A City-to-City and Temporal Assessment of Peer City Scooter Policy

Caroline Janssen
Department of Civil and Environmental Engineering
Vanderbilt University
Email: caroline.o.janssen@vanderbilt.edu

William Barbour (Corresponding Author)
Department of Civil and Environmental Engineering
Institute for Software Integrated Systems
Vanderbilt University
Email: william.w.barbour@vanderbilt.edu

Erin Hafkenschiel
Executive Director of Mobility
Division of Administration
Vanderbilt University
Email: erin.hafkenschiel@vanderbilt.edu

Mark Abkowitz
Department of Civil and Environmental Engineering
Vanderbilt University
Email: mark.abkowitz@vanderbilt.edu

Craig Philip
Department of Civil and Environmental Engineering
Vanderbilt University
Email: craig.e.philip@vanderbilt.edu

Daniel B. Work
Department of Civil and Environmental Engineering
Institute for Software Integrated Systems
1025 16th Avenue South
Nashville, TN 36212
Vanderbilt University
Email: dan.work@vanderbilt.edu

ABSTRACT
This article presents a micromobility scooter policy comparison between ten mid-size peer cities with respect to twelve policy dimensions. Due to the evolutionary nature of the policy, a temporal analysis of policy dimensions is required, which we conduct and present in this work. The impact of these individual policies reaches across the city itself, the operating company, and the mobility user – all of which are assessed throughout this work. Many of these policy dimensions are acute pain points for cities, such as fleet caps, permitting fees, and equity requirements. In the temporal analysis, some dimensions show not just happenstance variability in attempts to manage forms of micromobility, but appreciable trends. Approximately one year after the deployment of dockless electric scooters in cities throughout the United States and the world, cities have made multiple attempts at regulations and legislation to handle the new mobility mode. Throughout this time, cities have agreed from the start in some aspects of policy such as device removal, safety, speed limit, and bonds. In other dimensions, such as fleet expansion plans, equity regulations, and parking requirements, cities see directed movement over time towards a convergence point.
Keywords: scooter, micromobility, policy, peer cities

INTRODUCTION

Motivation

Micromobility has grown rapidly in cities across the United States and around the world, revolutionizing the landscape of transportation. In 2018, 84 million trips were made on micromobility in the U.S., double the number in 2017 (1). Of those 84 million, half were made on dockless, shared, electric kick-scooters, hereafter referred to simply as "scooters." As cities handle the arrival of new forms of transportation, they attempt to create policy and regulations that balance the benefits and challenges posed by scooters and other dockless devices. These new mobility options can deliver short trips to help users combat the first-mile/last-mile conundrum. This is ideally executed while ensuring that devices do not create a nuisance, users are safe, and they do not interfere with the safety of other transportation modes (e.g., walking, biking). However, other forms of transportation (e.g. car, bike) do not follow all of these guidelines themselves, making it a difficult bar for scooters to reach. Each city approaches this new challenge differently, but not much is known about the landscape of scooter policy between cities and over time.

Micromobility has a substantial history and, today, spans a variety of vehicle forms (with many others proposed). Docked bike share systems proliferated in large cities, subscribing thousands of users to monthly plans and providing visitors an efficient and fun means by which to explore a city. Their principle limitation – that they must be picked up from and returned to a docking station – was addressed with dockless bike share systems. These systems allowed a trip to be ended directly at a user's destination, with the bike parked nearly anywhere. Dockless scooters used this same operational concept, but with fully electric propulsion. They can be picked up and dropped of nearly anywhere and cost only a few dollars per ride, depending on distance.

In order to make progress on micromobility, the transportation community must first understand the current state of scooter systems and recognize the full set of dimensions covered in scooter policy. Mid-size cities are understudied and have unique challenges and high opportunity for growth in micromobility. Precise definitions of mid-sized cities differ, but can be loosely defined as those with a population between one hundred thousand and one million. Compared to larger cities, they are distinct in terms of size and transportation approach, e.g., public transit, single-occupancy vehicle driving. This makes direct comparison to larger cities questionable. Differences in micromobility policy are also to be expected, especially in terms of infrastructure and management approach. In fact, the dimensions covered in policies are not consistent, leading to a comparison that would focus more on which issues are addressed rather than differences in specific policy points. Additionally, in the absence of publicly available data for a range of cities, it is very difficult to quantify the successes and failures of certain systems and compare metrics.

To combat these roadblocks, the boundaries and specifics of the assessment were set to allow for the most applicable, comparable results. The set of cities chosen for evaluation should all be "peer" cities – cities that are similar in population growth, land area, government structure, and more (2). Scooter policies from such a subset of cities would be more directly comparable and applicable for cities with similar needs. We analyze a set of common-thread dimensions that appear in many policies and can be tracked and compared. The effect of each policy dimension is considered through a triple lens: the city perspective, the scooter company operator perspective, and the scooter user perspective. In places where dimensions are not quite consistent, examining

the dimension through this triple lens will allow insight as to whether two different policy dimensions are possibly instituted to contend with the same subject matter. Regarding data there is insufficient public availability of data across cities to make quantitative performance comparisons and draw conclusions about policy ramifications. Therefore, the emphasis of this work is placed on comparison of current scooter policy.

Contribution and Outline

The contribution of this article is an assessment examining how scooter policies among a group of ten peer, mid-sized U.S. cities compare between cities and over time. Each policy dimension is examined through the triple lens of: city perspective, scooter operator perspective, and scooter user perspective. Without sufficient data to draw definite conclusions on the success of cities' scooter systems, this assessment instead discovers how policy dimensions either converge or diverge over time amongst the peer cities, appraising the effectiveness of the policy.

The remainder of the article is organized as follows. First, a literature review sheds light on micromobility as a whole, the introduction and continued operation of scooters in U.S. and international cities, and past micromobility policy reviews and assessments. Second, we explain the assessment methodology. Third, data is presented on the comparison of scooter policies between cities and over time. These findings are discussed in the following section. Finally, the most meaningful information is distilled into the conclusion and areas of future research are given.

LITERATURE REVIEW

Micromobility as a Whole

Micromobility has disrupted the transportation sphere, with 207 million trips on shared micromobility since 2010 (1). Even before it was a disruptive technology, however, it began as a small-scale nonprofit, starting with White Bikes in Amsterdam in 1965, a first-generation bikesharing system. Modern implementations have seen the importance of the "network effect" at larger scale – where shared devices in close proximity to one another add convenience value to micromobility systems (3). If a large number of devices are consistently available in several concentrated areas, users can rely upon micromobility and may begin to use it for routine trips, such as commuting or grocery shopping.

