Shared Micromobility: Policy, Practices, and Emerging Futures

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Chapter 23: Shared Micromobility

Policy, Practices, and Emerging Futures

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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, households seeking first- and last-mile connections to public transportation, and those without access to a private vehicle trying to access jobs and essential services. Up until the global pandemic, shared micromobility grew worldwide on a relatively steep growth curve, beginning in the early 2010s. Shared micro- mobility is a transportation strategy that enables users' short-term access to a transportation mode on an as-needed basis (Shaheen et al. 2019). Shared micromobility includes a number of operational models, including station-based micromobility (where a bicycle or scooter is picked up from and returned to any station or kiosk) and dockless (or stationless) micro- mobility (where a bicycle or scooter is picked up and returned to any location). Another service model, sometimes referred to as a 'hybrid model,' blends aspects of station-based and dockless systems that allows users to check out a bicycle or scooter from a station and end their trip either returning it to a station or a non-station location (or vice versa) (Shaheen and Cohen 2019).

Common shared micromobility services include bicycle and scooter sharing. Fundamentally, bikesharing and scooter sharing provide users with on-demand bikes and scooters for one-way (point-to-point) or roundtrip travel. Both bike and scooter sharing models can include a variety of motorized and non-motorized devices, including moped-style scooters. Typically, shared micromobility fleets are deployed in a network within a metropolitan region, city, neighborhood, employment center, and/or university campus. The cost of shared micromobility services usually includes maintenance, parking and, if applicable, electric charge or gasoline.

Shared micromobility has the potential to offer an array of community and individual benefits, such as enhanced mobility, greater environmental awareness, and increased use of active transportation and non-vehicular modes. This chapter discusses the growth of shared micromobility, its impacts on users and communities, and policy considerations for managing potential adverse impacts of shared micromobility, such as increased curbspace demand. This chapter is organized into four sections. The first discusses the growth and evolution of shared micromobility. The next section summarizes user demographics and shared micromobility impacts. In the third section, the authors discuss shared micromobility policies and practices for managing devices and operations in a few contrasting urban environments. The final section concludes with a discussion of the future of shared micromobility.

Brief History, Growth, and Evolution of Shared Micromobility

Over the last five decades, shared micromobility's evolution can be categorized into four key phases beginning with bikesharing. These include the first generation, called "White Bikes" (or Free Bikes); the second generation: "Coin-Deposit Systems;" third generation or "Information Technology (IT)-Based Systems;" and fourth generation systems: "Advanced IT-Based Systems."

Shared micromobility originated in Europe with small non-profit systems in the 1960s. First-generation bikesharing, or White Bikes, began in Amsterdam in 1965, when 50 bicycles were left unlocked throughout the city for free public use (Home 1991). This initiative failed soon after its launch, however, because bikes were often stolen, damaged, and even confiscated by the police (Schimmelpennink, L., December 2012, unpublished data). These challenges with first-generation systems led Copenhagen to launch the first large-scale, second-generation coin-deposit system in 1995. Smaller scale coin-deposit systems began launching in the early 1990s. By designating specific bicycle station locations and adding coin-deposit locks, second-generation systems were much more reliable, as users have a defined and secure space to access available bicycles. However, due the customer anonymity that is associated with coin-deposit systems, theft is still a notable concern.

These shortcomings contributed to the development of IT-based systems. With IT-based services, shared micromobility operators are able to identify and track individual users, allowing monetary and legal enforcement for damaged equipment and inappropriate user behaviors. While the technology was first associated with a bikesharing system at Portsmouth University in the United Kingdom, Vélo à la Carte, which launched in 1998 in Rennes, France, was the first IT-based system available for public access (DeMaio 2009).

