Shared Micromobility in North America:

Exploring current regulation

Supervised Research Project
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Abstract

Shared micromobility services have become a relevant solution for first and last-mile travel in cities, often acting as an extension of public transportation services and representing a potential gateway to adopting more sustainable and healthy travel alternatives. Unfortunately, the rapid growth of platform-based, dockless shared e-scooters, bikes, and e-bikes in North America has created significant disruption as legislation was not in place to regulate such transport modes adequately. While some cities have tackled this challenge by implementing new regulatory frameworks, there is still little consensus on the best regulatory practices to enable the potential benefits of shared micromobility services and minimize the externalities associated with their operation.

Based on an analysis framework composed of 16 thematic elements, this study compiles and analyzes relevant elements included in policy mechanisms used by three major cities in North America to regulate dockless shared micromobility services. This study aims to inform high-level government officials and decision-makers at municipal and state or provincial levels on valuable policy frameworks currently implemented that might apply to different contexts.

Results show that regulatory frameworks are considerably similar among the studied cities. Washington DC, Chicago and San Francisco have developed valuable policy components that are worth considering for cities exploring options to implement regulatory mechanisms. Alternatively, it is also deduced that based on these frameworks, a high number of operators can lead to a significant administrative burden for cities to manage and enforce regulations. Moreover, there is still some uncertainty and ambiguity on new vehicle typologies' role and place in local and regional legislations.

Current consolidation trends and new regulatory precedents in the shared micromobility landscape create an important moment for cities to reevaluate current regulatory strategies. Creating partnerships with fewer operators in longer licencing periods can be an effective approach to achieve a more manageable and sustainable provision of shared micromobility services over time.

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1 Introduction

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Shared micromobility services, consisting of short-term leasing services for small, low-speed vehicles, have become a relevant solution for first and last-mile travel in cities, often intended to extend public transportation services and working as a potential gateway into the adoption of more sustainable and healthy travel alternatives.

These services have grown from small grassroots operations consisting of a couple of dozen bicycles in Amsterdam around the 1960s to big-scale operations with multiple fleets well over the thousands being used by cities around the world as a strategic component of transportation policy to reduce pollution, congestion and to increase accessibility conditions for residents.

More recently, a new generation of shared micromobility services characterized by their free-floating capabilities, no longer required to be parked in a specific docking station and thus, commonly referred to as dockless services, was introduced with substantial growth backed up by venture capital in cities around the world (Fearnley, 2020). Approximately 128 million shared micromobility trips were made in 2021 in North America, with more than half of them corresponding to dockless or free-floating devices and a significant portion of them (almost 80%) taking place in the United States (NABSA, 2022).

The rapid growth of platform-based, dockless shared e-scooter, bikes, and e-bikes in North America caught cities off guard (Riggs, Kawashima, & Batstone, 2021) as legislation was not in place to adequately regulate such transport modes, thus creating an uncontrolled operating environment. This has been recognized as a clear issue for cities, leading to multiple externalities that might surpass the potential benefits associated with these services (Fearnley, 2020).

This situation has put pressure on city officials tasked with creating regulatory frameworks that create healthy environments to promote sustainable modes of transportation, maintain the quality of public space, procure road safety, and handle complex issues such as business and data regulation. Given that cities had little to no warning due to the fast introduction of shared micromobility services and their exponential growth, they were forced to make decisions with incredibly limited knowledge: While some cities banned these services, others started implementing innovative regulatory approaches to control and mitigate their impacts (Riggs, Kawashima, & Batstone, 2021).

To this day, there is still little consensus on the best regulatory practices to ensure that these services work as useful complements of existing transportation systems and as effective alternatives to car travel.

The central research question of this study will explore the policy mechanisms that leading cities in North America are currently using to regulate shared micromobility services. This will serve to expand the understanding of current regulatory mechanisms implemented by North American cities leading the micromobility landscape, as well as the implications and effectiveness of such policies, helping to guide decision-making towards reducing the undesired effects of shared micromobility in transportation systems and the public space, and potentially enabling these services to reach the potential benefits associated with their use.

This study aims to inform high-level government officials and decision-makers at municipal and provincial levels; this includes persons such as city mayors, heads of transportation agencies and any other official with planning or policy-making responsibilities, especially those in charge of regulation around city planning and transportation.

This report is comprised of four sections covering the following topics:

Section 2: Literature review

This section presents the most relevant facts and findings from existing academic papers, book chapters, and grey literature, such as media publications and professional reports, all centred around relevant topics that characterize the evolution and current state of shared micromobility services. This covers multiple definitions of shared micromobility, an overview of its origin and evolution leading up to the newest wave of dockless services, an exploration of the benefits and challenges commonly associated with these services, and a review of the existing research on implemented regulatory policies.

Section 3: Methodology

Building from the previous section, this chapter briefly analyzes the recurring themes identified across the existing literature and, most importantly, previous research on shared micromobility regulation. Based on this, an overview of the analysis method is explained, outlining a thematic framework for the study, defined by 16 main policy areas that guide the policy review process.

Section 4: Analysis and review

The core of the study will be covered in section 4, which centres around the policy review and analysis for three cities in North America, consisting of Washington DC, Chicago, and San Francisco. This section will outline the key components of current regulation for such cities based on the thematic framework defined in the previous chapter and present a summary and discussion of the main trends and relevant discrepancies.

Section 5: Conclusions

The final section will consolidate conclusions from all three previous sections of the study while also discussing recent developments in the shared micromobility industry and potential new tools and approaches as options to complement or change existing regulatory frameworks, as well as discussing opportunity areas for further research.

2 Literature review

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Despite having its origins in the 1960s, shared micromobility services have only become widely known as transportation alternatives in recent decades; this has been reflected in a body of academic and grey literature that, while limited, has recently experienced significant growth in the last decade. This literature provides relevant information regarding the evolution of the services, which is vital to understanding the current state of affairs and providing multiple insights into the challenges that local governments have tried to address with regulatory policies.

The general approach for this literature review starts with identifying similar research in academic journals exploring shared micromobility regulation in North America. After identifying these articles, a "snowballing" approach is used to find relevant academic literature.

While this review initially focuses on academic papers, it should be noted that due to the relatively short life span of shared micromobility and its recent adoption as a viable transportation option, academic research is limited and tends to focus on services used before the introduction of dockless platform-based services.

Considering this, grey literature becomes a necessary complement and, in some cases, the primary source of information as media coverage on these services is sometimes the only available information that documents some of the reactions, challenges, and impacts shared micromobility services had in cities.

Technical reports, books and book chapters are essential literature elements since they are usually the most accessible sources of information for city officials trying to understand and inform their decisions. NGOs and industry associations, among other organizations such as the North American Bike Share Association (NABSA), the National Association of City Transportation Officials (NACTO) and the Institute for Transportation and Development Policy (ITDP), play an important role when informing the decisions of local governments; thus, their insights and recommendations are key elements when understanding the evolution of these services and the approach that cities have taken when regulating them.

This section will compile the main themes and topics tackled by existing literature around shared micromobility services, covering the usual definitions used to describe such services and recapping their history and evolution, focusing on their origins, leading up to the implementation of dockless platform-based services, which are the focus of this study.

Furthermore, this section will provide an overview of the potential benefits and challenges associated with these services by different authors, as well as an exploration of the main arguments in favour of regulation. Finally, the literature review will conclude with an overview of previous research that pursued similar explorations of shared micromobility practices in North America.

2.1 Definitions of micromobility and shared micromobility

Shared micromobility remains a relatively novel concept given its short life and recent recognition as a transportation alternative; thus, different actors have put forward multiple definitions.

The Merriam-Webster dictionary defines micromobility as "Transportation over short distances provided by lightweight, usually single-person vehicles (such as bicycles and scooters) (Micromobility, 2023)." At the same time, the United States Department of Transportation refers to the Federal Highway Administration definition, which "broadly defines micromobility as any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances." (U.S. Department of Transportation, 2021).

More specialized institutions such as the Institute for Transportation and Development Policy (ITDP) specify that micromobility encompasses low- to moderate-speed (25km/h to 45 km/h top speed respectively) vehicles that are either human or electric-powered, including scooters, Bicycles, skateboards, cargo bikes, and even rickshaws, making two additional remarks: (1) that these vehicles cannot be powered with an internal combustion engine or exceed a top speed of 45 km/h, and (2) that they could be privately owned or shared (Institute for Transportation and Development Policy, 2021).

The first of these two remarks coincide with the definition used by the US DOT, as both descriptions allude to the technical details of such vehicles, making an important distinction when it comes to their method of propulsion. Along with speed capabilities and other operating features, technical components are a particular aspect that still is a source of some discrepancy when defining this form of transportation. Moreover, the concept of Micromobility is often attributed to tech analyst Horace Dediu, who used it to describe shared vehicles weighing less than 500 kg (Reid, 2019). Alternatively, Planetizen, while referring to Dediu as the author of the term, points out that most micromobility 'devices' "weigh less than 100 pounds" or less than 50kg (Hogan, n.d.).

Again, this shows some definition discrepancy, a signal that it is still a growing and evolving concept, but there are still clear patterns of overlapping elements and matching definitions. These definitions agree that micromobility refers to short-distance transportation that relies on small and usually lightweight human- or electric-powered vehicles that operate at relatively low speeds.

The second remark made by ITDP that is important to highlight is the fact that micromobility vehicles can be privately owned or shared. The shared quality of this definition refers to short-term

leases for these vehicles, usually called shared micromobility services, a practice that has grown in popularity in recent decades worldwide.

The National Association of City Transportation Officials (NACTO) defines shared-micromobility as the "Shared-use fleets of small, fully, or partially human-powered vehicles such as bikes, e-bikes and e-scooters. These vehicles are generally rented through a mobile app or kiosk, picked up and dropped off in the public right-of-way, and meant for short point-to-point trips" (National Association of City Transportation Officials, 2019, p. 5). This definition picks up some of the most relevant defining traits of current shared micromobility services around the world.

2.2 History and early iterations

Several sources trace back the origin of shared micromobility services to Europe in the 1960s (Janssen, et al., 2020), (Abduljabbar, Liyanage, & Dia, 2021), (Lazarus, Pourquier, Feng, Hammel, & Shaheen, 2020), (Shaheen, Cohen, & Martin, 2013), when a grassroots organization named Provos promoted the implementation of a free bike lease program in the city of Amsterdam at a time when cars use was on the rise, generating concern in terms of road safety and pollution.

This first attempt at creating what would eventually be called a bikeshare system consisted of deploying 50 bikes (famously painted in a distinct white colour) around central Amsterdam for the public to easily pick them up when needed to use them for a short ride and drop them off wherever and whenever they finished using them. It was initially more of an experiment than a sustainable program, but most importantly, it demonstrated what a solution might look like (O'Sullivan, 2022).

This first generation of shared micromobility services faced the main challenge of bike theft as its free-floating approach with no lock requirement created the perfect conditions for bikes to disappear (Shaheen, Cohen, & Martin, 2013).

While this experiment didn't last for long, its impact was notable as the discussion on the implications of car usage continued paving the way for Amsterdam to become one of the world's cycling capitals (O'Sullivan, 2022). But beyond Amsterdam's transport policy and evolution, this idea created a new transportation option to be further developed and adopted worldwide.

As summarized by Shaheen Amsterdam's white bike programme, along with a small number of similar schemes in Europe, are considered to be the first generation of bikesharing systems, after which at least three more generations would eventually follow at the time of the author's research (Shaheen, Cohen, & Martin, 2013).

Informed by the experiences of the previous generation of systems, the second generation of bikesharing systems strengthen bicycle return requirements (Abduljabbar, Liyanage, & Dia, 2021), implementing a new and distinctive piece of infrastructure that would characterize bikesharing services moving forward: docking stations.

The use of designated docking stations consisted in specific parking infrastructure where bicycles could be accessed, usually by using a coin-deposit system where users pay a standard deposit to unlock and release bicycles from a special bike corral. This deposit would be refunded when users returned the borrowed bike at the same or at a different docking station. This measure helped to reduce bike theft, but user anonymity would still facilitate the recurrence of this issue (Shaheen, Cohen, & Martin, 2013).

Although the first bikeshare programme in the US followed the white bike model with the implementation of Portland, Oregon's yellow bikes in 1994 (Shaheen, Cohen, & Martin, 2013), this second generation was also characterized by the uptake of bikeshare systems in the United States with new services implemented in Texas and Wisconsin, as well as an extended European adoption in countries that included Norway and Finland (Abduljabbar, Liyanage, & Dia, 2021).

Despite this growth, one of the critical challenges of this generation was the limited scale of the services, which "wasn't robust enough to provide adequate support to influence travellers to make sustained mode choice changes" (Abduljabbar, Liyanage, & Dia, 2021, p. 6).

The popularity of bikeshare systems would grow substantially with the implementation of new, third-generation services, which leveraged technological breakthroughs from the 2000s that enabled the use of electronic and wireless devices to create new ways to manage access to the services; this resulted in what could be referred to as new "IT-Based" systems (Shaheen, Cohen, & Martin, 2013).

The most relevant features of these services included the use of credit and debit cards as the default payment method, the implementation of electronic kiosks in docking stations that users can use to register and start or end their trips, and the use of smartcards and intelligent keys to unlock bikes (Shaheen, Cohen, & Martin, 2013).

The implementation of credit cards created a new control measure that helped increase accountability and deter bike theft. It eliminated the anonymity factor present in previous iterations of bikeshare services. This also helped to create new fare structures, most notably introducing memberships or passes, a now popular feature offering usually daily, monthly, and annual passes that grant unlimited trips during the validity of the pass, allowing users to maximize the value of their memberships (Lazarus, Pourquier, Feng, Hammel, & Shaheen, 2020).

Alternatively, fares per trip are changed to usually cover a specific time allowance (i.e., the first 30 or 45 minutes of any given trip)

with additional fees applying once such period is exceeded, charged directly to the user's credit card (Lazarus, Pourquier, Feng, Hammel, & Shaheen, 2020).

Third-generation services still rely heavily upon the use of docking stations, but with these new IT characteristics, operators can access bike and user information allowing them to track bicycles and improve the management of the service (Shaheen, Cohen, & Martin, 2013), this led to increased importance on rebalancing practices, which consist of constantly relocating bikes from low-demand stations experiencing a surplus of docked bikes (thus leading to an inability to receive new drop-offs), to stations with increased demand, mainly catering for directional peak period demand along the day.

The heavy reliance on infrastructure such as stations, interactive kiosks, credit card readers and, notably, the constant use of light trucks and other vehicles for rebalancing operations increased considerably the cost associated with these services. Nevertheless, they achieved varying degrees of success in various geographies as new cities started embracing the role of these services as a new urban transportation option (Janssen, et al., 2020).

New regions such as South America, Asia, and Australia experienced a wider adoption once these third-generation services appeared, leading to more than 100 bike-sharing programs in 125 cities worldwide for an estimated total of over 139,000 bikes (Abduljabbar, Liyanage, & Dia, 2021).

The reliability achieved by these third-generation systems enabled these services to become viable transportation options for local governments to embrace as part of their transportation policies, often leading to publicly funded services, with most systems in the early 2010s in the US and Canada being either publicly owned or not for profit operations. However, a growing privatization trend was also becoming visible (Shaheen, Cohen, & Martin, 2013).

2.3 New wave of shared micromobility

Thanks to the popularity and visibility of third-generation services, new versions of these systems quickly started building upon the IT components and capabilities of the previous generation to expand the demand-responsive nature of these services (Lazarus, Pourquier, Feng, Hammel, & Shaheen, 2020). This characteristic, along with multimodality, would become the defining traits of what Shaheen calls fourth-generation bikesharing systems, which at the time of her study, she recognized them as "an evolving concept that has yet to be fully deployed" (Shaheen, Cohen, & Martin, 2013, p. 85).

These early iterations of new-generation services would start to roll out in the early 2010s. Still, not until the second half of that decade would these fourth-generation systems eventually be consolidated by their most distinctive attribute: their lack of dependency on docking stations, thus being commonly referred to as dockless or free-floating services.

Additionally, while Shaheen's generational analysis focused only on bikeshare systems, this fourth generation would also be characterized by the introduction of new vehicle topologies and electricity-powered vehicles, including electric bicycles (or e-bikes) and moped-style scooters, but most notably standing e-scooters (Lazarus, Pourquier, Feng, Hammel, & Shaheen, 2020). For the purposes of this research, E-bikes, E-Scooters, and traditional bikes are considered part of the same generation of shared micromobility, even if there are slight but relevant differences in their physical and operational characteristics.

Multiple technology breakthroughs paved the way for shared micromobility services that were easier and cheaper to deploy in cities. Their new vehicle features, such as GPS built-in capabilities, allowed operators to avoid the significant infrastructure costs associated with docking stations. Similarly, increased reliability on smartphone applications and platforms resulted in lighter and less demanding administrative structures and processes, with registrations and payments handled mostly online and through these devices.

This also was reflected in more user-friendly access to the service, allowing users to easily register and un-lock a vehicle in minutes without requiring long registrations or in-person transactions (Fearnley, 2020). Suddenly users could sign-up from home or on the go just before starting their trip, creating a more appealing service that could potentially incite more people to use these services.

Furthermore, the addition of electric motors not only enables users to travel longer distances but also allows people who are not usually inclined to engage in active transportation or sports, in general, to consider using these services, as they require less physical effort (Lazarus, Pourquier, Feng, Hammel, & Shaheen, 2020). This means that a person commuting in the morning can more easily hop on an e-scooter to attend a business meeting without worrying about the inconveniences of engaging in physical activity due to their trip, even when riding uphill.

Additionally, e-scooters, in particular, have been especially attractive for leisure and recreational trips, as Gossling (2020) references a report by the Boston Consulting Group mentioning that e-scooters are also characterized by "˜affective values' such as "an element of playfulness that appears to have considerable appeal." (Gössling, 2020, p. 2).

At the same time, the geo-location capacities of these vehicles opened the door for data collection around people's travel behaviours, which could become valuable datasets that could be used for research purposes and guiding decision-making for cities and city officials. These datasets, though, can also create opportunities for private companies to profit, which raises serious privacy concerns.

Technological improvements, thus, have sparked debates and proved to become important points for discussion as in most cities, vehicles with compact electric motors fell under legal grey areas, mainly concerning vehicle licensing and age limits to operate motorized vehicles (Fearnley, 2020). This is particularly relevant in some cases where the municipal attributions to regulate vehicles could be exceeded, as its regulation might fall under state or provincial legislative purview or even at a national level.

