RESEARCH REPORT

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Best Practices for the Public Management of Electric Scooters

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16. Abstract

This research projects evaluates the social, environmental, and safety impacts of shared electric scooters (e-scooters)' through a literature review, a nationwide scan of state and local laws and regulations, and a case study of Oakland's experience with e-scooters, including an analysis of the city's user survey and our own in-depth interviews. E-scooters offer an enjoyable, low-cost travel option, but are used mainly by young, affluent, white males. To improve equity, cities are requiring e-scooter rental companies to serve low-income and minority communities and some further mandate that a share of the e-scooters accommodate people with disabilities. E-scooters are quiet and produce no tailpipe emissions, but their cumulative environmental impact depends on their manufacture, useful life, disposal, and use. In early applications, rental e-scooters survived less than a year. Some 30-50 percent of e-scooter trips replace short auto trips. Cities and states can improve e-scooter safety by encouraging helmet use, offering rider training, limiting speeds, improving pavements, managing parking, and calming traffic.

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Disclaimer

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Executive Summary

Executive Summary

Electric scooters (“e-scooters”) that can be located using an app and rented by the minute were introduced to American cities only three years ago, yet this new form of shared mobility has become quite popular. Most of the companies offer electric stand-up scooters, though some offer other vehicle types as well. Rentable e-scooters are generally "dockless” — they can be picked up and dropped off almost anywhere within a designated service area.

By 2018, shared e-scooter use had eclipsed short term bike rentals or bikesharing, with 38.5 million trips compared to 36.5 million trips on shared, docked bicycles. In 2019, 86 million trips were taken on e-scooters, more than doubling the number of 2018 trips. E-scooters have been deployed in over 100 U.S. cities. In California alone, dockless e-scooters are officially operating in dozens of cities.

While their usage rates amount to a tiny share of overall travel, dockless e-scooters have had an outsized impact on the cities where they have been introduced. Advocates point out that they offer an affordable and convenient mobility option for users, can provide first and last mile access to transit, and are an energy efficient and environmentally benign way to make short trips. However, e-scooters have also created a number of problems for cities, with a spate of injuries from falls and collisions, complaints about conflicts with pedestrians and motorists, and parking conflicts including blocked sidewalks and unauthorized parking on private property. Equity issues also have been raised about the use of public funds to provide infrastructure for e-scooters, especially when the majority are provided as rentals. Also, in most cities where shared e-scooter services are operating, users are disproportionately male, relatively affluent, and young; and use remains low in communities of color and low-income communities (“communities of concern”). For this reason, some local interests have objected to giving public priority to e-scooters because they see them as serving a small, privileged group, while others have argued that government intervention is needed to reduce the safety hazards they. Many others have pushed e-scooters rental companies to extend their services to a broader range of users. Overall, there is a widely shared interest in finding better ways to manage urban e-scooters, increase their benefits to the public, and reduce their adverse impacts.

In this report, we present a detailed review of the literature on e-scooters and their impacts, a scan of key e-scooters laws and regulations in California and other states, an assessment of areas of agreement and divergence in practice, and a case study of Oakland drawing upon a survey of e-scooter users as well as interviews with people who live and/or work in Oakland, including many who do not personally use e-scooters. We find that e-scooters offer a fun, low-cost travel option, but that they are currently used mainly by young, affluent, white males. Cities are trying a variety of methods to improve equity, including mandating e-scooter distribution in communities of concern and requiring or incentivizing discounts for low-income users. Some cities are also mandating that a share of the e-scooters work for people with disabilities. Almost no attention has been given to date to the gender gap, which also is present in bicycle use.

E-scooters are quiet and produce no tailpipe emissions, but their overall environmental performance is contingent on their manufacturing content and processes, their useful life, and disposal practices as well as whether they attract trips away from car use rather than from walking, biking and transit. For the initial deployments of e-scooters, useful life was measured in months. E-scooter companies are now investing in sturdier, reparable vehicles in order to address this problem.

Safety is a concern for riders, who have suffered head injuries and broken bones, and for pedestrians, for whom dockless e-scooters parked in public rights of way can create tripping hazards or require hazardous detours. Encouraging helmet use,

offering rider training instruction, limiting speeds (especially in areas with high potential for conflicts), improving pavement quality, managing parking locations, and calming traffic are some of the ways that safety can be improved.

Proactive management of e-scooters is in the public interest and is consistent with city responsibilities to protect the public health and welfare. Cities can draw upon their police powers as well as explicit delegations of authority for regulating businesses operating within their jurisdictions to provide oversight. Working with the e-scooter providers and city residents and businesses can produce positive results.

From our reviews and analyses we identify 18 "best practices" for e-scooter programs:

1) Require shared e-scooter providers to obtain a business license.
2) Require rental e-scooters to be registered.
3) Regulate fleet sizes based on expected demand, and adjust permitted fleet sizes based on utilization, performance, and compliance with city requirements.
4) Restrict e-scooter speeds to 15 mph, with lower speeds in areas of heavy pedestrian use.
5) Allow e-scooters to operate in bike lanes or paths, but not on sidewalks.
6) Require signage where e-scooter travel, speed, or parking is restricted, and use geofencing (as feasible) to reinforce restrictions in specific areas.
7) Require e-scooters to be parked upright; prohibit parking of e-scooters in or in front of pedestrian crossings and loading zones; and regulate parking of e-scooters on sidewalks to maintain Americans with Disabilities Act (ADA) access, which may include directing e-scooter parking to corrals, parking racks, or other designated parking locations.
8) Require, or if state law prohibits a requirement then recommend, helmet use to reduce head injuries.
9) Ensure equitable access by setting targets for e-scooter distribution and/or availability at the neighborhood-level and adjust the target as needed to address the mobility needs of each neighborhood, and require rebalancing of e-scooter distribution on at least a daily basis.
10) Require options for renting an e-scooter with cash and without a smart phone.
11) Require discounts for low-income users and publicize available discount programs.
12) Incentivize the provision of adaptive e-scooters for persons with disabilities.
13) Require multi-lingual customer service, website, signage, outreach, and app.
14) Require e-scooter providers to submit a hiring plan that explains how the program will operate, including education and outreach, customer service, and fleet management (i.e., redistribution of scooters and removal of those that need repair or are illegally parked); and mandate or incentivize local hiring for these activities.
15) Require e-scooter providers to engage in information provision, education, and outreach activities.

16) Prioritize city investments in street paving, bike lanes and parking, and other street redesigns to improve safety for e-scooter riders as well as other micromobility users, in partnership with e-scooter providers and community groups.

17) Establish data reporting requirements that allow the city to monitor compliance of e-scooter providers with city requirements; assess the impacts of e-scooters on congestion, safety and the environment; evaluate equity concerns (e.g., distribution of e-scooters in specific neighborhoods); and determine infrastructure investment needs.

18) Set fees to cover full program costs to the city, including administration and oversight, data analysis, and planning and programming.

Contents

Introduction

E-Scooters as a Mobility Innovation and Public Management Challenge

While electric scooters ("e-scooters") have been sold in the U.S. for decades, shared e-scooters were introduced to American cities only three years ago by companies whose apps allow users to locate a scooter and rent it by the minute. Most of the companies offer electric stand-up (or kick) scooters, though some offer other vehicle types as well. E-scooters are generally "dockless" — they can be picked up and dropped off almost anywhere within a designated service area.

Shared e-scooters quickly became popular. According to the National Association of City Transportation Officials (NACTO), riders took 38.5 million trips on them in 2018, eclipsing the 36.5 million trips on shared, docked bicycles (NACTO, 2019). By 2019, 86 million trips had been taken on e-scooters in that year, more than doubling the number of 2018 trips (NACTO, 2020). In California alone, dockless electric scooters are officially operating in dozens of cities. Advocates point out that shared e-scooters offer an affordable and convenient mobility option for users, can fill a need for first and last mile access to transit, and are an energy efficient and environmentally benign way to make short trips.

However, e-scooters have also created a number of problems for cities, with a spate of injuries from falls and collisions, complaints about conflicts with pedestrians and motorists, and parking conflicts including blocked sidewalks and unauthorized parking on private property. Equity issues also have been raised; in most cities where e-scooter companies are operating, users are disproportionately male, relatively affluent, and young; e-scooter use remains low in communities of color and low-income communities. Thus, there is a widely shared interest in finding better ways to manage urban e-scooters and increase their benefits to the public.

E-scooter companies largely followed an "act first, apologize later" strategy in introducing the vehicles, leading to controversies in a number of cities. Some cities moved quickly in setting some rules for e-scooter providers and users; others blocked them altogether until they could get regulations in place, and a few have maintained bans. In several states, new laws have established safety rules, and, in some cases, state legislators have restricted the regulatory options available to cities. The result is a patchwork of policies that most likely add costs to cities and operators and may create user confusion and uncertainty about rules and expectations, especially in areas where users frequently cross municipal boundaries.

Some variation in approaches seems justified; different contexts may call for different policies. However, there also may be important opportunities to collaborate across jurisdictional boundaries to create clearer, safer, and more equitable policies for all parties. By assessing the pros and cons of e-scooters and reviewing a range of e-scooter laws and regulations and evaluating how different approaches work, we can identify best practices. This study draws upon a variety of sources and methods to identify e-scooter benefits and drawbacks and recommend best practices for their public management.

Research Approach

We examined the issues raised by the growing use of electric scooters in the following tasks:

Task 1) Literature review on new mobility with a special emphasis on electric scooters

We reviewed academic and professional literature, news reports, and blogs as well as marketing material for electric scooters, including the rules and guidance (advice) that companies provide users on vehicle performance and operation. In the review we focused on identifying potential benefits to the public and to the traveler, including low cost and ease of use as well as energy and environmental impacts; we also identified concerns raised about e-scooters, including their longevity, vandalism, parking issues, and safety or riders and other users of public rights of way, especially pedestrians. We reviewed these issues with a critical eye to the availability and strength of evidence backing up the claims.

Task 2) Inventory of laws and regulations that have been set up to regulate e-scooters

Using the findings on key issues as a guide, we identified and reviewed electric scooter laws and regulations in California and a sample of other states that have experienced substantial market penetration by e-scooters. We also reviewed a sample of city-level ordinances and regulations that address key issues identified in the literature review: vehicle safety features (e.g., required reflectors, etc.), vehicle operation rules (e.g., speed limits, parking rules), fees and taxes that may be charged by cities, data reporting requirements, privacy requirements, user training requirements, user equipment requirements (e.g., helmet use).