In addition to these IT-based shared micromobility deployments in the developed world, IT-enabled bike and scooter sharing systems are also growing in developing economies. In Africa, the first IT-based bikesharing system, Medina Bike, started operating in 2016 in Marrakech, Morocco. In the Middle East, the United Arab Emirates (UAE) has become an epicenter of shared micromobility activity. Cyacle, an initiative of the Khalifa Fund for Enterprise Development, launched a station-based bikesharing program with 75 bicycles and 11 stations in Abu Dhabi in December 2014. This service was acquired by Careem in 2019. Additionally, a number of service providers offer bike and moped sharing in India. SmartBike is a station-based bikesharing program with more than 1,500 bicycles and 150 stations in Chennai, Chandigarh, and New Delhi. Yulu is a dockless micromobility provider offering users access to shared bikes and e-bikes in India. In South-East Asia, one of the earliest bikesharing programs, Pun Bike Share, was launched in Bangkok, Thailand in October 2012. The service had an estimated 500 bikes and 50 stations in May 2021.

More advanced fourth-generation IT-based systems feature demand-responsive rebalancing (e.g., real-time information that informs the system where there are imbalances in supply and demand) and integrate – both spatially and digitally – with other transportation modes. They can also include dockless charging stations; electric bikes; public transit linkages; mobile, solar docking stations; and integration with mobility as a service (MaaS) and public transport fare payment. In recent years, the advent of IT-based shared micromobility systems began to enable a number of new business and operational models, such as peer-to-peer (P2P) bikesharing. 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 platforms, etc.). In 2012, the smartphone app Spinlister 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 valet (where a bicycle is delivered 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. Improvements in technology also contributed to the development of dockless shared micromobility options. In addition to P2P and station-based services provided by B-Cycle, Motivate, and others, a number of new dockless vendors entered the marketplace, including: JUMP (formerly Social Bicycles), Limebike, MoBike, Ofo, Spin, and an array of smaller service providers offering dockless systems that allow users to pick up or drop off enabled bicycles anywhere within a geographic area. Although not required for a dockless system, some bikes are equipped with a locking mechanism on the device that allow the bikes to be "locked to" a bicycle rack, 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 "geofencing." A geofence is a virtual perimeter, which limits the range of mobility of an enabled bicycle, by comparing the GPS-satellite coordinates of the bicycle to the allowable geographic area.

As of May 2018, an estimated 1,608 bikesharing programs were operational globally (Gauequelin 2020). In 2019 in the US, 50 million bikesharing trips were taken – 40 million station-based and 10 million dockless electric trips (National Association of City Transportation Officials 2020). During the same time period, European bikesharing operators were in more than 350 cities and provided 65 million rides (Motor Insights 2020). Scooter sharing has also experienced a rapid growth. In 2019, moped-style scooter sharing was available in 88 cities across 21 countries internationally (Gauequelin 2020). Moped-style scooter sharing grew by 164% in 2019 and 44% in 2020 to reach a total of 95,000 available devices (Gauequelin 2020). In the US in 2019, 86 million trips were taken via standing electric scooter sharing services (National Association of City Transportation Officials 2020). Additionally, according to the September 2020 report from Mobility Foresights, scooter sharing was available in approximately 97 European cities. Mobility Foresights (forthcoming) also reported that in 2020 in Asia there were over 15 scooter sharing operators; however, most were piloting schemes and were not fully operational (Mobility Foresights Forthcoming, 2020).

In spite of this growth, enabled by large venture capital investment, a number of cities around the world 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). There are a variety of reasons that contributed to the reduction in dockless micromobility fleets. In many cases, a large number of devices deployed in small geographic areas within a short timeframe contributed to complaints about improper parking and vandalism. This led some operators to reduce fleets, change operational strategies around parking and fleet balancing, and in some cases exit markets altogether. In response to the global pandemic, some cities have implemented "slow or healthy street" programs intended to support micromobility, outdoor dining, and other outside socially distanced activities in response to the pandemic.