Another highly relevant aspect that has characterized this new generation of shared micromobility services is their business models and, notably, the sources of funding that have given life to a significant portion of companies, often tech start-ups, to build and develop these services. Aligning with the introduction of shared e-scooters, companies such as Bird and Lime raised considerable venture capital funding, achieving valuations in the billions of US dollars, enabling quick growth (Ajao, 2019)

Despite this, questions surrounding their capacity to become profitable have constantly been raised, especially when the lifespan of vehicles tends to be considerably short, particularly for e-scooters (Hawkins, 2018). But rather than focusing on creating revenue at the early stages of operations, companies usually focused on expansion and growth, trying to establish market dominance, something common within the realm of new innovative services led by the tech sector.

Following this rapid expansion stage after the introduction of shared e-scooters, consolidation between companies started becoming a recurrent trend that would only speed up with the start of the COVID-19 pandemic in early 2020 (Heineke, Kloss, Möller, & Scurtu, 2022). This situation accelerated not only this process but also the setback of multiple operations in cities around the world, with companies rapidly existing markets where demand was more scarce.

Currently, and only after approximately half a decade after the last big "˜boom' of shared micromobility services, some insights on how companies might be able to achieve profits with free-floating vehicles have started to being brought up by industry experts, pointing out mainly to higher utilization rates per vehicle, while also, as previously mentioned in this section, tapping on their potential demand as extensions of existing public transit services (Kiessler, 2019).

But this potential synergy with public transit might echo some similarities with both services, as in most cases, public transportation services are not expected to yield profits and are often subsidized by governments since they have a valuable purpose. This raises a relevant question on whether or not shared micromobility services should be subsidized and if their role dictates the answer to such question in some capacity.

2.4 Benefits

Shared micromobility services have been linked with multiple benefits mostly centred around their direct impact on transportation choices and behaviour, but often also have secondary effects on numerous aspects. These benefits have been well documented mostly for traditional bikeshare system, most specifically third-generation systems, as an uptake in the number of published academic papers covering micromobility was observed starting around 2010 (Abduljabbar, Liyanage, & Dia, 2021), which coincide with the growing popularity and consolidation of third-generation services.

One of the most widely discussed benefits potentially associated with Shared Micromobility services is their capacity to influence a modal shift, specifically acting as a viable alternative to car travel. This significant benefit can be expressed in two main roles played by shared micromobility services that concentrate on multiple scenarios. The first one being the use of these services as a replacement for short trips made solely by private cars, taxis or even ride-hailing services. This is particularly relevant considering that almost half of all trips in the US take no more than 3 miles creating a significant overlap in the demand that these services could cover since they can be an effective option for distances reaching up to 7 kilometres with the use of e-scooters or e-bikes (Riggs, Kawashima, & Batstone, 2021).

Secondly, a role often assigned to these services is to act as first/last mile solutions, extending and complementing other transportation services, most commonly existing public transit services. This means that users can replace a car trip that would generally be preferable due to the limited reach of public transportation (i.e., a bus not reaching a specific origin and destination) with the combination of shared micromobility services and public transport. Bridging the access/egress point of the public transport services and the origin-destination with a quick bike or scooter trip can produce a double-sided benefit as it reduces car trips and enables public transit use. Moreover, a study carried out in Canada found that the 85th percentile walking distance to bus transit services in Montreal was around 500 metres (El-Geneidy, Grimsrud, Wasfi, TÃ©treault, & Surprenant-Legault, 2014), a distance that can be easily covered by shared micromobility services, potentially convincing users generally hesitant to walk relatively long distances.

In both cases, the main benefit associated with shared micromobility services is the reduction of car usage, which could lead to lower levels of traffic congestion levels and reduce greenhouse gas emissions. Multiple studies and surveys have found that North American users have reduced driving or substituted car trips by using shared micromobility services (Janssen, et al., 2020), (NABSA, 2022).

Furthermore, these services can act as gateways for people hesitant to adopt active travel in their routines or even as a leisure activity. If these services are widely adopted, the benefits

described above could also contribute to broader, secondary benefits in healthcare systems by embracing healthier lifestyles. As Shaheen pointed out, "Because public bikesharing addresses the storage, maintenance, and parking aspects of bicycle ownership, it encourages cycling among users that may not use bicycles otherwise" (Shaheen, Cohen, & Martin, 2013, p. 83).

Additionally, linked with its complementary role in wider transportation networks, the relatively low capital cost of implementing these services creates an opportunity to quickly deploy, adapt and expand the services in multiple areas within a city (Fearnley, 2020). This is particularly relevant for regions and populations historically underserved by traditional public transit services, increasing their accessibility conditions (i.e., access to job opportunities, healthcare, recreational spaces, etc.).

While its potential to reduce car travel is likely, there is also a possibility that these services could replace walking trips, this would hardly lead to any environmental benefit, but time savings and convenience benefits could still be associated with these trips.

2.5 Challenges

The rapid expansion of dockless shared mobility services caught cities off guard, with little to no time to explore the potential externalities these services might produce.

The first and most visible problem generated by introducing these services was the general cluttering of public space by shared micromobility vehicles. As shared micromobility services depend on a network effect to be viable transportation options, large fleets are often seen as a desirable feature by operators to attract users, on top of the added visibility that this naturally brings. Thus, as pointed out by (Fearnley, 2020), given the relatively low capital costs combined with the massive venture capital funding meant that cities flood with vehicles overnight, this is only exacerbated when adding multiple companies competing for the same userbase in every city.

Furthermore, parking was another important cluttering issue associated directly with these services' operations. The dockless nature of these new services created a novel challenge as vehicles were commonly dropped in inappropriate places, often obstructing sidewalks, streets, and other public spaces in multiple cities around the world, in some extreme cases finding vehicles in the bottom of rivers and even the top of trees, catching considerable media attention (Irfan, 2018).

As some of these vehicles were new, their role and rules of operation were not clearly defined, thus creating confusion on how they should be operated, including if e-scooters should be used on sidewalks, cycle paths and streets. These interactions created frequent conflicts in the public space, producing safety concerns exacerbated by some of the sporadic cases of imprudent driving with multiple users on a single vehicle. All these issues commonly resulted in some backlash from the public which varied per city as the services started to be perceived as nuisances, shadowing their potential benefits (Irfan, 2018).

Additionally, the electric component of some of these vehicles created concerns for additional safety risks associated with the higher speeds that these vehicles were capable of reaching. These concerns have been supported by data as e-bikes tend to result in higher incident rates than traditional bikes (Rune, 2021).

Access to new technological components also created problems not present in earlier iterations of these services. GPS tracking capabilities opened serious privacy concerns, fearing access to sensitive information and the risk of associating personal information with geographic tracking (Bliss, 2019). Furthermore, on top of services having a high financial access barrier due to the often-high costs per trip, credit card requirements created additional barriers for low-income populations with limited access to baking services, raising equity concerns.

The introduction of electric-powered vehicles also raised several questions surrounding the environmental footprint of these services, normally sold as environmentally friendly solutions. Concerns surrounding the required measures linked with the operation of these services, such as rebalancing, battery charging and the overall lifecycle of the vehicles, made cities question if these services were actually achieving a net zero footprint.

Finally, along with the visible high competition between companies, questions regarding the financial sustainability of such services in the long term were commonly raised.

All of these concerns were the result of limited time for cities to prepare and proactively manage the externalities, combined with the fact that these disruptions were also partly produced by an aggressive strategy from operators to expand, as pointed out by Dickey, these companies "were quickly known by begging for forgiveness rather than asking first for permission," (Dickey, 2018), something that Fearnley mention to have important similarities with the introduction of ride-hailing services earlier in the 2010 decade (Fearnley, 2020).

2.6 Why regulate?

The introduction of dockless shared micromobility services caught cities off guard. The aggressive strategies employed to achieve fast expansion, combined with the significant legal grey areas and public backlash, added to considerable city disruption. The regulation was often a response from local governments to contain the situation, as the purpose of these policies generally is attributed to two main factors, the prevention of externalities and negative impacts associated with these services (Riggs, Kawashima, & Batstone, 2021) and the stimulation of their potential benefits (Janssen, et al., 2020). Based on existing literature, it is common that authors assume regulatory practices to be natural and logical answers without spending too much time debating whether or not these services should be regulated.

In chapter 10 of Shaping Smart Mobility Futures: Governance and Policy Instruments in times of Sustainability Transitions, Fearnley provides a more in-depth exploration of the main reasons to regulate shared e-scooters, providing some insight on what would be the potential outputs regulation might bring depending on its approach, here Fernley list three main areas for regulatory intervention which might be applicable for shared micromobility services in general, beyond shared e-scooters only (Fearnley, 2020).

- Market failure, which includes addressing externalities such as incidents and safety concerns, managing economies of scale by restricting or stimulating the number of vehicles in a city, and addressing unfair competition. In this last point, similarities are drawn from the fact that passenger transport services competing for the same user base (such as taxis) are thoroughly regulated.
- Use of public space, which might focus on managing crowding and littering issues. However, Fearnley points out that commercial activity in the public space and right of way can be a strong and legitimate argument for cities to take control.
- Societal goals, which focus on using these services to push forward policy goals, such as reducing emissions, reducing congestion, promoting modal shift, equity, etc. This approach is centred around enabling the services to achieve their potential benefits through regulation.

Alternatively, Fearnley goes beyond this and entertains the idea of choosing not to regulate, arguing that regulation comes at a cost for cities. Thus, it might be desirable to maintain regulation at a minimal level. Simultaneously, an interesting point is raised about the fact that "the e-scooter industry itself so actively demands "˜rules of the game' and regulations would in normal circumstances raise a red flag." (Fearnley, 2020, p. 177). With this, the author argues that regulating services to protect them from themselves could work in favour of companies but not the public interest. This coincides with recent developments of shared mobility services claiming a lack of robust regulatory frameworks as one of the main reasons that led them to stop operations and exit some markets (Bird, 2022).

In the end, Fernley argues that a laissez-faire approach to e-scooter has been proven unsustainable because the objective of venture capital-funded services is to expand their market penetration to inflate stock value, looking in parallel to expand its "network effect" to attract more users. Thus, it is generally understood that the financial success of these services and their attractiveness to users depends on having a large fleet, which comes at the cost of littering, cluttering and obstructing the public space, adding a significant reason to what the author calls "a strong case for the regulation of e-scooter markets." (Fearnley, 2020, p. 182).

While there seems to be an overall agreement that regulation is desirable for cities to manage externalities and create environments that enable the potential benefits associated with shared micromobility services, there is also a strong consensus around the need to have flexible frameworks that make room for innovation and that can adjust to a highly fluid environment.

This has led to a wide variety of regulatory approaches being implemented in cities, often relying initially on relatively short pilot programs and then iterating from them into either new rounds of piloting or eventually legislating to establish sound regulatory frameworks.

2.7 Existing research on regulation

As mentioned before, for the most part, shared micromobility research has been centred around station-based bikesharing systems, gaining popularity around the late 2000s. Given the relatively recent introduction of fourth-generation services, research is still considerably limited regarding free-floating services.

Few studies have compared the experiences of implemented policies between different cities and regions. Recent studies by Janssen et al (2020) as well as Riggs et al (2021), employed similar approaches to consolidate and evaluate regulatory policy practices around shared micromobility in North American cities, differentiating themselves by the scale and scope of the regions covered and thus, the depth of their study of individual cases.

Janssen et al (2020) focused on ten mid-size cities evaluating what they call "policy dimensions" for a total of twelve different analyzing criteria while also including a temporal assessment to track and evaluate changes over time, enabling them to find several trends. The study found that the adoption of performance-based policies grew, highlighting that if cities overcome the technical challenge of defining appropriate performance metrics, this can help address saturation issue. Otherwise, cap increases could lead to financial stress as operators profit less from supporting an unnecessarily larger fleet. The authors point out that equity regulations have become stronger and more comprehensive over time, while data-sharing requirements have stayed consistent (Janssen, et al., 2020).

Riggs et al (2021) utilized a simplified approach with a broader scale, comparing five policy dimensions from a sample of 61 cities in the US, here the authors found some contention between vendors and city officials in the use of fleet caps, but while the effectiveness of these measures at encouraging the distribution of vehicles is considered inconclusive, their use to limit market saturation is widespread. Alternatively, the study points out that equity policies may not be as effective as cities consider them and that this might impact the financial feasibility of these services (Riggs, Kawashima, & Batstone, 2021).

Conclusions in both benchmark studies might align with Fearnley's argument in favour of a flexible approach, as Riggs also suggests that cities should explore the implementation of "a pilot programme to study policies that best align with their goals and objectives." (Riggs, Kawashima, & Batstone, 2021, p. 25). These conclusions tend to confirm a regulatory environment characterized by the high fluidity of the market, its actors, and their operations, making it difficult to avoid the iterative process of trial and error to find policy solutions.

Alternatively, research conducted by Stehlin (2022) questions the role of privately funded shared micromobility platforms in juxtaposition with similar publicly funded services (typically station-based bikeshare systems). Based on interviews with city officials and experts around the case of Austin, Texas, Stehlin argues that despite their benefits, most shared micromobility services are benefiting from "inadequacies of urban transport" in the US rather than addressing them (Stehlin & Payne, 2022). This points out potential tensions between existing transportation systems and the operation of new shared micromobility services, which might explain the decision of some cities to impose bans on these services.

3 Methodology

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The purpose of this study is to explore current regulatory mechanisms for shared micromobility services in North America, finding common practices across cities and notable strategies from specific cases; the result of this research integrates into the existing body of literature discussed in the previous section.

Similar to Janssen et al (2020), this study matches the authors' description of policy assessments, which "compiles information from a large breadth of sources so that it is available in one place" (Janssen, et al., 2020, p. 221), while this is specifically referred to e-scooter research, there are solid and relevant similarities when accounting for the full spectrum of services covered under shared micromobility.

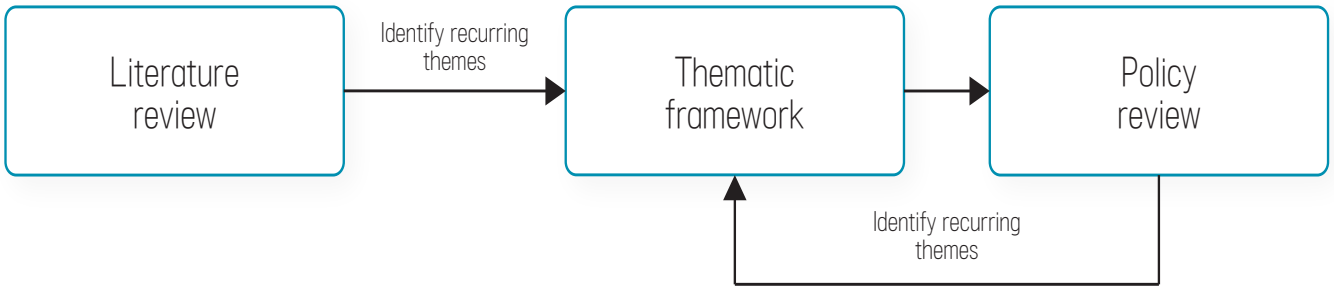
By compiling not only the main elements and themes discussed in policy documents but also comparisons between approaches (highlighting relevant differences), this information is expected to generate a valuable source of knowledge for local decision-makers, that informs on the potential applicability of specific regulatory tools and strategies for their local context.

3.1 Thematic framework

To guide analysis, a thematic framework informed by findings from existing literature is established; this provides structure to evaluate and distill the most substantial elements of implemented policies. This framework draws inspiration mainly from the 12 policy dimensions used by Jannsen et al (2020), as they represent a rather comprehensive coverage of the main elements found in shared micromobility regulation in North American Cities.

While this served as the base for the thematic framework, additional components were integrated. In contrast, others were consolidated or excluded based on the study's findings and complemented with some of the policy domains laid out by Riggs et al. (2021) and the areas discussed by Abdjuljabbar et al. (2021) under the second thematic cluster titled Policy.

Figure 1. Methodological process used.



This framework, thus, focuses on 16 thematic elements:

Figure 2. Final thematic framework.

This framework allows consistency across the evaluation for all cities. It intends to provide a more in-depth analysis of regulatory policies, steering away from the approach used by Riggs et al. favouring broader and more diverse geographies while limiting the evaluation to 5 specific attributes.

Finally, it is worth noting that this was structured as a flexible framework, which was empirically expanded and consolidated after identifying new elements on the policy documents, combining deductive and inductive approaches. Moreover, specific themes found in any particular city are included in addition to the 16 core themes.

3.2 City selection

The policy review will focus on three cities leading micromobility cities in North America. Cities were considered "leading cities" if they had:

1. A public bikeshare system in place before the introduction of private shared mobility services,
2. Multiple iterations of private shared micromobility pilot programmes,
3. Publicly available information on the rules and requirements for operation.

For the purposes of this research, it is assumed that if a city implemented a public bikesharing system before the introduction of a wider diversity of shared micromobility services, particularly 4th generation services, this could be considered a sign that such cities are invested in the use of shared micromobility services as new components of their transportation networks, giving them a place not only physically in the city but also as part of their policy agenda. Furthermore, it is also assumed that such systems have created valuable experience and knowledge on the benefits and challenges of these services. Both assumptions explain criterion 1.

Similarly, cities that have engaged in multiple rounds of pilot programmes as part of their process to establish regulatory frameworks are considered to have acquired relevant experience and knowledge regarding the management of these services. Thus, this experience is part of the criteria to define leading cities, as indicated by criterion 2.

Finally, information availability and ease of access is the final aspect that informs city selection (criterion 3); cities which had dedicated websites or repositories that concentrate all applicable by-laws, policy documents and reports linked with shared micromobility services in a single place were favoured when selecting three cities. This is a pragmatic consideration as document availability simplified the analysis process.

With these criteria, the selected cities consisted of Washington DC, Chicago, and San Francisco, all of which have a public bikesharing system within the top 5 largest system ridership numbers in the US in 2021, according to a NACTO report (National Association of City Transportation Officials, 2022).

3.3 Data collection

Focusing on the five selected cities, policy documents were collected by visually surveying official city websites. Similar to Riggs et al (2021), this is only a snapshot of current regulation complemented by reports and other relevant material that provides context and background information, furthermore this is also not an exhaustive collection of policy documents as per Janssen et al (2020) point out, previous iterations of regulatory documents are often replaced with newer versions, thus complicating the integration of previously implemented policies.