Multimodal transportation relies heavily upon flexible use of different transportation options. Micromobility is not an isolated system; it induces benefits in how it can connect with the larger system and increase the value of other available transportation options. Shared mobility should extend the catchment area of public transportation, providing a solution to the first-mile/last-mile problem by bringing users directly to their destination, making public transportation more attractive (4). Flexible and well-distributed transportation options are also beneficial in terms of transportation equity and reducing social exclusion risk (5).

Bikeshare began the micromobility revolution, not only in Amsterdam in 1965, but also around the world in the start of the 21st century. These docked bike share systems realized varying degrees of success and, while they typically incur high costs (e.g., infrastructure, rebalancing), many have been very successful (6). One such success metric is car usage. In a survey of bikeshare members in five major North American cities, bikesharing reduced respondents' driving by large margins in all cities. In Montreal and Toronto, 29% and 35% reported driving less, while in Minneapolis Saint Paul and Salt Lake City, 53% and 55% reported

driving less, and in Mexico City, 53% reported driving less (6). While there exist no quantitative metrics on exactly how much or how often bikeshare members reduced their driving, it is certainly a step in the right direction. Bikesharing systems are also a good comparative metric for scooter system usage and success. In Washington, D.C., bikesharing is used primarily for work commutes, scooter-share is used more for leisure, recreation, or tourism (7). As the predecessor to scooter-share, bikesharing provides a wealth of past experiences to build on and data for comparison.

As governing entities create policy to regulate micromobility systems, they are often pushed to think ahead and create proactive legislation – a difficult task given the rapid pace of technological change (8). Other cities chose to wait it out and watch how other programs play out, learning from those programs' mistakes. The *Shared Micromobility Playbook* attempts to give governing entities guidance on where to begin, outlining national standards on topics from operations and community engagement, to equity, data, and metrics to measure success (9).

Proliferation of scooters

Scooters first arrived in late 2016 and 2017, after several dockless bikeshare companies raised funds and began to launch (10). Scooters reached a large set of U.S. cities through blunt launches in 2018 – deploying rapidly without warning. In response, many cities instituted bans on scooters to contend with the unexpected deployments (11). This was followed by the development of pilot programs: a chance to test out scooters in the city and run a trial on policies. Some of these programs instituted data sharing requirements.

Some basic figures start to arise. In one study in San Jose, scooters were seen be parked, for the most part, inoffensively (12). Of the scooters observed, ¾ were parked on the sidewalk (their designated parking zone), and only 2% were parked blocking accessibility infrastructure or taking up more than half the width of a sidewalk. In another study in D.C., the median scooter trip duration was found to be around 10 minutes, compared to bikeshare members who were at 15 minutes, and bikeshare casual riders, who were at 20-25 minutes (13).

The data continues beyond trip metrics, giving an idea of attitudes towards scooters and how they are being used. In a statistically representative sampling of the population in 11 major U.S. cities, one study found that the majority of people perceive e-scooters positively and found more positivity among women and lower-income populations (10). Beyond positive social perceptions, scooters are also beneficial for the environment. In a 2018 report from Portland, 34% of Portland natives contemplating their last scooter trip and 48% of visitors contemplating their last scooter trip took a scooter in the place of a car trip, ride-share, personal car, or other (14).

Regarding safety, however, scooters are more questionable. In a study of downtown San Jose in summer 2018, only five of 156 riders, or 3.7%, wore helmets (15). Though scooter riding on sidewalks is a safety concern, it is important to put the use of scooters into perspective. In the same San Jose study, the average speed of scooters on the sidewalk was 9.5 mph, slightly lower than what previous studies found for in-line skates and skateboards (15). Despite the safety concerns, scooters still demonstrate real benefits. These factors can be balanced by ensuring there is adequate infrastructure and regulations in place to provide safe conditions for riding, as well as requiring scooter riders to practice safe use.

Scooters must also be addressed from a transportation equity perspective. A significant portion of U.S. households, roughly 8%, are un-banked and cannot have credit or debit cards. Additionally, 36% of the country does not have a smartphone. These factors, alone, place

limitations on the possible users of dockless mobility devices. Another 10% of the U.S. population, who have physical mobility limitations (e.g., wheelchairs, walkers), must be considered in that they cannot access these forms of transportation (16).

The characteristics of micromobility, as recorded above, are novel from that of other transportation modes. It is pertinent to be aware of these characteristics and how they interact with policy so that we can design an analysis that incorporates them.

Past Micromobility Policy Reviews and Assessments

There are several past scooter system assessments, as well as a wealth of micromobility assessments. Several papers gather information with the purpose of providing guidance for future programs. Anderson-Hall et al. emphasize the importance (and difficulty) of regulations that maximize transportation options such as micromobility whilst preserving public safety and benefit (11). A report released by the *National League of Cities* does the same, diving into individual cities and their individual policy (17).

Others use quantitative data to draw conclusions on the relative success of micromobility systems. Shaheen, Martin, and Cohen surveyed members from four major bikesharing organizations in four major North American cities to get data on how these members were using bikesharing and on their personal sentiments towards bikeshare (18).

The last group of scooter system assessments compiles information from a large breadth of sources so that it is all available in one place. They break down policy into comparable units and identify trends and meaningful correlations within the data. Agrawal, Fang, and Hooper went through the vehicle code for each state, looking for any regulations that could/would apply to personal transportation devices, and identified commonalities in how states do or do not regulate personal transportation devices (19).

Our paper falls into the last group of assessments, as it breaks down policy into comparable units. However, this paper is unique in that it has no quantitative data for analysis. Instead, we use a temporal assessment and an inquiry through a triple lens to investigate the policy practices. This assessment comes at a time when cities are looking for guidance to create policy for an uncharted future and looking to their peer cities for support.

METHODOLOGY

This assessment sets out to determine which policy regulations are effective for a group of understudied, peer, mid-sized U.S. cities. To complete such an assessment, several parameters and methods must be established. The group of peer, mid-sized U.S. cities is defined based on quantitative measures. Scooter policy and legislation for each peer city is identified. The policy dimensions upon which the analysis is performed are pulled from policy measures found in scooter legislation. A procedure to perform the temporal assessment is organized, which sets the bounds for meaningful results that can inform future policy decisions. Finally, a triple lens view of the assessment is ratified as another layer of examining whether policy is effective without having quantitative data.

