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What's the 'Big' Deal with Shared Micromobility?

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Shared micromobility – or short-term access to shared bikes and scooters – provides a flexible alternative for households living in urban areas, individuals seeking first- and last-mile connections to public transportation, and those without access to a private vehicle trying to reach jobs and essential services. In this paper, the authors discuss the history, growth, and evolution of bike and scooter sharing in North America; summarize the demographics and impacts of shared micromobility; and explore shared micromobility policies and practices for managing devices and operations such as: device caps, service area limitations, designated parking areas, fees, equipment/operational requirements, and enforcement. In the future, enhancements in device automation, battery range, charging times, and weight are likely to contribute to the evolution and development of additional devices and service models, which could allow improved range and e-hail for shared micromobility devices.

Over the last two decades, a variety of social and technological factors have converged contributing to the growth of the sharing economy. The sharing economy is a phenomenon based on renting and borrowing goods and services, rather than owning them. The sharing economy can improve efficiency, provide cost savings, monetize underused resources, and offer social and environmental benefits. Shared micromobility, the shared use of a bicycle, scooter, or other low-speed transportation modes, is one facet of the sharing economy.

Shared micromobility in US cities has been on a relatively steep growth curve, starting in the early 2010s. Micromobility systems offer shared active transportation and low-speed modes for first- and last-mile trips, many-mile trips, or both in an urban environment (Shaheen *et al*., 2019*a*). Shared micromobility is an innovative transportation strategy that grants users short-term access to a transportation mode on an as-needed basis. Shared micromobility includes various service models and transportation modes that meet diverse traveller needs, such as station-based and dockless micromobility. With a station-based system, a bicycle or scooter is picked up from and returned to any station or kiosk. In a dockless system, a bicycle or scooter is picked up and returned to any location (Shaheen and Cohen, 2019).

Common modes include bikesharing and scooter sharing. *Bikesharing* provides users with on-demand access to bicycles at a

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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, neighbourhood, employment centre, and/or university campus (Shaheen *et al.*, 2019*a*). *Scooter sharing* allows individuals to access scooters by joining an organization that maintains a fleet of scooters at various locations. Bike and scooter sharing models can include a variety of motorized and non-motorized scooter types. Scooter usage rates typically include gasoline or electric charge (in the case of motorized bikes and scooters), maintenance, and may include parking. Scooter sharing can include different types of scooters, such as moped-style and standing electric scooters (*ibid.*). These modes are illustrated in figure 1.

Both bike and scooter sharing can be deployed in one of three service models: (1) station-based systems that enable access to bicycles via unattended stations; (2) dockless systems that allow users to check out a bicycle and return it to any location within a predefined geographic region; and (3) hybrid systems that enable users to check out a bicycle from a station and end their trip by either returning it to a station or a non-station location or *vice versa* (*ibid.*).

Shared micromobility has the potential to offer an array of individual and community benefits, such as increased mobility, greater environmental awareness, and

Station-based Bikesharing


Dockless Bikesharing


Standing Electric Scooter Sharing


Moped-style Scooter Sharing

Figure 1. Common types of shared micromobility. (*Sources*: (*clockwise from top left*): Henderson, 2018; Seattle Department of Transportation, 2018; Emat, 2020; Manthey, 2020)

increased use of active transportation and non-vehicular modes (SFMTA, 2019; Skip, 2019; Shaheen *et al*., 2019*a*). With careful planning and public policy, micromobility can also enhance accessibility and quality of life in cities (Shaheen *et al*., 2019*a*; Martin *et al*., 2016; ADA National Network, 2015; SFMTA, 2020). Organized in five sections, this article discusses the growth of shared micromobility, its impacts on users and communities, and policy considerations for managing the potential adverse impacts of shared micromobility on curb space management (Shaheen *et al*., forthcoming). The first discusses the growth and evolution of shared micromobility in the US. The next section summarizes the research methods used for this article. In the third section, the paper discusses the user demographics and impacts of shared micromobility. The fourth examines shared micromobility policies and practices, including two policy case studies from Seattle, Washington and Santa Monica, California. In the final section, the authors conclude with a discussion of the future of shared micromobility.