3.4 Analysis

Using the thematic framework as a guide, the policy documents were examined and compared to identify relevant differences and similarities while also highlighting relevant components that might be particularly innovative or useful, providing fresh approaches to regulation.

4 Analysis

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4.1 Washington DC

4.1.1 Context

Formally known as the District of Columbia, Washington DC has a population of 683,154 according to the 2021 5-year estimates of the American Community Survey and composes the central area of the Washington-Arlington-Alexandria Metropolitan area, the sixth largest in the US with a total population of 6,332,069 (U.S. Census Bureau, 2021).

In 2010, the District of Columbia and Arlington County launched Capital Bikeshare, the DC Metropolitan area public bikeshare system, one of the first large-scale bikeshare systems in North America; the system currently operate with a fleet of more than 6,000 bikes and over 600 docking stations (Capital Bikeshare, n.d.).

Dockless shared micromobility services started operations in the city in September 2017 with the implementation of the Dockless Bikeshare Demonstration pilot programme (DDOT, 2018). According to data compiled by the company Ride Report, as of Q3 of 2022, shared micromobility services accounted for almost 2 million total trips in this 3-month period, with a daily average of 22,300 trips and daily deployment of 9,960 vehicles (Ride Report, n.d.). As of 2023, four private companies operate in the district of Columbia: Lime, Lyft, Spin and Veo.

Photo by Maria Oswalt on Unsplash

4.1.2 Approach to micromobility in Washington DC

The district of Columbia makes a distinction between privately operated shared micromobility companies (referred to in the Municipal Regulations as "Shared fleet device operating company") and the city's public bikesharing system Capital Bikeshare, treating the latter separately from the regulations established in the Municipal Regulation's sections previously mentioned.

An evaluation report on the initial Dockless Vehicle Sharing Demonstration, published in December 2018, informs on the original motivations that DDOT had to run an initial pilot programme for shared micromobility services after receiving inquiries from operators in the summer of 2017. According to the report, DDOT considered the introduction of dockless shared mobility services as "an opportunity to supplement station-based bikeshare" and argued that "private dockless operators may foster more competition and innovation, which may lead to a higher quality service" as well as potentially accommodating adaptive vehicles for people with disabilities and producing valuable data for planning (DDOT, 2018, p. 8).

The city also creates a clear distinction between "shared fleet devices" defined by the municipal regulation as "An electric mobility device, bicycle, or electrically-powered motorized bicycle that is available for short-term rental and is permitted for use in public space" and "Shared motor-driven cycles" which alternatively are defined as "a motor-driven cycle that is available to rent in the public right-of-way for short-term one-way trips through a rental system that is available to the public" , this effectively creates a distinction between shared E-scooters, traditional bicycles and E-bikes, and mopeds which are treated under a different programme currently undergoing a pilot test (District of Columbia, 2022, pp. Section 24-3399).

Considering these distinctions, the policy document analysis focused on the regulation of shared fleet devices, namely between shared E-scooters, traditional bicycles, and E-bikes.

4.1.3 Policies and policy documents considered

The Department of Transportation for the District of Columbia (DDOT) is in charge of shared micromobility services regulation in the Washington DC region. Most of the policy documents regarding these regulations were found on the "Micromobility in the District" page, located in the "Getting around" section on their official website, and under the "Bike and Scooter" subsection. The information allocated in this website leads to the District of Columbia's Municipal Regulations hosted by the Office of Documents and Administrative Issuances, where all regulations applicable to shared micromobility services are hosted under Title 24, "Public space and safety" Chapter 33, "Public right of way occupancy permits" , specifically in sections 14, 17, 18 and 19 (District of Columbia, 2022). The

content of this section, thus, is sourced from these documents.

4.1.4 Specific policy elements

4.1.4.1 Policy objectives

At a high level, The District of Columbia's Multimodal Long-Range Transportation Plan titled "Move DC" provides some indications on the role of shared micromobility for the region in its December 2021 update (District of Columbia;, 2021). Here, as part of the list of 41 strategies laid out by the authority, most strategies referring to shared micromobility services tend to focus on equity and data privacy considerations, such as strategy 29, which centers on increasing accessibility for low-income population to these services.

It should be noted that the distinction between private shared mobility services and the Capital Bikeshare System becomes more apparent in this plan, as one of the plan's strategies puts forward a significant push in favour of Capital Bikeshare expansion, setting ambitious goals towards increasing the number of people enrolled in the services, the number of new station installed per year, the proportion of the electric fleet and even the percentage of residents and jobs located within a quarter-mile of a station. This clearly shows the great role that the city allocates to its bikeshare programme, something that is not necessarily reflected in other shared mobility services.

Beyond the Move DC plan, the policies included in municipal regulations chapters 24-3314, 16, 17, 18 and 19 do not establish a clear goal or objective at a more specific level to which the regulatory framework strives for.

4.1.4.2 Pilot programme results

Limited information on previous pilot programmes for shared fleet operation permits was found. Notably, the main source of information consisted of the 2018 pilot evaluation report. The report denotes the lack of a regulatory framework to guide the use of shared micromobility services, identifying the limited applicable regulation and stating that the city decided to host this initial demonstration process to identify the requirements for new regulation to maximize benefits and minimize potential unintended consequences (DDOT, 2018). The main facts of the district's approach to the pilot programme include:

First pilot programme ran from September 2017 to April 2018 and was extended until August 2018 after "promising but inconclusive results." (DDOT, 2018, p. 11)

- Operators were limited to 400 vehicles each to prevent oversaturation and required to provide public data and monthly reports.
- Seven companies participated offering either shared bikes or e-scooters.
- DDOT implemented the program as an open permit system, allowing operators to demonstrate eligibility to issue programme permits.
- No fees were charged to operators.

The evaluation method laid out by the report indicates that the measure of programme success used by DDOT not only relied on usage metrics aligned to achieve active transportation goals but also included public perception by residents, workers, and visitors.

The findings presented in the report establish that the program showed promise but most of the answers to guiding questions provide inconclusive results. Overall, the pilot programme was considered to be "additive" to the district's public bikeshare system, with few parking violations observed and generalized support for the programme from the surveyed public. Considering this, the report recommends continuing the expansion of the dockless vehicle programme, ensuring staffing capacity to manage service regulation enforcement and continued engagement with the district's public.

4.1.4.3 Permits, licences and fees

Regulation for the current programme was adopted by the District of Columbia's Municipal Regulations on October 14th, 2022, before the permit application period opened for the 2023-2024 programme. As of January 2023, DDOT awarded 24-month permits to four operating companies: Lime, Lyft, Spin and Veo, with all four companies operating shared e-scooters and e-bikes (with the exception of Lyft, which only operates shared e-scooters) for a total of 8,220 scooters and 3,720 e-bikes distributed as indicated by Table 1:

Table 1. Authorized private shared micromobility fleets as of January 2023.

Operating Company	E-scooters	E-bikes
Lime	2,500	2,500
Lyft	2,500	0
Spin	2,500	500
Veo	720	720
Total	8,220	3,720

Source: DDOT (District Department of Transportation, n.d.)

Currently, the permit application process requires operating companies to submit a document answering a set of questions outlined by section 24-3317 of the municipal regulation. This questionnaire comprises 51 questions tackling subjects that include: Equity and Accessibility, Safety, Accountability and Data, Labor, Sustainability, Innovation, Past Performance, Device and Equipment, Operations, Education and Engagement. The

answers provided by companies are intended to inform on the operator's capacity to provide the services and the conditions of the service itself, with the district using a point-based system to evaluate these responses. The administrative issuance outlining the most recent points-based scoring system was not available for review at the moment of this study.

Any application is subject to the following applicable fees:

- Application permit fee: $50 USD per permit
- Technology fee: $25 USD per permit
- Permit fee to operate in the public right of way: $250 USD (renewal is $100 USD)
- Refundable deposit: 10,000 USD
- Monthly fee per device: 10 USD (paid on a bi-annual basis)

Previous iterations of applicable regulation show that lower deposits and no permits to operate in public right-of-way were in place in past programs.

4.1.4.4 Operator and fleet caps

The current permit framework sets specific limits on the number of operators and fleet per operator, limiting the total number of permits awarded to a maximum of 9 simultaneous operators, of which a maximum of 5 companies could be granted permits to operate electric devices such as e-scooters. This can be an indication that the city is striving towards balancing the offer between the electric and nonelectric vehicles or at least limiting the presence of electric vehicles, which are likely to have a higher ecological footprint and/or lead to more injuries when compared to human powered vehicles with lower speeds, although there is no specific mention of the reasons or logic behind this restriction. Similarly, there are differentiated limits on fleet size, as operators are initially limited to a maximum fleet of 720 e-scooters or 2,500 bicycles, both of which can be incremented to a maximum of 5,000 vehicles via the fleet increase application framework. Considering that 4 permits have been issued for the 2023-2024 programme, an effective total fleet cap of 20,000 vehicles is currently implemented.

4.1.4.5 Expansion policies

DDOT regulates fleet increases through a specific section of the municipal regulations under the "Public right of way occupancy permits" chapter; this document establishes the requirements and application process for the DDOT director to approve any fleet increase. Overall, expansion permits are directly linked with an equity performance indicator, namely, the percentage of trips made by low-income plan users as presented in Table 2:

Table 2. Fleet increases awarded by the District of Columbia.

Fleet increase	% Of total trips made by low-income plan users in last seven days*
50 units	Between 2% and 4%
100 units	Between 4% and 6%
150 units	Between 6% and 8%
200 units	8% or more

*at least five people from low-income plans must have participated in the previous week.

Source: DDOT (District of Columbia, 2022).

Additionally, for these increments to be allowed by DDOT, operators must demonstrate that for each of the last 7 days, at least 90% of the currently permitted fleet was available for services and that at least two trips of no less than 2 minutes were taken per fleet device. In the specific case of shared bicycles, the initial maximum fleet size can be increased if the company demonstrates that 75% of its fleet was available during the previous 30 days and that at least one trip per vehicle was made daily during this period; this marks another softer restriction on non-electric vehicles.

Fleet increases might be revoked if operators don't deploy at least 55% of their permitted fleet between November 1st and April 30th, 75% between May 1st and October 31st, or if low-income plan users make less than 1% of all trips.

4.1.4.6 Operating areas

DDOT, through municipal regulations, do not include any provision that establishes a specific service operation area with clear boundaries; it is inferred, though, that operations are restricted only to the District of Columbia's ten wards and its boundaries. Beyond this, policy documents do link one of the provisions of the regulations to a specific geographical area, prohibiting shared micromobility devices from riding on sidewalks in the city's central business district located mostly within ward two but also extending into a small area of ward six.

4.1.4.7 Speed Limits

DDOT only establishes that shared micromobility devices should operate at a top speed of 10 miles per hour (approximately 16 kilometres per hour), enforcing this via a built-in speed governor in all devices. No regulatory provisions for special or reduced speed limits in specific zones were identified beside the general maximum speed stipulated in section 3314.5-U of title 24 of the municipal regulations (District of Columbia, 2022).

4.1.4.8 Operational requirements

Extensive operational requirements are included in the district's regulations; these mostly target fleet deployment and distribution, parking requirements and compliance-adjusting operations in special circumstances.

Operators must make available at least half of the total fleet at all times in the district, deploying no more than 35% of vehicles in a single ward of the total of 8 city wards and no less than 3% during the 5 am to 7 am morning period. No more than five devices can be allocated in a single block face, nor should they be within 300 ft of an elementary, middle school, or senior wellness center unless a transit station is adjacent. Additionally, any vehicle that has been moved for less than 20 feet in the last 84 hours must be relocated within 12 hours after this unused period is met.

Whenever a vehicle is noncompliant with parking rules (covered in a subsequent section), operators are responsible for moving the devices proactively, and when notified by DDOT, they must take corrective action within 2 hours of such notification. Operators are required to establish a toll-free customer service phone line where user assistance can be provided and allow users and the public to report any complaint with the service.

Additional restrictions on the operation of shared micromobility vehicles indicate that users should be at least 16 years old, with users younger than 18 required to use a helmet to ride. Vehicles must be used by a single user, without using headphones or similar devices, preferably circulating on cycle lanes where available. As mentioned in previous sections, devices should be operated at a speed that does not exceed 10 mph. While circulation on sidewalks does not appear to be generally banned by DDOT, it does expressly prohibit users from doing this within the city's CBD area.

Operators are required to submit an official operations plan to DDOT and ensure sufficient staff is available to deliver operational tasks, including rebalancing, maintenance, and compliance with parking rules. Operators must also cooperate with DDOT and suspend service in case of inclement weather, special events and/or emergencies. Furthermore, DDOT can set temporary geofencing areas (virtual areas designated for operation) for periods ranging from two hours to 30 days. Operators are encouraged to use geofencing to limit the use of devices and ensure compliance with regulations, which can include speed limits, parking restrictions and delimitating private and public spaces.

4.1.4.9 Data requirements

Another extensive component of DDOT's regulations is centred around data sharing requirements, mostly targeted at the sets of data that operators must feed periodically to DDOT as well as the ones that should be publicly available. Regulations specify that all the data requested by DDOT and provided by operators can be used to regulate public space and planning purposes.

Operators are responsible for providing data to help evaluate the impact of their shared fleets, although details and formats for what this information requirement encompasses were not identified at the time of this study, even though policy documents specify that this should be defined on DDOTs website.

Furthermore, operators must provide two different Application Programming Interfaces (API): one that provides the current location of its shared fleet devices, publicly posted on the company's website and using the General Bikeshare Feed Specification (GBFS) format, and a second, internal API provided to DDOT for data visualization or analysis purposes.

In terms of reporting, operators must share with DDOT the origin, destination, route travelled, and device type for each trip completed, as well as all penalties or fines assessed against riders by the operator, while also compiling crash and injury data. Furthermore, they must inform DDOT of devices being held in private space, exchange data with the maintenance management system to track tickets and report any incidents within 24 hours of their occurrence. They must also establish an emergency disclosure request process to be used in case of life-threatening events.

All real-time information must be updated with a delay of no more than 5 minutes, data for planning purposes must be delivered with a delay of no greater than five days, and monthly reporting has to be done with seven days of the end of the reporting month.

While a considerable portion of the requirements center on data sharing, the specificity of such requirements could still be considered somewhat superficial, especially when dealing with the format in which such data must be delivered, as there is no specific guideline or standard to follow other than the GBFS specification which only deals with real-time data. A document regarding Data and Reporting Standards for the 2020 Dockless Permit Programme (DDOT, 2020), that specifies the required compliance with an additional data specification (Mobility Data Specification or MDS), this is not reflected in the municipal regulations, thus while likely, it is unclear if this requirement is still applicable.

Furthermore, data privacy protection seems to be relegated to specific situations, such as preventing operators from requiring customers to grant location services from their smartphones when locking or unlocking devices and asking for any other data such as contacts, photos, or other personal files. The lack

of further data privacy protections can be a significant concern, particularly when sharing the origin and destination information for all trips required by DDOT, which does not specify format and data privacy protection measures.

Using this information, the district has partnered with RideReport, a shared mobility data aggregator platform, to display the usage information provided by operators through the use of an interactive public-facing online dashboard that allows performing quick data summaries, including the number of vehicles and trips for a specific time period as well as their average trip distances and speeds.

4.1.4.10 Performance requirements

No specific performance metrics linked with the usage of vehicles of specific rides (i.e. minimum rides per device per day) appear to be procured by the city, other than those regarding fleet expansion requirements.

4.1.4.11 Equity requirements

The low-income plan is one of the three equity requirements set for operators by DDOT and is notable as it's the only requirement linked with performance indicators that the district tracks, only as part of the fleet increase requirements. To comply, operators must offer free unlimited 30-minute trips for adults over 18 years old that either earn less than $24,980 USD per year as a single person or that are part of a family of four or more where the household income is less than $51,500 USD per year. Complementary, the other two equity requirements are focused on lowering access barriers to shared micromobility services, requiring operators to offer a cash payment option for individuals without access to banking services at the same rate as the card payment and without any additional fees or surcharges, and offering the option to access the services for individuals without access to a smartphone device.

At the time of the study, the District of Columbia hosts documents from 6 different operating companies, composed of Bird, Lime, Lyft, Razor, Spin and Skip/Helbiz (assumed to be past operators); in these documents, the operators outline the details of the equity provision. While, according to this information, the requirements are met, the measures from some companies tend to be more appropriate than others, possibly relying on commercial agreements and technological solutions to offer these equity provisions. For example, companies such as bird limit their cash payment options by requiring users to purchase a prepaid credit card at convenience stores. This measure could be considered to rely on assigning users the responsibility to find a payment alternative.

Alternatively, Lime's solution to this requirement is made possible by a partnership with PayNearMe, a payment platform that allows users to directly pay with cash at participating convenience stores to receive a code to ride; this removes the need to use a credit card, while still offering the option of using prepaid cards and PayPal. A similar process is used to access the service without using a smartphone, where all operators offer the option to send a text-to-ride SMS message, call a customer service line or a similar solution to receive a riding code.

4.1.4.12 Parking requirements

In terms of parking requirements, vehicles must be parked in an upright position, locked to fixed infrastructure elements, and located within the furniture zone of the sidewalk (where it exists), always maintaining a 3 feet clearance for pedestrian circulation and clear of obstructing entrances to private property, driveways, ramps, and parking spots for people with disabilities, capital bikeshare stations, public transit stops or shelters and vehicular circulation in the public right of way.

Supplemental information guiding parking indicates that vehicles are generally advised to be parked preferably where bike corrals are available, and if parked within the furniture zone of the sidewalk, one wheel should ideally be placed on the curb to minimize obstruction. As a complementary policy, the District of Columbia supported the operation of shared micromobility services by providing designated parking spots consisting of on-street bike corrals; according to information on their official website, there were 42 installed corrals as of January 2020 out of a total of 100 planned for all eight wards.

4.1.4.13 Vehicle specifications

In terms of vehicle technical specifications, all devices must have GPS capabilities enabled to track location, functional headlights, taillights, and reflective elements and sport a distinct visual identity with a visible and easily recognizable logo. Additionally, weight and size restrictions, limiting vehicles to a top weight of 75 pounds (approximately 35kg) and a maximum length of 55 inches (approximately 1.4 meters), are briefly mentioned in section 24-3318 of the municipal regulations covering details on permit revocation, suspensions, and penalties, this will be further discussed in the following section.

4.1.4.14 Education and outreach

Regarding safety and education, operators must educate users regarding the law and safe practices applicable by requiring each user to watch a video via the dedicated smartphone application provided by the operating company. Furthermore, operators must offer an optional free class at least once a month to educate users regarding the law and safe practices and offer to ship a helmet to any user who requests it for a price determined by DDOT.