Task 3) Policy consistency

We used the inventory of laws and regulations together with findings from the literature to carry out an assessment of areas of policy consistency as well as to flag areas for which policies appear to be heading in different directions. We also noted policy debates that are not yet fully resolved — for example, vehicle maintenance and sanitation requirements, rules on access by low income individuals, and regulations concerning the use of sidewalks and bike lanes. The comparison of California and other states identified policies and practices in effect elsewhere that California may wish to adopt, either at the state level or at the city level, or that some cities in California have adopted that others may wish to emulate.

Task 4) Interviews with key stakeholders

We interviewed selected transportation experts and public officials in cities with significant market penetration by e-scooters to discuss the efficacy of various policies. The interviews also served to double-check our assessments from the previous tasks and to flag issues that might not have been apparent from the document reviews and evaluations, such as staffing requirements and enforcement needs. We discussed the pros and cons of various policies and regulations concerning e-scooters and the data and analyses the cities are using to evaluate their policies. We also inquired about unintended consequences — salutary or problematic.

Task 5) Identification of best practices

Based on the findings of tasks 1-4, we identified a set of policies and practices that appear to reduce conflicts, clarify expectations for providers, regulators and users, and improve the overall performance of e-scooters as a new mobility option.

Task 6) Oakland case study

Using data from the City of Oakland as our case, we analyzed data collected by the Oakland Department of Transportation (DOT) through an online survey to determine user demographics, e-scooter trip frequency, trip purpose, trip Origin/Destination characteristics, trip length, speed, reasons for use or non-use, other modes available and used (e.g., auto ownership, bike ownership, transit pass holder), effects of price, willingness to use docking stations if available, and willingness to use helmets. We also evaluated the limitations of an online, opt-in survey for these purposes.

In cooperation with Oakland DOT staff, we then drafted and pretested a random sample survey designed to obtain views of non-users as well as users of e-scooter programs and other mobility options. Our intent was to collect and analyze survey data from 400-600 Oakland residents and to use field observations and stakeholder interviews to validate and augment the survey results. We planned to administer the survey and carry out the additional data collection steps in early April 2020, after the Northern California rainy season had ended and while local colleges were in session. However, because of the COVID-19 pandemic and the resulting shelter-in-place orders, and school and business closures, the survey and field work could not be launched. (More specifically, it would not have produced useful results if launched while schools and businesses were closed. Nor was it possible to conduct field observations in e-scooter "hot spots" to evaluate whether problems identified in earlier tasks are present in different parts of Oakland (downtown, neighborhood shopping areas, student areas, etc.) because the pandemic and responses to it greatly reduced e-scooter use and altered patterns of use.)

Instead, we developed a set of questions to guide interviews with Oakland residents and employees about their e-scooter use and for nonusers, their views on this new mobility option. We drew upon a list of Oakland residents and workers — some were both — who had volunteered in an earlier study to be contacted for future research on transportation issues. The resulting sample of 42 respondents, while small, was representative of the Oakland population in terms of race/ethnicity, age, gender, and household income, was drawn from neighborhoods and employment districts across the city, and included a small number of e-scooter users (10) as well as non-users. As a result, the interviews covered a wider demographic than the larger Oakland survey and helps put its findings into a broader perspective.

Task 7) Conclusions

Conclusions reflect the findings from the case study as well as those from earlier tasks.

This final report covers the entire project. The following sections discuss the work performed under each task, in turn.

Literature Review

Background on E-Scooters and Their Impacts

Micromobility (i.e., light vehicles, such as bicycles, electric bikes, and electric scooters) has become the focus of considerable policy attention in urban areas over recent years. Some 84 million shared micromobility trips were taken in 2018, twice as many as in 2017 (NACTO, 2020). While this is a tiny portion of overall travel in the U.S. — according to the Bureau of Transportation Statistics, Americans take 411 billion trips a year — micromobility's fast growth, utilization of high tech, and potential for either aiding or disrupting other modes of transportation have made micromobility a topic of growing study.

E-scooters are the newest micromobility introduction to U.S. cities. While they have been used elsewhere for a number of years, their rapid introduction and use in this country has been especially noteworthy. Most are lightweight (25-35 lb.) stand-up models, though some companies offer other vehicle types as well. E-scooters capable of carrying an adult typically have a range of 10-20 miles, a carrying capacity of 200-250 lb., and a top speed of 15-20 mph, though some of the newer and costlier models claim higher weight limits and ranges and speeds two to two and a half times higher. An e-scooter can be purchased for $200-500 and up, but the boom in use came when inexpensive rentals became widely available and were introduced on a dockless basis.

The "dockless" approach means that an e-scooter can be dropped off almost anywhere within a designated service area. (They are redistributed daily or more often by the company to keep their access quick and easy.) E-scooters can be rented by the minute for a modest fee (typically $1 initially and 15 cents a minute thereafter) and can be located and unlocked through an app. Memberships are usually optional but make use and payment quicker and easier for the frequent user. Batteries are recharged by either enticing users to charge a scooter (or a set of scooters) at night and drop it off the next morning in exchange for a credit (amounts vary, but $5 is a typical amount) or by employing teams to pick up the vehicles and charge them (Sisson, 2018).

Private companies, many of them tech startups, have deployed e-scooters in many dozens of cities since 2017. Bird was the first company to launch dockless, electric scooters in the U.S., starting by placing the vehicles on the sidewalks of its home town of Santa Monica (Sisson, 2018). Deployments in other cities quickly followed, with e-scooters placed in dense downtowns such as San Francisco as well as in in tourist hubs like Venice in Los Angeles (Fonseca, 2019). By 2019, over 100 cities in the U.S. had e-scooters available.

In 2018, with 38.5 million recorded trips, e-scooters out-performed docked bikeshare services (36.5 million trips) (NACTO, 2020). *Wired* magazine called 2018 the "Year of the Scooter" as this particular form of micromobility surged in popularity and usage (Marshall, 2018a).

The concentration of micromobility trips in urban centers has led to considerable attention to their impacts, positive and negative (BTS, 2017). Supporters of e-scooters argue that they provide a fun, convenient, low-cost, easy-to-use transportation option that can be deployed almost anywhere. Further, they argue, there are public benefits: e-scooters can extend access to public transit, increase mobility without significantly adding to congestion, and are environmentally benign.

However, the rapid growth in e-scooter deployment and use also has also sparked major pushback. In Los Angeles, they have been tossed into the trash, thrown into the ocean, buried, burned, and disabled (Newberry, 2018.) In Portland, OR, Multnomah Sheriff Department divers in a single two-day cleanup recovered some 57 e-scooters that had been deposited in the Willamette River (Culver, 2019). In Austin, TX, vandalism took a darker turn: e-scooters near a downtown housing complex were found with their brakes cut (Streicher, 2019).

In San Francisco, the sudden arrival of shared e-scooters polarized the city; some residents lauded the new form of mobility, while others expressed disdain for what they saw as a symbol of gentrification and complained that the scooters littered sidewalks and posed a safety risk for pedestrians (Wong, 2018). Some San Franciscans went farther in expressing their disapproval, cutting some of the vehicles' wiring or painting over the QR codes on the vehicles needed to unlock them (Sandler, 2018). The San Francisco Municipal Transportation Agency (SFMTA) warned the three initial operators that they would "not tolerate any business model that results in obstruction of the public right of way of and poses a safety hazard" (Marshall, 2018b) and issued cease-and-desist orders to these companies that had chosen to "act first, answer questions later" (Holley, 2018).

Supporters of micromobility options like e-scooters underscore the variety of benefits they are believed to provide and argue that the opposition they engender and at least some of the problems they have created mostly result from inexperience with the new mode. Most supporters argue that e-scooters are a benign option, allowing users to make short trips without having to wait for transit, pay for pricy taxi or ride share service, or face the hassle of driving and parking a car. They see them as offering economic benefits, especially for those with limited incomes, and environmental benefits in the form of reduced tailpipe emissions and less congestion. They note that the vehicles take up only a little space, are lightweight and easy to move, and require less time than walking (traveling bike speed, 10-15 mph vs. 2-3 on foot) with less physical effort than cycling.

However, the extent to which e-scooters are actually achieving the benefits claimed for them continues to be contested. Table 1 lists some their key benefits, as well as some of the reasons the benefits are called into question. Studies aiming to provide a factual basis for e-scooters' evaluation are beginning to appear and are being updated as additional data becomes available.

Here we review studies published through mid-2020 that focus on four key policy issues: disparities in e-scooter use and the equity of e-scooter programs; their relationship to other modes, their environmental consequences; and their health and safety impacts.

Table 1. Potential E-Scooter Benefits; Limitations

Benefit Description	Limitations
Environmental benefits, including greenhouse gas and other pollutant emissions reductions and less noise from automobiles	Depends on mode shift from automobile to e-scooters; Vehicle miles traveled (VMT) reduction also depends on trip lengths
Congestion reduction	Depends on mode shift from automobile to e-scooters, location of use, time and day of use
Better life cycle energy and environmental results than alternatives	Depends on longevity of e-scooters and scooter components, including batteries; also depends on feasibility and cost-effectiveness of vehicle repair, battery replacement, remanufacturing and recycling, waste disposal practices
Affordable compared to other forms of transportation	Unless subsidized, likely to be more costly than walking, biking; may or may not be more affordable than transit, private auto
Can serve mobility-deprived neighborhoods	Depends on how e-scooters are actually deployed and user interest, comfort with them
Health benefits from using active transportation	May actually reduce activity if e-scooter travel replaces biking, walking; increased potential for user injury; may injure others in collisions or tripping incidents; some benefit for walk to and from pickup/dropoff but program is designed to minimize this
Supports high density development	Depends on how vehicles are deployed

Disparities in E-Scooter Use and the Equity of E-Scooter Rental Programs

Because e-scooters are relatively affordable and easy to use, advocates argue that they can provide a valuable way for people who are mobility-deprived to travel, at least for short trips. On the other hand, social justice advocates have raised concerns about e-scooters and other new mobility options, fearing that they serve the privileged and exacerbate gender gaps and racial, income, and other social disparities. Studies of cycling have long shown such gaps (e.g., Emonds et al., 2018), and a 2019 analysis of National Household Transportation Survey (NHTS) data on travel by "little vehicles" — defined by the authors as "bicycles, scooters, Segways, skateboards, and more" — found that most trips on little vehicles were being made by young men (Krizek and McGuckin, 2019).