Methodology

This paper employed a mixed-method qualitative approach to researching shared micromobility in North America. First, the authors conducted a comprehensive review of shared micromobility literature which included academic databases, government reports, conference proceedings, and other items. This review was supplemented with an Internet search documenting recent and planned developments. In addition, the research team conducted four focus groups to gain insight into concerns associated with micromobility from a user and non-user perspective. The research team recruited focus group participants through online forums (e.g. Craigslist) and paper flyers distributed in Berkeley, California; Arlington, Virginia; and Washington, DC. The advertisements and flyers included information about the focus group (e.g. subject, time, location, research team contact information). Participants could sign up online or by calling the phone number provided. The research team screened focus group participants on a first-come, first-served basis based on their experience with micromobility and demographic diversity. The research team separated focus group participants into groups based on their previous experience with shared micromobility (i.e. users, non-users). In addition, the authors conducted forty-two expert interviews between September 2019 and September 2020 with practitioners and policymakers to better understand the history and evolution of shared micromobility, opportunities and challenges from the public and private sector perspectives, and issues related to the Covid-19 pandemic. The research team developed an expert interview protocol for subject matter experts and senior-level officials involved in shared micromobility policy and planning. The experts represented academia, non-profit organizations, the public and private sectors, community-based organizations, and shared micromobility service providers. Experts were selected based on their experience with micromobility policy, planning, and implementation. Each of the interviews lasted approximately one hour. As with any qualitative research, the insights from the experts and focus group participants may not be entirely unbiased. To attempt to mitigate potential bias, experts and focus group participants were asked standard questions, and an effort was made to engage multiple participants representing diverse backgrounds. Responses were aggregated for the analysis to ensure the objectivity of the final results.

Growth and Evolution of Shared Micromobility

Recent growth of shared micromobility over the past decade includes four milestone periods depicted in figure 2 and described below.

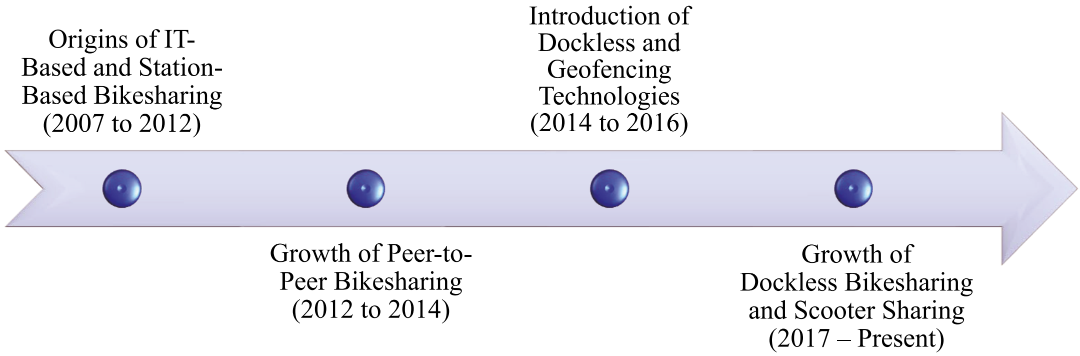

Figure 2. Shared micromobility milestone growth periods.

Origins of IT-Based Micromobility and Station-Based Bike Sharing (2007 to 2012)

North America's first information technology (IT) enabled bike-sharing system, Tulsa Townies, started operating in 2007 in Tulsa, Oklahoma. Tulsa Townies was the first mobile solar-powered, IT station-based system in the world. The service is free of charge, with a credit card refundable deposit. By 2012, IT-enabled station-based bikesharing had grown to twenty-two operators in the US, claiming approximately 884,442 users sharing 7,549 bicycles (Shaheen *et al*., 2014).