4.1.4.15 Insurance and liability

Policy documents determine that operators are required to "indemnify the district against all liabilities associated with the use of the public right-of-way by the shared devices" ; moreover, they must carry a liability insurance good for no less than 1 million dollars per incident (District of Columbia, 2022, pp. Section 24-3314.33).

4.1.4.16 Penalties and incentives

DDOT city can notify the operator of any noncompliance; the operator then has 2 hours to either commence corrective measures or notify the city in writing that corrective measures cannot be performed within the 2-hour limit due to unforeseen circumstances and provide a proposed timeline for the corrective measures to be completed. If an operator fails to comply with this, DDOT can take actions to restore the public right of way and make the corresponding deductions to the refundable deposit to cover these corrections.

Failure to comply with the regulations can lead to a permit suspension or revocation; this also can be triggered if DDOT determines that the service poses "a hazard to the public safety" . If a suspension comes into effect, operators have three business days to address the reasons for the suspension and submit an official explanation in writing. If this explanation is delivered in time and considered reasonable, DDOT might grant a hearing or issue a written decision. If the operator issues no response on time, the suspension will be upheld by an additional five days, followed by a notice of revocation.

Whenever a suspension is issued, the operator has 24 hours to remove devices from public space, whereas, in the case of revocation, this period is extended to 72 hours. Any unpermitted deployment of shared micromobility devices will make the operator ineligible for a permit for the next two years. The only fines stipulated in the policy documents refer to a $100 USD penalty applicable whenever a deployed device does not comply with the size and weight specifications established by DDOT (max 75 pounds in weight and 55 inches in length)

Alternatively, the only incentive identified in DC's policy documents is the possibility of accessing a reduction or waiver of the per-vehicle monthly fees. If more than 10% of total miles or time travelled in the six months before the bi-annual payment were made by low-income plan users, DDOT can waive the device monthly fees. If the proportion of low-income plan trips is less than 10%, then a proportional discount for these fees can be applied.

4.1.5 Other items to consider

4.1.5.1 User protection

Regulations only establish a few user protection measures, such as restricting operators from requiring riders to agree to class action waivers or other terms that would force riders to waive their rights, in addition to some data privacy provisions where, as mentioned in a previous section, operators must refrain from requiring users to provide location information when locking or unlocking a device.

4.1.5.2 Commercial advertisement

No provisions on the use of advertisement elements on shared micromobility vehicles are included in the policy documents consulted; thus, is not clear if service providers can engage in advertisement contracts to add funding sources to further support their operations.

4.1.6 Key takeaways

The District of Columbia is the only city in this study that regulates both bike and scooter sharing programmes under the same regulatory policy, and also the only city where both types of services currently operate. Washington DC issues two-year operating licences with a per-device fee structure, while also limiting the number of extra devices significantly, thus capacity to expand for operators appears to be highly restricted by the city. Furthermore, it is also the only city that employs incentives for operators to extend equity benefits and that includes policy provisions that favour bikes over e-scooters, nevertheless, fleets are still largely composed of e-scooters rather than bicycles.

The District makes little to no use of any geographical restrictions or rules, except for restricting sidewalk riding in the city's CBD, potentially indicating that sidewalk riding is allowed elsewhere. Education and outreach requirements are considerably limited. Lastly, the District establishes vehicle requirements such as maximum weight and speed that are more in line with the use and role of these devices as active transportation alternatives.


Photo by Pedro Lastra on Unsplash

4.2 Chicago, IL

4.2.1 Context

The city of Chicago, seat of Cook County in the state of Illinois, has a population of 2,742,119 according to the 2021 5-year estimates of the American Community Survey and is part of the Chicago-Naperville-Elgin Metropolitan area, the third largest in the US with a total population of 9,607,711 (U.S. Census Bureau, 2021).

Launched in 2013, the "Divy" started operations as Chicago's Department of Transportation public bikesharing system. Its latest expansion kicked off in 2021 and is expected to grow to a total fleet of 16,500 bikes and more than 800 stations (City of Chicago, 2021).

While the Divy system was implemented in 2013, it was not until 2018 that the city started exploring the adoption of 4th-gen shared micromobility services trough a series of pilot programmes. Based on results from the 2020 scooter share pilot, an average of 4,391 daily trips were made with an average fleet of 7,415 devices, accounting for more than half a million trips (City of Chicago, 2021). Currently, three private companies operate in the City of Chicago: Lime, Spin, and Superpedestrian.

4.2.2 Approach to micromobility in Chicago

The city of Chicago approached the exploration of dockless shared micromobility services by separating shared bikes and scooters into different evaluations. The reasons behind using this approach are unclear based on the policy documents reviewed.

The city held a six-month dockless bikeshare programme in 2018, with four dockless bike share companies participating. The city held a scooter share pilot a year later, granting permits to 10 companies. A second iteration followed this pilot programme in 2020, expanding the scale of the programme with an operating area four times larger than the previous one and five times the number of devices deployed initially. It was carried out, although, with a reduced number of selected operators totalling three companies, a decision mostly targeted at reducing administrative burden for the city.

These pilots were used to evaluate these services' viability and applicability in the City of Chicago. While results for both pilot programmes appear to show potential (and also note significant challenges), based on the available information, the city's intentions to adopt dockless bikeshare services after the initial pilot programme are unclear. This lack of clarity is supported by the fact that the City's official website only shows information regarding the current scooter-sharing programme. At the moment of this study, and based on publicly available information, it is unclear if dockless bike sharing services are available in the city or if the current regulation allows them.

Furthermore, the city's effort to adapt regulations for scooter-sharing companies to operate is more evident. A code ordinance amendment in Chapter 9-4-010 of the municipal code was introduced before the scooter share pilot programme to specify three different types of vehicles (City of Chicago):

- Traditional bicycles.
- Low-speed electric bicycle (with three different sub-classes depending on power)
- Low-speed electric mobility device, which corresponds to a vehicle that:
  - Has no operable pedals.
  - Is no more than 26 inches wide.
  - Weighs less than 100 pounds.
  - Is powered by an electric motor that can propel the device with or without human propulsion at a maximum speed of 15 miles per hour on a paved levelled surface.
  - Is intended for transporting one individual.

According to a 2019 publication from the NABSA, the Chicago Department of Transportation Assistant Commissioner mentioned that the new provision for low-speed electric mobility devices or LEMDs is intended to give LEMDs riders "the same rights and responsibilities as people riding bikes." According to the Assistant Commissioner, this was something that the city identified as a novel approach, not used in other cities (North American Bikeshare & Scootershare Association, 2022).

Besides these three vehicle typologies, the city also treats mopeds (or vespas) and motorcycles as different devices, with district regulations applying specifically to them. Given the currently available information and policy documents, more specifically, the lack of information regarding dockless bike sharing, this study will focus on the provisions set forward by the City of Chicago to regulate dockless scooter-sharing services.

4.2.3 Policies and policy documents considered

The City of Chicago's Department of Transportation and the Department of Business Affairs and Consumer Protection, and their respective commissioners manage scooter-sharing companies' regulations. Moreover, in some instances, the city's Department of Streets and Sanitation may also be involved in some aspects of the current regulatory framework. Policy documents consulted for this analysis were retrieved from the "Scooter Sharing in Chicago" webpage under the supporting info section on the City's Department of Transportation official website.

Most of the city's applicable regulation to shared micromobility services is summarized in the document titled: "City of Chicago Scooter Sharing Business Rules" published on February 27th,2023 (City of Chicago, 2023), and has its legal base in the "Scooter Sharing Ordinance" located in Chapter 9-103 of the city's Municipal Code (City of Chicago). The following content, thus, is sourced from this document. Furthermore, complementary documents, such as the pilot evaluation reports for the 2019 and 2020 pilot programmes, are also referenced to provide supporting information.

4.2.4 Specific policy elements

4.2.4.1 Policy objectives

The City of Chicago has defined clear goals for its licencing programme, putting forward a standalone document informing on the current regulation's ten objectives. As its first goal, the document lists increasing access and ridership of shared micromobility services, especially for "residents facing elevated economic, health, mobility and accessibility barriers", denoting importance assigned to equity considerations for this policy (City of Chicago;).

Following this, the rest of the objectives are more specific and practical as they tackle specific situations or issues associated with these services. These include minimizing sidewalk riding, oversaturation and unused vehicles, promoting safe uses, limiting potential challenges for users, ensuring device safety and timely remedy of improperly parked, achieving high-quality public outreach and education and finally, maximizing net environmental benefits.

4.2.4.2 Pilot programs results

As previously mentioned, the City of Chicago carried out three different pilot programmes between 2018 and 2020, the first corresponding with the evaluation of dockless bike-sharing services. The following two focused on dockless scooter sharing.

Results from the initial dockless bikeshare pilot program evaluation pointed out that demand for the service was confirmed, noting that users from companies that offered e-bikes made three-quarters of all trips instead of traditional ones. The evaluation report seems to validate the feasibility of having multiple companies with similar service offers coexisting and that operations were carried out without major disruptions (City of Chicago;, 2019).

Despite this, the reports highlight that coexistence with the city's public bikeshare system was not evaluated as the pilot programme was targeted at areas not yet serviced by the Divy system, leaving an important question on competition between private and public services. Moreover, the geographic allocation of this pilot program targeted areas with limited density; thus, scalability to denser areas was also left as a pending question.

As for the scooter pilot evaluations, the January 2020 report mention that the pilot "showed promise that e-scooters could aid in filling transportation gaps" while recognizing that the regulations put forward by the city before the programme started were successful at preventing known issues in similar cities (City of Chicago, 2020, pp. 10, 87).

According to the reports, the first scooter pilot programme saw a concentration of trips in areas with many other transportation alternatives ranging from Divvy bikes to transit services. In contrast, after introducing requirements to service-specific equity-priority areas, the second pilot saw a more balanced utilization. Despite this, the reports mention that "the jury is still out on whether e-scooters connect riders to public transit or replace private car or ride-hailing trips" (City of Chicago, 2020, p. 10).

This leads to another critical concern regarding sustainability and environmental impact as the results point out a short device lifecycle and scooter trips potentially replacing walking trips, a situation which, according to surveys, could account for 30% of all shared scooter trips.

4.2.4.3 Permits, licences and fees

Scooter-sharing licenses are issued for 2-year periods to applying companies with a licence fee of $ 1 per day per approved scooter to be paid before the start of the licenced period, meaning that license cost is proportionately linked with the size of the fleet. In addition to this, according to the city's official website, operators must also pay a personal property lease tax equal to 9% of trip revenue. However, further information on this provision was not found in the analyzed policy documents.

In order to obtain a licence approval, operators must submit an application providing details on multiple topics that inform the city of the operational capacity and experience of the company as well as multiple practices to be implemented in the city of Chicago. Within its rule document, the city has laid out a standard scoring system outlining the criteria used to rank applicants considering the level of detail provided, innovation, ability to solve known challenges and achieve the city's goals, and the system's applicability to Chicago's context.

The scoring system allocates the highest value to the "Operations and relevant experience". This component evaluates the company's similar operations in other cities focusing on the scale of operations and relevant experience in large and dense commercial areas, managing and deterring improper parking, fleet rebalancing, stale devices management, maintenance practices and data specification requirements. Generally, the larger the scale of operations in referral, the higher the score, with additional points awarded for specific target area deployments (such as designated equity zones).

Furthermore, the operator must share a proposed plan of operations for the city of Chicago, including details on staffing, hiring plan, and the environmental impact measures to be taken. Service providers must also provide detailed information on the devices' technical specifications and the measures to guarantee their safe operation.

The City of Chicago also requires operators to share contact information on references corresponding to operations listed as relevant experience, which can provide information to evaluate the applicant's character in a separate evaluation component focusing on reputation and incurred suspensions and penalties.

Additionally, the city evaluates accessibility provisions as a separate component, focusing on multiple equity considerations, including low income-plans, adaptive devices, and cash payment options. It also evaluates safety provisions, focusing on practices and technology the operator has used or intends to implement to deter underage and sidewalk riding and incentivize helmet use.

The evaluation process and framework appear to be clear and predictable, something that could provide certainty to operators intending to apply. Based on the contents of the analyzed documents, there is no indication of a vehicle cap for initial licencing, potentially inferring that it is up to the operator to decide the scale of their fleet based on the maximum number of vehicles allowed by the city. Furthermore, the application requirements indicate that the operator should disclose the maximum potential fleet intended for deployment at the start of the licensing period and the maximum potential fleet they could ultimately deploy.

4.2.4.4 Operator and Fleet caps

The City of Chicago has established a maximum fleet cap of 3,000 scooters among all operators on the initial day of operations; this could be assumed to be intended to achieve a gradual deployment. Subsequent fleet increases authorized by the city can be issued until a maximum fleet of 12,500 vehicles is reached when accounting for all operators.

While the City of Chicago has not established an operator cap, this shared maximum fleet cap influences the number of operators, as an increase in one operator fleet will result in a reduced capacity for new operators to access licencing if the overall maximum fleet is achieved. Similarly, if licences are revoked or cancelled, the capacity to increase existing fleets or apply for new fleets is expanded. The total fleet is calculated based on the total number of vehicles in the public right of way (available, non-operational and on-trip) as reported by the Mobility Data Specification (MDS) API.

4.2.4.5 Expansion policies

The city of Chicago allows operators to apply for first-time fleet expansion authorizations if the overall maximum cap has not been reached, requiring a 60-day waiting period after the issue of the initial license. The cost for fleet expansions is calculated based on the same rate established on the initial permit (1 USD per-authorized-scooter-per-day) prorated to the remaining time of the current licence. First-time expansions might be granted on 500 or 1,000 vehicle increases depending on compliance with 7-item criteria which include:

- Average utilization of at least one trip per device per day in the past 30 days
- At least 90% of the fleet deployed in at least 27 of the last 30 days
- Met the daily equity priority area and sub-area requirements measures at least in 24 of the past 30 days.
- At least 12 education and outreach events carried out, including an in-person event in each of the equity priority sub-areas
- The operator has not exceed the total allowed fleet cap by more than 5% on 24 of the last 30 days, and has not exceeded the total cap by more than 10% in any of the past 30 days.
- The operator has remedied at least 80% of the parking complaints within 2 hours of notification during operating hours in the past 30 days
- The operators has registered at least 100 low-income customers in the city, or has instituted a discount of at least 50% of the per-minute rate or unlock fee for free beginning or ending in an equity priority area

If the operator complies with 5 of these requirements, a 500-vehicle increase is granted. If it complies with six or more, a 1,000-vehicle increase is authorized. Compliance with less than five requirements will result in a request denial, after which

operators can reapply once 30 days have passed after the decision.

If the first fleet increase is approved, operators must wait 90 days before requesting a subsequent increase. The same evaluation criteria apply for subsequent increases, although with some higher requirements demanding higher utilization-per-scooter performance, higher compliance levels on equity targets, parking complaint remedy levels, and higher low-income user registry levels (userbase total equivalent with at least 10% of authorized fleet devices).

Operators can retract from approved fleet increases, relieving them of the required payment for additional permit fees. If retracted from the first fleet increase and allowed to operate in the Core Areas and Central Business District (a restriction explained in the subsequent section), service providers can still operate in these areas. Any subsequent fleet increase application will be evaluated using the same criteria as the initial expansion evaluation.

4.2.4.6 Operating areas

The city of Chicago has established a set of geographic boundaries with specific applicable rules, these can be summarised in the following items:

- General Service Area
- Exclusion areas
- Equity priority sub-areas
- Core Area and CBD

The general service area establishes the general zone where service providers can operate, although the specific rules might vary depending on sub-areas within this general service area. Most importantly, the general service area sets the hard boundaries to which scooters must adjust. All operators must rely on technological solutions to force all vehicles travelling outside the services area boundaries to be slowed down to a stop within a 1-block distance after exiting the operating area. Furthermore, vehicles must not be allowed to end a trip outside the service area boundaries. Operators must ensure that vehicles are distributed evenly across the city based on population, although the specifics of this requirement are unclear in the documents analyzed.

Within the confines of the general service area, the City of Chicago has determined four specific areas where shared e-scooters operations are prohibited; these exclusion areas must be geofenced by operators so that vehicles can not be ridden or parked. Exclusion areas include the lakefront trail, the Bloomingdale Trail, the Chicago riverwalk and O'Hare airport, effectively prohibiting shared e-scooters in most of the city's waterfront, an elevated linear park and the city's airport area.

The city also establishes ten equity priority sub-areas where operators must deploy at least 50% of their total fleet while ensuring that at least 3% of all vehicles are located in each of these sub-areas. Further specific rules linked with these sub-areas are covered in subsequent sections.

Finally, the city determines a "Core Area" boundary in central Chicago with a second sub-area delimiting the city's CBD or Central Business District. The City of Chicago has prohibited the deployment of shared e-scooters in both of these areas within 60 days of the start of operations for all licensees. To comply with this, operators must set up a geofence and stop all vehicles breaching this provision. Once the 60 days are passed, operators may apply for authorization to operate in the Core Area and CBD with additional scooters via the fleet expansion request process, where a decision will rely on performance and utilization assessments.

Once operations in both areas are authorized, service providers can deploy a maximum of 4% of their fleet within the core area and no more than 1% in the CDB. Fleet caps are calculated with the same criteria established in section 4.2.4.4 Operator and Fleet Caps, relying on the MDS report of total devices in the public right-of-way, including rented and non-operational devices. The city may use the MDS Geography and Policy endpoint to enforce geofencing and fleet maximum restrictions.

Overall, the operating area requirements represent a good use of multiple regulatory tools, combining fleet caps with data specifications and geofencing and even using technological features that can enforce certain physical restrictions.

4.2.4.7 Speed Limits

The City of Chicago has established, via its low-speed electric mobility device requirements set in Section 9-04-010 of the Municipal Code, a maximum speed of 15 miles per hour (approximately 24 kilometres per hour). This speed is referred to as a technical characteristic that these devices must meet: "powered by an electric motor capable of propelling the device with or without human propulsion at a maximum speed of 15 miles per hour on a paved level surface". It is unclear, though, if speed limits must be enforced using speed governors if more powerful motors are used.

Additionally, the city requires operators to cap the maximum speed of all first trips made by new users at ten mph while ensuring that this restriction is adequately communicated to the user before starting the ride. It should be noted that no speed restrictions linked with specific operating areas were identified on the consulted policy documents.

