on TNCs (as demonstrated by California and San Francisco) with EV incentives
Data reporting requirements	• Require data collection; monitoring, validation, and publicly share data on portions of vehicle miles traveled by TNC-owned or operated EVs for each fleet

Adapted from: (Slowik et al., 2019)

Table 17.2 Summary of City-Level Support Policies for TNCs	
Action	**Policy Overview**
EV action plans	• Incorporate TNC-specific strategies in city electric vehicle action plans to identify and shape local actions to overcome adoption barriers
Streamline DC fast charger permitting	• Streamline permitting to expedite installation of charging infrastructure, especially DC fast chargers in urban areas with high TNC vehicle usage
EV-ready building codes	• Adopt EV-ready building codes to ensure charging infrastructure everywhere, including multi-unit dwellings, curbside, and public DC fast charging
Public rights-of-way for parking and charging	• Permit public rights-of-way to be used for constructing EV charging infrastructure, including strategically dedicating electric TNC vehicle parking
Partner with shared fleets	• Form partnerships with shared mobility companies to overcome barriers, identify optimal charging locations, and cost-share charging infrastructure installation
Preferential access to curb space	• Convert parking into designated areas for EV pickup and drop-off by TNCs
Preferential lane access	• Allow verified shared EVs in TNC fleets to use public transit-only and high occupancy vehicle (or HOV) lanes
Priority queue at key locations	• Grant priority access for EVs in TNC fleets to queues at airports, train stations, public transit hubs, taxi ranks, and other locations
Implement vehicle licensing caps	• Implement TNC fleet vehicle license cap to limit gasoline-powered vehicles, and incrementally increase the share of permits that go to EVs each year
Low-emission areas	• Restrict vehicle traffic in select areas within the city, exempting only vehicles that emit zero emissions and are shared among multiple passengers
Pricing schemes	• Implement or adapt pricing structures (e.g., price per trip or per mile) to be proportional to vehicle emission levels • Exempt EVs in TNC fleets from fees
Partnerships	• Partner with TNCs to identify ways to complement public transit systems and provide first- and last-mile connections • Require TNCs to meet minimum electric share to join partnership

Adapted from: (Slowik et al., 2019)

Utilities also play an important role in promoting EV adoption by TNCs. Table 17.3 introduces policies that utilities can adopt to support EV adoption.

Table 17.3 Summary of Utility Support Policies for Electric TNCs

Action	Policy Overview
Dedicated DC fast chargers	• Invest in dedicated DC fast charging for TNC fleets, optimally placed for high use and to reduce deadheading, increase sharing, and complement public transit
Time-of-use rates	• Offer rate plans that include lower rates for charging EVs in TNC fleets, linked with required data sharing
Preferential EV rates	• Provide a special rate plan for EV charging • Modify tariff structures to initially minimize or eliminate demand charges
EV or DC fast charger incentives	• Offer incentives for EVs in TNC fleets • Offer incentives for dedicated fast-charging infrastructure for EVs in TNC fleets
Informational materials, cost comparison tools	• Provide information tailored to TNC drivers to raise awareness and understanding of electric models, incentives, and charging options • Offer a total cost of ownership tool specific to TNC drivers and fleets to increase understanding of the economic benefits of EVs

Adapted from: (Slowik et al., 2019)

Maven Gig

In six U.S. cities, Maven carsharing allows drivers to rent Chevrolet vehicles for TNCs and delivery businesses through its Maven Gig program. Drivers can choose to rent the Chevrolet Bolt EV starting at $374 per week with unlimited free charging. By providing EV carsharing to TNC drivers, the service helps overcome barriers to EV ownership and helps reduce vehicular emissions from TNC fleets (Maven Gig, 2019).

Expanding Charging Infrastructure for Shared Fleets

Expanding access to charging infrastructure can support the adoption of electric shared mobility. Selected ways to expand charging infrastructure for shared mobility fleets include (Slowik et al., 2019):

- **Enhancing Charging Infrastructure at Multi-family Residences -** Expanding EV charging at multi-family residences can serve a multi-purpose function of providing charge points for residential carsharing and residents (including TNC drivers). Policies and funding that support the expansion of EV charging at higher density residential locations is one method to increase shared mobility electrification.

- **Expanding Charging Infrastructure for Underserved Communities -** Historically, low-income and minority communities have been less likely to use electric modes, including electric shared mobility. Policies and programs that target expanding access to electric charging stations in disadvantaged communities is one way to expand electric shared mobility access. For example, BlueLA, an all-EV carsharing service in Los Angeles, has charging points strategically located in low-income neighborhoods near downtown (Coplon-Newfield & Lunetta, 2017).