Growth of Peer-to-Peer Bike Sharing (2012 to 2014)

Approximately five years after the launch of station-based bike sharing, a variety of dockless technologies began to emerge, enabling new operational and business models such as peer-to-peer (P2P) bike sharing. P2P micromobility services involve the sharing of privately owned micromobility devices where companies broker transactions among micromobility owners and guests by providing the organizational resources needed to make the exchange possible (e.g. locking mechanism, online platform, etc.) (Shaheen *et al*., 2019*a*). In 2012, Spinlister, a smartphone application, launched a P2P bicycle rental marketplace where a bike owner could make their bicycle available to others for short time periods, enabling direct exchanges between individuals via the Internet. Spinlister eventually shut down in April 2018, but it relaunched in January 2019 with new features including remote locking and bicycle delivery (a bicycle brought to a user). At the same time that Spinlister was launching in 2013, another company, BitLock, created a keyless bike lock accessible via smartphone technology, enabling another P2P bikesharing option (Shaheen *et al*., 2014).

Introduction of Dockless and Geo-Fencing Technologies (2014 to 2016)

Shortly after the introduction of P2P bikesharing services, a number of bikesharing startups launched dockless or flexible docked bikesharing systems, featuring 'smart bikes' that host the locking mechanism on the bike rather than the dock (Shaheen *et al*., 2012). Dockless and flexible docking systems enable users to pick-up and drop-off bicycles anywhere within a geographic area by locking the bicycle to a bikesharing station, existing bicycle parking, street furniture, or a designated bikesharing rack. Users identify bicycle availability and locations in real time through mobile or Internet applications or via bikesharing kiosk screens. The geographic proximity of bikesharing (docked and dockless systems) can be limited through 'geo-fencing'. A geo-fence is a virtual perimeter, which limits the range of mobility of an enabled bicycle, by comparing the GPS coordinates of the bicycle to the allowable geographic area (Shaheen *et al*., 2019*b*).

Growth of Dockless Bikesharing and Scooter Sharing (2017 to Present)

Beginning around 2017, the number of bikesharing providers began notable growth. In addition to docked or station-based services provided by B-Cycle, Motivate, Zagster, and Social Bicycles, a number of new dockless vendors entered the marketplace including: JUMP (formerly Social Bicycles), Limebike, MoBike, Ofo, Spin, and an array of smaller vendors and service providers. In September 2017, Bird became the first app-based scooter-sharing provider to launch in Santa Monica, California. Several other companies launched shortly after (Linton, 2019). The National Association of City Transportation Officials (NACTO) estimates that there were 136 million shared micromobility trips (scooters and bikes) in the US in 2019 (including 86 million trips with standing electric scooter sharing, 10 million dockless electric bikesharing trips, and 40 million station-based bikesharing trips) (NACTO, 2019*a*). Between 2010 to 2019, 343 million shared micromobility trips were completed in the US. In spite of this growth, a number of cities saw a reduction in dockless shared micromobility fleets in late 2019, with some cities reporting increased use and others decreased use during the Covid-19 pandemic (Wilson, 2020; Grogan and Hise, 2020). Some cities have implemented slow streets programmes intended to support micromobility, outdoor dining, and other outside socially distanced activities in response to the pandemic.

User Demographics and Shared Micromobility Impacts

While North American studies of dockless micromobility are limited, there is anecdotal evidence that the user demographics of dockless shared micromobility are similar to other shared modes (i.e. carsharing, microtransit, transportation network companies [TNCs], etc.) (Rayle *et al*., 2016; Cohen and Shaheen, 2016; LeVine *et al*., 2014; Fishman, 2015; Kopp *et al*., 2015). A number of studies have documented different demographic profiles across a range of shared modes. Older studies of shared mobility have found that users generally tend to be: (1) well educated (often with a college or postgraduate degree); (2) younger adults (typically between the ages of 21 and 45); (3) childless households; (4) middle- and upper-income households; and (5) living in urban built environments, often with limited vehicle access (e.g. zero or one car households) that use multiple transportation modes, such as public transit, cycling, and walking.