4.2.4.8 Operational requirements

The City of Chicago puts forward multiple service and scooter operations requirements. Notably, shared micromobility operators are prohibited from offering services between midnight and 5 am. They must prevent the parking of "an excessive

number of scooters" in a single location, although this concept is not clearly defined and seems to be determined by city officials. Furthermore, scooters that have not been moved in 240 hours must be relocated at least one block from their current location.

Operators have 48 hours to retrieve any non-functional or damaged vehicle proactively. The unavailability of such devices should be reflected in the MDS and GBFS data feeds; alternatively, any non-functional scooter reported by the public has to be retrieved within a 2-hour timeframe after the operator is notified. All vehicles deemed unavailable must either become available though the appropriate corrective measures or be removed from the right-of-way within 2 hours.

At the start of operations, service providers must designate a contact person for communications with the city and an operations manager to coordinate with the city; additionally, the operator must ensure that the initial launch of its fleet is done from private property.

Geofencing technology and capability must be available "to restrict operations in certain areas and during certain times, either permanently or temporarily to protect public safety, private property and convenience," stating that this could include but is not limited to special events or emergencies. The city reserves the right to require operators to remove vehicles at its discretion, claiming potential inclement weather and health and safety concerns as potential reasons for requiring this.

Regarding general vehicle operation rules, scooters can operate the same way as bicycles do per section 9-52-130 of the city's municipal code. Users must ride only on bike lanes where they are available and circulate on streets where they are not, noting that operation on sidewalks is strictly forbidden. Furthermore, operators must encourage the use of helmets and refrain from offering service to individuals under 18, with 16- and 17-year-olds only allowed to access the service trough their parents or legal guardians. Additionally, service providers can require a valid driver's license for users in order to access the service.

It is worth noting that as part of the education and outreach requirements (covered in a subsequent section), the City of Chicago requires operators to communicate riding directions and rules to its users, including that they may ride on streets but that "streets are not intended to be used by scooters" (City of Chicago, 2023, p. 8), this denotes a visible tension and potential confusion when defining the role and space that scooters can make use of.

4.2.4.9 Data requirements

The City of Chicago has established extensive data requirements, mostly centred around the adoption of the Mobility Data Specification (MDS) complemented by the General Bikeshare Feed Specification (GBFS). In this sense, operators must fully comply with MDS and provide the city with the API license while also publishing an API fully compliant with the GBFS standard to provide information on the locations of charged, rentable and available scooters.

The Open Mobility Foundation or OMF explains that MDS "standardizes communication and data-sharing between cities and private mobility providers, such as e-scooter and bike share companies." Thus, this data specification enables cities to "share and validate policy digitally," helping them manage shared vehicle services. Complementarily, MDS requires using GBFS feeds to inform some of its endpoints. GBFS intended use is targeted toward service providers to enable users to access service information (such as vehicle status and availability) via applications (Open Mobility Foundation, 2021).

In a specific instance, though, compliance with MDS has momentarily been put to a side for equity purposes as the city has required operators to identify accessible devices, a feature not included in MDS at the moment of the policy document publication, adjusting to GBFS requirements in the meantime. This mandate could indicate that the city understands the data specifications and their limitations, pushing the specification features further to fill the gaps identified.

The city requires operators to submit quarterly metric reports informing them of their operations, including performance indicators, engagement events, environmental impact, customer service and parking compliance. Operators must inform the city of the number of users, rides and average rides per day, attendance to engagement events and list of local organizations involved, and report on identified barriers to barriers to scooter utilization due to local issues.

Moreover, operators are required to estimate and report a carbon emission inventory calculated per day using total vehicle miles travelled by scooters and service vehicles, accounting for the energy used for battery recharge, and informing on scooter and battery recycling and average scooter lifecycle.

Also included in these quarterly reports, operators are required to disclose the number of customer calls and emails, average answer time, the average duration of customer calls and the number of refunds granted, as well as to report on parking compliance, including a random representative sample of parking photos which are required to users at the moment of concluding a trip.

Operators must inform the city of the number of incidents and crashes with detailed information on each event. However, while a summary list is required for the recurrent quarterly report, operators must report all incidents and crashes no later than 24 hours after learning about the event.

Finally, service providers must assist the city in distributing online surveys to the customer base upon request from the city while also requiring them to collect data required to implement "sidewalk riding detection technology." However, this requirement's specifics are unclear based on the information provided by the consulted policy documents.

4.2.4.10 Performance requirements

General performance targets procured by the City of Chicago are mostly linked with fleet expansion requirements, where one of the 7-item criteria requires operators to achieve a minimum daily average utilization of 1-ride-per-device in the 30 days prior to the first fleet expansion application. The criterion for any subsequent expansion raises this minimum to 2 rides per device in each of the past 30 days before application submission.

Besides fleet expansion, as part of the minimum requirements for day-to-day operations, the city tracks an equity performance indicator requiring service providers to comply with a minimum of 2 daily trips per thousand residents in each equity priority sub-areas divided by the total number of operators.

4.2.4.11 Equity requirements

As explained in previous subsections, The city requires operators to guarantee that half of their fleets are deployed within all ten equity priority sub-areas, which cover a significant portion of the general service area, with a minimum of 3% of the total vehicles being allocated in each of these sub-areas. Additionally, operators must integrate adaptive vehicles in their fleets that serve residents with diverse physical needs, complying with a minimum number of vehicles that amount to at least 5% of each operator's total fleet.

The city establishes that all operators must implement a low-income and equity pricing program which must remain in place for the duration of the licenced period, making information on how to access and sign up for this program on the operator's official website. Despite this, the requirement's specific criterion is unclear based on the reviewed documents, leaving the characteristics of such programs to operators pending approval from the city.

In terms of barriers that limit access to shared micromobility services, operators are also required to provide users with payment alternatives that do not require the use of credit or debit cards, nor any type of bank account, enabling access to the service through cash payments. Furthermore, operators must provide a low-tech access programme that allows users to access the services without the need for a smartphone, including at least the option to access the service and unlock devices by calling a designated customer service phone line or sending a text message.

Complementarily, operators are encouraged to have specific contracting goals for minority-owned, women-owned and disadvantaged businesses for workforce development and/or training, as well as hiring 75% of their staff from within the city of Chicago and at least 30% of their staff from job training placement programmes operating in Chicago. It is unclear, though, if this only constitutes a recommendation from the city or if it is considered a requirement based on the language used in the policy documents.

Several other measures targeted at the designated equity-priority areas are in place and linked with other components of the policy farmwork, such as fleet expansion requirements discussed in previous sections, education, and outreach requirements, which will be covered in a subsequent section. These requirements include compliance with minimum daily trips, the delivery of a specific minimum number of education and outreach events and a minimum low-income plan userbase.

4.2.4.12 Parking requirements

The City of Chicago mandates that all scooters must be parked in an upright position leaving at least a 6-feet clearance from all other physical elements allowing for free circulation and avoiding obstruction of building facades and access points, fire hydrants, bus stops and loading zones. Operators must require smartphone users to submit a photo of their scooter parked after ending a ride; these photo records are shared with the city in its entirety or as a representative sample, including location information.

As mentioned in previous sections, all improperly parked vehicles must be corrected by the operator within 2 hours after being notified, with all parking complaints received outside of operating hours should be solved by 7 am. Additionally, operators are responsible for preventing the parking of "an excessive number of scooters" in a single location.

4.2.4.13 Vehicle specifications

As mentioned previously, the definition for Low-Speed Electric Mobility Devices in Chicago's municipal code specifies that these vehicles must have a maximum width and weight of 26 inches and 100 pounds, respectively, this weight exceeds the average for heavier vehicles such as e-bikes, leaving a broad space for heavier e-scooters to operate, and thus potential creating safety concerns. They must also be powered by an electric motor at no more than 15 mph with no operable pedals and transporting only a single individual.

Furthermore, a set of minimum technical specification requirements for all devices is put forward by the city of Chicago for operators to comply. All devices must feature white front lights and red taillights visible from a distance of at least 500 feet, front and rear brakes, a warning bell and locking hardware capabilities. Additionally, scooters must feature a unique identifier and easily visible contact information, including company name, website, email address and a toll-free number for customer support.

Required IT features include GPS capabilities to enable geofencing and functionality for "remote control of individual and fleetwide scooter operations" oriented at enabling multiple operator-triggered control actions such as:

- Capping and reducing device speed, including slowing down devices to a stop.

- Preventing the start/end of trips outside of approved areas
- Enforcing parking in designated areas and preventing it in no parking zones.
- Disabling fleet partially or in its entirety when requested by the city.

4.2.4.14 Education and outreach

The City of Chicago puts forward an extensive education and outreach component within the shared scooter rules and regulations document, where operators must engage with their userbase and the general community trough different communication campaigns and events.

Operators must undertake a recurrent public information campaign focused on safety, responsible riding and parking compliance, communicating, and educating all users about riding directions, rules, and applicable laws regarding scooter operations. All appropriate information from such campaigns must also be publicly available on each operator's official website.

Additionally, service providers must develop a specific education program for all first-time users, including an app-based quiz to evaluate content comprehension. Users must correctly answer at least 80% of the quiz's questions (which must be reviewed and approved by the city) before being permitted to ride.

Operators must conduct at least nine education and outreach events in Q2 (April - June) and Q3 (July - September), with 6 of them taking place in the equity priority area and at least 4 in Q1 (January - March) and Q4 (October - December) with at least 2 in the equity priority area. At least two-thirds of Q2 and Q3 and half of Q1 and Q4 events must be in-person and include a learn to ride-component.

If ridership levels in any equity priority sub-area fall below the minimum monthly threshold between May and October, operators must carry out an outreach and marketing plan targeted at that specific sub-area. A summary report detailing execution and outcomes shall be submitted to the city by operators no more than 45 days later.

Accepted education and outreach events: include formal participation in events hosted by a community organization, performing scooter demonstrations or providing scooter for a free group ride at another organizations event, hosting stand-alone events or free group rides, pop-up engagement campaigns in which staff provide information to by-passers, and online information session. The city can rule out any reported event that it does not consider adhering to standards; thus, seeking preapproval for events is encouraged.

4.2.4.15 Insurance and liability

The city requires operators to provide insurance coverage for a minimum of $5,000,000 USD per incident. Additionally, service providers must indemnify the city for any externality of the services and cover the cost of any damage to public property. Further penalties and fines are covered in a subsequent section.

4.2.4.16 Penalties and incentives

A small number of fines is outlined in the regulatory documents put forward by the City of Chicago. In general terms, any violation of the license rules will be subject to a fine of no less than $500 USD and will not exceed a maximum amount of $10,000 USD. Nevertheless, each day a violation or noncompliance persists, it will be deemed a separate offence constituting a separate fine.

Suspensions are applicable for 30 days and triggered in case of repeated violations, outstanding violations and violations that pose a significant threat to safety, as determined by the city. Immediate suspensions are applicable when public safety is at risk or in case of involvement from the operator in felonies or under an arrest warrant.

While the triggering of potential revocations is not entirely clear based on the policy documents consulted, it is inferred that it potentially constitutes an escalation from repeated suspensions, with license revocations resulting in a 3-year ban from the city. Before any suspension, revocation or fine is imposed, operators will be notified of specific charges and their right to a hearing.

The city can remove devices not properly parked at their discretion, requiring the operator to reimburse the city a $100 USD fee per scooter to claim the scooter. If scooters are thrown into any of the city's water bodies, operators are responsible for retrieving such vehicles within 24 hours; if they fail to comply, the city can retrieve them, with the operator compensating for the costs of such actions.

4.2.5 Other items to consider

4.2.5.1 User protection

Several user protection elements are laid out across the different components of the rules and regulations for shared scooters, particularly regarding data requirements and payment structures. Operators are required to publish all applicable terms of service publicly, user agreements and/or privacy policies while also timely notifying the city in case of any changes. Furthermore, the City of Chicago mandates these documents to be made available with plain language explaining and summarizing all relevant information.

Service providers must clearly communicate to users all applicable fees, charges, tariffs, and taxes associated with the use of the service prior to renting a scooter; additionally, operators

cannot require users to pay for more than one ride in advance.

The pricing structure, including memberships, base-price and per-minute fees, and variable pricing options and discounts must be shared with the city while communicating any price changes two weeks before implementing such changes. Operators must make a public API available to customers to rent and pay for scooters in third-party apps.

Regarding data privacy, operators are forbidden from requiring users to share data with third parties to use the service; only an opt-in option can be made available. Furthermore, operators are responsible for protecting users from data harvesting or transmission from users' smartphones.

4.2.5.2 Commercial advertisement

Operators may incorporate advertisement elements in their devices, allowing service providers to expand their funding sources. All advertisement and marketing plans to be implemented in any operator's fleet must be subject to approval by the city, with a cost of $100 USD per permit; this approval process will take 30 days and will be valid for a maximum of 1 year.

Operators must comply with a set of specific guidelines that, among other things, restrict displaying false information, sexually explicit images, graphic violence and/or profanity. It also limits advertisement elements to be located on the handlebar stem and sides of the foot deck as stickers or decals, along with other specifications on the physical characteristics of such elements.

4.2.6 Key takeaways

The city of Chicago issues two-year permits to e-scooter operators with a per device fee, currently three e-scooter operators split a total maximum of 12,500 devices, while no bike share operators were identified. The city's regulatory framework establishes extensive requirements for community outreach and education as well as data sharing requirements relying on industry standards such as the MDS and the GBFS specifications.

The city has also leveraged the IT capabilities of these devices through its policy, enabling the city and operators to enforce rules such as remotely disable vehicles and reduce speeds based on geofencing rules. Furthermore, the city makes an extensive use of geographic areas to enforce certain operating and equity rules dealing mostly with minimum and maximum allocation and distribution of vehicles.

Chicago restricts the operation of e-scooters between 12am and 5am, while allowing vehicles to weigh up to 100 pounds and ride at a top speed of 15mph, both of these provisions are higher than the limits used by Washington DC. A considerable high weight limit can create safety concerns for the operation of these vehicles in shared spaces with human powered bikes and scooters. Finally, the city of Chicago is the only one in this study that puts forward provisions for operators to engage in commercial advertisements contracts, enabling them to access additional funding sources.

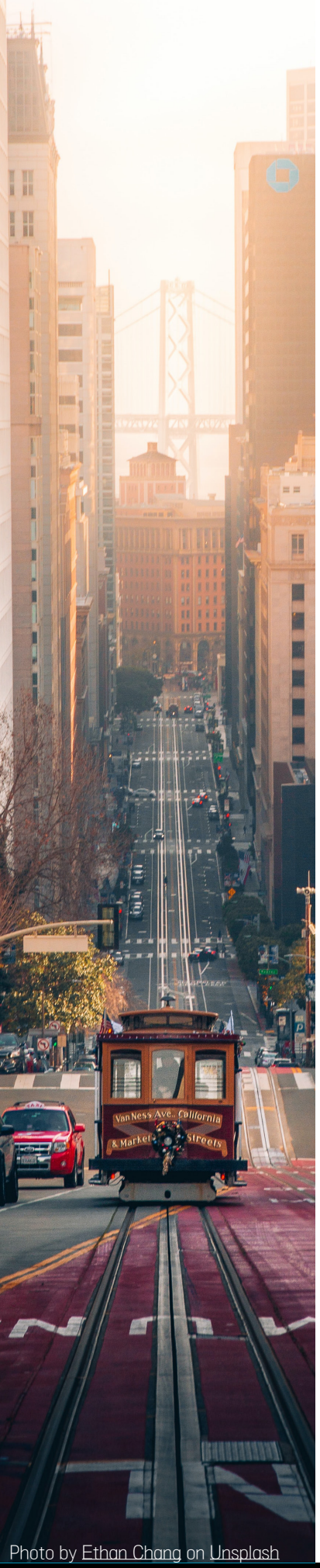

Photo by Ethan Chang on Unsplash

4.3 San Francisco, CA

4.3.1 Context

The County of San Francisco in northern California has a population of 865,933, according to the 2021 5-year estimates of the American Community Survey. It is located in the region commonly known as the Bay Area (formally named the San Francisco-Oakland-Berkeley Metropolitan Area), the thirteenth largest in the US, with a population of 4,725,584 (U.S. Census Bureau, 2021).

The city of San Francisco launched its public Bikeshare programme (currently known as Bay Wheels) in 2013, followed by a significant expansion in the summer of 2017 and the assignment of a new operating company. After partnering with the company Motivate (a subsidiary of Lyft), the system will grow to a total fleet of over 7,000 bicycles and 550 stations (Metropolitan Transportation Commission, 2022).

Operation of dockless shared micromobility services started with an initial pilot programme in the summer of 2017, eventually growing demand to an all-time high in February 2020 with approximately 628 thousand trips (SFMTA, 2022). According to data compiled by the company Ride Report, as of Q3 of 2022, shared micromobility services accounted for more than half a million total trips in this 3-month period, with a daily average of 6,100 trips and daily deployment of 2,095 vehicles (Ride Report, n.d.). As of 2023, two private companies operate in the City of San Francisco: Lime and Spin, with Bird, recently withdrawing from the market (SFMTA, 2023).

4.3.2 Approach to micromobility in San Francisco

Following a similar approach to Chicago's, San Francisco uses different programmes depending on the types of shared micromobility vehicles and, thus, different regulations applying to each of them; one of these relevant distinctions is between dockless shared bikes and scooters.

The city first issued a dockless bikeshare permit to JUMP bikes in January of 2018, establishing a pilot programme, which was scaled up to allow additional operators in June 2019. Based on the available information, it is unclear if this programme continued. The city's shared mobility dashboard shows that the last bikeshare trip reported by a private company (i.e. not made via the Bay Wheels system) was made in march 2020. This might indicate that the company stopped operations during the early stages of the COVID-19 pandemic.

Following the launch of the dockless bikeshare pilot programme, the city implemented an initial scooter pilot running from fall 2018 to fall 2019, with two operators allowed to deploy a maximum of 625 vehicles in the first six months and up to 1,250 when complying with specific equity requirements.

Lessons learned from both pilot programmes led to the creation of the first Powered Scooter Share Permit Program, running from 2019 to 2020 and extended until April 2021, when four companies were issued permits, and only three remained. The city adopted an annual permit scheme starting with the 2021-2022 permit application period. Its last iteration launched in June of 2022, when the city of San Francisco issued permits to three operating companies for the third and current Powered Scooter Share Program running from July 2022 to June 2023.

Considering the stop of operations for dockless bikeshare services, the regulations summarized in this study will focus on those applicable to dockless shared scooter services.