Peer Cities

Despite the novelty of scooters, there have already been assessments performed on scooter systems in cities in the U.S. and around the world. However, these have all been concentrated around large cities. As a result, mid-sized cities fall to the wayside and have no one to look to for guidance on policy. A valid comparison of policies between cities and over time, must

address similar issues and situations in the respective cities. For example, relating policies between Los Angeles and Louisville would not have much import, as their policies are created to deal with entirely different social, governmental, and infrastructural systems. This assessment specifically targets midsize U.S. cities that have not been thoroughly reviewed in the past. As such, this assessment selected a group of peer cities as the basis for review, cities that have similar size, growth, government structure, bike infrastructure, and commuting behavior. Both bike infrastructure and commuting behavior are especially relevant for an analysis of micromobility. It is a reasonable assumption that these peer cities would need similar policies to govern micromobility solutions. Therefore, they create an excellent domain in which to compare scooter policies.

The city selection originated in and is deeply inspired by the *Peer City and Aspirational City Review* of Nashville's WalknBike plan*,* which identified a group of peer cities to Nashville (a good starting point for identification of peer mid-sized cities) through a set of quantitative criteria (2). The criteria were: population size, recent population growth, land area, population density, government structure, and Bicycle Friendly Community (BFC) ranking. These criteria ensured that the cities identified as peers are not only similar in population and structure, but also align regarding bike usage and infrastructure in the city, which is extremely helpful for the mobility assessment being performed in this paper. Charlotte, North Carolina, did not appear in the initial list, but was added because of its inclusion on the *Peer City Identification Tool* from the Federal Reserve Bank of Chicago (20).

The resulting ten peer cities based on the quantitative criteria are: Austin, Texas; Charlotte, North Carolina; Denver, Colorado; Indianapolis, Indiana; Louisville, Kentucky; Memphis, Tennessee; Minneapolis, Minnesota; Nashville, Tennessee; Raleigh, North Carolina; and Seattle, Washington. The column charts in Figure 1 show the data on how these cities align across several of the quantitative criteria. While the selection of mid-sized cities differs within each metric, there are no cities that emerge as clear outliers across all metrics.

Seattle, as one of the ten peer cities, is an interesting case study. Seattle has been a long holdout on scooters, opting instead for three dockless bikeshare companies after establishing official bikeshare rules in July 2018 (21,22). In May 2019, the mayor announced plans to begin crafting a scooter pilot program (23). The city will likely not accept applications until September or October 2019, with soft plans to launch in January 2020. The city council will focus on four non-negotiable principles in creating the pilot program: safety, fairness, protection through indemnification, and equity (23). Seattle will be discussed throughout the article, as their plan to create policy was detailed and merits inclusion, but they will not be included in the tables and timelines, since they do not have concrete policy enacted.

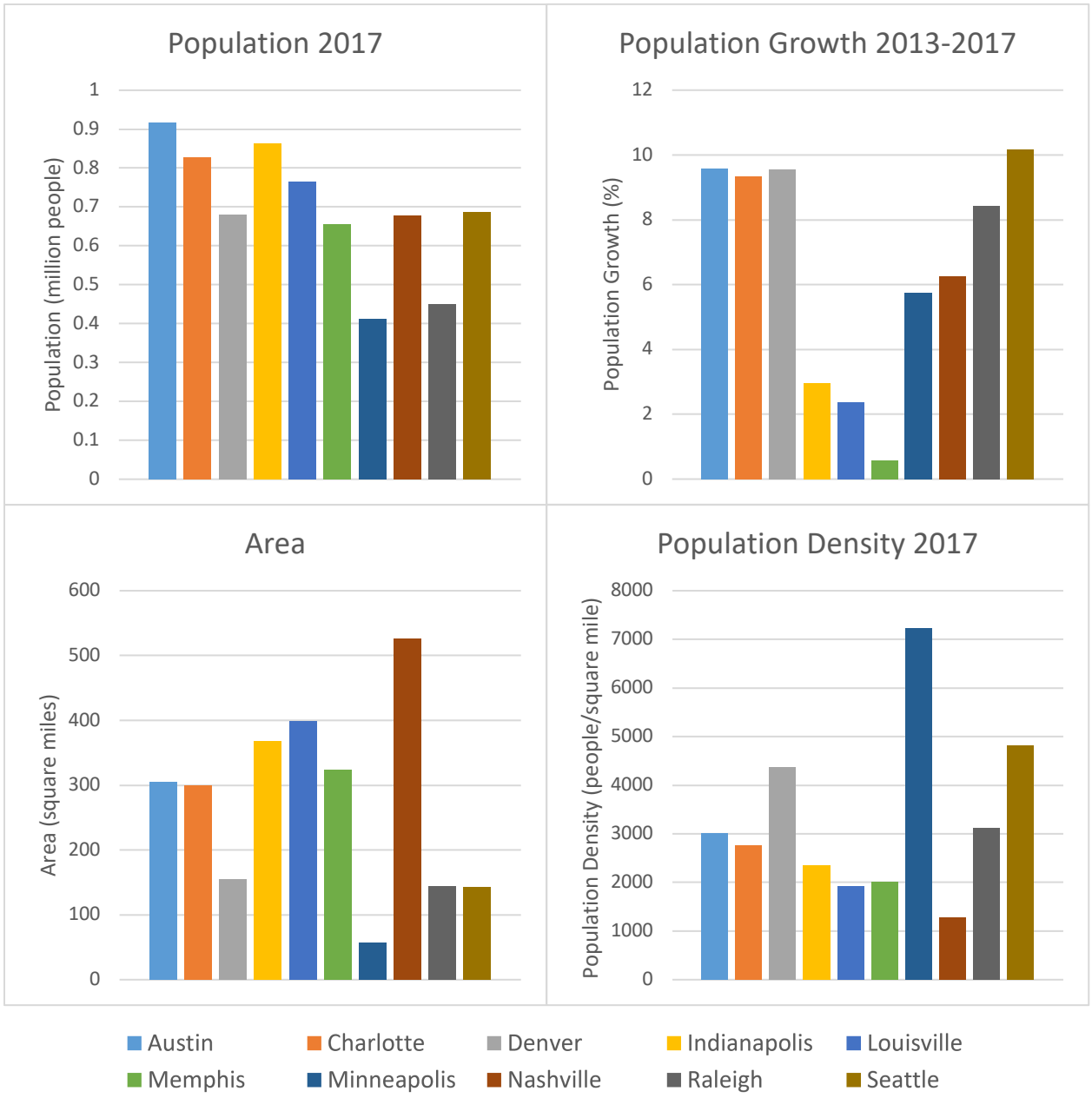


FIGURE 1. Column charts comparing the designated peer cities along four of the quantitative criteria: population, population growth, area, and population density (24)**.**