User Demographics and Shared Micromobility Impacts

A number of studies have documented the demographic profiles of shared micromobility users and their impacts. Older studies of shared micromobility have found that users are typically: (1) well educated (often with a college or graduate degree); (2) younger (typically between 21 and 45 years of age); (3) childless households; (4) middle- and upper-income households; and (5) households living in more urban neighborhoods, often with limited vehicle access (e.g., zero or one car) that tend to use multiple transportation modes, such as public transportation, cycling, and walking.

These studies tend to reflect the demographics of early adopters, urban lifestyles, and households without children for a number of reasons. First, urban neighborhoods tend to be more walkable, bikeable, and less conducive to private vehicle use (e.g., expensive and limited parking). Moreover, the presence of children in a household is commonly associated with higher levels of household vehicle ownership. Additionally, most shared micromobility programs are not designed for families with small children. Finally, active transportation (particularly cycling) in the US can be associated with a social stigma whereas private vehicle ownership is often viewed as a status symbol. Additionally, in many lower-density North American communities limited public transport service reinforces private vehicle ownership due to its role in facilitating access to jobs, healthy food, education, and health care for individuals in communities with more limited mobility options.

In addition to user demographics, a number of studies have documented the impacts of station-based bikesharing, while studies of dockless bikesharing and scooter sharing are still emerging. Broadly, these studies of shared micromobility have documented impacts in four areas: (1) environmental impacts, (2) mode shift and substitution, (3) public health impacts, and (4) safety.

A number of studies have found that shared micromobility reduces greenhouse gas (GHG) emissions by replacing personal vehicle trips (Shaheen and Cohen 2019; Martin et al. 2020). Studies also indicate that shared micromobility has the potential to reduce congestion and fuel use, lower emissions, and increase environmental awareness. Shared micromobility also can be integral to bridging spatial and temporal gaps in the transportation network and encouraging multi-modal trips. The impacts of shared micromobility on personal vehicle and public transit use tend to vary by operational 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). A number of studies conclude that shared micromobility could be an effective first- and last-mile strategy to connect travelers to public transportation, while others indicate that micromobility may also cause shifts away from public transit (e.g., more direct bike and scooter trips replacing long public transit routes with transfers and/or long headways between buses or trains) (Shaheen et al. 2014). Some of these studies document shifts toward public transit in situations where bikesharing tends to be more prevalent in lower-density regions on the urban periphery. In this context, station-based bikesharing may serve as a first- and last-mile connection in communities with lower densities and less mature public transportation networks. Similarly, the findings suggest that regions with higher densities and more mature public transit systems, station-based bikesharing may offer faster, cheaper, and more direct connections compared to shorter distance transit trips. For these reasons, bikesharing may be more complementary to public transit in small and medium regions and more substitutive in larger metropolitan areas. However, even competition with public transit could be a strategic goal for some transit agencies seeking to perhaps provide strategic relief to crowded public transit lines during peak periods (Shaheen and Martin 2015). In addition to public transit impacts, bikesharing and scooter sharing have also been used to replace vehicular modes – including taxis, transporta- tion network companies (TNCs, also known as ridehailing and ridesourcing), and personal vehicles – and facilitate trips that would previously not have been taken (Martin et al. 2020). However, more research is needed to study the impacts on mode choice, particularly related to dockless micromobility services.

Shared micromobility may increase active transportation use, thereby having the potential to improve public health. A study of station-based bikesharing found an increase in physical activity among users (Martin et al. 2020). Some studies have also concluded that micromobility users report reduced stress and increased weight loss due to bikesharing. However, a key limitation associated with many of these health impact assessments is that they do not examine negative health impacts associated with ridership, such as the costs associated with increased exposure and risks to injuries and collisions from micromobility use (Alberts, Palumbo, and Pierce 2012). One study of standing electric scooter sharing found that it attracted new people to active transportation (such as walking and cycling) (Portland Bureau of Transportation 2018). With respect to safety, studies have found that shared micromobility users tend not to wear helmets; however, more research is needed to determine the overall impacts of these behavioral differences on safety outcomes. 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 due to high speeds, low rates of compliance with rider age requirements, and low rates of helmet use (Trivedi et al. 2019). Although studies have documented a high number of micromobility-related injuries, more research is needed to understand key risk factors such as: (1) unsafe rider behavior, (2) appropriate speeds (for vehicles and micromobility users), and (3) infrastructure design that both prevents and contributes to scooter sharing user injuries (Shaheen and Cohen 2019).