Concerns about e-scooter programs' equity for low income and racial minorities arose when they were initially placed in dense downtown areas, tourist spots, and other districts where high levels of use and revenue generation were expected, but not in less tony and lucrative neighborhoods. As conflicts emerged over such' disruptive effects, a number of cities stepped in to limit their numbers or in some cases, suspend operations or ban the vehicles until regulations could be set in place. Some communities objected that the limited numbers also meant that lower-density and lower-income areas of the

city and communities of color might never be served. For example, community groups in outlying areas of San Francisco underserved by public transportation (e.g., the Sunset and Richmond districts) and in historically black neighborhoods (Bayview and the Western Addition) expressed their disappointment in the city's limits on the number of e-scooters, believing that the limits meant that this new form of mobility would not be deployed in their neighborhoods (Aguilar-Canabal, 2019). Evidence of disparities were shown in San Francisco Metropolitan Transportation Authority's (SFMTA's) assessment of its pilot project in April 2019: 63 percent of e-scooter riders were white, 82 percent were male, and 68 percent had incomes over $100,000 annually (SFMTA, 2019), in a city whose population is 41 percent white, 51 percent male, and has only 49 percent with incomes over $100,000 (American Community Survey 2017 5-year estimates). In addition, less than 0.1 percent of riders were taking advantage of discounted payment programs for low-income customers. National data point to similar disparities; only 17 percent of Lime e-scooter users are black or latinx, according to a user survey conducted in February 2020. Part of the disparity, however, may reflect uneven distribution of e-scooters and limits on dropoff areas (e.g., Bhuyian, 2019a).

Not every neighborhood welcomed e-scooters and indeed, in San Francisco, local community leaders in the Tenderloin and Chinatown expressed concerns about e-scooters exacerbating congestion in those areas because both neighborhoods have narrow, crowded sidewalks; they asked e-scooter companies to limit parking there (Bhuyian, 2019b). This does not mean that there is a lack of interest in e-scooters among low income and diverse populations, however. For example, the rideshare consulting firm Populus sampled a thousand households from 10 cities in the U.S. and reported that 72 percent of those who earn less than $25,000 a year have a positive view of e-scooters, while a notably lower 64 percent of residents who earn more than $200,000 do so. In addition, they found that the gender gap for e-scooter adoption is smaller than that for other new mobility modes such as bikeshare (Populus, 2018).

Features of the e-scooter business model that may work in favor of making it an equitable mobility option is the relatively low fees and the opportunity for users to offset some of that cost by collecting, recharging, and redistributing the vehicles. Affordability also depends on what other options are available. At $1 plus 15 cents a minute and an average speed of 10 mph, a three-mile trip on a rented e-scooter would cost $3.70, or about $1.23 per mile — less than a Transportation Network Company (TNC) ride like Lyft or Uber, but more than most bus rides and more than most private automobiles for the same distance. Discounts for low income e-scooter users may bring costs in line with transit, however.

E-scooter companies are offering discounts (sometimes are required to do so) to low income users who qualify for government assistance programs and have taken steps to make it possible to pay without having a credit card or bank card. In addition, since the majority of e-scooters are dockless, the added flexibility this delivers may reduce the equity gap by allowing a wider range of origins and destinations to be served. Another dockless form of mobility, dockless bikeshare, has been found to be more equitable than its docked counterpart; researchers found that when dockless bikes were available, there were no significant differences in bike availability or idle bike times between more and less socioeconomically privileged neighborhoods (categorized by race/ethnicity, income, and education levels) (Mooney et al., 2019). Finally, closing "first and last mile" gaps in public transit systems and increasing access to underserved populations that live in mobility deserts can improve transportation equity (DuPuis et al., 2019) — but only if e-scooters are available in the communities of concern.

Cities can deal with some of these issues through policies that require micromobility to be equally distributed in historically underprivileged areas and by creating and marketing additional incentives and discounts for low-income riders (Shaheen and Cohen, 2019). Such policies also could extend to communities with high levels of zero-auto households and to areas underserved by local transit. In Oakland, for example, e-scooter operators are required to deploy 50 percent of their

vehicles in areas designated as “Communities of Concern” by the Metropolitan Transportation Commission (OakDOT, 2019). Still, monitoring and enforcement is an issue, and advocacy groups have commented that “Communities of Concern” sometimes are large enough that service still could be focused on affluent enclaves and downtown employment centers rather than in low income neighborhoods in need of better transportation options (Wirtschafter, 2018).

Heavy traffic, potholes, and lack of bike lanes are common problems in low income and minority communities and can deter e-scooter use. Cities can address these problems and improve equity for residents of these areas, e-scooter users included, by expediting the provision of improved infrastructure. In addition, best practices that improve equity include providing apps and information in all the languages that the city requires, reviewing policing practices to reduce disproportionate enforcement against minorities, and offering benefits such as rider training programs in cooperation with community leaders in neighborhoods throughout the city (NACTO, 2018).

Some micromobility operators have launched campaigns or initiatives to bridge the socioeconomic divides associated with their products. For example, Lime launched “Lime Action: Helping Riders Advocate for Safer Streets and Equitable Communities” a few weeks after George Floyd’s killing by police officers in Minneapolis (Lime, 2020a). This program connects Lime riders with local organizations tackling issues of social and racial disparities, unsafe streets, and unsustainable travel. Lime also has launched “First Ride Academies” in communities of color and has developed a “Key Lime small business program,” which features local businesses of color in the Lime app (Lime, 2020b).

Impact on Other Modes

E-scooters have had variable impacts on other travel modes. Table 2 shows the findings on mode shift from auto, additional trips made, and access trips to transit, drawing from surveys from nine cities across the United States. The table shows that 30-50 percent of the e-scooter trips were reported as shifted from automobiles (private cars, TNCs, taxis). Some 3-9 percent of the e-scooter trips would not have been made at all if one had not been available. As many as 60 percent of users reported having used the mode to access transit, but this question was asked in various ways and so the data are not directly comparable. When frequency of use to access transit was asked, the results varied widely; the number of e-scooter users who reported using them to access transit even once a week ranged from about one in five (Denver) to one in two (Hoboken, NJ).

User characteristics and the travel options they have available to them are known to affect mode choice and its consequent impacts on congestion, emissions, and safety. For example, according to a ridership survey in Portland, 34 percent of Portland-based riders and 48 percent of visitors chose to ride an e-scooter instead of driving a car or taking a TNC (PBOT, 2018). However, while this mode shift may be reducing emissions, it may not be actually mitigating peak hour congestion because e-scooters are used most frequently on weekends. In Washington, D.C., while bikeshare members take rides during peak hours, e-scooters are not often used for commuting purposes, but instead are mostly used for non-work purposes, at off-peak times (McKenzie, 2019). In contrast, in Chicago most e-scooter trips occur during commute hours and are used to connect to transit (Smith and Schwieterman, 2019). To compare this mode shift across geographies, a collection of these data for different cities was compiled (Table 2) to illustrate whether e-scooter availability tends to substitute for other modes of travel, induce new or additional trips, or complement other forms of trip-taking by improving access to other modes such as public transit. The variability in patterns of use suggest that decisions whether and when to use e-scooters depend on the specific context.

Table 2. E-Scooter Mode Shift, Induced Travel, and Complementarity

City	Mode Shift from Motorized Vehicles	Induced Demand	Connect to Transit as Trip Purpose	Connect to Transit at Least Once a Week	Connected to Transit on Most Recent Trip
Alexandria, Virginia	44%	9%	40%		
Atlanta, Georgia	42%	5%			21%
Chicago, Illinois	43%	3%	34%		
Denver, Colorado	32%	2%		19%	
Hoboken, New Jersey	36%	6%		49%	
Oakland, California	38%	3%	60%	38%	
Portland, Oregon	34%				
San Francisco, California	41%				34%
Santa Monica, California	50%				4%

Notes: Mode shift from motorized modes includes shifts from personal automobiles, taxis, and TNCs. Induced demand refers to respondents who would not have taken the trip had it not been for an e-scooter. Blank cells are instances when the specific question was not asked. Links to surveys:
Alexandria, Virginia: https://www.alexandriava.gov/uploadedFiles/tes/info/EvaluationReportReducedSize.pdf
Atlanta, Georgia: https://www.atlantaga.gov/home/showdocument?id=45981
Chicago Illinois: https://www.chicago.gov/content/dam/city/depts/cdot/Misc/EScooters/E-Scooter_Pilot_Evaluation_2.17.20.pdf
Denver, Colorado: https://www.denvergov.org/content/dam/denvergov/Portals/705/documents/permits/Denver-dockless-mobility-pilot-update-Feb2019.pdf
Hoboken, New Jersey: https://assets.website-files.com/58407e2ebca0e34c30a2d39c/5dd570e833006067e38907ca_e-scooter%20survey.pdf
Oakland, California: https://www.oaklandca.gov/news/2019/we-want-to-hear-from-you-take-the-oakland-scooter-survey
Portland, Oregon: https://www.portlandoregon.gov/transportation/article/709719
San Francisco, California: https://www.sfmta.com/sites/default/files/reports-and-documents/2019/08/powered_scooter_share_mid-pilot_evaluation_final.pdf
Santa Monica, CA:
https://www.smgov.net/uploadedFiles/Departments/PCD/Transportation/SharedMobility_UserSurveySummary_20190509_FINAL.PDF

Environmental Impacts

While e-scooters are often cited as a sustainable alternative to other transportation modes, there is uncertainty about how environmentally friendly they actually are. Electric scooters are quiet, and they produce no tailpipe emissions. They can travel 100 km per kilowatt hour (kWh) of electricity, while a Volkswagen e-Golf travels only 6 km per kWh, and a traditional car that runs on gasoline is even more energy intensive (Agora Verkehrswende, 2019).

E-scooter use could produce benefits by reducing congestion, noise and emissions if it is a substitute for short car trips, but the magnitude of the benefits depends on location, time of day, and day of week of travel. These benefits vanish if the e-scooter substitutes for walking or biking.