Scooter Policy and Legislation Identification

Within the ten peer cities, the first scooters were introduced during 2018. Cities sometimes responded to scooters being deployed suddenly and other times created proactive policy before scooters arrived. Data on scooter policies from the peer cities is sourced from policy documents (e.g., ordinances, bills, amendments) and supplemented with other sources (e.g., city websites, meeting minutes, news articles) to connect the policy legislation and complete the analysis of each city. The search is not limited to any specific type of policy document. It must be noted, however, that if the scooter operating regulations are updated, a city may post an updated version that (very rarely) supersedes the older version of the regulations if the two have the same

ordinance number, which would make the older version inaccessible. Due to this potential removal, this is not an exhaustive collection of policy documents. There may be some past regulations that are not included in the assessment, since they could not be accessed.

Policy Dimensions

In completing a temporal assessment, the dimensions that will be tracked in policy documents over time and compared between cities must cover the full breadth of regulations. The dimensions must also be consistently present in many policy documents to make the temporal assessment meaningful. Once the policy documents are collected, each city's policy is examined for notable elements and topics covered. The policy topics from each city are compared, and the topics that consistently are covered by the scooter legislation become the common policy dimensions by which the policy will be analyzed.

Temporal Analysis

Understanding the present state of mobility is important in assessing how policies have been interpreted and are being lived out in cities across the country. However, it does not cover the temporal dimension of how policies have been revised or evolved. By analyzing the history of legislation and policy, seeing a moving status of policy dimensions, the assessment becomes kinetic. It opens the door to asking why the policy has changed, what caused these changes, and perhaps shows a course for future mobility policy. This kinetic assessment requires more data, which is not widely and consistently available at present, and emphasizes the importance of extensive data sharing for shared mobility services in the policy and research communities.

The Triple Lens: City, Operators, and User

Even in a set of peer cities, where the policy is designed to regulate similar circumstances, the policies still vary widely. Between cities where policy dimensions are not quite consistent, further examining the perspectives and intended target of policies can generate a more complete comparison. Therefore, we examine policies through the triple lens of city perspective, operator perspective, and user perspective. An effective policy balances all three legs of the triple lens. We can use the triple lens in conjunction with the temporal analysis to identify which policies have come out on top, are effective, and have the potential to work in other peer cities.

The triple lens also highlights the balanced needs between perspectives. These perspectives often guide how legislation changes before it is passed as a city ordinance. A policy that is imbalanced between the three perspectives may face a lot of turbulence.

When it comes to new, disruptive technology, there is often not a large knowledge or experience base to build on when crafting legislation. As a result, some of the earlier policies may benefit only one or two of the three entities. As policies evolve, this balance within the triple lens may change to more equally represent all three components. This can be seen through the temporal policy analysis performed in this work.

RESULTS

This section presents the results of the scooter policy assessment. We first enumerate the policy dimensions that were selected for analysis from the candidate dimensions. We then discuss the degree to which cities agree or exhibit variety across these dimensions. Finally, we analyze selected dimensions in a temporal manner, looking at how policies converge or diverge over time.

Policy Dimensions

After identifying topics from the scooter policy documents of each city, the topics from each city are compared. Topics that consistently appeared in the policy are selected as the policy dimensions through which the analysis is completed. The twelve selected policy dimensions are listed below with a brief explanation of content each topic may cover. The policy topics that we found but did not include in the analysis are: 1) insurance, 2) outer limits of scooter operation zone, 3) comparison of policy from different stages (pilot, permanent, ban), and 4) the brands of scooters allowed to operate in a city.

- Number of operators: range of allowed operators; agreements with specific operators.
- Fleet size and limits: start small and increase; begin with a high limit and allow operators to self-regulate.
- Expansion and downsizing plans: occur automatically over time; performance-based.
- Designated areas of operation: allowed/prohibited on sidewalks; no-ride zones (e.g., using geofences).
- Permitting fees: annual application fee; per-scooter fee.
- Hours of operation: nighttime use allowed/prohibited.
- Speed limit: may not be a limit at all; may apply only in certain zones.
- Performance bond: potentially per scooter, could be capped, potentially overall.
- Equity: distribution requirements; marketing requirements; accessibility programs.
- Parking regulations: minimum sidewalk clearance; designated parking zones.
- Parking fines and enforcement: fines for improperly parked scooters; impoundment.
- Data-sharing: real-time fleet information; maintenance and collision reports; API requirements.

City Comparisons: Where Do City Policies Align and Where Do They Diverge?

We extracted details about each policy dimension for each of the ten peer cities. We investigated investigating not only the letter of the law but also the current state of scooters (i.e. how the law has been interpreted/enacted).

In this section, Table 1 lists the current policy (at the time of writing this article) of each city across the twelve policy dimensions. In addition to this complete enumeration of policies, we discuss seven of the twelve policy dimensions in detail.

Operators

The number of operators varies widely. Few policies have an explicit number of operators, but several have an upper limit to the number operators, and several have no limit at all. Austin has the largest number of operators: 9 at maximum and down to 8 in July 2019. Austin never had a limit on the number of operators. Raleigh, on the other hand, has an exclusive agreement with just one operator, Gotcha, in a hope for more consistent service outcomes.

Fleet Caps and Fleet Expansion/Downsizing Plans

Most cities chose to limit the fleet size of each operator, with only Minneapolis opting for a city-wide limit split evenly among the operators. For the many cities that had a performance-based expansion plan such as Austin and Charlotte, where a certain number of rides per scooter per day would entitle an operator to an increase, they often had similar regulations for downsizing if

operators were below a certain performance threshold. In Minneapolis, fleet sizes were simply allowed to expand after two months, and Public Works had the discretion to require a reduction. Denver was unique in its fleet sizing regulation, requiring half of the quantity of each increase to start each day in a designated opportunity area, a geographical area where vulnerable populations may be centered.

Permit Fees

The amount required for permits fees varied widely. Most cities have an application fee and permit/license fee that each operator must pay, although the fee type differed between a one-time fee (Denver), an annual fee, a per-scooter-fee (Minneapolis, Raleigh, Nashville), or some combination thereof (Memphis, Louisville, Indianapolis). Nashville is at the low-end of the spectrum, with a $500 application fee and a $35 per scooter per year fee, while Memphis rounds out the top with a $10,000 application fee, an annual renewal fee of $1,000, and a $365 per scooter per year fee.