4.3.3 Policies and policy documents considered

San Francisco Municipal Transportation Agency (SFMTA) is the public authority tasked with managing shared micromobility services in the city and regularly issues policy documents linked with each year's licence programme. Most of the current regulations are summarized in SFMTA's 2022-2023 Powered Scooter Share Program Permit Terms and Conditions (SFMTA, 2022) as well as its corresponding appendices, which are governed by municipal legislation specifically including division 2, section 916 of the city's Transportation Code (SFMTA). Considering this, most of the content analyzed in this study will focus on such documents; thus, the following sections will mostly reference said documents.

Complementary to local regulation, some state laws regulate the parking and operation of e-scooters, as the state of California is responsible for issuing technical regulations for vehicles (State of California, 2019). The applicable definition for e-scooters, called "Powered Scooter," is in division 2, section 901, of the city's transportation code. It specifies that these are devices of two or more wheels powered by an electric motor or "other power source"; featuring handlebars and a floorboard where users can stand, with the possibility of including a seat. It should be noted that the definition also specifies a clear distinction from motorcycles and mopeds, which are subject to different regulations. Mopeds are part of a different shared mobility programme, which this study will not cover due to the different technical and operational characteristics (SFMTA).

4.3.4 Specific policy elements

4.3.4.1 Policy objectives

While specific goals are not established in the main Terms and Conditions document, the SFMTA official website on its Powered Scooter Share Permit Program section states that "Scooters are a sustainable mode of travel and a complement to Muni (the city's municipal railway network) and public transit service." The official website also mentions that the policy framework established by the city intends to ensure that scooter operation supports the city's recovery (assumed to allude to the economic recovery from the effects of the COVID-19 pandemic) in a "safe, sustainable, and equitable way," while also being developed to ensure "private mobility options contribute to the public welfare of the City" (SFMTA, 2023).

It should be noted that despite not identifying specific objectives within the main Terms and Conditions document, individual appendices for such document disclose specific purposes for each guidelines document, making the goals of each specific regulation component much clearer.

4.3.4.2 Pilot programme results

SFMTA launched the first pilot for dockless shared bikes in early 2018, conceding an 18-month permit to Jump. The company was allowed to deploy a 250-bike fleet that enabled 362,000 trips in the first seven months of operations, leading to a recommended service expansion after the interim evaluation made halfway through the program. This evaluation concluded that demand for these services is high and complements the public bikeshare system, with different trip lengths, origins, and destinations. Also, the report found an increasing demand for bike parking facilities driven by these services, which benefit from using such infrastructure, resulting in less improper parking. Finally, some highlighted areas for improvement included rebalancing practices, equitable distribution, and community engagement (SFMTA, 2018).

A second pilot focused on dockless scooter share systems was implemented in late 2018 after the arrival of these services earlier that year. The pilot established 12-month permits with a maximum total of 1,250 scooters distributed across all operators, which after the initial six months, could be expanded to 2,500 at SMFTA discretion. The mid-pilot evaluation concluded that "demand for shared scooters is strong" and that these systems "can serve the public interest when properly regulated," potentially helping to reduce private auto use and VMT (SFMTA, 2019, p. 2). Furthermore, the measures implemented through the pilot programme significantly reduced sidewalk riding and improper parking complaints, highlighting the benefit of featuring a lock-to design. Finally, as with the bikesharing pilot programme, the evaluation recommended more robust equity engagement to "ensure powered scooter share programs effectively serve historically disadvantaged communities, especially low-income individuals" (SFMTA, 2019, p. 2).

The findings from both programmes' evaluations have informed the current Powered Scooter Share Permit programme, with multiple requirements and provisions addressing the specific recommendations put forward by these evaluations.

4.3.4.3 Permits, licences and fees

SFMTA opens a permit application period annually, issuing 12-month permits for applying operators. Applicants must pay an application fee to participate and, if selected, must pay an annual total fee to operate. Operators must also pay a "Bike Rack Fee" for each permitted device to cover the installation of bicycle racks to ensure an adequate supply of bicycle parking. Costs are outlined in Table 3:

Table 3. San Francisco permit fees

Concept	Fee (USD)
Permit Fee (new applications and renewals)	$41,681
Application Fee	$5,843
Bike Rack Fee (per permitted device)	$100

Source: (SFMTA)

Applying operators must submit a document providing detailed information on pricing structure, operations plan, safe riding measures, hiring and labour, community engagement, insurance, and data-sharing, among others. The application document must also include several device standards and safety specifications, ensuring compliance with multiple technical standards required by SFMTA.

Permit application guidance for the 2021 period indicates that fleet sizes and the number of awarded operators could be flexible, stating an intended range of total devices and operators; it is unclear if these criteria persisted for the 2022 permit application period.

4.3.4.4 Operator and fleet caps

Based on the policy documents available for the 2022-2023 permit period, the total number of scooters allowed varies depending on each operator application and is only stipulated once a permit is issued. While there is no indication of a strict limit imposed on the number of vehicles and operators prior to the permit application, the guidance document for the 2021 permit application indicates that for that specific permitting period, the city intended to issue approximately three permits between 1,000 and 2,500 vehicles each. By communicating a range of vehicles distributed among a desired number of operators, the city approach might be interpreted to have some flexibility.

This indicates that in 2021, the city intended to have between 3,000 and 7,500 total vehicles, eventually issuing two 2,000-device and one 1,500-device permits totalling 5,500. As a result of the evaluation process, the city decided to keep the 2019 total cap of 10,000 scooters among all operators. According to SFMTA's official website, as of March 2023, two operators have been allowed to operate fleets of a maximum of 2,000 devices each.

Beyond fleet and operator caps at the moment of permit issuance, scooter deployment is limited in the city's downtown area, where a maximum of 400 devices per operator is enforced, with the possibility of increasing this number by 100 per each 500-vehicle fleet increase approved by the city.

4.3.4.5 Expansion policies

SFMTA allows licenced operators to apply for fleet expansion approvals, limited to 500 vehicle increases per request. Each subsequent request must be submitted after a minimum waiting period of two months after the previous one. Based on minimum distribution thresholds, fleet expansions appear limited to a maximum fleet of 3,000 devices per operator, as no further guidance on larger fleets is provided. Alternatively, if larger fleets are permitted, minimum distribution thresholds might remain as indicated for fleets of 3,000.

Expansion approval depends on previous compliance with operational terms and conditions while also relying on additional requirements, including:

- Continuous deployment of at least 70% of the total permitted fleet without exceeding downtown max in 15 of the last 30 days
- Compliance with equitable distribution targets
- Compliance with low-income plan participation metric (one subscription per every two permitted devices)
- Compliance with labour harmony commitments
- Complaints database compliance
- Compliance reports submitted every quarter
- Lifecycle analysis submitted
- Response time of 2 hours on at least 95% of all improper parking notifications and within 1 hour for 50% of all cases for 25 of the last 30 days
- Less than 0.5 citations per permitted scooter for quarters 2 and 3

A relevant consequence of approved fleet expansion is that operators must provide service in more areas and within larger extensions as they access larger fleets. This results in a higher service distribution requirement as fleets must provide 75% of service areas. This requirement is further explained in a subsequent section.

4.3.4.6 Operating areas

Policy documents establish service areas to prevent scooter over-crowding in San Francisco's downtown area and ensure service availability in specific neighbourhoods targeted as a priority by the city. Two main operating areas are determined: the Core Service Area, which includes the downtown core and Key (priority) Neighbourhoods, and the Expanded Service Area. Specific rules apply in terms of vehicle allocation depending on the operating area:

- Downtown core: no more than 400 scooters per 1,000 permitted devices are allowed to be deployed per operator; this cap can be extended by 100 vehicles per each additional 500 permitted scooters.
- Key Neighbourhoods: operators must maintain 75% of coverage for 75% of the time between 6 am and 10 pm
- Expanded service area: depending on awarded fleet increases, operators must deploy vehicles in additional areas where the same regulations apply to key Neighbourhoods.

Furthermore, operators must implement geofencing restrictions to their devices based on SFMTA requests, preventing parking, and locking in specified areas or addresses, and directing users to designated parking areas.

4.3.4.7 Speed Limits

California vehicle code Division 11 article 22411 specifies that motorizes scooters must not be operated over 15 mph (approximately 24 kilometres per hour) (State of California, 2000). Beyond this regulation, there is no indication of other applicable speed limits within policy documents.

4.3.4.8 Operational requirements

Extensive operational requirements are laid out in SFMTA's Terms and Conditions for the 2022-2023 Powered Scooter Share Program Permit. Operators must ensure that at least 50% of the total authorized fleet is deployed on 25 of 30 consecutive rolling days for the duration of the permit. Rides can be offered only hourly or in smaller intervals, potentially denoting that they cannot be leased for multiple days. Trip rates may vary by duration of usage or by duration of usage and distance; however, pricing information must be clearly and understandably communicated to the customer before accessing the service.

SFMTA puts forward specific guidelines and requirements for distribution and rebalancing to enable scooter share as a convenient first/last mile travel option across the city. This aims to maintain its reliability outside "regular commute times and patterns" while at the same time servicing key neighbourhoods and establishing metrics to regulate and manage operators.

Regulations stipulate that subcontracting is allowed to operators, which must implement and submit to the SFMTA a maintenance, cleaning, staffing, and repair plan for approval by the SFMTA. Guidelines apply to employees and contractors carrying out rebalancing activities, including yielding and prioritizing public transit vehicle circulation, no staging or idling, and providing contact info to SFMTA.

Operators must rebalance scooters within two hours of any request issued by the city, correctly re-park scooters not parked properly within two hours of identifying the situation and remove inoperable scooters from the right-of-way within 24 hours of notification. Furthermore, scooters parked in the same location for seven days may be removed by the city staff at the expense of the operator; in addition to this, the city may request operators to stop placing scooters in a specific location, with operators required to comply within 48 hours of such notice.

Policy documents specify that operators must develop mechanisms to deter users from sidewalk riding, but no specific details on enforcement or compliance are provided.

Operators must perform maintenance checks for every vehicle at least every two months while ensuring that graffiti from scooters is removed within 24 hours of identification, which is reduced to four hours if the graffiti involves inappropriate images or profanity.

4.3.4.9 Data requirements

SFMTA establishes a specific set of guidelines for data reporting to enable accountability and collaboration from service providers to provide "safe, reliable, sustainable, and equitable transportation choices for the public." Such guidelines state that real-time data collection will enable it to manage operators, enforce adherence to the programme terms and conditions, evaluate programme results and support further planning efforts. In order to achieve these goals, SFMTA requires operators to submit monthly reports to SFMTA, including data regarding:

- Baseline operations
- Safety
- Equitable access
- Disabled access
- Sustainability
- Accountability
- Labour
- Collaboration

Information for all these topics is detailed in the guidelines, specifying evaluation metrics for each component which the city will use to assess operations. Based on the extensive list of metric requirements provided by SFMTA, the evaluation appears to be quite comprehensive.

Operators must maintain accurate books and accounting records relating to its Powered Scooter Share Program. This allows the city to perform audits while maintaining databases with all public complaints and reported collisions broken down by severity. The city can require the operator to provide user-identifiable information when there is an injury, claim or lawsuit about which the user may have information.

In addition to periodic reporting, operators must provide SFMTA data on its permitted fleet trough a private feed compliant with the Mobility Data Specification (MDS) version 0.3.2, updating feeds without exceeding a 1-hour delay and being available 99.5% of the time over a year. Complementarily, operators must publish a public feed compliant with the General Bikeshare Feed Specification (GBFS) version 2.2 that does not require authentication. Operators must provide SFMTA reports every quarter beginning to document compliance with these requirements.

4.3.4.10 Performance requirements

As part of its distribution guidelines and requirements, the city specifies two main key metrics for operational distribution: Service coverage and trips per scooter per day. Operators are required to provide a service coverage of at least 75%. This metric is calculated by assigning a ¼ mile radius circle to every available scooter (representing a 5min walk to access the service); the sum of all these areas will then be divided by the total service area, resulting in a share of area coverage.

Alternatively, SFMTA will divide each day's total number of trips by the total deployed fleet to track trips per scooter per day, both for total operations and for each key neighbourhood and

community of concern. While policy documents explain how the trip per scooter per day metric will be calculated, no specific metric target could be found in the consulted documents.

Beyond these distribution metrics and as mentioned in previous sections, operators must deploy at least 50% of their fleet daily.

4.3.4.11 Equity requirements

Multiple equity measures are put in place by applicable regulations. Starting with accessibility pricing equity, operators must offer either a one-year low-income customer plan that waives any applicable deposit and offers a minimum 50% discount off rental fees or a plan that offers unlimited trips under 30 minutes to any customer with an income level at or below 200% of the federal poverty guidelines. At least one low-income plan user per every two vehicles authorized for operation is mandated; meanwhile, operators must also offer a cash payment option that is "clearly advertised and easy to use."

Operators must deploy at least one type of adaptive scooter to "expand access to people with various physical disabilities," including at least two out of the three following features: three wheels, a seat, and a basket. Furthermore, the cost to rent an adaptive scooter must be the same as a regular one, and adaptive scooters must make up at least 5% of the total permitted fleet.

In terms of service accessibility, operators must provide a "multilingual website with languages determined by the SFMTA, a call center, and a mobile application customer interface that is available 24 hours a day, seven days a week" while also ensuring that outreach materials are provided in multiple languages determined by SFMTA (SFMTA, 2022, p. 6).

Operators must adhere to the city's Mobility Justice Requirements, participating in SFMTA training and emerging mobility public-outreach efforts, and community engagement development programs to address disparities in the transportation system. Additionally, operators must implement a "targeted community outreach plan at its own cost," keeping and providing records to SFMTA monthly of any public feedback received.

Finally, as stated in previous sections, SFMTA has determined specific Key Neighbourhoods, including priority communities called "Communities of concern." These are composed of census tracts with either concentration of minority and low-income residents or a concentration of low-income population that is combined with at least three of the following six disadvantage factors:

- Persons with limited English proficiency,
- Zero-vehicle households,
- Seniors aged 75 years and over,
- Persons with one or more disabilities,
- Single-parent families,
- Renters paying more than 50 percent of their household income on housing.

4.3.4.12 Parking requirements

Specific guidelines for scooter parking are provided as an appendix of the 2022-2023 Powered Scooter Share Program Permit terms and conditions, detailing multiple parking rules. Following this guideline, devices must be parked on designated spots such as bike racks or in the sidewalk area closest to the curb in an upright position and are generally restricted from parking on:

- Pedestrian circulation space
- Corners or in front of curb ramps
- Narrow sidewalks that are less than 9 feet wide
- Against building facades
- Bus stops or boarding areas
- Fire hydrants
- In front of doors and driveways
- Next to seating areas, atm, mailboxes and other street furniture

These guidelines include an extensive number of illustrations, photographs and other graphic elements that cover potential parking scenarios, providing helpful clarification on whether or not these situations comply with the established set of rules.

As mentioned in previous sections, SFMTA requires operators awarded with licences to pay a $100 USD "Bike Rack Fee" to fund the installation of bike parking racks or bike corrals in the city, ensuring sufficient parking space. While details on the number of bike corrals installed with these funds are not entirely clear based on available information, it is worth noting that regulations stipulate that shared mobility devices are limited to occupying up to 50% of available spaces in bike racks.

4.3.4.13 Vehicle specifications

Devices must meet California's Vehicle Code specifications, specifically with division I section 407.5 and division II section 21223, which mostly covers light and reflector visibility requirements, as no weight and size specifications are provided. Furthermore, the permit program terms and conditions require devices to feature a distinct emblem with the operator logo and a unique identifier at least 1 inch in size while displaying a sticker stating the message: "No sidewalk riding."

All devices must be equipped with an on-board GPS device

capable of providing real-time location data and an integrated locking mechanism to securely hold the scooter when parked at a bike rack or other fixed object.

Finally, operators must provide SFMTA with a sample device per vehicle typology for inspection purposes, as SFMTA must verify that vehicles adhere to the required specifications.

4.3.4.14 Education and outreach

SFMTA has established specific engagement guidelines and requirements to inform and involve the public in agency decisions, working towards achieving equitable transportation systems that contribute to "the fair treatment, access, opportunity, and advancement of all people." (SFMTA, 2022, p. Appendix 3). Operators must submit a community engagement plan that stives to enable meaningful participation and identify community needs. This plan must:

- Provide the public with comprehensive, well-communicated information.
- Ensure that community concerns are regularly heard and considered; and
- Incorporate community feedback and priorities to the maximum extent possible

Furthermore, the SFMTA's guideline document requires operators to develop their community engagement plan including provisions for a set of ten elements composed of:

- Mobility Justice Goals and Priorities
- Multilingual communications services
- A communications strategy routinely updated for service change
- Maintain an easily accessible public online forum for community feedback concerns and reporting complaints
- Strategy to incorporate disability community input into services
- Expand outreach beyond current users or target market
- An easily navigable online annotated record of community engagement efforts,
- A community engagement staffing plan
- A culturally sensitive marketing plan
- Partner-ready programs

The guidelines also provide recommendations on how operators might develop their community engagement process. These guidelines highlight the importance of establishing goals and metrics at early stages, contacting, and reaching out to residents, business owners and other stakeholders, and attending local events and places such as community centers to identify and establish potential partnerships with community-based organizations. This propositive and constructive approach goes even further as SFMTA also provides a list of local organizations that operators might contact to establish partnerships.

Beyond the required community engagement plan, operators are responsible for educating users regarding applicable laws associated with the safe operation and parking of scooters. Service providers must offer their users at least one safety training class every quarter. The safety training class must cover safe scooter riding rules, parking requirements and inform customers that riding on sidewalks is prohibited. Furthermore, operators must distribute SFMTA public service announcement videos in-app to all users and distribute at least one customer survey annually prepared by the SFMTA.

4.3.4.15 Insurance and liability

An extensive set of requirements regarding insurance is established by SFMTA in the permit program terms and conditions, mandating operators to comply with different liability conditions covering employees, users, and general liability, but also extending into cyber security.

Operators are required to comply with the following liabilities:

- Workers' Compensation in case of accident, injury, or illness with a limit of no less than $1,000,000 USD per occurrence.
- Commercial General Liability Insurance covering bodily injury and property damage, with a limit of no less than $2,000,000 USD per occurrence and $5,000,000 as general aggregate.
- Commercial Automobile Liability Insurance covering bodily injury and property damage, with a limit of no less than $2,000,000 USD per occurrence.
- Professional liability insurance covering negligent acts, errors or omissions regarding the services provided, with a limit of no less than $1,000,000 USD per occurrence.
- Cyber and Privacy Insurance covering theft, dissemination, and use of confidential information, with a limit of no less than $1,000,000 USD per occurrence.