Thus, when evaluating their environmental benefits, it is important to know whether e-scooters are replacing auto trips, are generating new trips, or are replacing transit, bike, or walking trips. While the studies reported in Table 2 provide a partial indication of the modal effects of e-scooters, it is clear that more finely honed data are needed with regard to overall substitution, complementation, and induction effects (as identified in Table 2) and the respective trip lengths for each of these phenomena.

Environmental benefits also depend on how long the e-scooter lasts, since manufacturing and disposal have environmental consequences (Hollingsworth et al., 2019). Currently, e-scooters' short lives lead to concerns about their life cycle impacts on the environment. E-scooters in private ownership typically last 2-3 years or longer, and many come with a limited warranty against manufacturer defects for at least one year. However, reports have found that as of 2019, the average life of a rideshare (rental) e-scooter is just about three months (Schellong et al., 2019), or possibly as short as a month, according to another analysis (Griswold, 2019). E-scooter companies dispute the one month finding but themselves have reported lifespans of three months for their less expensive models and have moved to new, sturdier designs to extend the lifespan to closer to a year (See, e.g., Claybaugh, 2019). The useful life of an e-scooter is an important question because its environmental impact includes production, maintenance, and disposal as well as operation.

Environmental impact also will vary with hardware choices (e.g., battery technology), energy sources, production processes, and materials quality (which affect how fast the e-scooter will wear out), and design features including the ease of repair or parts replacement and the feasibility of recycling parts and materials. Those that wear out fast, are hard or impossible to repair, and end up in the trash are an environmental problem.

Materials content also matters. For example, in China lead pollution from e-bike batteries expressed on a per-kilometer basis was found to be up to 100 times greater than bus lead emissions (Cherry et al., 2009). Lithium-ion batteries are now being used in most e-bikes but they too pose environmental hazards if disposal is not handled properly.

Taking these broader factors into account, researchers have found that e-scooters do not necessarily reduce environmental impacts of the transportation system. Considering operations, only when e-scooters replace automobile travel is there likely to be a net reduction in operations-based environmental impacts (Hollingsworth et al., 2019). Lifecycle impacts must also be considered and when they are added to the operations calculus, e-scooters may or may not be more environmentally friendly, at least from a carbon dioxide (CO2) perspective, than cars (Chester, 2019).

To mitigate e-scooters' environmental impact, a variety of measures are being taken and more are being evaluated. For instance, the German government wants to make swappable batteries mandatory for e-scooter operators, in an effort to reduce the amount of fuel that is used by vans picking up and dropping off vehicles for charging — and a leading e-scooter operator, TIER Mobility, has agreed to these demands (DGAP Media, 2019). On the software end, some companies are creating software meant to help e-scooters last longer and also prevent battery fires and other safety issues (Wiggers, 2019). At least one operator, Spin, has committed to becoming carbon negative by 2025 through strategies like recharging e-scooters with renewable energy, increasing vehicle longevity to at least 24 months, and tracking rider mode shift (as a core company sustainability metric), to encourage replacement of automotive trips (Spin, 2020). How well these measures will work (and whether they can be monitored and enforced) remains to be seen.

Health and Safety Impacts

Community health benefits can accrue where e-scooters replace car trips and reduce pollutant emissions and traffic levels in so doing. Likewise, if an e-scooter makes it possible to ride transit rather than drive a car, the community and personal health benefits are likely to be positive. E-scooters provide a health benefit to users when they walk to and from the devices, but if they are widely distributed and dockless, such walks should be short. Riding an e-scooter offers little physical exertion and if it replaces a walking or biking trip, the overall health effect can be negative (ActiveTrans.org, 2019).

A major health concern with e-scooters has been injury accidents from user falls and crashes. A 2019 Consumer Reports investigation tabulated injuries from 110 hospitals in 47 U.S. cities and found that at least 1,500 riders had been injured since e-scooters were introduced in late 2017, with eight deaths as of the time of the article's publication (Felton, 2019). E-scooter accidents can be caused by inexperience — there is some evidence that first time users have a particularly high accident rate — but other factors tied to injuries include operating under the influence of alcohol or drugs, use by children under the age of 18, and operating without a helmet. The prevalence of these behaviors has been confirmed by studies in several cities. For example, a recent study in Los Angeles found that only 4.4 percent of e-scooter riders wore a helmet, 4.8 percent were intoxicated, and 11 percent were under 18 (Trivedi et al., 2019).

In an investigation conducted by the Centers for Disease Control and Prevention (CDC) in cooperation with the Public Health and Transportation Departments in Austin, Texas (Austin Public Health, 2019), the research team calculated that 20 individuals were injured per 100,000 e-scooter trips taken during the three-month study period. This is a high rate of injury. Almost half of the injured riders sustained head injuries and fifteen percent experienced traumatic brain injuries. Fewer than one percent of the injured riders was wearing a helmet (Holder, 2019).

Studies indicate that infrastructure has a significant impact on e-scooter user injuries; in the Austin study, 50 percent of those interviewed believed that surface conditions like a pothole or a crack in the pavement contributed to their injuries (Austin Public Health, 2019). Operating speed is another important factor, with 37 percent of those interviewed reporting that riding at excessive speed contributed to their injury.

Despite such safety concerns, in California, Assembly Bill 2989 relaxed the requirement that adults must wear a helmet while operating a e-scooter, though helmets are still mandated for operators under the age of 18. Furthermore, the law allowed users to operate in streets with speed limits up to 35 mph, up from the 25 mph limit previously (Chiland, 2018). E-bikes must operate at 15 mph or lower regardless of the posted speed limit, however.

While many safety studies have focused on injuries to users, e-scooters also raise concerns for nonusers, due to their use of sidewalks for travel and parking. Opponents have complained about their colliding with pedestrians or creating near misses. E-scooters parked haphazardly on sidewalks have been criticized for impeding pedestrians and making the passage of wheelchairs, strollers, baby carriages, and other forms of mobility aids difficult or impossible. Disability advocates point out that these issues are especially acute for older people, who may not be able to maneuver around obstacles as easily as their younger counterparts, and for people with limited vision; in some cities lawsuits have been filed (Bowen, 2019; Williams, 2019; Mazoch, 2019).

Although complaints have arisen in many cities, some researchers have questioned the magnitude of the sidewalk problem. In San Jose, researchers found that 97 percent of e-scooters were parked upright and 90 percent were parked out of the way of pedestrian access, suggesting that sidewalk blockages may be less prevalent than critics have implied; the San Jose study found that only about two percent of the e-scooters observed in the study obstructed Americans with Disabilities Act

(ADA) access (Fang et al., 2018). It is likely, however, that this problem is context-specific, depending on land uses and sidewalk widths and designs. In addition, it may only take one e-scooter to be parked badly to narrow the pedestrian way or block access to a curb cut, as Figure 1 illustrates.

To mitigate e-scooter parking issues, some operators like Spin have launched "mobility hubs" which come with designated parking spaces (Graham, 2019). Further, Spin has created challenges to encourage e-scooter transportation advocates to "build a better barrier" (i.e., develop innovative ways to create a barrier to protect bike (micromobility) lanes) (Teale, 2020).

NACTO recommends several options for e-scooter parking, from "free-floating" to designated locations and restricted areas depending on local conditions, but cautions that unrestricted parking on sidewalks could create ADA violations and put not just e-scooter providers but also cities at risk of a lawsuit (NACTO 2018).

Figure 1. E-Scooter Parking Issues

Left photo: E-scooters parked on a sidewalk (Karl Sonnenberg / Shutterstock)

Right photo: E-scooter blocking curb cut (: https://wheelchairtravel.org/electric-scooters-blocking-wheelchair-access-sidewalks/ Photo credit: @inmci/Instagram.)

Laws and Regulations on E-Scooters

When e-scooters suddenly appeared on city streets, public officials quickly recognized that there was a lack of clarity on what laws and regulations providers and users needed to follow. The issues ranged from business regulation (e.g., whether a business license was needed to offer e-scooter rentals; whether e-scooters could be parked on city sidewalks) to operating rules (e.g., whether there should be age restrictions for e-scooter use, whether helmets would be required, permission to operate on bike paths and sidewalks, applicability of vehicle code provisions) (Irfan, 2018). As e-scooter use surged, public officials also became concerned about safety, conflicts with other vehicles and with pedestrians, theft, vandalism, and illegal parking issues (Lazo, 2018). Growing experience with e-scooters revealed additional issues, such as social disparities in their use and disputes over government reporting requirements, including data sharing and privacy concerns (NACTO, 2018; Descant, 2019).

State legislatures often determined that legal changes were necessary because it was unclear whether e-scooters should be considered a motor vehicle within the meaning of state law and therefore subject to the applicable equipment, registration, inspection, and operating rules (which technically made e-scooters illegal in several states). In addition, state legislatures sometimes took action because local governments were establishing regulations that varied significantly from one jurisdiction to the next, creating confusion for the public and compliance difficulties for e-scooter providers.

Several legal principles provided the rationale for public intervention and oversight (NACTO, 2019). Table 3 outlines key interventions and the rationales for them.

Today, all but two or three U.S. states have enacted laws governing aspects of e-scooter business operations and/or user operating rules, have clarified how existing vehicle laws apply, or have done a little of both. However, the coverage of issues is spotty; see, e.g., Unagi (2019) for an overview of the situation in each state. In addition, the law pertaining to e-scooters remains in flux as legislatures continue to consider whether additional rules or restrictions are needed.

In California, both the state Legislature and many cities have taken actions to regulate e-scooters. California is a home rule state; Article XI, Section 7 of the California Constitution provides that cities and counties may make and enforce ordinances and regulations not in conflict with general laws. In addition to this general grant of authority, under various provisions of the state legal code, local governments have additional, explicit authorizations to regulate businesses and travelers such as e-scooter companies and users. For example, localities are authorized under the state's Business and Professions Code to require enterprises to obtain a business license in order to operate within their jurisdictions, and may impose licensing fees; under the Vehicle Code local governments are authorized to regulate motorized e-scooters' registration, operation, and parking on public streets. However, the Legislature has taken the lead on a number of issues, including helmet requirements, speed limits, and streets where e-scooters can be operated and, in some cases, has preempted local action. (Table 4).