Figure 17.2. Photo of BlueLA EV. Photo Courtesy of BlueLA

State of the Practice in Shared Micromobility Electrification

The number of electric scooter sharing and bikesharing systems is increasing across the U.S. Both offer an affordable first- and last-mile strategy. Because these micromobility services are electric, they offer opportunities to reduce transportation emissions. Electric-assist devices can also provide an easier riding experience, especially for cities with inclined surfaces. Public agencies can support electric micromobility options by partnering with private operators to deploy pilot programs, as well as expanding electric charging infrastructure for micromobility devices.

Birmingham, Alabama

In Birmingham, the city established the first station-based electric bikesharing program. Zyp BikeShare has 100 Pedelec electric-assisted bicycles charged by solar-powered kiosks. Zyp also offers 300 standard bicycles (Angell, 2017; Zyp, 2019).

Figure 17.3. Zyp BikeShare Station. Photo Courtesy of Zyp Bikeshare

Expanding Charging Infrastructure for Shared Micromobility

Public agencies can support shared micromobility electrification by providing a network of reliable charging stations. A growing number of companies - such as Swiftmile and Charge - are offering combined charging and parking stations for micromobility. Charging stations can be adapted for station-based or dockless systems and may be powered by plug-in or solar power.

Charge's Electric Scooter Charging Stations

New York-based company Charge has developed charging stations for standing electric scooters that could be housed in parking lots, garages, gas stations, and other off-street locations. The company has plans to locate up to 400 charging stations across New York City that could support up to 10,000 scooters. Users would be able to locate docking stations through a map on the Charge app, which would also identify available scooters and their level of charge. The company is currently developing partnerships with parking companies and anticipates scooter sharing providers will cover the cost of charging for their users. In August 2019 Charge

Figure 17.4. A Charge scooter station in a parking garage. Photo Courtesy of Harol Baez/Charge

unveiled a demo location in New York City (GetCharged, Inc, 2019; Rosenberg, 2019).

Electric Shared Mobility Hubs

Shared mobility hubs are places where transportation connections, traveler information, last-mile delivery, and other traveler amenities are co-located and aggregated into a seamless travel experience. Shared mobility hubs are generally located at major public transportation hubs or park-and-ride facilities. Most importantly, they are located at places where frequent services converge to allow convenient connections between mobility services. Mobility hubs may also include public transit oriented and joint development to create walkable destinations.

Shared mobility hubs represent a key opportunity for public agencies to support the electrification of shared mobility services by providing safe and reliable charging infrastructure. By providing charging stations at shared mobility hubs, public agencies can create synergies between shared mobility and electrification that further support emission reductions and accelerate the adoption of electric mobility options.

Key Takeaways

- In the transportation sector, electrification refers to the transition from internal combustion engines (ICEs) to electric motors as the source of vehicle power. EVs powered by low carbon energy augment California's climate goals by reducing transportation emissions.
- Shared mobility provides a low-cost opportunity to increase EV access, as well as provide outreach to non-EV owners. For example, the presence of EVs in a TNC fleet can introduce passengers to new vehicle technologies.
- Expanded access to charging infrastructure - particularly at multifamily residences, apartment buildings, and in underserved communities - will be needed to serve the growing number of EVs.
- Public agencies can support shared micromobility electrification through partnerships with private operators and expanded charging infrastructure.
- Shared mobility hubs are located at places where transportation services and traveler amenities converge to allow convenient connections between mobility services. Providing safe and reliable charging infrastructure at shared mobility hubs is a key opportunity for public agencies to support shared mobility.

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Conclusion

Shared mobility is an innovative transportation strategy that is continuously evolving and reshaping urban mobility. Over the past two decades, shared mobility services have rapidly grown in the U.S. and around the globe. Shared mobility requires thoughtful policies and planning to help maximize potential benefits. Public agencies can ensure that shared mobility supports a range of social and environmental benefits by: 1) developing policies that enhance equity and accessibility, 2) encouraging competition and modal choice through public policy, 3) supporting multimodal transportation, and 4) preparing for the transition to automated and electric mobility. Prudent public policy can help public agencies:

- Provide gap filling services and help bridge first- and last-mile connections with public transportation;
- Promote social, interregional, and intergenerational equity to meet the basic transportation needs of all travelers;
- Manage limited rights-of-way more equitably for all modes and users;
- Integrate shared mobility with new and existing developments to support sustainable and vehicle-lite lifestyles;
- Enhance understanding of shared mobility impacts through data sharing and research;
- Prepare public infrastructure for the growth of shared mobility through planning and modeling;
- Simplify multimodal travel through integrated traveler services such as mobility hubs, integrated fare payment, and information services; and
- Prepare communities for the deployment of shared automated vehicles.

Transportation is undergoing a rapid transformation. The policies discussed in this toolkit reflect current understanding and will continue to evolve. Ongoing research and collaboration among stakeholders are necessary to ensure an equitable and sustainable transportation future.