For a variety of reasons, these studies tend to reflect the demographic profiles of early adopters, urban lifestyles, and households without children. First, urban built environments tend to be more walkable, bikeable, and less conducive to private vehicle use (e.g. limited and expensive parking). In addition, the presence of children in a household is commonly associated with increased vehicle dependency. Finally, in the US active transportation can be associated with a social stigma whereas vehicle ownership can be perceived as a status symbol. It is not uncommon for vehicle ownership to be associated with freedom, mobility, and a lifeline to job access for individuals underserved by public transportation or nonvehicular modes.

In contrast, there is some anecdotal evidence that suggests the user base for shared micromobility services could be more diverse than other shared modes since dockless bike sharing and scooter sharing have demonstrated success in reaching underserved areas in some cities. Although studies on dockless shared micromobility impacts are more limited, a number have documented the demographics of station-based bikesharing users.

While multi-city bikesharing studies in North America are more limited, a few focused on station-based bikesharing indicate that users are often Caucasian, generally younger, have an upper to middle income, and are more highly educated (Shaheen *et al.*, 2012; 2014). Although there are some variations by city, key demographic ranges include: (1) *Race/Ethnicity*: 74 per cent to 92 per cent of surveyed users are Caucasian, compared to 1 per cent to 5 per cent that are Hispanic or Latino and 1 per cent to 2 per cent that identify as African American; (2) *Household Income*: 29 per cent to 39 per cent have household incomes greater than US $100,000 a year, compared to 9 per cent to 26 per cent that earn less than US $35,000 annually; (3) *Educational Attainment*: 55 per cent to 89 per cent of surveyed users have a minimum of a four-year college degree; and (4) *Age*: 37 per cent to 54 per cent of surveyed users are under the age of 35 and 36 per cent to 51 per cent are between the ages of 35 and 54. Other studies of station-based bikesharing tend to echo these findings (Hoe, 2015; Bachand-Marleau *et al.*, 2012; Smith *et al.*, 2015; Kille, 2015; McNeil *et al.*, 2017; Ursaki and Aultman-Hall, 2015).

In addition to documenting user demographics, a number of North American studies have documented station-based bikesharing impacts, while studies of dockless bikesharing and shared scooter sharing are emerging. Studies of shared micromobility have documented impacts in four key areas:

Environment: Several studies indicate that shared micromobility reduces greenhouse gas (GHG) emissions by replacing personal vehicle trips (Shaheen and Cohen, 2019). Additional environmental considerations include lifecycle impacts associated with support staff using vehicles to rebalance the devices, along with manufacturing, recycling, and battery replacement impacts (Fishman, 2015).

Mode Substitution: The impacts of shared micromobility on private vehicle and public transit use appear to vary by service model (i.e. station-based and dockless); device (i.e. bicycle or scooter); and study location (Shaheen *et al.*, 2012; 2014; McNeil *et al.*, 2017; Fishman, 2015; Shaheen *et al.*, 2021). Some studies suggest that shared micromobility may be an effective first- and last-mile strategy connecting users to public transportation, while others indicate that micromobility may result in shifts away from public transit (e.g. more direct micromobility trips replacing public transit transfers and/or long headways between buses or trains) (Shaheen *et al.*, 2014). Some of these studies have shown that shifts towards public transportation due to bikesharing tend to be more prevalent in lower-density regions on the urban periphery. This suggests that station-based bikesharing may serve as a first- and last-mile connector in smaller metropolitan regions with lower densities and less robust public transit networks. The findings also suggest that in larger metropolitan regions with higher densities and more robust public transit networks, station-based bikesharing may offer faster, cheaper, and more direct connections compared to short-distance public transit trips. In addition, public bikesharing may be more complementary to public transit in small and medium metropolitan regions and more substitutive in larger metropolitan areas, perhaps providing relief to crowded public transit lines during peak periods (Shaheen and Martin, 2015). Additional studies are needed to clarify impacts on mode choice, particularly related to dockless service models.

Public Health: Shared micromobility may increase the use of active modes. A study of station-based bikesharing indicated an increase in physical activity among users. Some studies have found that micromobility users reported reduced stress and weight loss due to bikesharing. However, a key limitation of these health impact assessment studies is that they do not examine negative health impacts associated with ridership, such as the costs linked to increased exposure and risks related to injuries and collisions (Alberts *et al*., 2012). One study of standing electric scooter sharing found that it attracted new people to active transportation (such as walking and biking) (Portland Bureau of Transportation, 2018).