Times and Areas of Operation

Only a few cities have designated hours of operation, and when they do they are often allotted time for charging and rebalancing scooters. Every city has a scooter program zone within the city to contain devices, but Denver and Louisville also have exclusion zones within the city. Four cities forbid sidewalk use completely, two cities forbid sidewalk use only in designated "business districts," and Denver originally required that scooters use *only* the sidewalk, although now promotes roadway usage.

Parking Regulations

Precise parking regulations vary widely among the peer cities, but there are several common threads. Many have a selection of restricted areas where scooters are not allowed to park. Others reserve the right to establish designated parking zones where scooters are required to park. Austin, Denver, and Louisville all have the ability to require operators to install or cover the cost of designated parking boxes, often as a percentage of their total fleet (i.e. one box for every 10 scooters, etc.). Several mention that scooters must leave a minimum "clearance" (between 3 and 6 feet) to retain that area as usable sidewalk, for some as a stipulation for meeting ADA requirements.

Enforcement legislation is more consistent across cities in the assessment. Most cities reserve the right to remove or impound improperly parked scooters if the scooter is not moved by the operator within a specific amount of time. Fines for improperly parked vehicles range from $25 (Indianapolis and Nashville) to $500 (Louisville).

Equity Programs

Equity programs seem to converge around three main principles: distribution, accessibility, and marketing. Distribution concerns the spread of scooters across a city, making sure that low-income areas are given a fair portion of devices when the scooters are rebalanced. Accessibility covers those who may need a cash payment option, do not have a smartphone, or who have a disability and cannot use a stand-up scooter. And finally, marketing ensures that everyone in the community is well-aware of the mobility services available and provides information for non-English speakers.

Indianapolis has a very thorough distribution requirement, and a significant portion of the other cities have more lenient, but still required, equity distribution rules. When it comes to accessibility and marketing however, the legislation is loose and mostly optional. Cities including Austin and Nashville require operators to submit a plan to cover these two equity principles, but no explicit requirement to follow-through.

Data Sharing Requirements

Every single city has a data-sharing requirement. The data is most often shared through an API, and several cities stipulate that they may make the data publicly available, including Louisville, Memphis, and Nashville. Most commonly required are: real-time information on the fleet, monthly reports on maintenance, operations, and collisions, and anonymized user demographic data. Finally, cities running pilot programs often require that the operator to distribute a customer survey at the end of their first permit period and share the results with the city.

TABLE 1. Scooter policy and practice in nine peer cities as of July 2019.

	Austin	Charlotte	Denver	Indianapolis	Louisville
Operators	No limit, currently 8	3	5	6 limit, currently 4	8 limit, currently 7
Fleet Size/Caps	Max of 500/operator	Min of 500/operator, dynamic max	Initially 250/operator	Max of 1000/operator	Max of 1050/operator
Expansion	Performance-based: 3 trips/scooter/day	Performance-based: 3 trips/scooter/day	Performance-based: 3 trips/scooter/day; with distribution requirement	Performance-based: 3 trips/scooter/day	Performance-based: 3 trips/scooter/day
Downsizing	Performance-based: 2 trips/scooter/day	Performance-based: 2 trips/scooter/day	Performance-based: 2 trips/scooter/day	Performance-based: 2 trips/scooter/day	Performance-based: 2 trips/scooter/day
Areas of Operation	Downtown project coordination zone	No sidewalk in the Uptown core	Forbidden in 16th Street Mall	-	No sidewalk, several prohibited areas
Permitting Fees	Must pay all fees established by the ordinance	Must pay all fees established by the ordinance; city may revise permit fees	Application: $150 Permit: $15,000	License: $15,000 annually $1/day/scooter	License: $2,000 for probationary, $1,000 for full-operating $50/year/scooter $1/day/scooter
Hours of Operation	-	No trips after 9pm	Rebalancing completed by 7am	-	Deployed before 7am
Speed Limit	20 mph	15 mph	-	20 mph	15mph
Performance Bond	$100/scooter	-	$30/scooter	-	$10,000
Equity	Required marketing and accessibility	-	Required accessibility, recommended distribution	Required distribution	Required distribution, recommended accessibility and marketing
Parking Regulations	3 feet sidewalk clearance Operators pay for parking boxes (1 parking : 20 scooters)	6 feet sidewalk clearance Operators perform afternoon fleet inspection	5 feet sidewalk clearance Parking installed by operators (1 parking : 10 scooters)	4 feet sidewalk clearance	4 feet sidewalk clearance Parking installed by operators (1 parking : 10 scooters)
Parking Fines and Enforcement	City can remove improperly parked scooter after 48 hours	-	-	City can remove improperly parked scooter after 24 hours $25 for illegal parking, $100 impoundment fee	$500 for parking violation
Data-Sharing	Real-time fleet information through API Monthly complaint, collision, and demographics report May share data with university researchers	Real-time data upon request Monthly data report with trip, user, maintenance, and complaint data	Real-time fleet information through API Monthly report with trip information Operators must survey users at 3-month intervals	Real-time data through API Anonymized OD, user, and trip data Must keep track of maintenance, operations, and collisions	Real-time data through API Data made available to the public with a link on the city website
Sources:	(25-29)	(30-33)	(34-38)	(39-42)	(43-45)