Shared Micromobility Policies and Practices

While shared micromobility has the potential to offer individual and community benefits, the growth of shared micromobility is causing some urban centers to become increasingly con- gested as a variety of modes compete for space to pick-up, drop-off, and use micromobility devices (Shaheen et al. 2021). Dedicating bike lanes and curbspace for micromobility is an important policy area confronting public agencies. Key elements of micromobility policies typically include: (1) device caps, (2) service area limitations, (3) designated parking areas, (4) fees, (5) equipment and operational requirements, and (6) enforcement. Each of these are described in greater detail below.

1. **Device Caps:** Fleet 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 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 net- work varies based on a number of factors such as: service area, built environment, density, and usage frequency. Device caps may also have unintended consequences that limit the supply of available devices, reduce the size of service areas (to ensure adequate coverage in remaining service areas), and potentially result in reduced coverage in less profitable neighborhoods (which could raise social equity concerns for low-income and minority communities).
2. **Service Area Limitations:** Some cities have geographic access zones where operators can deploy devices. Access limitations can include permissible and prohibited operational areas that may be enforced through virtual geographic boundaries (sometimes

referred to as a ‘geofence’).

3 **Designated Parking Areas:** A number of communities have designated parking areas for micromobility devices. These parking areas 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 (e.g. a painted, barricaded, or geofenced parking location for shared micromobility devices).

4 **Fees:** A number of cities charge operator fees for allowing the placement of shared micro- mobility devices in the public rights-of-way. Examples of these fees include per trip taxes, application fees, and annual fees based on the number of devices deployed. In the US, for example, Portland charges a $0.25 US tax per scooter ride. The funds are placed in a “New Mobility Account” that finances program administration, enforcement, infrastructure improvements, and access for underserved communities. Barcelona, Spain charges an annual fee per shared scooter (about $85 US per device) to fund micromobility infrastructure improvements (Garcia Valdivia 2020). Similarly, Stockholm, Sweden charges an annual permit fee of approximately $166 US per shared scooter (Drive Sweden 2021). In Auckland, New Zealand, scooter sharing operators pay approximately $24.75 US per device for a six-month permit in inner-city locations. Devices that operate outside the city and in the suburbs are assessed between $3.50 and $15.00 US depending on the location (Nadkarni 2019). In Singapore, bikesharing companies pay approximately $44 US per bicycle permit fee and $1,100 US to apply for the permit (Choo 2018). In the US, Chicago and St. Louis charge an application fee (typically $250 to $500 US) per opera- tor. In Japan, a proposed payment system would collect fees from bikesharing operators and users to pay for micromobility infrastructure and program management (Suzuki and Nakamura 2017). Other fees that cities have assessed 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 (bonded) payments per device (or a block of devices).

5 **Equipment and Operational Requirements:** Cities can also establish 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.

6 **Enforcement:** Enforcement is important to ensure that shared micromobility devices are safely parked and equitably dispersed throughout a neighborhood. Enforcement can also help ensure that devices do not impede access for people with disabilities. A variety of methods can be used to enforce micromobility use and operational guidelines. For example, Santa Monica is one of the first cities to require operators to use geofencing to improve rider compliance and safety by establishing deactivation zones around the city’s beach area, effectively slowing devices to zero miles/kilometers per hour in areas of high pedestrian activity (Iglesias 2019). Some cities have also found that when fleets

become stagnant (i.e., not used because they are parked in low-traffic areas) and imbalanced (i.e., too many devices located in a particular area), devices can end up congregating in areas of low activity and contributing to curbspace management challenges. Some cities have developed policies that require service providers to rebalance fleets on a particular schedule and correct parking violations within a specific time frame to address these challenges.