4.3.4.16 Penalties and incentives

SFMTA requires operators to compensate the city for costs incurred while addressing or correcting any violations of the terms. A citation for an improperly parked scooter is $100 per occurrence, while administrative citations for up to $500 per infraction may be issued for failure to comply with the terms; these violations might lead to suspension or licence revocation.

When public health or safety risks become a concern, SFMTA reserves the right to suspend an operator's permit. Similarly, the city reserves the right to revoke an operator's licence at its discretion. However, reasons triggering a revocation are unclear beyond failure to comply with applicable laws and terms, including sidewalk operation, parking requirements, or creating public health and safety risks.

In case of any licence revocation, the city may reissue a permit to a previous applicant with the next highest score or re-open the application process. Additionally, revocation may result in a ban for any subsequent permit application at the city's discretion.

4.3.5 Other items to consider

4.3.5.1 User protection

Some user protection provisions are scattered around SFMTA Powered Scooter Share Program Permit terms and conditions dealing mostly with payments and data privacy. Operators must comply with Payment Card Industry Data Security Standards (PCI DSS) for their implemented payment methods, linking the scooter identification ID number registered with SFMTA to each transaction.

Regarding personal data, service providers must provide a Privacy Policy that "safeguards customers' personal, financial, and travel information and usage including, but not limited to, trip origination and destination data," complying with state privacy protection acts (SFMTA, 2022, p. 12). Aligned with this, users must be able to decline sharing any data not required to access the service.

Operators must not collect personal data regarding race, gender, religion, national origin, age, or sexual orientation unless for survey purposes and only on an opt-in basis.

4.3.5.2 Commercial advertisement

No provisions on the use of advertisement elements on shared micromobility vehicles are included in the policy documents consulted for the city of San Francisco. Considering this, it is unclear whether service providers can engage in advertisement contracts to add funding sources to support their operations further.

4.3.5.3 Environmental requirements

SFMTA established specific sustainability requirements targeting compliance with battery certification and best practices to increase device longevity, energy efficiency, zero waste practices and transit-friendly best practices incentivizing trip start or end along key transit lines.

These guidelines require operators to submit a comprehensive metric report monthly, allowing SFMTA to track compliance regarding operation, maintenance and charging activities as well as waste. Some of the sustainability metrics required by the city include:

- Vehicle miles travelled for operations vehicles
- Sources of electricity to charge scooters and details of the locations where this occurs
- A fleet-wide average number of kilowatt hours per mile per scooter
- The number of batteries disposed and the location of disposal

Additionally, service providers must conduct a Life-Cycle Analysis (LCA), for each scooter model in its initial fleet, including adaptive models, and submit it to the SFMTA within three months of permit issuance. Moreover, operators must adjust to the City's Zero Waste Policy concerning the disposal of scooters and scooter parts, including hazardous waste such as batteries, and disclose the number of scooters and scooter parts ending up in the City's waste stream.

4.3.6 Key takeaways

The city of San Francisco awards one-year licences to operators with a flat license fee regardless of fleet size. Currently 2 companies operate e-scooter services with 2,000 vehicle fleets as a third licensee recently exited the market. In the past the city has taken a flexible approach when setting caps in earlier licencing programmes, specifying an intended range of operators and scooters. Beyond the regular requirements for fleet expansions, the city of San Francisco requires operators awarded with expansions to extend operations to specific priority areas.

The city has established some important and useful provisions in the policy framework including a specific performance indicator to measure service coverage as a proxy to guarantee that the service is accessible to most of the population through a 5 min walk. Additionally, the city has implemented a parking fee linked with the licence fees that is used to fund the construction of new bike corrals across the city, a measure to address demand that can have a significant impact in reducing parking noncompliance.

Furthermore, the city has introduced robust environmental requirements forcing operators to commit to frequent reporting on the environmental impact associated with the services. Similarly, liability and insurance requirements are more extensive than other cities, requiring specific insurances covering different amounts for specific events including, professional liability, workers compensation and even data privacy breach.

5 Results & discussion

Photo by Mika Baumeister on Unsplash

5.1 Results

As described in Chapter 3, the analysis of the selected cities was based on a 16-item thematic framework informed by similar existing studies and complemented with the findings of the analysis itself, adjusting it based on empirical information. Cities were selected based on data availability for practical purposes but focusing on cities that operate a public bikesharing system and have implemented pilot programmes for private shared micromobility services.

Previous sections have focused on summarizing and compiling the information in each city's policy document. This is followed by a summary of the findings in the current section, highlighting relevant practices and commenting on the main differences and similarities between cities.

5.1.1 Policy objectives

Chicago and San Francisco set clear goals for their shared micromobility policies, establishing links with the cities' strategic goals or targets. San Francisco stands out as specific policy elements are linked with specific SFMTA strategic goals and guiding principles across different policy documents. Alternatively, DC does not present a clear objective associated with its policies or establish a connection with wider policy orientations for the District of Columbia.

5.1.2 Pilot programmes results

As established by the selection criteria, all cities have implemented at least one pilot programme for shared micromobility services; the results of all programmes have shown various degrees of success and confirmed demand for shared bikes and scooters. The implementation of the pilots appears to have successfully reduced the number of complaints compared to unregulated operations. The services are also sometimes considered complements of the existing public bikesharing systems. Evaluation reports commonly mention equity and public engagement as relevant areas for further analysis and strategy development.

5.1.3 Permits, licences and fees

All cities grant operating licences through an open application process in which applicants must provide technical, administrative, and logistical information about the intended operations plan and demonstrate sufficient relevant experience operating such services. While the questions and scoring criteria vary from city to city, these are comprehensive questionnaires and clear rules covering similar thematic areas. Permits in the analyzed cities vary from 12 to 24-month licencing periods, generally increasing the licencing period compared to the pilot programmes.

Operating fees are approached in different ways by each city, where corresponding feed for operators in Chicago and Washington DC depends on fleet size and the intended time of operation, while San Francisco establishes a flat fee per operator. The approach taken by Chicago and DC can result in significantly higher costs for operators (and thus, higher returns for cities); however, per-scooter fees might also be proportional to the impact caused by the service scale.

5.1.4 Operator and fleet caps

Each city uses different approaches and combinations of fleet and operator caps. Washington DC establishes a considerably high fixed operator cap (compared to findings in existing literature), limiting simultaneous operations to a maximum of 9 companies. At the same time, the City of Chicago and SFMTA do not impose a hard cap on the number of operators but rather express their intention to distribute a maximum fleet between a small number of operators, currently ranging from two to four operators. It is worth noting that despite the high operator cap set by Washington DC, this city's current number of operators is more in line with the other two cities.

Regarding fleet caps, the cap established by the District of Columbia depends on individual caps established for operators, which can go to up to 5,000 vehicles per operator, potentially setting a total citywide fleet that can go up to almost fifty thousand vehicles (although currently capped at twenty thousand based on the number of current operators). Contrastingly, the city of Chicago has a fixed total maximum of 12,500 vehicles combining all operators. While San Francisco initially did not have a fixed cap (communicating an intended fleet per operator for each licencing period instead), a cap of 10,000 devices was eventually established by SFMTA based on the 2021-2022 licencing programme fleet.

Fixed total caps for all operators might create tension between companies and compromise the capacity of some operators to grow and achieve financial sustainability as it often relies on market share capture. San Francisco's approach provides more flexibility allowing gradual expansion without compromising other operators before setting a fleet cap. Furthermore, current consolidation trends in the shared micromobility industry might indicate that a small number of operators per city could be more realistic and preferable since it requires less administrative work and imposes less financial stress on regulating departments by not requiring them to manage multiple operating companies.

5.1.5 Expansion policies

All cities establish an application process for operators to expand their fleets, requiring them to comply with specific minimum performance metrics to justify fleet increases, including rides per day per device, and percentage of the total fleet deployed in recent weeks, among many others.

Beyond these basic performance measurements, Chicago and San Francisco cities also include a comprehensive set of requirements

covering equity, community engagement, reporting and issue-solving, among other topics. The city of Chicago grants 500 or 1000 vehicle increases depending on compliance with the list of requirements, increasing the minimum thresholds of these requirements of all subsequent increases. Alternatively, the city of San Francisco only grants fleet increases for 500 vehicles at a time.

A different approach is used by the District of Columbia, where expansion requirements, aside from basic performance metrics, depend on an equity performance indicator based on the number of low-income plan users registered. The city allows expansions of 50, 100, 150 or 200 vehicles depending on the percentage of the total user base composed of low-income plan users.

5.1.6 Operating areas

Both Chicago and San Francisco use specific area designations to guide operation requirements linked with other thematic areas, such as equity requirements, fleet caps and minimum performance requirements.

Besides establishing the general operating area boundaries, the city of Chicago establishes four different area types where specific rules apply. These include equity priority zones where multiple equity-focused provisions are enforced, exclusion areas where riding and parking are restricted, and Core and CBD areas, which impose specific fleet caps to avoid cluttering issues in these high-demand and high-density areas. It is worth noting that the City of Chicago incorporates several geofence-based requirements, forcing operators to stop scooters entering areas not authorized for operation.

San Francisco uses a similar approach for managing the downtown area and "key neighbourhoods" (an equity-focused designation) while defining specific areas for expansion requiring specific deployment minimums for operators whenever a fleet expansion is approved.

Contrastingly, DDOT in the District of Columbia does not use many area-specific requirements other than prohibiting sidewalk riding in a specific area in the city's CBD.

5.1.7 Speed limits

Policy provisions managing speed limits are fairly similar between cities, mandating a ten mph (approximately 16 kph) limit in Washington DC and a 15mph (approximately 24 kph) limit in Chicago and San Francisco.

5.1.8 Operational requirements

All three cities put forward extensive operational requirements covering multiple topics. All three policy frameworks mandate operators to relocate devices that have not been used for long periods and redistribute devices parked together in excessive numbers.

Regulations for all cities also set specific deadlines and maximum response times for operators to correct improper parking or any other situation that might impact the public space. Additionally, operators must submit and constantly update their operations plan, allowing for some coordination with municipalities, including cooperation to adjust or suspend services in case of emergencies, special events or inclement weather conditions.

Washington DC, and San Francisco establish minimum fleet deployment percentages, with DC also stipulating specific fleet distribution minimums across wards in the district and restricting deployment within 500 feet (approximately 150 m) of schools. Alternatively, Chicago is the only city that restricts operations during nighttime.

Regarding vehicle operation, Chicago and San Francisco expressly forbid sidewalk riding, limiting vehicle use to cycle lanes where available or streets. While Washington DC also encourages use in cycle lanes, it does not appear to prohibit sidewalk riding except in the CBD area. Furthermore, DC mandates helmet use for users between 16 and 18 years old; the City of Chicago, alternatively, rather than mandate helmet use, only encourages it. Finally, helmet requirements are not included in San Francisco policy documents.

5.1.9 Data requirements

Extensive data-sharing requirements are put forward by all studied regulatory frameworks, requiring operators to provide a public feed with system information and availability of vehicles, and a private feed for the city to access information. Both Chicago and San Francisco cities require compliance with the GBFS and MDS specifications for the public and internal data feeds, respectively. In contrast, DC only requires GBFS for a public feed.

Based on the policy documents, Chicago demonstrates significant knowledge of the limitations of the data specifications as it requires operators to adjust beyond the requirements of the current versions of the spec in order to provide reliable information. Contrastingly, DC's specificity on data requirements could be considered somewhat superficial as there is no specific guideline or standard to follow other than the GBFS specification.

All three cities also require operators to periodically share information covering a wide variety of topics, including operation metrics, origin-destination data, incidents and collision databases, among others. Additionally, periodic reports diving deeper into the analysis of such metrics are also required,

although with less frequency.

Washington DC, and San Francisco have made ridership data available, as both are listed in RideReport's micromobility dashboard providing basic usage metrics. Furthermore, the city of San Francisco has established its own Shared Mobility Dashboard providing more detailed information about shared micromobility usage in the Bay Area (SFMTA, 2022).

5.1.10 Performance requirements

Performance requirements for all cities, such as minimum trips per vehicle per day and deployment minimums, are mostly tied to other thematic elements. Washington DC, only requires operators to comply with specific performance targets (trips per device per day and minimum share of fleet available) to access fleet expansion authorizations. Chicago establishes a minimum of 1 to 2 trips per device per day requirement as part of its fleet expansion authorization criteria while also requiring a minimum of 2 daily trips per scooter per 1,000 residents in each equity priority area.

San Francisco establishes a service coverage metric that evaluates quick access to the service based on spatial distribution and the "service footprint" of devices. Using this metric, the city requires operators to provide a minimum of 75% area coverage in key neighbourhoods, meaning that three-quarters of all zones in a specific area have access to the service in an approximately 5-minute walk or less. The other distribution metric San Francisco's policy documents mentioned is the daily trips device, although no specific target is put forward for this indicator.

The service coverage indicator developed by SFMTA is a good example of translating policy objectives into enforceable regulations.

5.1.11 Equity requirements

The pilot programmes' findings have informed the development of extensive equity requirements in all three cities. All three regulating frameworks require compliance with three basic equity requirements where operators must be able to provide: a low-income plan for disadvantaged populations, a cashless option to access the service and service access without the use of smartphones.

Washington DC seems to rely heavily on the low-income plan requirement to address equity issues; this plan must provide free 30-minute rides to adults within certain income thresholds. As for Chicago and San Francisco, low-income plan requirements are more open as SFMTA offers the option of implementing an equity-pricing programme with discounted rates, while Chicago, respectively, does not specify the requirements of such plans.

Despite this, the equity requirements put forward by Chicago and San Francisco are much more extensive. They tie operation performance goals with specific geographies to ensure service access to underserved populations, filling service gaps and balancing distribution, avoiding device allocation only in wealthy districts. Furthermore, these requirements establish more engagement responsibilities for companies in these areas and require the deployment of adaptive vehicles to accommodate users with different needs.

5.1.12 Parking requirements

Parking provisions for all cities are fairly similar, requiring devices to be parked in an upright position that does not interfere with sidewalk and right-of-way circulation, favouring bike racks and corrals. Lock-to-device features are required in all cities to ensure better parking management and less littering and vandalism, a measure generally informed by pilot programmes' results.

While the lock-to feature combined with a mandate to park on bike corrals exclusively can significantly deter improper parking, it can also create major reductions in bike parking availability for other users. DDOT and SFMTA have implemented programmes to construct new bike corrals to address this. Furthermore, the City of San Francisco has implemented a bike parking fee for all permit applications to fund the construction of more bike corrals as operations continue and expand.

Finally, the city of Chicago mandates operators to require users to provide parking photos to finalize trips, a measure also targeted at reducing improper parking, although associated not only with questionable effectivity but also with potential unintended privacy issues.

5.1.13 Vehicle specifications

Technical requirements for vehicles are also similar for all three studied cities, requiring vehicles to comply with the provision of basic safety and operational elements such as headlights, taillights, reflective elements, and brakes while featuring a distinctive visual identity, easily identifiable company logos and contact information.

All cities require devices to be equipped with GPS capabilities and locking hardware. There are slight variations in dimensions and weights in each city, with vehicle weight requirements ranging between 75 and 100 pounds (34-45 kg. approximately).

Furthermore, while all cities require some type of vehicle demonstration, SFMTA requires operators to deliver sample devices for each vehicle typology intended for operations in order to check compliance.

5.1.14 Education and outreach

All studied cities require operators to engage with their user base in different capacities. DDOT in the District of Columbia puts forward a short set of minimum requirements for operators to educate and inform users on applicable laws and safe practices. Contrastingly, Chicago and San Francisco establish extensive provisions for operators to engage with the community, participating in community events, offering classes and carrying on communication campaigns.

The City of San Francisco appears to use a slightly more flexible approach. While still requiring an engagement plan from operators, it leaves room for operators to define its components, suggesting valuable elements for plans to include. Moreover, the city provides a list of community organizations for operators to establish partnerships.

Chicago's requirements are stricter as besides the basic educational campaigns on rules and safety; the city requires operators to enforce a specific education program for first-time users, evaluating their knowledge. Operators must deliver a specific number of quarterly engagement events, establishing a minimum number of events in equity priority areas. Furthermore, an interesting provision requires operators to carry out marketing campaigns targeted at equity sub-areas where ridership is low.

5.1.15 Insurance and Liability

All three cities require operators to acquire liability insurance. Minimum insured amounts per event vary from city to city, with DDOT setting a minimum of one million dollars, while the City of Chicago requires a minimum of five million.

Liability requirements in the city of San Francisco are more extensive. Operators are required to acquire multiple specific insurances covering general bodily injuries and property damage with commercial and automobile liability insurances; worker compensations for accident, injury, or illness with worker insurance; covering negligent acts, errors, or omissions with professional liability insurance and even theft, dissemination, and use of confidential information with Cyber and Privacy Insurance.

5.1.16 Penalties and incentives

Cities can issue license suspension and revocation at discretion when noncompliance with licence terms is identified, particularly for improper parking and similar complaints, which often cause fine and penalty allocation to operators. The City of Chicago establishes that fine fees can range between $500 USD and $10,000 USD per day of non-compliance, while the city of San Francisco specifies that a fine of $100 USD is assigned to improper parking citations, while administrative citations can be for up to $500 USD.

Cities generally stipulate that if operators do not remedy these situations, the city might take action to do so, with the remediation expenses charged to the operator. DDOT requires operators to concede a deposit of $10,000 at the start of the operating period, from which these expenses will be deducted.

The only incentive provision identified across all policy frameworks corresponds to the District of Columbia allowing operators to access a device fee waiver or reduction if a certain threshold on the share of low-income plan users is reached.

5.1.17 Additional thematic elements

All cities include provisions for user protection, including privacy and data collection protections, service information availability and clarity (such as pricing information changes), and the restriction of operators from requiring users to waive their right to suit the operator through a class action lawsuit.

The City of Chicago establishes provisions for operators to sell advertisement space in shared mobility devices, regulating the characteristics of the advertising elements while allowing operators to access an important additional funding source to support operations.

SFMTA requires operators to comply with extensive environmental requirements, mandating periodic reports to track several compliance metrics covering vehicle miles travelled for operational vehicles, sources of electricity for recharging and battery disposal, among many others. Operators must also perform Life-Cycle Analysis for every vehicle typology operating and adjust to city waste policies.