Safety: Studies indicate that shared micromobility users often do not wear helmets, but additional research is needed to determine if these modes are more dangerous than other transportation modes. One retrospective study of scooter sharing safety in Los Angeles, California between September 2017 and August 2018 found that scooter-related injuries are common with varying levels of severity, low rates of adherence to rider age requirements, and low rates of helmet use (Trivedi *et al*., 2019). Although studies have documented a high number of scooter-related injuries and hospitalizations, more research should be conducted to understand risky riding behaviour, safe speeds, and riding locations that contribute to injuries of scooter sharing users (Shaheen and Cohen, 2019).

Although before-and-after studies detailing the impacts of dockless shared micromobility are limited, a few North American programmes have conducted user surveys to document outcomes. These studies suggest that a number of social, environmental, and behavioural impacts are attributable to dockless shared micromobility – although more research is needed. Many cities have used regulatory frameworks for managing micromobility operators to ensure low-income and under-banked residents have equitable access to dockless devices. Equity programmes tend to include designated underserved areas for daily device distribution, a reduced-fare option for low-income residents, and an option for payment and device access that does not require a smartphone. Some equity programmes include requirements or incentives for improving access for older adults or individuals who have visual, auditory, or physical disabilities. Many experts reported that cities have established equity of access programmes to promote ridership among underserved communities as mandatory conditions for service providers to operate in their jurisdiction. Finally, the rapid emergence of shared micromobility (particularly standing electric scooters) has caused concern over the safety of vulnerable curb users (Shaheen *et al*., forthcoming). In response to these challenges, cities are increasingly developing policies and practices to request access to the public rights-of-way and to guide locations where devices should be parked.

Shared Micromobility Policies and Practices

While shared micromobility can offer an array of potential individual and community benefits, the growth of bikesharing and scooter sharing has caused urban curbs to become increasingly congested as a variety of modes compete for docking stations, parking corrals (a painted or barricaded parking location for shared micromobility devices) and racks, parking spaces, and pick-up and drop-off locations (Office of the Mayor, 2020; Erdhart *et al*., 2021; Charm *et al*., 2020; Shaheen *et al*., 2019*a*). Both the experts interviewed and focus group participants raised notable concerns about shared micromobility curb space management. Key concerns noted included: safety (e.g. riding on curbs and/or at speeds that impact pedestrians and other curb users); equity (e.g. devices that block access for people with disabilities); and concerns about how to regulate micromobility and manage the curb. As such, dedicating curb space for micromobility is an important policy area confronting public agencies. Key elements of micromobility curb space management include the design, maintenance, enforcement, and policy approach applied to curb access. The experts interviewed identified key aspects of micromobility curb space management policy such as: (1) the policy process; (2) device caps; (3) service area limitations; (4) designated parking areas; (5) fees; (6) equipment and operational requirements; and (7) enforcement. Each of these is described in greater detail below. This discussion is followed by two case studies focused on curb space management practices in Seattle and Santa Monica.

The Policy Process: 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 approaches, including pilot programmes and case-by-case approvals from administrative staff (Cohen and Shaheen, 2016; Institute of Transportation Engineers, 2018; SFMTA, 2020; Schaller Consulting, 2018).

Device Caps: Caps are employed to limit the number of bicycles, scooters, or other devices that can be used for shared micromobility. Public agencies may limit the number of devices in a category (e.g. dockless bike-sharing, 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: service area, built environment, density, and usage frequency. Caps could also have unintended consequences for constraining demand or the size of service areas (Moran, 2021; Shaheen *et al.*, 2019*a*).

Service Area Limitations: Some cities, such as Austin and San Francisco have geographic access zones where operators can deploy devices (Eubank, 2019; Moran, 2021). Access limitations can include permissible and prohibited operational areas, which may be enforced through virtual geographic boundaries (commonly referred to as a geo-fence) employing GPS, radio-frequency identification (RFID), or other technology (Reclus, 2013; Hutchings and Perry, 2021; Shaheen *et al.*, 2020).