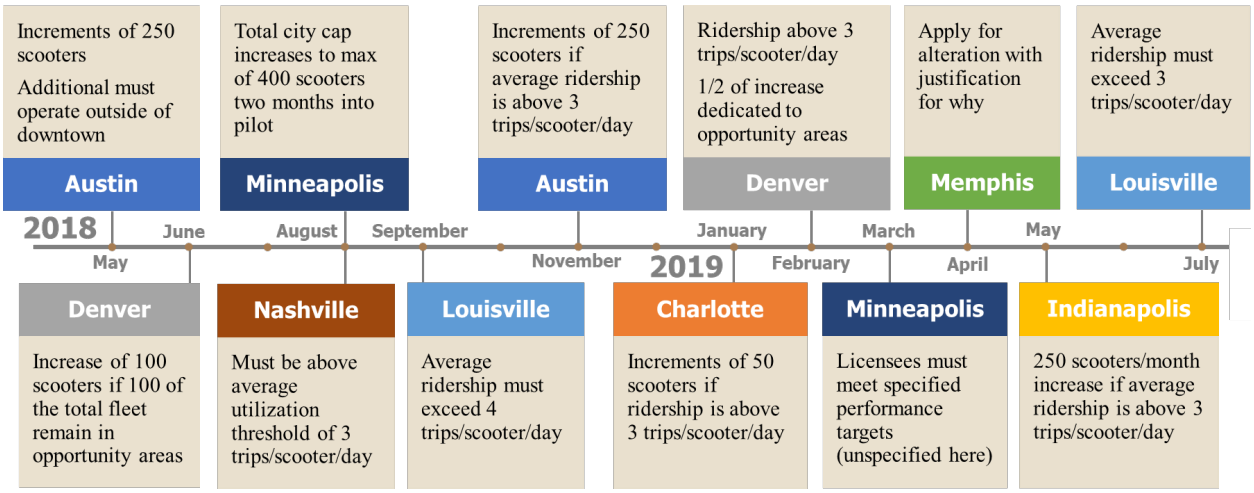
Table 1 continued on the following page

Table 1 continued below

	Memphis	Minneapolis	Nashville	Raleigh
Operators	4	4	Not limited, currently 7	1
Fleet Size/Caps	Min of 250/operator	Max 2000 in entire city	Max of 1000/operator	Max of 1000/operator
Expansion	Propose plan to city, meet new fleet size within 4 weeks	Meet provisions such as usage, equity, distribution, etc.	Performance-based: 3 trips/scooter/day	Meet usage, safety, and performance metrics
Downsizing	-	Director has final discretion	Performance-based: 3 trips/scooter/day	-
Areas of Operation	-	No sidewalk	No sidewalk in business district	No sidewalk
Permitting Fees	Application: $10,000 Permit: $1,000 $365/year/scooter	$100/scooter	Application: $500 $35/scooter/year	Application fee: unspecified Administrative fee: $70 $300/scooter/year
Hours of Operation	-	-	-	6am to 11pm
Speed Limit	-	15 mph	15 mph	-
Performance Bond	$50/scooter $20,000 cap	-	$80/scooter $100,000 cap	-
Equity	Required marketing and accessibility, recommended distribution	Required distribution, marketing, and accessibility	Required distribution, recommended accessibility	Required distribution, marketing, and accessibility
Parking Regulations	Operators can request or install their own parking Designated parking may be enforced with geofencing	-	Designated parking may be enforced with geofencing	5 feet sidewalk clearance
Parking Fines and Enforcement	City can remove improperly parked scooter after 72 hours	City can remove improperly parked scooter after 24 hours $56 impoundment fee	City can remove improperly parked scooter after 48 hours $25 fee for parking violation	City can remove improperly parked scooter after 2 hours
Data-Sharing	Real-time fleet information through API City may publish data to the public City may request the distribution of a customer survey	Anonymized data sharing to monitor compliance and to evaluate the pilot program	Real-time fleet information through API Metro may publish that data to the public Weekly maintenance reports Operators consent to distribute user survey	Anonymized real-time data, upon request Customer survey within one year Monthly and annual reports regarding rate structures
Sources:	(46,47)	(48-51)	(52-54)	(55-57)

Temporal Assessment: How Do Policies Fluctuate Over Time Amongst the Peer Cities?
The city policy comparisons provide a view of the dimensions covered and how different cities have created legislation within those policy dimensions. The following temporal assessment, however, adds a time dimension to the data: how the policies have shifted over time, and where policy began before the cities reached their current state.

Expansion and Downsizing
Early on, expansion plans were to happen automatically over time, with no requirements to "earn" the expansion. Very quickly, policy shifted to a performance-based approach, requiring a certain number of average rides per scooter per day in order to be eligible for an expansion and settling on 3 rides per scooter per day. A few policies had an additional distribution measure to supply underserved communities, communities that could benefit from micromobility but do not have enough supply to meet the need. Such distribution measures for underserved communities were implemented intermittently and did not change over time, as seen in Figure 2.



Sources: (28–30,35,37,39,43,44,47,48,51,53)

FIGURE 2. Timeline examining how expansion regulations change over time in scooter policy documents.

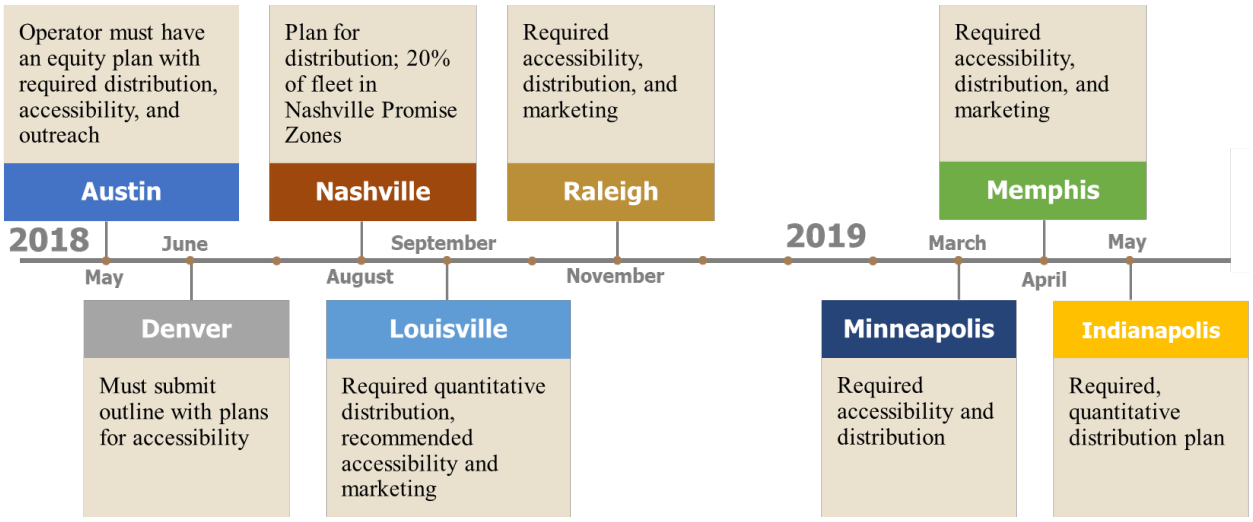
From the beginning, downsizing policy lead the way with a performance-based approach, decreasing fleets if they were not meeting ridership threshold. There were varying numbers over time, but the threshold converged around 2 rides per scooter per day.