Table 3. Rationales for Government Intervention on E-Scooters

Intervention	Rationale
Business licenses required for e-scooter companies to operate	Public responsibility to assure that the public is protected by requiring owners to register their businesses so they can be held accountable for their action and can be taxed; protect public health, safety, and welfare
Regulation of e-scooter use of public infrastructure (streets, sidewalks, bike paths, parking)	Government has a right and responsibility to regulate the use of public property, including streets and other public works, to ensure safe passage and equitable access
Regulation of time and place of use of e-scooters (e.g., night bans, parking rules)	Public welfare and safety: Residents and businesses have a right to protection of private property from nuisance
Safety regulations, e.g., speed limits, helmet requirements	Government responsibility to protect the health and safety of vehicle users and those around them
User requirements and restrictions, e.g., age, license, DUI rules	Government responsibility to protect user and public health and safety
Environmental regulations, e.g., rules on disposal of vehicles	Cities (and/or states) have a responsibility to ensure public health, safety, and welfare
Contracts for service; enforcement of contract provisions providing exclusive or limited service territories to particular parties	Cities have corporate rights to enter into contract and are responsible for complying with contracts

Table 4. Key California Laws Applying to E-Scooters

Issue	Law	Details
Helmet requirements	AB 2989	Riding an e-scooter permitted without a helmet if the person is at least 18 years old.
Speed limit for e-scooters	AB 2989	E-scooters can't legally go faster than 15 mph, even if road is posted for higher speed
Streets where e-scooters may be operated	AB 2989	E-scooters permitted on streets with speed limits of 25 mph or less; can be allowed on streets with speeds limits up to 35 mph if locals permit
Use of bike paths and bike lanes	AB 2989	E-scooters allowed on Class II and Class IV bike paths
Applicability of vehicle code	CA Vehicle Code	E-scooters must obey all traffic laws that apply to vehicle driving such as not driving under the influence of alcoholic beverages; must be 16 and have a driver's license or learner permit.

Other states share some of the provisions California has enacted, but there also are numerous differences (Unagi, 2019). For example, most states agree that e-scooters should not be driven on sidewalks, but a few states allow it. Some states treat e-scooters as motor vehicles except when such treatment would be impossible (e.g., emissions inspection rules); a few apply bicycle rules and a few have established a separate category for electric micromobility. Table 5 lists some examples of key features of other states' laws regarding e-scooters that differ from those currently in effect in California.

Further complicating the legal landscape, local governments have adopted their own e-scooter regulations, utilizing state-delegated legal authorities and/or their broad police powers. Moreover, the local regulatory landscape has changed rapidly. When e-scooter companies dropped their vehicles on city streets without government permits or consent, some cities welcomed the new mode, but many others responded to the unprecedented launches with cease and desist orders, fines, or both (PBOT, 2018). In the ensuing years, most local governments have developed regulations that manage their relationship with e-scooter companies and address user safety issues.

Table 5. Key Features of E-Scooter Laws – Examples from Other States

Legal Issue	Examples
E-scooters may operate on sidewalks	Louisiana, Virginia
E-scooters need to be registered with the DMV	Alabama, Illinois, North Carolina
Driver license required	Kansas
E-Scooters are classified as bicycles	Arizona, Hawaii, Kentucky
Helmet if under 16	Delaware, Massachusetts, Oklahoma
Speed limit for e-scooters 15 mph	Maryland, Minnesota, Tennessee
Speed limit for e-scooters 20-25 mph	Colorado, Florida, Iowa, Utah, New Jersey
Operator must be age 18+	Maryland, Oregon
Operator must be 16+	Arkansas, Connecticut, Virginia, Nevada
Operator must be 14+	Mississippi
Operator must be 8+	Utah

Notes: Examples are as of 6/2020; rules may have changed. Examples are not exhaustive and additional states not listed may have the same rules.

City rules frequently have focused on e-scooter parking issues, a major sore point in many communities. Both regulations and city initiatives have been implemented. Among the cities that have implemented regulations to assign responsibility for safe parking to e-scooter companies and users is San Francisco. San Francisco has mandated a lock-up option for e-scooters that has led to a significant reduction in complaints about parking problems, as many users attach the e-scooter to a post or other fixed object out of the way of pedestrians. Other cities have developed e-scooter corrals or designated parking spaces in busy areas, restricted sidewalk parking to the street furniture zone (the area where benches, bus stops, etc. are installed), and used geofencing (i.e., using GPS or RFID technology to create a virtual geographic boundary around an area, enabling software to trigger a notification when the fenced area is traversed) or lower-tech signage to gate off sensitive areas such as busy pedestrian ways or campuses to e-scooter parking and use. Other strategies to improve parking practices include training for e-scooter distributors (so that they don't just dump the e-scooter on the street) and city policies permitting relocation, lockup or removal of improperly parked vehicles.

Cities also are taking the lead on increasing the availability of bike lanes, compete streets, and traffic calming measures as e-scooters join the mix of nonmotorized vehicles on local roads. Reports show a higher injury and fatality rate for e-scooter share trips than bike trips and that some crashes may have been caused by hitting a pothole or crack in the pavement. These reports have sounded an alarm for city officials, though some also point out that e-scooters' small wheel size (8-10 in. wheel diameter vs. 20-26+ in. for bikes) heightens the risk. Investments in better paving, bike lanes that are also suitable for e-scooters, and street designs that are friendlier for bikes, e-scooters, and pedestrians have become a higher priority for many cities.

Another area where cities have increasingly intervened is social equity. As noted earlier, studies have shown that e-scooter users tend to be predominantly white, male, affluent, and under 40, although the specific user profile varies city to city. Since one of the selling points of e-scooters is that they can make low-cost mobility available to a wide range of users, including people in underserved communities, low rates of use among ethnic and racial minorities and those with low incomes have been disappointing. City policies aimed at addressing these issues have included requirements for community outreach, including public information and training events on how e-scooters can be accessed and used. Several cities have mandated daily redistribution of e-scooters to communities of concern, as in Oakland, CA, and have offered city subsidies for people with low incomes, as in Chicago. Cash payment options and other lower-tech means of accessing an e-scooter have also been pursued in several cities. Some cities have tied the number of e-scooters that can be deployed to performance measures, including measures of diversity in the user population. While major e-scooter companies already offer a discount to low income users, several cities have sought deeper discounts for low income residents, such as $5 annual memberships.

While most cities were unprepared for the unannounced arrival of dockless rental e-scooters in 2017-2018, they now are far more ready to manage the number of vehicles and providers serving their communities, regulate the conditions of operation, and provide oversight. NACTO (2019a) reports that as of December 2019, 21 of the 50 largest U.S. cities had used formal requests-for-proposals (RFPs) or some other competitive application process to determine which companies, and how many, are permitted to operate. Methods by which governments have intervened are shown in Table 6. A number of cities initially opposed the e-scooter companies' actions and banned their vehicles' operation, or threatened litigation. Others welcomed e-scooters initially but came to see the need for rules about sidewalk use, parking, and user eligibility. As cities learned from their own experiences and those shared with peers, policies were refined. Many cities are now limiting the number of vendors allowed to operate at the same time, tying fleet sizes to performance, and mandating service in low-income neighborhoods or places with limited transportation options. Service providers who win a competitive bid for a limited number of permits or who are awarded a contract typically are required to provide information about their operations that allows the city to monitor performance and make adjustments if needed.

Table 6. How Authorities Have Regulated Micromobility

Method	Details
Ban	Interim or indefinite ban of e-scooters or other types of micromobility from being used in municipality or parts thereof. Can include cease-and-desist orders, vehicle impoundments, and operator fines; may include interpretations of vehicle code that effectively act as bans. Examples: New York City, Berkeley, CA, San Francisco, CA, Columbia, South Carolina; Pennsylvania (vehicle code interpretation).
Open	City has minimal requirements such as prohibition of sidewalk riding, but no fleet caps. Usually temporary position. Example: Indianapolis.
Permit	City has formal application and permitting process. Permittees must comply with city requirements like fleet caps and data sharing. Number of permits is typically limited. Examples: Oakland, CA, San Francisco and many cities in second wave.
Contract	City has public-private partnership (contract agreement) with micromobility provider. City exerts control over deployment of vehicles in exchange for limited or exclusive operating rights for the contractor. Examples: docked bikeshare programs like New York Citi Bike.

Source: Modified from Zaref et al., 2019 and NACTO, 2018

Still, a high level of variability from city to city persists, and areas of contention remain.

Areas of Policy Consistency and Divergence

Variability in the regulation of the e-scooter industry and the rules applied to its users can serve a quasi-experimental function, by allowing a comparison of the various policies and approaches and facilitating an evaluation of how well different approaches work. NACTO has been working with its members to track their experiences and identify best practices as well as topics for which there is not yet clear evidence. Here we draw upon the NACTO reports, other literature on e-scooter regulation, interviews with micromobility experts, policymakers, and advocates, and our own observations and analyses. We identify areas where there is consistency in approaches, flag areas for which policies appear to be heading in different directions and identify policy debates that are not yet resolved.

A topic of near-consensus is the need for government oversight of e-scooter operations. However, as noted in Tables 5 and 6, cities and states have adopted different ways of doing this, for example, by interpreting and extending existing laws and ordinances, by adopting new laws and ordinances, or through industry-specific business license provisions, or competitive bidding. NACTO (2019a) recommends that cities and other relevant agencies assert the right to limit the number of operators within their jurisdiction and require that any operator have prior written permission before commencing operation. The NACTO guidebook on micromobility also identifies a number of general provisions that its members agree should be included in regulations, permits, and contracts, such as minimum insurance requirements, indemnification of the city, right to cancel permits and licenses for cause, and consequences for situations in which an operator is to be considered in breach of its agreement with a city (e.g., fines, vehicle impoundment, and/or the right to temporarily suspend or permanently revoke a permit if the operator does not comply with contract provisions).

Other elements that cities are increasingly including in their permits or contracts include setting both minimum and maximum limits on the number of e-scooters operating within a jurisdiction or service areas. Some cities do this as a firm cap and others allow dynamic adjustments based on performance data. Cities also are establishing distribution and rebalancing rules to avoid having some areas too crowded with e-scooters and others under-served, as well as rules requiring prompt removal of vehicles that are no longer operable or need repair.