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 a bicycle rack or other piece of street furniture, or a condition to return a device to a designated station or corral (Seattle Department of Transportation, 2019; Shaheen *et al.*, 2019*a*).

Fees: A number of US cities charge operators a variety of fees for allowing the placement of shared micromobility devices in the public rights-of-way. These fees can include per trip taxes, application fees, and annual fees based on the number of devices placed in public rights-of-way. Portland, Oregon, for example, charges a $0.25 tax per scooter ride. The funds are placed in a 'New Mobility Account' to pay for programme administration, enforcement, infrastructure improvements, and access enhancements for underserved communities (City of Portland, 2019). Some cities, such as Chicago, Illinois and St. Louis, Missouri charge an application fee (typically $250 to $500) per operator (City of Chicago, 2021; City of St. Louis, 2018). Other cities have established permits and permit review fees (e.g., Seattle) (Nickelsburg, 2018). Others may charge an annual fee per device (typically $10 to $50) (e.g. Reno, Nevada; Chicago, Illinois). Other cities have established variable fees for a block of devices. For example, Aurora, Colorado charges $2,500 for the first 500 bicycles, $5,000 for the first 1,000 bicycles, $7,500 for the first 2,000 bicycles, or $10,000 for fleets with more than 2,000 bicycles) (City of Aurora, 2019). Other fees that cities which have assessed shared micromobility operators include: (1) fees per docking station; (2) performance bonds (to protect the public entity if the micromobility company goes out of business or fails to meet certain terms under a contractual agreement); or (3) escrow payments per device (or a block of devices) (Anderson-Hall *et al*., 2019).

Equipment and Operational Requirements: A number of cities have established equipment requirements (such as maximum allowable operating speeds) and permissible areas of operation, such as prohibitions from operating devices on sidewalks, bicycle lanes, pedestrian malls, etc. (Anderson-Hall *et al*., 2019; Shaheen *et al*., 2019*a*). In Massachusetts, for example, all scooters are required to have brake lights and turn signals. However, proposed legislation would remove turn signal and brake light requirements and add requirements for insurance and add $0.20 per ride tax (Borchers, 2019).

Enforcement: Enforcement is important to ensure that shared micromobility devices are parked properly, equitably, and safely dispersed throughout a community and do not impede pedestrians or Americans with Disabilities Act access. To keep fleets from becoming stagnant (not used because they are parked in low-traffic areas) and imbalanced (too many devices located in a particular area), some cities have developed policies requiring service providers to rebalance their fleets on a particular schedule and to correct parking violations within a specific time frame. Failure to comply with these requirements can often result in fines, device impounding, or the eventual loss of operating permission in a jurisdiction (National Association of City Transportation Officials, 2019*b*).

The experts interviewed identified eleven jurisdictions with prominent shared micromobility policies to help manage operations and parking to enhance equity and safety outcomes. Many of the experts identified Seattle, Washington and Santa Monica, California as jurisdictions with forward thinking policies to help identify, mitigate, and prevent common challenges associated with shared micromobility. Key policy features from each of these case study locations are discussed in greater detail in the subsections that follow.

Seattle's Curb Space Management Approach

In Seattle, Washington, the city's department of transportation (SDOT) has established curb space design and management guidelines to manage the curb for a variety of functions and users. SDOT has classified sidewalk frontage into three zones (see figure 3).

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 cafés, store entrances, retail displays, 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 (0.61 m) 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 and unloading; trash cans; etc.

These zones form the foundation of Seattle's micromobility 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 (approximately 0.91 m);

- Lock devices to a bicycle rack (as long as they do not block pedestrian access);

- Park bicycles in designated parking zones (sometimes referred to as corrals); and

- Leave a clearance of at least six feet (approximately 1.8 m) 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.