One North American operator, Spin, has developed a three-wheel scooter intended to help with parking compliance and reduce the need for enforcement (Figure 23.1). Because the scooter has three wheels, it is less susceptible to tipping over and blocking curbs. The three-wheel design also allows Spin operators to be able to remotely move the scooter and reposition it if a parking violation is detected. The company plans to add a feature that would allow customers to e-Hail a scooter and have it autonomously dropped off with a user. By eliminating the need for centralized parking locations, the ability to autonomously deliver a shared micromobility device has the potential to change the way curbspace is managed in the future.

Figure 23.1 Spin's Three-Wheeled Scooter

Source: Ford Media Center, 2021.

Future of Shared Micromobility

Over the next decade, enhancements in battery range, charge times, and weight will likely contribute to the evolution and development of additional devices and/or new "form factors" (e.g., motorized quadricycles, light electric vehicles (EVs), electric auto-rickshaws, and neighborhood EVs that carry two to four passengers and operate at speeds up to 25 miles (approximately 40 kilometers) per hour. However, new form factors and operational speeds have the potential to raise a number of operational and safety challenges for shared micromobility users. Thoughtful planning and policy are needed to manage this and other emerging issues to minimize the potentially adverse impacts and maximize the opportunities of new developments.

In the future, automation, safety, data privacy, and public policy could impact the evolution of shared micromobility. Automation of shared micromobility vehicles could have transformative impacts. Automating shared micromobility devices could help to simplify curbspace management and charging by allowing devices to be delivered to a person's door and returned automatically at the conclusion of a trip. Automation could also allow the parking of micro- mobility devices (both personally owned and shared) to be relocated to private property. While the automation of shared micromobility devices creates opportunities, vehicle automation could pose a number of risks. Shared automated vehicles could compete with micromobility for short urban trips, particularly if per trip or per mile/kilometer costs are more competitive. Early evidence from the global pandemic suggests that micromobility may be serving longer urban trips; however, more research is needed to systematically document these observations. It is important to note that vehicle automation could reinforce historic infrastructure funding and design biases that prioritize motorized vehicles over active transportation.

In addition to automation, safety could also impact community acceptance and shared micromobility growth. Several improvements could enhance safety and encourage ridership such as: (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 curbspace management); and (3) education and outreach with users (e.g., public awareness and "share the road" campaigns).

Data privacy could also impact public acceptance of shared micromobility whose operators typically track several important user data metrics, such as trip origin and destination, travel time, and trip duration. However, these data may reveal the daily routines or the residences/ workplaces of users. Implementing industry-wide data protection and compliance standards could be key to protecting sensitive data; managing risk; and enhancing consumer confidence in shared micromobility (e.g., the Mobility Data Specification [or MDS], which has been adopted in the US and several other nations). MDS is a data standard that allows cities to gather, analyze, and compare real-time and historical data from shared micromobility providers. The specification also serves as a tool that can help enforce local regulations.

In the future, the growth and success of shared micromobility will be largely dependent on public policy. Prioritizing parking and high-visibility locations for bikes and scooters; enhancing infrastructure (e.g., slow lanes, multi-use trails, corrals, stations, etc.); and incorporating bike and scooter sharing into MaaS or mobility on demand (MOD) platforms could increase shared micromobility connectivity for users. By enhancing the visibility and convenience of shared micromobility and reducing rider stress, communities have an opportunity to encourage the use of bikes and scooters for first- and last-mile connections to public transit and shorter distance trip making. Since the global pandemic, micromobility has become an integral strategy for many 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 to reduce traffic volume and speeds and to expand space for pedestrians, cyclists, scooter riders, and outdoor recreation. The recovery presents an opportunity for communities to institutionalize these policies and encourage shared micromobility.

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