With a few exceptions, cities have prohibited e-scooter use on sidewalks and require that they be operated on low-speed streets or on bike paths. Most jurisdictions ban e-scooters from travel on streets and highways with posted speeds over 30-35 mph, either explicitly in e-scooter regulations or through vehicle code provisions that limit highway use to vehicles meeting specified equipment and performance standards. There is widespread agreement on the need for e-scooter speed limits, though some have opted for 15 mph, some for 20-25 mph, and some have set lower speeds (e.g., 8 mph) for pedestrian districts.

State law rather than city rules usually govern user age and licensing criteria. Most states require that e-scooter users be at least 16, although a few states have set lower age limits, and some have set the age at 18. The need for a driver license or permit is less clear; in states that consider e-scooters a motor vehicle it would appear that a license would be required, although we were unable to verify whether this has been enforced. In states that classify e-scooters as bicycles, licenses would not be needed.

Cities also agree that e-scooters add to the need for separate bike lanes, and many are beginning to give bike lanes higher priority, not only because of the e-scooter boom but because bicycles and other micromobility devices also benefit from separate lanes. NACTO and micromobility experts further recommend increased consideration of street design standards that explicitly accommodate micromobility, for instance complete streets, traffic calmed streets, and streets with parking areas for bikes and e-scooters.

On the issue of e-scooter parking, cities have taken several different approaches, especially in downtowns and other high density, high traffic areas where there is competition for street and sidewalk space. Many cities restrict parking to the street furniture zone or the planting strip area of the sidewalk. However, an increasing number of cities are installing on-street corrals, lockup posts, and docking points in busy districts and directing e-scooters to those locations. Operating rules increasingly require operators to geofence or otherwise restrict e-scooter parking in areas that are “off limits.” including the immediate vicinity of bus stops and crosswalks and next to loading zones.

Funding for bike lanes and racks and signage for bikes and e-scooters is often hard to come by. For this reason, NACTO recommends that cities set fees to cover needed infrastructure as well as to cover costs of program administration and develop mechanisms to earmark the portion of permit fees based on infrastructure needs. However, cities also report pushback on this from the operators. Several cities report that an alternative way to obtain funding for e-scooter infrastructure is a negotiated partnership with bikeshare and e-scooter providers for cost sharing. Cities also have used partnerships with downtown associations to improve bike lanes and parking.

There is less experience to date with customer service requirements. A growing number of cities are specifying that program information should be provided in multiple languages, reflecting local needs; some cities also are specifying the desired level of customer service, such as 24-hour contact numbers. A few cities call for outreach and engagement events, safe riding demonstrations, and targeted information about available discount options.

Labor issues are also being addressed in some of the recent agreements between e-scooter providers and cities. For example, some cities provide incentives for local hiring for customer service and outreach.

As noted earlier, equity for underserved communities has been an issue with many forms of new mobility services. Practices are highly varied, with some cities mandating discounts, other offering incentives for them, and still others subsidizing increased access to underserved communities using city revenues from e-scooter licensing and operations fees. A handful of cities have mandates or incentives for adaptive e-scooters for people with disabilities. We were unable to locate programs designed to increase ridership among women.

NACTO recommends fee structures that enable cities to recoup their costs not only for managing dockless mobility in their cities, but also to help fund city efforts to provide infrastructure for these services. The fees currently charged vary widely and may include an application or permit fee — which can run into the tens of thousands of dollars — as well as a per vehicle or per trip fee.

Some cities also require a performance bond to cover expenses that might be incurred in case of a business failure or withdrawal, including those for storage, removal and/or disposal of vehicles no longer in service.

A key area of contention is what data must be submitted to the local government as a condition of continued e-scooter company operation. Cities seek information about vehicle utilization rates and the trips made by location, route, and time of day along with user information in order to assess whether the number of vendors or vehicles permitted should be expanded, determine where to make infrastructure investments, and evaluate whether the program is meeting equity goals

and producing other public benefits, including reducing congestion and emissions. E-scooter providers have resisted providing this level of detail, preferring to provide only aggregate data on trips and vehicles. They have claimed, as have some advocacy groups, that such information requirements put their customers' privacy at risk.

The mobility data specification (MDS) developed by Los Angeles DOT (and since adopted by many other cities) is a case in point. MDS was developed as a way to standardize data collection for companies and ensure that cities had the information to manage vehicle deployments (Zipper, 2019). MDS has a "provider" platform that requires all dockless operators to send real-time trip data back to the city and an "agency" platform that allows the city to communicate directly with companies to alert them of issues related to their operation (Bliss, 2019). While some e-scooter providers like Lime have lauded MDS, other mobility providers including Lyft, Bird, and Uber have protested providing the required individual level data. Lawsuits have been filed against LADOT by Uber and the American Civil Liberties Union, with the latter contending that the data tracking amounts to an unlawful search and seizure (Hawkins, 2020).

The California Legislature also considered the issue in 2019-20 in the proposed Assembly Bill (AB) 1112 (Friedman). In its original form, AB 1112 would have prevented California cities from collecting individual trip information, essentially ending MDS in California. However, AB 1112 stalled in the state Senate despite repeated amendments, and the proposed bill now addresses only relocation of shared mobility devices.

Options for dealing with privacy issues do exist, including data processing that codes origins and destinations to approximate locations (e.g., the nearest intersection or small zones) and codes trip purpose to categories (work, education, shopping, medical, etc.) and approximate locations rather than actual street addresses — the same methods used in travel surveys. Third party data anonymizers can handle this task. Real-time information on routes, which can be useful in figuring out trip lengths, need for infrastructure improvements, congestion impacts, etc. can be modified in near or near real time to reduce the resolution at which trip ends are reported; algorithms to clip or fuzzy up trip starts and ends could be applied. It also should be noted that because e-scooters are dropped off on the street, even x-y coordinates on locations do not necessarily indicate where the user's trip actually began or ended.

Finally, an issue that a few cities have raised is whether e-scooter users need to be apprised about their insurance status. The issue is that riders are covered by e-scooter companies' insurance if a crash happens due to a faulty vehicle, but their rental agreements put responsibility for other crashes on the rider. Other insurance that a rider may have — automobile insurance and homeowner's or renter's insurance — generally do not cover motorized bike or scooter trips. If the rider is injured, health insurance may cover the expenses at least in part. However, if another party is injured or their property is damaged, for example, if the e-scooter user hits a pedestrian or a car and is at fault, the liability falls on the e-scooter user and could be substantial. At present, e-scooter riders can obtain special-use liability insurance for e-scooters they own, but many companies do not offer such insurance for rentals or cover it only with an umbrella liability insurance policy, an extra charge. Several of the experts we interviewed expressed concern about this situation and recommended that riders be notified about their insurance status before each rental.

Best Practices

Considering the findings of Sections 2 through 5, we identify the following as best practices for cities in managing e-scooters:

1) Require shared e-scooter providers to obtain a business license.
2) Require rental e-scooters to be registered.
3) Regulate fleet sizes based on expected demand, and adjust permitted fleet sizes based on utilization, performance, and compliance with city requirements.
4) Restrict e-scooter speeds to 15 mph, with lower speeds in areas of heavy pedestrian use.
5) Allow e-scooters to operate in bike lanes or paths, but not on sidewalks.
6) Require signage where e-scooter travel, speed, or parking is restricted, and use geofencing (as feasible) to reinforce restrictions in specific areas.
7) Require e-scooters to be parked upright; prohibit parking of e-scooters in or in front of pedestrian crossings and loading zones; and regulate parking of e-scooters on sidewalks to maintain Americans with Disabilities Act (ADA) access, which may include directing e-scooter parking to corrals, parking racks, or other designated parking locations.
8) Require, or if state law prohibits a requirement then recommend, helmet use to reduce head injuries.
9) Ensure equitable access by setting targets for e-scooter distribution and/or availability at the neighborhood-level and adjust the target as needed to address the mobility needs of each neighborhood, and require rebalancing of e-scooter distribution on at least a daily basis.
10) Require options for renting an e-scooter with cash and without a smart phone.
11) Require discounts for low-income users and publicize available discount programs.
12) Incentivize the provision of adaptive e-scooters for persons with disabilities.
13) Require multi-lingual customer service, website, signage, outreach, and app.
14) Require e-scooter providers to submit a hiring plan that explains how the program will operate, including education and outreach, customer service, and fleet management (i.e., redistribution of scooters and removal of those that need repair or are illegally parked); and mandate or incentivize local hiring for these activities.
15) Require e-scooter providers to engage in information provision, education, and outreach activities.
16) Prioritize city investments in street paving, bike lanes and parking, and other street redesigns to improve safety for e-scooter riders as well as other micromobility users, in partnership with e-scooter providers and community groups.

17) Establish data reporting requirements that allow the city to monitor compliance of e-scooter providers with city requirements; assess the impacts of e-scooters on congestion, safety and the environment; evaluate equity concerns (e.g., distribution of e-scooters in specific neighborhoods); and determine infrastructure investment needs.

18) Set fees to cover full program costs to the city, including administration and oversight, data analysis, and planning and programming.

Oakland Case Study

Background on Oakland

Oakland, California, is located along the eastern shore of the San Francisco Bay, across from San Francisco. The third largest city in the San Francisco Bay Area and the 45th most populated city in the United States, Oakland was home to 433,000 people in 2019. Racially diverse, the Oakland population is 28 percent white/not Hispanic, 27 percent Hispanic/Latino, 24 percent black, and 16 percent Asian, with 7 percent mixed and about 1 percent from other ethnicities and cultures. Median household income over the 2014-2018 period was $68,442, more than 13 percent higher than the U.S. median for the period; but 17.6 percent of Oaklanders lived below the poverty line, compared to 11.6 percent nationwide (U.S. Census, 2019).

Oakland's transportation system is multi-modal. The city is served by eight BART stations as well as by AC Transit buses and Amtrak commuter and intercity rail. Interstates 580 and 880 traverse the city along with State Highways 13 and 24, both limited access freeways carrying heavy traffic loads. Eight percent of households in the city do not have a car and 31 percent have access to only one vehicle (American Community Survey (ACS) 2018 1-year estimate). Of workers in Oakland, the most common method of travel is to drive alone to work (52 percent), followed by public transit (24 percent) and carpooling (9 percent) (ACS 2018 1-year estimate). The average commute time in the city is 31 minutes and the most common work destinations for Oakland residents are Oakland, San Francisco, and Berkeley (2017 LEHD).