Areas of Operation
Gradually, policies began to either ban sidewalk use in specific areas or ban sidewalk use completely. Denver's policies were an outlier, shifting from requiring that scooters ride only on the sidewalk to requiring scooters to ride in the road unless the speed limit is greater than 30 mph.

Equity
Equity regulations tend to break down to one of three principles: distribution, accessibility, and marketing. Distribution may consist of deploying scooters in opportunity areas, while accessibility ensures that users without smart phones or a bank account can still utilize scooters. Marketing actions range from education on safe scooter use to clearly communicated scooter

usage rates. These equity measures are intended to promote safe, easy use for any consumer who wants to be a scooter user.

Equity policy began very qualitatively and open-ended, requiring operators to submit a plan with their strategy to ensure equity. When more specific measures were listed, they were optional and not required. Over time, the conditions became more quantitative and more obligatory, requiring all three principles and giving strict guidelines for how to meet them, visible in Figure 3 below.



Sources: (29,35,39,43,47,51,53,55)

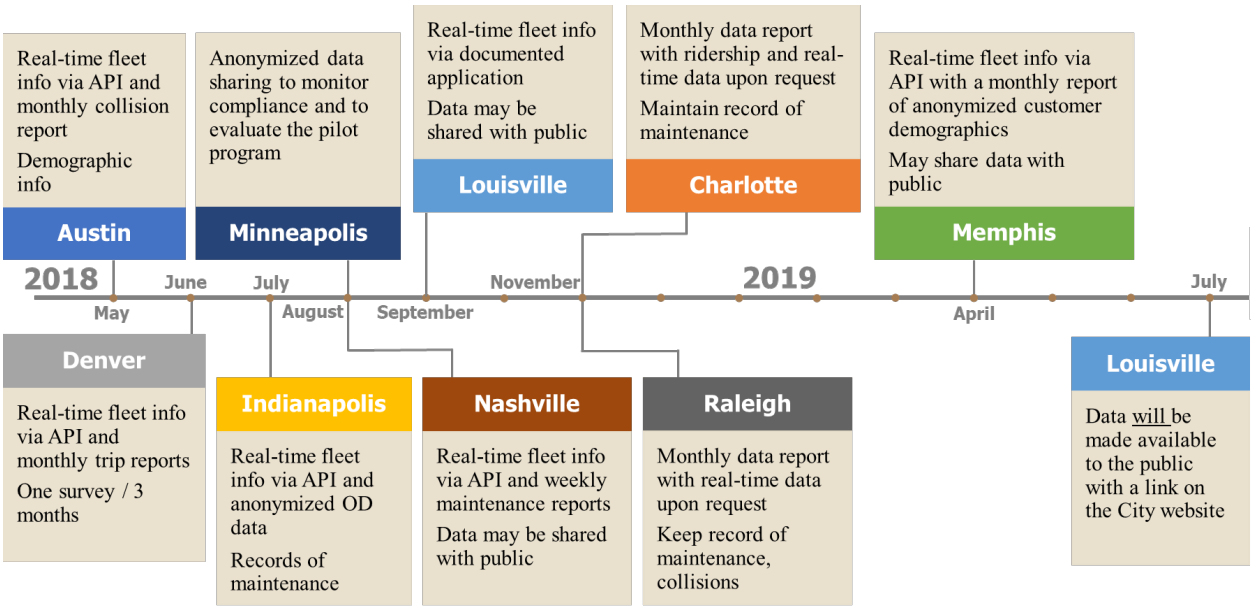
FIGURE 3. Timeline examining how equity regulations change over time in scooter policy documents.

Parking

Most policies that addressed parking included a condition for the quantity of clearance that had to remain on the sidewalk after the scooter was parked, so as to maintain the open pedestrian pathway. The amount of clearance did not converge overtime, but policies continued to include it in their regulations. Furthermore, policies began to place weight on parking zones. Policies either required the operators to cover the cost of installation, or later, in an April 2019 policy, operators could place requests for specific designated parking spaces to be provided by the city.

Data Sharing

Data sharing has been incorporated into policies from the beginning. Consistently, policies called for real-time fleet information via an API and monthly reports on trips, maintenance, operations, or ridership. Over time, however, policies began to include stipulations that the data received by the city could be shared with the public, as seen in the latter half of Figure 4.



Sources: (29,35,41,48,53,43,33,55,47,39,44)

FIGURE 4. Timeline examining how data-sharing requirements change over time in scooter policy documents.

Consistent Dimensions

The policy dimensions mentioned above (equity, parking, data sharing, etc.) all changed over time, often ending at a convergence point where many of the cities had the same policy. Other policy dimensions not mentioned above, however, did not show significant change over time. The policies in these dimensions tended to either stay consistent or follow no distinct trend, as the cities seemed to be on the same page from the very beginning. Below, we share a summary of the most common policy measures in each category.

- Scooter removal or permit termination: at the discretion of the director, particularly if there are public safety concerns.
- Safety: guidelines followed similar practices.
    - Users age requirements of either 16 or 18 years.
    - Helmets required for minors, optional for others.
    - One rider per scooter.
    - Starting in fall 2018, several policies began to mention public safety information campaigns, to be run by operators.
- Performance bond: consistent; exact values were different, but all on the same order.
- Speed limit: varied between 15 mph and 20 mph.

DISCUSSION

Comparisons between peer cities show these individual policies as part of a bigger picture. This data also covers how the cities and operators made use of the policies in real life – how many operators ended up getting permits? Have they all increased their fleet size up to the limit, or have they stopped somewhere below that threshold?

The data found in the temporal assessment, on the other hand, demonstrates the effect of events in the past and how policy will continue to develop in the future. The city scooter policy timelines illustrate the circumstances in which the policies assessed in this paper were created. Most cities began with a trial or semi-permanent program, estimating how scooters would assimilate into the city. This gave cities the means to adapt regulations once they had collected data on the success of scooters in their city under a particular policy.

The Triple Lens

In the temporal assessment, there does not yet exist sufficient data to prove that the newer policies were more successful than older ones, nor to say that one city definitively learned from another's mistakes. Qualitative evaluations as to "why," however, may be completed through the triple lens.