Figure 3. Summary table

	Washington DC	Chicago	San Francisco
Policy objectives	No clear policy objectives identified, shared micromobility included as part of the city's transportation objectives.	Clear and specific objectives associated with the regulatory framework. Aligned with the city's strategic goals	Clear and specific objectives associated with the regulatory framework, including goals specific policy components. Aligned with the city's strategic goals
Pilot programmes results	Pilot showed promising results, large number of participating operators was identified as a potential issue.	Multiple pilot programmes led to further develop equity, sustainability and distribution policy components.	Pilot led to reduced sidewalk riding and improper parking. Strong demnd for demand for shared scooters was identified, as well as the need to further develop equity requirements
Permits, licences and fees	2-year permits, fees mostly based on fleet size, deposit requirement. Four current operators for bikes and e-scooters	2-year permits, fees based on fleet size. Three current e-scooter operators. No dockless bikeshare operating in the city.	1 year licences, flat fee for all operators regardless of fleet size. Two current e-scooter operators. No dockless bikeshare operating in the city.
Operator and fleet caps	Individual fleets initially capped at 720 e-scooters or 2,500 bicycles, with a maximum cap of 5,000 vehicles per operator after approved expansions.	Cap of 12,500 scooters split among operators. Special fleet caps on initial day of deployment.	Flexible approach in earlier licencing programmes, specifying an intended range of operators and scooters. Previous cap at 10,000 vehicles.
Expansion policies	Expansions ranging between 50 and 200 vehicle increments, granted based on equity considerations and other performance requirements.	500 or 1,000 vehicle expansions granted based on compliance with multiple performance requirements covering different topics.	500 vehicle expansions granted based on compliance with multiple performance requirements. Expansions require operators to extend service to priority areas.
Operating areas	Little to no use of any geographic restrictions, except for sidewalk riding restriction enforced on the city's CBD.	Extensive use of specific geographic areas to control minimum and maximum deployment, distribution and operation restrictions.	Extensive use of specific geographic areas to control minimum and maximum deployment.
Speed Limits	10 miles per hour	15 miles per hour	15 miles per hour
Operational requirements	Extensive requirements for distribution and re-balancing, covering maximum allocation per ward, maximum number of devices per block face, etc.	Extensive requirements for distribution, re-balancing, minimum deployment and relocation of clustered/unused scooters. Operations restricted between 12am and 5am.	Specific guidelines and requirements for distribution and re-balancing, minimum deployment.

	Washington DC	Chicago	San Francisco
Data requirements	Periodic reports on usage and operations. Requirement to comply with GBFS open data standard. Ridership data is publicly available.	Periodic reports on usage and operations. Requirement to comply with MDS and GBFS open data standards.	Periodic reports on usage and operations. Requirement to comply with MDS and GBFS open data standards. Ridership data is publicly available.
Performance requirements	No specific performance requirements identified.	Minimum of 2 daily trips per thousand residents in equity priority areas	Minimum of 75% coverage of the total service area (based on 1/4 mile radius per scooter).
Equity requirements	Low-income plan, cash and smartphone-less alternatives to access service.	Low-income plan, cash and smartphone-less alternatives to access service, adaptive fleet, minimum vehicle distribution.	Low-income plan, cash and smartphone-less alternatives to access service, adaptive fleet, minimum vehicle distribution, multilingual access.
Parking requirements	Lock-to requirement, the city has started implementing new parking infrastructure.	Lock-to requirements, no identification of new parking infrastructure being implemented as part of the policy.	Lock-to requirement. Operators must pay a parking fee that is used by the city to fund the implementation of new parking infrastructure.
Vehicle specifications	Maximum weight of 75 lbs. Multiple mechanic and visual feature requirements including reflective elements, lights, breakes, etc.	Maximum weight of 100 lbs. Multiple mechanic and visual feature requirements. IT features required to disable scooters and reduce speeds based on geofencing rules.	No specification on weight and size. Multiple mechanic and visual feature requirements including reflective elements, lights, breakes, etc.
Education and outreach	Operators required to educate users regarding applicable laws and safe practices trough an in-app educational video.	Extensive education and outreach requirements. Operators required to engage with communities, complying with a minimum number of organized events.	Extensive education and outreach requirements. Operators required to develop engagement plan with policy documents suggesting local organizations to partner with.
Insurance and liability	General liability requirement covering events of up to a million USD.	General liability requirement covering events of up to five million USD	Multiple liability and insurance requirements for specific events, with coverage ranging from one to five million USD
Penalties and incentives	Fee waivers conditional to meeting equity targets (only city to offer incentives). Multiple fees and penalties linked with noncompliance of policy provisions.	Multiple fees and penalties linked with noncompliance of policy provisions. Fines ranging between 500 and 10,000 USD.	Multiple fees and penalties linked with noncompliance of policy provisions. Fines ranging between 100 and 500 USD.

5.2 Discussion

Based on the previous results, the following section provides an overview of the findings that can be relevant points for further discussion and exploration.

5.2.1 Cities use similar regulatory frameworks

Through this policy review exercise, it was possible to identify that the three analyzed cities have implemented rather similar regulatory frameworks, as they all use what could be called a business-licence approach. All three cities issue one to two year permits to operators that submit an application through a point-based system used to evaluate each operator capacity, experience and the details of the proposed operation.

Associated with the issuance of these permits, cities require operators to pay a permit fee that, with the exception of San Francisco which uses a flat rate, is mostly based on the scale of the fleet and proposed length of operations, increasing proportionally to the number of devices and days of operations.

Local governments usually establish an operator cap, a vehicle cap, or a combination of both, with this provision being one of the more generally adopted with slights variations in each city. Furthermore, all cities regulate fleet expansions trough an application process that requires operators to comply with a comprehensive set of performance metrics covering different areas and topics.

Extensive data sharing requirements have been implemented by all cities, mandating operators to provide periodic reports with travel information and to adopt industry standards for open data such as the Mobility Data Specification (MDS) and the General Bikeshare Feed Specification (GBFS). Similarly, equity requirements have been extensively developed in all cities, requiring operators to provide low-income plans, adaptive vehicles, and access to the services without requiring the use of credit cards or smartphones.

Finally, regulatory frameworks in all cities seem to demand considerable inspection by city staff as the compliance of these policies relies on the issuance of fines and suspensions for violating the terms and conditions of operations, and almost no use of incentives to promote better service quality and compliance.

5.2.2 Multiple operators can result in significant administrative burden

The administrative burden created by enforcement and inspection tasks can be exacerbated by an increased number of operators, as managing an additional service providers create the need for additional policing, procurement, while also creating a new set of challenges associated with competition practices among operators. Based on the current requirements from all cities, and with the exception of higher income due to permit fees, there appears to be no indication that having a larger number of operators might be convenient or desirable by cities, but rather the opposite.

This might echo the approach that has been commonly taken to regulate multiple transport services in cities across the world, where bus routes are eventually bundled into a single operator or municipal agency, or where taxi services are consolidated into a small group of highly regulated companies.

Based on pilot reports and previous iterations of licencing programmes, there are already signs that the number of operators in cities is being reduced. The original number of seven companies operating in DC's first pilot can be used as an example of this trend as the total number of operators has reduced to four companies currently operating. Furthermore, a smaller number of operators also aligns with current industry trends of consolidation.

In line with reducing the number of operators to ease administrative burden in cities, a relevant approach missing in the analyzed cities is the implementation of bids or tenders for an exclusive role as the city's designated dockless shared bike or scooter provider. Complementary, establishing a longer licencing periods can enable a selected operator to access economies of scale and a longer period to access returns in their capital investments, potentially helping achieve financial sustainability, and thus guaranteeing operations in the future.

Establishing a partnership with a single operator can require increased attention and coordination in early stages, but it can also set up cities and operators for success in the long run with less intervention required in the medium and long term. This also evokes similarities with the way other transportation services are managed, as concessions on bus routes or train operations are usually allocated for periods well over 10 or 15 years.

5.2.3 The legal status of new vehicle typologies is still a grey area

There is still a considerable ambiguity and differences across cities when it comes to defining and regulating the physical characteristics of shared micromobility vehicles, especially new taxonomies associated with technologic innovations such as electric scooters.

Vehicle licensing and regulation is frequently governed at a provincial or state level, whose legislation might not always adapt as quickly as local regulation demands. Furthermore, regulatory approaches have historically depended on propulsion technology (i.e., gas powered vehicles regulated distinctly from

active transport) but new technologies have brought ambiguity with them as, for example electric cars are regulated in a similar way as gas powered cars, but contrastingly e-scooters and e-bikes are regulated like their human-powered counterparts despite having the capacity to engage in considerably higher speeds and weight significantly more.

Specifically, these different characteristics create tensions when both human-powered and electric vehicles are expected to co-exist and share infrastructure. Cities allowing considerably heavier and faster vehicles for shared mobility, such as the city of Chicago 100-pund wight limit and 15mph top speed, can create unsafe conditions for users, who might also be unaware of the risks associated with operating such vehicles, as the ambiguity in their definition and regulation might also lead to a lack of proper education and training.

5.2.4 There are current practices worth exploring for cities implementing regulation

The policy review showed that there are practices implemented by the studied cities that can be helpful for municipalities exploring the implementation of regulatory frameworks for shared micromobility devices.

The District of Columbia has implemented incentives to favour operators that align with some of the city's goals to promote equity and sustainability, by offering fee waivers to operators that comply with certain low-income plan adoption targets and allowing higher vehicle caps to operators offering shared bikes instead of e-scooters, associated with a higher carbon footprint. Furthermore, DC's fleet expansion approvals are dependant on certain equity performance targets, further increasing the impact that regulation can have in addressing inequality in the city.

The City of Chicago has established extensive geography-based rules, allowing it to control the deployment of vehicles in high-demand areas, while also procuring service provision in equity-focused areas. Similarly, the city has employed special vehicle caps to control and guarantee a gradual fleet deployment at service launch, reducing the potential disruption that these services could produce at early stages of operations. Additionally, the city of Chicago has implemented robust outreach and education requirements linked with equity provisions, forcing operators to develop close engagement with the community.

Alternatively, the provisions for data sharing used by the city shows that understanding the benefits and limitations of data specifications can improve data accuracy and, thus, service operations, while leveraging the technical capabilities of new vehicles can open new opportunities for regulation and enforcement, such as geofencing-based rules enabling the city to halt operations outside the city's boundaries. Finally, a proactive regulation of advertisement agreements for operators enables them to access additional funding that can help secure the financial sustainability of these services.

The city of San Francisco has introduced a parking fee associated with the issuance of licences that allows the city to fund the implementation of much needed parking infrastructure, helping deter parking noncompliance, cluttering and general saturation of the public space. Another major policy implementation done by the City of San Francisco is the introduction of a service coverage performance indicator, that allows the city to track and require operators to ensure that service is accessible to most people.

Additionally, the city of San Francisco has implemented a requirement that forces any operator that has been granted a fleet extension to use part of these expansion to provide service in specific priority areas, guaranteeing that services not only expand to already serviced areas usually with high demand. Lastly, San Francisco regulatory framework stands out for having extensive environmental requirements that demand frequent and robust reporting of the environmental impact that shared micromobility operations produce.

In general, all cities have implemented:

- Strong equity- and community-focused requirements, often combined with other policy elements such as fleet expansions and operating areas, denoting coordination and alignment between policy elements.
- Lock-to requirements for parking, minimizing cluttering in the public space trough hardware device solutions
- Tightly controlled expansion approval framework that require operators to demonstrate high utilization rates to access fleet expansion
- Robust reporting and data sharing requirements, using data to track service use and quality, helping inform decisions and allowing different organizations and individuals to plan more effectively.

Through regulation, cities can steer the use of shared micromobility services to help achieve strategic goals by implementing a combination of the tools pioneered or developed by other cities. This regulation might lead to more effective results if planned thoughtfully and in coordination with operators, understanding how both parties can cooperate to provide real user benefits. Thus, it is important that cities learn from their peers' experiences.

6 Conclusions

Photo by Joshua Fernandez on Unsplash

6.1 Ongoing changes in shared micromobility

After the quick rise of the latest generation of shared micromobility services, the industry has experienced considerable change and instability in an arguably short time. While cities were still adapting regulations and continuing pilot testing for shared mobility services, the start of the COVID-19 pandemic in early 2020 created significant disruptions. Lockdown measures and a generalized trip reduction halted demand for these services, forcing operators to withdraw from some markets (Hawkins, 2020).

Simultaneously, the COVID-19 pandemic generated a revaluation of active transportation as it represented an alternative to public transit services at a time when procuring personal space and social distancing was essential. Similarly, active transportation as a leisure activity provided a much-needed escape from the large amounts of indoor time experienced by the vast majority of the population, resulting in an uptake of cycling trips in cities across North America (Bliss, 2020).

This mix of contrasting challenges and opportunities is reflected in ridership numbers. Annual demand fell by 64% in 2020 before making a significant recovery in 2021, with e-scooter rides nearly doubling, although still falling short of 2019 demand by 27%, while the recovery for station-based systems was much more quickly (National Association of City Transportation Officials, 2022).

Furthermore, another situation in the aftermath of the COVID-19 pandemic was the significantly reduced backing of venture capital funding, which was the driving force behind the aggressive expansion strategies at the beginning of the dockless boom.

These conditions led to an accelerated consolidation process still undergoing, with multiple companies exiting markets while others capitalizing on the opportunity to grow their footprint. After some high-profile acquisitions in previous years, 2022 continued this consolidation trend with some other relevant acquisitions, including Lyft buying PBSC Urban Solutions (Montreal Gazette, 2022), Tier acquiring Spin (Hawkins, 2022) and Helbiz purchasing Wheels (Bellan, 2022).

This year also saw major drawbacks from companies such as Spin and Bird, claiming challenging regulating conditions. Spin's CEO claimed that "Factors such as low consumer demand, prohibitive regulations (i.e., curfews, no ride/parking zones), unregulated competitive landscapes, and/or disadvantageous operating cost structures greatly limit the ability to operate profitably..." (Bellan, 2022). Complementarily, Bird stated in a blog post that "the lack of a robust regulatory framework" is often the reason for lacking conditions to build an economically viable business (Bird, 2022).

These claims only put more pressure on a significant moment for shared micromobility services, but most importantly for their regulation. Recently, a highly relevant precedent for regulation has just taken place as the April 2023 Paris referendum on rental electric scooters have resulted in an overwhelming majority of voters backing a ban on these services with close to 90% of the votes (Nouvian, 2023). This referendum comes after months of public debate spurred by frequent riding violations such as disregarding red lights and travelling in pairs, which led to stricter restrictions and increasing polarization, ultimately resulting in the city delegating the decision to the public vote (The Guardian, 2023). While voter turnout was considerably low with less than 8% of the voter base, the win for those in favour of banning the services set an important precedent for the future of shared micromobility regulation, as Paris emerged as a leading city adopting the newest generation of shared services in recent years (Dillet, 2023).

6.2 Regulation moving forward

Given the recent changes in the industry, a logical conclusion could be to assume that regulation will grow stricter to limit the externalities of these services and, thus, the pains that cities experience, but stricter regulations can also create more hostile conditions for these operating companies to subsist.

Long-term commitment and scalability could be key for services to achieve financial viability, as capital expenses might need to be mitigated in periods larger than the current licencing periods and with operations large enough to create economies of scale for administrative and operational activities. Considering this, longer licencing periods could be explored by cities once the regulating framework developed is considered to be sound enough. This can give operators more certainty regarding their capacity to achieve investment returns and secure the sustainability of their operations (National Association of City Transportation Officials, 2022).

As for scalability, cities currently allow fleet expansion and usually can grant renewals for the number of devices already deployed by operating companies. Despite this, fleet caps might condition each operator's ability to expand, thus adding some uncertainty for future operations; for such cases, reduced operator caps might be a solution. Taking this option a step further, it might be convenient for cities and operators to choose a specific operator to provide services, creating closer relationships with designated operators and increasing coordination and close operational planning with the city. There appears to be an appetite from service providers to create exclusive partnerships rather than compete in free markets (Bellan, 2021), enabling them to pick their battles might create a win-win situation for cities.

Furthermore, incentives are rarely used in cities as part of cities' strategies to regulate shared micromobility services; allowing operators to work towards achieving fee waivers for significant

contributions or exceptional service conditions might be an option worth considering to achieving city goals.

Moreover, if cities can identify specific positive outcomes achieved through the operation of shared micromobility services, such as an adequate performance as a first/last mile solution complementing transport or as a productive equity and social justice tool, they might explore the allocation of public funds to support specific operations.

Profit is not usually expected for public transport operations and most equity programmes; however, these are rather seen as investments for the good of the public interest. If, after evaluating their options, a city deems that private shared micromobility operators can help achieve city goals and provide benefits for the public interest, small subsidy packages might be a way to improve and expand fruitful aspects of current shared micromobility services. Cities must evaluate where these potential subsidies could lead to reduced city costs to validate and confirm the viability of such allocations.

Overall, trends seem to favour a more hands-on approach to regulation in close collaboration with operators for extended periods, favouring operations and accountability while reducing administrative burden and customizing the service to serve its users better.

6.3 Limitations and future research

This research project is only a first step to understanding context and compiling current practices in shared micromobility regulation in North America based on the cases of three cities with proven experience. While a great amount of information was available for these cities, this only captures a portion of the conditions in which shared micromobility services operated, leaving important areas for further research to provide context and factual information on the effects of such policies.

Based on available information is hard to understand what the levels of compliance were associated with the applicable regulations; thus, an important next step would be to analyze data collected by regulating agencies to understand the effect of such policies better. Furthermore, analyzing the impact on ridership can also provide important insights.

Additionally, it is important to note that each regulatory framework and the public adoption of these services is influenced by specific local conditions, which might be difficult to capture with a policy review study. Thus, an important continuation of this study is to engage with local officials from the studied cities to get firsthand information and perceptions from people on the ground. Therefore, a subsequent interview-based study is recommended, which can also inform on details from previous iterations of permit programmes and the relationship between the city and private operators.

Despite most of the demand for shared micromobility services in North America being concentrated in the US, it is also worth looking at experiences in Canadian and Mexican cities, which can provide useful insights informed by different sociopolitical and cultural contexts within North America.

These are only some potential avenues to continue and enrich the base provided by this research and to complement the growing literature on shared micromobility studies developed by researchers not only in North America but around the world. Integrating experiences from shared micromobility services in cities across the world can also provide substantial value for future research, as with most urban planning research, there is still much to be learned by the experiences from different contexts and geographies.

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