Seattle requires dockless bikesharing companies to move improperly parked bicycles and to correct parking violations within two hours of a problem report during normal business hours. In September 2020, Seattle invited Lime, Wheels, and LINK scooter sharing companies to participate in a scooter sharing pilot programme (Olsen, 2020). The city is permitting up to 500 scooters for each company initially, with the option to expand fleets up to 2,000 scooters per operator pending city approval (Seattle Department of Transportation, 2020). The pilot also requires that scooter sharing service providers limit the speed of devices to 8 miles per hour (mph) on a user's first ride and a speed limit of 15 mph beginning on a user's second ride.

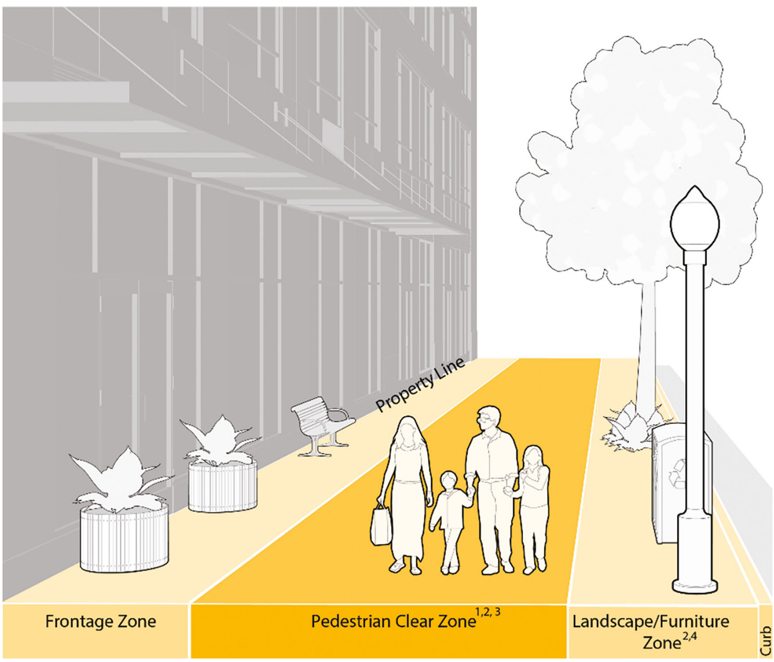

Figure 3. Seattle's sidewalk zone. (*Source*: City of Seattle, 2017)

Santa Monica's Micromobility Corrals

Beginning in 2011, Santa Monica, California started 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 shared micromobility parking corrals to accommodate approximately eight to fourteen bicycles or standing electric scooters. These corrals can be installed on the curb or in the footprint of one automobile parking space. The corrals also can include a variety of markers and barriers to increase visibility and protect equipment (Shaheen and Cohen, 2019).

In August 2018, the city began installing corrals (figure 4) for a 16-month shared micromobility pilot that launched in mid-September 2018 (City of Santa Monica, 2018). In May 2020, Santa Monica approved an extension of the pilot programme due to the Covid-19 pandemic. In 2020, the city had approximately 100 shared micromobility corrals, approximately two-thirds of which are located on sidewalks and one-third along the street edge. For the most part, Santa Monica has installed the street edge corrals in red painted curb areas to avoid removing on-street parking. The city estimates that each corral cost $200 to $800 to install, depending on the design and type of supplies required (i.e. paint or bollards) (Linton 2018).

While lessons learned from the pilot programme and corral deployments are still emerging, the city reports corral usage has been mixed with a number of users continuing to park scooters elsewhere. Nevertheless, operators return e-bikes and scooters to the corrals after they have been picked up for charging. Geofencing and user incentives may be required to encourage or enforce corral use (Linton, 2018).

Both case studies exemplify the diverse ways that cities are responding to the challenges associated with the rapid growth in the number of micromobility devices. Developing curb space management policies for shared micromobility can be key to providing policy support for non-vehicular

Figure 4. Santa Monica's micromobility corrals. (*Source*: Linton, 2018)

modes, managing curb space congestion, and helping to ensure safe, convenient, and multimodal access for all travellers.