E-scooters have been in operation since 2018 in Oakland. Lime introduced e-scooters to Oakland (and other cities in the Bay Area) in March 2018. As in San Francisco, they were met with mixed reactions; some were excited about the new transportation option, while others felt they cluttered the street (Wong, 2018). Vandals in Oakland tossed e-scooters into Lake Merritt (CBS SF Bay Area, 2018). By July 2018, Oakland city council members began to propose methods to regulate e-scooters in the city (Berg, 2018). The resulting ordinance allowed companies with a city permit to deploy their dockless e-scooters in designated locations and required them to hire maintenance staff, provide discounted membership for low-income residents and keep "no less than 50 percent" of their vehicles in Oakland's designated Communities of Concern. By summer 2019, the city had issued permits to four operators, Lime, Bird, Lyft, and Clevr (now with e-scooters known as Grüv) and set a cap on the total number of rental e-scooters (Said, 2019).

In spring 2019, the Oakland DOT conducted an online survey to get feedback on e-scooters in the city; the survey also was distributed by operators to their users residing in the city. The survey was 28 questions long for those that indicated that they had used an e-scooter before and much shorter for those who indicated that they had not. Questions included the respondent's reasons for using an e-scooter, frequency of use, trip purposes, travel choice if an e-scooter had not been available, and parking behavior, along with demographic information. The Oakland DOT collected 866 responses. Because of the distribution methods used, it is unclear what percentage of the city population actually received information about the survey's availability and therefore impossible to determine the response rate.

Three-quarters of the survey respondents said they used e-scooters fairly frequently, with 25 percent reporting monthly use, 36 percent saying they used one weekly, and 13 percent reporting daily use (Figure 2). Seventeen percent reported that they "rarely" used an e-scooter — presumably, less than once a month. Only eight percent of the respondents were non-users.

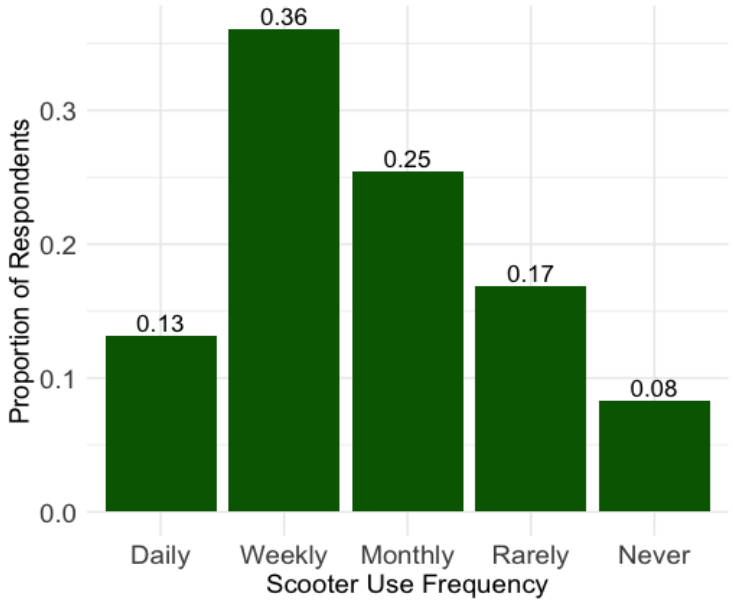

Figure 2. Frequency of E-Scooter Use in Oakland (April 2019).

Source: Oakland DOT survey

Connecting to transit was the most common trip purpose reported, with 60 percent of the respondents saying that at least one of their trip purposes was transit access. Of this group, 11 percent said they rode an e-scooter to transit daily. Other common trip purposes for which respondents use e-scooters are “fun and recreation” (55 percent), “social activity” (54 percent), “work” (52 percent), and “shopping or errands” (47 percent).

Many users (41 percent) would have walked had an e-scooter not been available, but almost as many (38 percent) would have driven alone or used a ridehail service. Fifty-five percent said that they have used ride-hailing less since riding e-scooters.

Those who reported never riding an e-scooter (n=80) cited several barriers that kept them from riding. Topping the list were: “the scooters seem unsafe” (53 percent), “not interested” (34 percent), and “no safe place to ride them” (30 percent).

The survey provides an indication that low income people and people of color may be using e-scooters more than others: 16 percent of lower income riders (from households that earn less than $50,000 per year) and 17 percent of riders of color reported using an e-scooter daily. However, males appear to be more frequent riders than females: 15 percent of males ride daily, versus nine percent of females.

A limitation of the survey is that it is clearly not representative of the population of Oakland, as indicated by the ACS 2018 1-year estimates, and therefore the attitudes and behaviors reported should be interpreted with caution. For example, in the survey, 34 percent of respondents were people of color, well below the 71 percent proportion for Oakland. Similarly, 14 percent of respondents reported earning less than $50,000 per year, a much lower percentage than the ACS 2018 1-year estimate that 35 percent of Oakland households earn less than $50,000. Males are heavily represented in the survey; of those who reported their sex, 64 percent identified as male and 36 percent identified as female. In comparison, 52 percent

of the residents of Oakland identify as female. Only two percent of the survey respondents were 65 and older, compared to an estimated 14 percent for the city.

The differences between the survey sample demographics and income and the ACS population estimates most likely are due to the survey being completed mainly by e-scooter riders. It seems probable that Oakland's e-scooter riders simply do not match the characteristics of the general population, and plausible that they are younger, more affluent, and more likely to be male — a finding that would be consistent with studies conducted elsewhere. However, we do not have confidence that the survey conducted by the Oakland DOT fully captured the population of e-scooter riders either, because the survey was entirely "opt-in" and there was no baseline data against which to benchmark the sample. Furthermore, it is unclear that the demographic makeup of the respondents who reported not riding an e-scooter is reflective of this general population for Oakland. Thus, we believe the results reported here should be interpreted with caution, and recommend that future data collection include counts, a random sample survey of city residents' travel choices and perspectives, and a targeted survey of e-scooter users. As we discuss below, we had planned to do such data collection, but the COVID-19 pandemic made that plan impossible to implement.

Planned Follow-Up Survey and Field Work

In consultation with Oakland DOT staff, we planned to carry out a random sample survey of Oakland residents in the spring of 2020, in order to gain a broader set of views on e-scooter use from non-users as well as users. We drafted and did a preliminary pretest of a survey and planned to conduct it in early April 2020, during which time we also planned to carry out field observations of key e-scooter "hot spots." The survey was intended to document e-scooter frequency of use, trip purpose, trip origin and destination, route choice, and time of use, as they relate to user and household demographics and income and availability and use of other modes. The field work was intended to document on-the-ground impacts of e-scooter use including interaction with pedestrians and parking choices.

The COVID-19 pandemic forced a change in plans for the survey. The effect of the pandemic on e-scooter use and demand, and indeed on all travel, has been complicated and turbulent. During the initial days of the pandemic, micromobility use remained strong as commuters opted for their use instead of public transit. In New York, for example, Citi Bike observed a 67 percent increase in ridership, year over year, in early March during the initial days of the pandemic (Raskin and Meyer, 2020).

Very quickly, the tide turned, as cities went into shelter-in-place and concern for infection from shared transport modes increased. In the first few weeks of the pandemic, e-scooter operators reacted in different ways. As bus and rail ridership plunged, Spin stepped up its operations to ensure that urban commuters had a transportation alternative to public transit, and shared how they were enhancing and disinfecting their fleet (Wilson, 2020). Lime, Bird, and Jump, on the other hand, pulled out of many markets to reduce losses during the time of low travel demand, despite the leaders of these operators often arguing that e-scooters are a form of essential transportation.

Travel ground to a near-halt throughout the world as the seriousness of the pandemic and need for quarantining became apparent. From the beginning of March to April 7, 2020, total vehicle miles traveled dropped by 72 percent on average across the United States, with the greatest drop in urban areas (Boston Consulting Group, 2020). With these huge drops in travel, the valuation of Lime decreased by 80 percent by the end of March 2020 (Weinberg, 2020). In April 2020 Lime laid off 13 percent of their staff as COVID-19 diminished the demand for e-scooters (Browne, 2020). Bird laid off more than a quarter of their employees in a notorious Zoom webinar in March 2020 that lasted only a couple minutes (Black, 2020).

After a month of sheltering in place, restrictions were gradually lifted, but not fully removed. Many office workers have continued to telecommute, schools and colleges are offering instruction online instead of in person, and many businesses have remained shuttered or are open for takeout only. The travel patterns that emerged in late spring and summer were much different than before the pandemic. For example, Lime observed the following changes before and after "lockdown" in the cities it served (Lime, 2020):

- Average ride durations increased 34 percent from 9.7 minutes to 13.1 minutes
- Average ride distances increased 18 percent from 1.7 km to 2.1 km
- More rides used for recreation and to run errands (7 percent increase)
- Fewer rides during rush hours, but more riders generally in the afternoon
- More rides originating in "neighborhoods" (i.e., residential areas).

With these changes in e-scooter use, operators and manufacturers have adjusted their business models. In addition to cutbacks in the number of deployed e-scooters, there have been new services offered in some markets. For example, Unagi, an e-scooter producer, developed a leasing (subscription) program called Unagi "All Access" (Toll, 2020). The program aims to attract customers who would be unwilling or unable to purchase an e-scooter outright but would prefer to not use shared e-scooters during a global pandemic.

Cities have also adjusted during the pandemic by expanding access to active transportation infrastructure. Many cities, including Oakland, have established "slow" streets (called "open" streets in some cities), blocking most automobile traffic and reserving the street space for active transportation and micromobility. The responses to these initiatives have varied, with some commending the cities for their swift action in response to the need for more room to walk and take advantage of active transportation, and others bashing the cities for making major infrastructure changes without adequate community input. On the latter point, some commentators have argued that slow streets exacerbate existing infrastructure disparities between wealthy, white communities and lower income communities of color, especially black communities (Bliss, 2020; Thomas, 2020).

To better understand public opinion of these "slow" or "open" streets, some cities have surveyed respondents. In the case of Oakland, their slow streets survey had received 1,136 responses as of September 8, 2020 (Oakland DOT, 2020). Seventy-seven percent of respondents did express support for the Oakland Slow Streets program, but this proportion varies according to race and geography. Under 50 percent of black respondents expressed support for the program, but about 86 percent of white respondents did so. However, the survey has some problematic biases: only 60 respondents identify as black compared to nearly 600 white respondents, and only about 100 responses have been from East Oakland (an area home to many people of color) compared to 500 from North Oakland (a gentrifying, more white area). It is not clear whether this response is the result of mobilization of those with strong views on the issue, while those with less interest sat out the survey, or underscores the methodological difficulties raised by on-line opt-in surveys.