For expansion and downsizing of fleets, policies converged towards a performance-based approach. Initially, fleet increases were allowed after a set amount of time had passed. Operators were perhaps content since they got to increase their fleet without any hurdles, but it could lead to over-saturation of the market, meaning they would start losing money as they maintain an unnecessarily large fleet. Under a performance-based approach, scooters are ideally provided at an equal rate to demand, which means fully utilized fleets for the operators and the inability of one operator to dominate by saturating the market. City officials may be content if this keeps the scooter population from inflating, 34 could be due to the policy including provisions to make equity directly beneficial for operators. Some policies permitted fleet expansions *if* the operator promised to place a portion of those scooters in underserved areas. Even broader, the operator receives benefit by receiving the operating permit in the first place, and so by continuing to write in well-defined equity requirements, the operators will continue to oblige since they have direct benefit (the ability to operate).

Finally, data sharing requirements and methods have stayed reasonably consistent over time. Newer policies include a stipulation that the city may share data provided by the operator with the public. Some mention potential collaboration with outside research groups to perform analytics on the data. Many cities have in place open data programs and could view scooter data as part of that program, like other city data sources. The city can derive direct benefit from this data as well, perhaps using it to identify streets with the highest usage and greatest need for new mobility infrastructure. If pursued, these uses can feed back as benefits for users and operators with safer and friendlier infrastructure.

Scooter policies have begun to recognize the importance of publicly available data, but there is still progress that needs to be made. The policy data from this work becomes particularly relevant if the policies can be evaluated for effectiveness through quantitative data analysis. Data of several forms can be used to evaluate policies: trip data (e.g., areas of greatest usage intensity, parking compliance, performance metrics), safety data (e.g., effectiveness of new safety requirements and initiatives), user demographics (e.g., success of equity programs), and more.

Aspirational Peer Cities

Within the group of peer cities, there are four cities that rank above the others in the metrics of mobility: Bicycle Friendly Community (BFC) ranking, bike commute share, and walk commute share (Figure 5). Those cities (Austin, Denver, Minneapolis, and Seattle) could be considered *aspirational peer cities* in terms of micromobility, as their higher BFC ranking indicates they have well-developed bike infrastructure, effective enforcement, continuous education, and more.

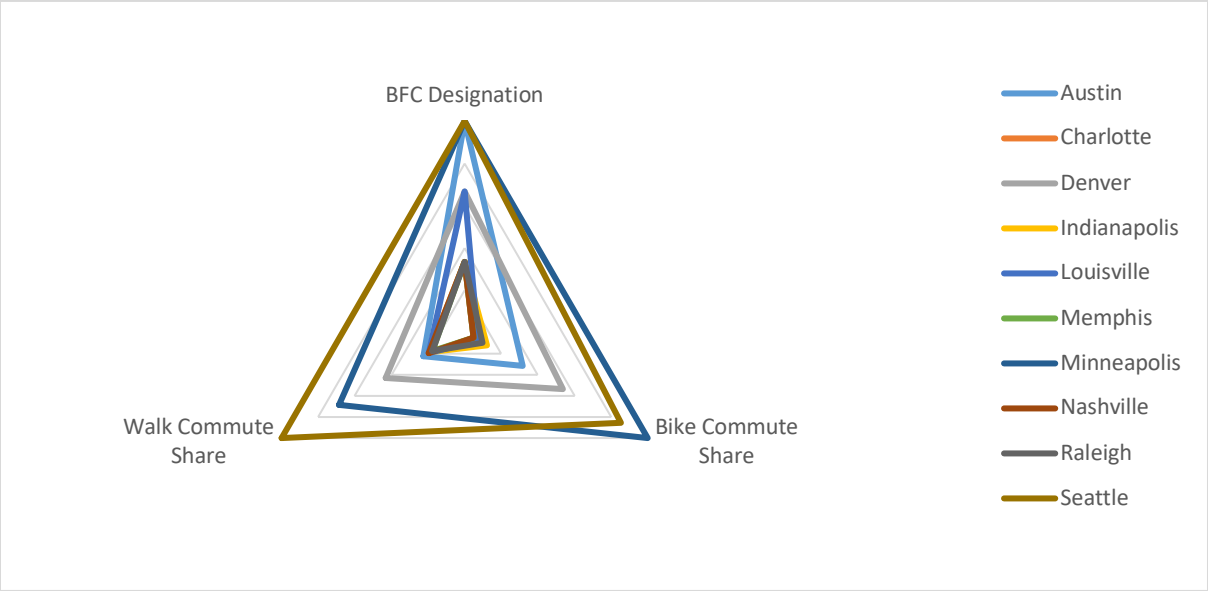


FIGURE 5. A spider plot displaying the higher mobility status of Austin, Denver, Louisville, and Seattle, designating them as Aspirational Peer Cities (24).

Within the assessment, the three aspirational peer cities that have scooter programs (Austin, Denver, and Minneapolis) were some of the first to release scooter policy, and sometimes started a policy trend to which other policies converged to later on. Austin, which released the very first scooter policy within the peer city group, worked with the idea of average ridership from the very beginning, which is the concept on which both expansion and downsizing policies converged. Denver was the first city to require operators to install parking zones, which propagated in later policies. As scooter policy continues to evolve in the future, these aspirational peer cities may be good indicators of where policy trends may shift.

CONCLUSION

This article investigated micromobility policies, with focus on electric scooter regulations and legislation, for ten mid-size peer cities chosen based on key quantitative criteria. A total of twelve policy dimensions were identified based on common incidence within the scooter legislation of multiple peer cities. These policy dimensions were then analyzed for each city. A comparison of these policy dimensions across the cities revealed numerous areas of consistency, such as device removal, safety, speed limit, and bonds, and numerous areas of policy variability over time, such as fleet caps, data sharing, and equity requirements.

The temporal assessment of policy dimensions conducted in this work revealed similar results: some policies changed significantly over time, while others were relatively static. For example, fleet expansion plans, permissible operating areas, and parking requirements all

demonstrated significant movement in policy terms over time. Cities are clearly adapting policy over time, though it is not clear if they are doing so in response to only their own experience, or if they have considered the experience of other cities. The policy data set forth in this article can and should serve as a useful benchmark and history for this type of policy reflection and evolution.

Areas for interesting future inquiry include the quantitative performance assessment in the context of specific policy factors. This is challenging due to data availability, but as noted in the article, cities are beginning to release scooter data publicly. Additionally, it could be beneficial to explore the findings of this group of mid-size peer cities in contrast to similar results from distinct, larger cities.

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study design, data collection, draft manuscript preparation, and analysis and interpretation of the results: Caroline Janssen. Interpretation of results and draft manuscript preparation: William Barbour. Study conception and design and interpretation of results: Erin Hafkenschiel. Study conception and assessment direction: Mark Abkowitz, Craig Philip. Study conception and analysis and interpretation of the results: Daniel B. Work.

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