Future of Shared Micromobility

With the growth of shared micromobility fleets, cities are increasingly confronting questions about curb space management. Comprehensive curb space management policies such as operator agreements to access the rights-of-way; limits on the number of devices; and rider education and outreach may help address key challenges associated with device management and pedestrian safety. In addition, co-locating micromobility stations and corrals next to public transportation hubs may be key to encouraging multi-modality. Enforcement mechanisms such as device impounding, parking fines, and revoking device permits for repeat violations may be key to enforcing compliance with regulations. Also, rider education and outreach that includes where riding is prohibited and how to park devices lawfully at the end of trips may help increase compliance.

Aside from curb space management, shared micromobility may raise a number of related policy concerns such as safety, security, and social equity. The placement of micromobility devices in the public rights-of-way can present notable challenges for people with disabilities when bicycles or scooters block curb or ramp access. Similarly, micromobility can have notable impacts on the safety of active transportation users and other curb users, particularly when devices are ridden or parked on the curb. The greater prevalence of protected infrastructure and lower speed limits on the streets have the potential to reduce illegal sidewalk riding. Gathering, analysing, and comparing real-time and historical micromobility data can help inform policy and infrastructure planning. However, data can also reveal sensitive information about users' and a data breach could expose public agencies to risk. Protecting sensitive data, managing risk, and ensuring compliance with security standards will be key.

In the future, improvements in battery technology (i.e. range, weight, etc.) are likely to support the continued growth and development of an array of short-range electric devices and/or new ‘form factors’, such as motorized quadricycles, light electric vehicles (EVs), and neighbourhood EVs that are typically built to carry two to four passengers and operate at speeds up to 25 miles (40.2 km) per hour.

Four trends related to automation, safety, data privacy, and public policy could impact shared micromobility. First, automation (shared micromobility devices and vehicles) could have transformative impacts. Automating shared micromobility devices could help to simplify curb space management and charging by allowing devices to be e-hailed or delivered to a person’s door and returned automatically at the conclusion of a trip. While the automation of shared micromobility devices creates potential opportunities, vehicle automation could pose a number of risks. Shared automated vehicles (e.g. cars, shuttles) could compete with micromobility for short urban trips, particularly if per trip or per mile/kilometre costs are more competitive. Second, vehicle automation could reinforce historic infrastructure funding and design biases that prioritize motorized vehicles over micromobility and active transportation.

In addition to automation, safety could impact public perception and potential growth of shared micromobility. While shared micromobility safety records can be challenging to access/assess due to imprecise incident coding and the relatively small number of bike and scooter sharing users, several improvements could enhance safety and encourage ridership including: (1) improved device design (e.g. larger wheels to reduce the impacts of potholes); (2) infrastructure enhancements (e.g. better pavement quality, dedicated facilities for shared micromobility use, and curb space management); and (3) education and outreach with users (e.g. public awareness and share the road campaigns).

Data privacy may also impact community acceptance of shared micromobility. Shared micromobility operators typically track several important data elements related to use, such as trip origin and destination, travel time, and trip duration. However, these data may reveal the daily routines of the residences/workplaces of users. Implementing industry-wide data protection and compliance standards could be key to protecting sensitive data, managing risk, and building consumer confidence in shared micromobility (e.g. the Mobility Data Specification [MDS], which has been adopted in the US and several other nations).

Going forward, the growth and success of shared micromobility could be largely dependent on regulatory and policy environments. Prioritizing parking and visibility for bikes and scooters; enhancing infrastructure (e.g. slow lanes, multi-use trails, etc.); and incorporating bikesharing and scooter sharing into multimodal trip planners could aid shared micromobility effectiveness. By enhancing the visibility and convenience of shared micromobility and reducing rider stress, communities have the opportunity to encourage its use for shorter distance travel and to connect with public transit. Since the global pandemic, micromobility has become an integral strategy for cities across the globe to encourage safe, active transportation, while accommodating the need for social distancing. Many cities have expanded street space for active transportation (often called slow or healthy streets) to reduce traffic volume and speeds and to expand space for pedestrians, cyclists, scooter riders, and outdoor recreation (National Association of City Transportation Officials, 2020).

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