Today, there is evidence that vehicle miles of travel nationally have returned to pre-COVID levels (Figure 3), but the distribution and types of travel has changed. According to data from Apple, walking has increased by 23 percent across California, driving has increased by 17 percent, while transit use has decreased by 60 percent (Apple, 2020). Unemployment is high, many who are still able to work do so from home, schools are closed or open under partial and restricted circumstances, and many businesses are still closed or are operating with restrictions. While data are not available at the city level for Oakland, Alameda County data are shown in Figure 4; they are similar to the national trends. Oakland has

about a quarter of the county population, and this suggests that Oakland travel patterns are very different from those pre-pandemic.

As a result of these circumstances, we first postponed the survey and field work until May, then postponed it indefinitely because it was clear that we would not be measuring stable conditions.

We considered surveying Oakland residents about their responses to e-scooters during the COVID crisis but decided against it after finding that such a survey would likely duplicate other surveys that are being conducted to better understand COVID-related changes in travel behavior, including the use of micromobility modes. For example, researchers at Arizona State University and the University of Illinois, Chicago have been conducting a "COVID-19 and the Future" survey to gather responses on how people are traveling during the pandemic (covidfuture.org, 2020).

There also are recent or ongoing surveys that target micromobility and e-scooter use in particular. For example, McKinsey (2020) conducted a global consumer survey of micromobility use in May 2020, with responses from more than 7,000 respondents. Their results indicate that the share of the population interested in private and shared micromobility may have increased by 9 percent and 12 percent, respectively as a result of COVID-19 concerns. Also, a group of researchers at the University of Tennessee and Portland State University received a National Science Foundation (NSF) RAPID grant to "understand how shared mobility systems will recover safely from COVID-19." They are surveying transit riders and bikeshare and e-scooter share users in Portland and Nashville.

Given these other surveys of COVID-19 responses, we decided that instead of pivoting to a COVID-19 survey, we would carry out in-depth interviews with Oakland residents and workers regarding their recent experiences with e-scooters, if any, and for nonusers, their views of the new travel mode.

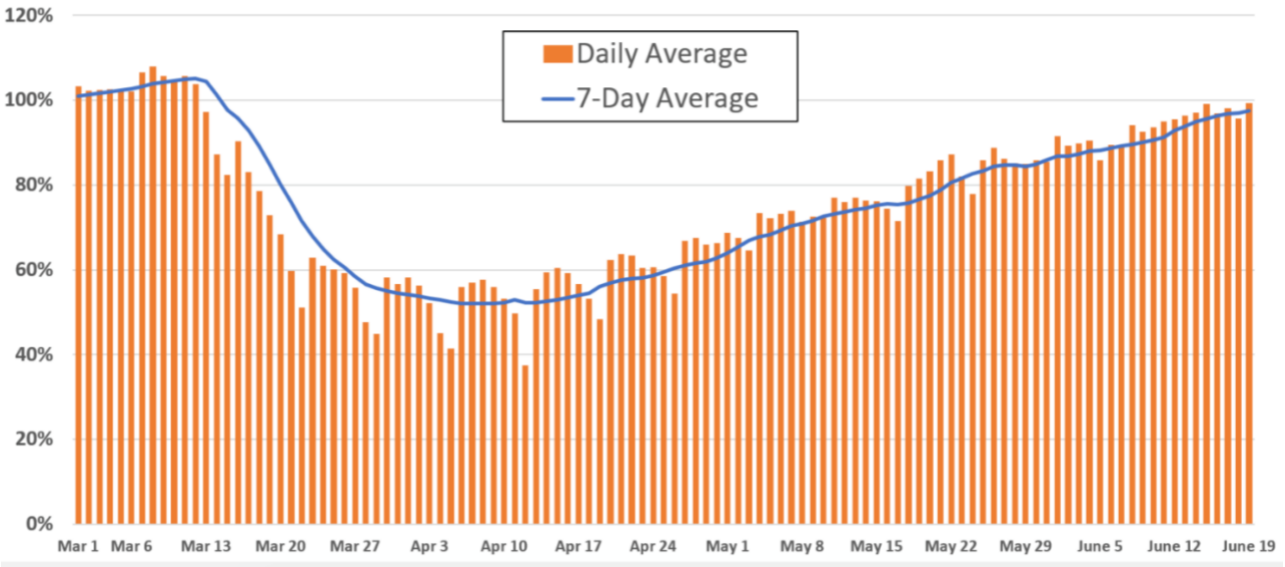

Figure 3. National Passenger Travel Response to COVID-19

Source: INRIX https://inrix.com/blog/2020/06/covid19-us-traffic-volume-synopsis-14/

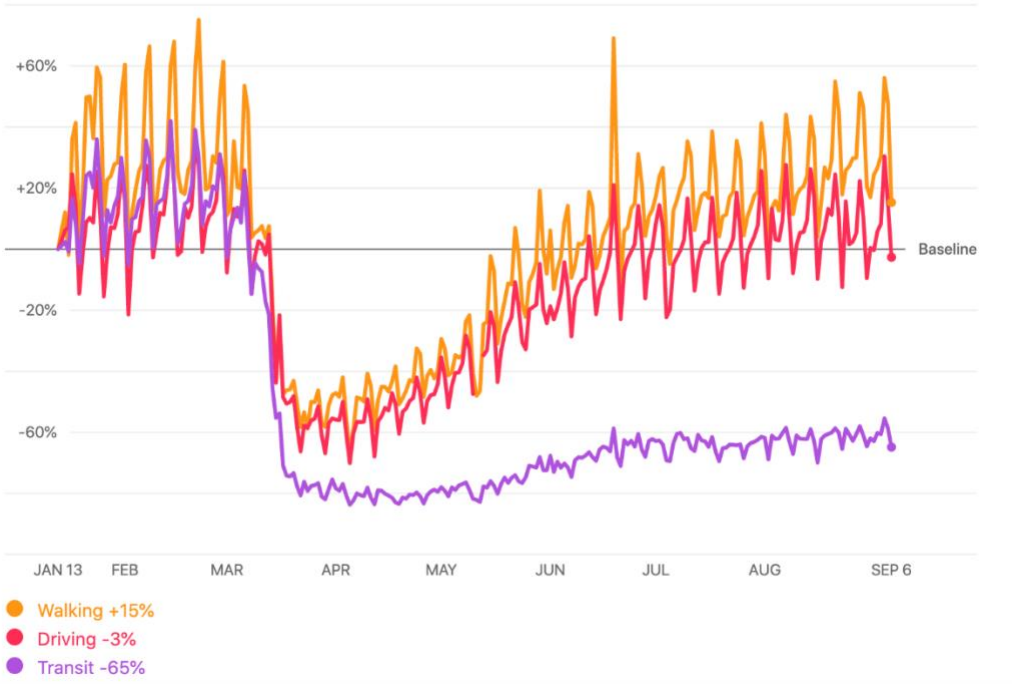

Figure 4. Alameda County Changes in Travel Patterns According to Apple Data

Source: Apple https://covid19.apple.com/mobility

Revised Plans: Interviews

While we were not able to implement our plan to survey and conduct field observations of e-scooter users and others affected by e-scooters in Oakland, we were able to pursue an alternate path forward: interviews with Oakland residents and workers, including e-scooter users and non-users. Using a database of respondents from a previous research project who had indicated an interest in participating in future studies, we were able to interview 44 people who lived in Oakland, worked in Oakland, or both. The participants ranged in age from 21 to 75, were roughly representative of the racial and socioeconomic composition of the city, and lived and/or worked in different neighborhoods, including East Oakland, West Oakland, Fruitvale, Lake Merritt, Downtown, Rockridge, and the Oakland hills. The sample included ten people who had used an e-scooter at least once in the last five years — some in other countries — plus 34 who had not. Eight of the ten had a car available for their use and six of the ten owned a bicycle, although only four considered their bike a viable alternative for utilitarian trips in Oakland.

While the sample is small, it gave us the opportunity to discuss e-scooter issues in depth from a variety of viewpoints in open-ended interviews guided by the following questions:

- If you have used an e-scooter in the past five years, what was your experience like? How did your experience as a rider compare to your trips as a pedestrian, as a transit user, as a car driver?
- For what kinds of trips did you use an e-scooter? Where did you use it (city, origin, destination)? How often have you used an e-scooter in the past year? If you had not used an e- scooter, how would you have made the trip instead (if at all)?
- If you have **not** personally used a scooter, do you view this mode of transportation positively or negatively? Why so?
- What benefits do you see from e-scooters?
- What problems do you see from e-scooters?
- How would you like to see the Oakland city government manage e-scooters on the public streets? Are there specific policies or regulations that you would support?

Each interview lasted 30-45 minutes. Interviews were not recorded but notes were taken and anonymized.

Of the ten respondents who had ridden a e-scooter, all were between ages 21 and 35; six were students, three were retail workers, and one was an attorney. Eight of the ten were unmarried. Only one was female. None of the ten was a frequent rider, i.e., used an e-scooter at least once a week, but six of the ten reported that they used e-scooters once or twice a month before the COVID-19 pandemic hit.

For the occasional riders, that is, the once or twice a month scooter users, typical scooter trips were made midday to go to lunch or run a personal errand at a destination that was a little too far to walk, or after work to meet a friend. Only one of the ten had used an e-scooter to access transit, reporting that they usually walked to work from BART but had used an e-scooter on a few occasions when they were running late. Three reported that they had used an e-scooter occasionally for fun, riding with friends. One had tried an e-scooter once, out of curiosity, but had not used it since. Two had ridden an e-scooter in San Francisco but not in Oakland; in San Francisco, the trip purpose was recreational. One had ridden an e-scooter in Taiwan.

The e-scooter users reported that their trips were typically in the half mile to two-mile range. Had an e-scooter not been available, most users would have walked for their trip and in many cases would have chosen a closer destination (e.g., a restaurant in downtown Oakland rather than in Chinatown). Some would not have taken the trip at all. Three would have biked instead. Only two thought they might have taken a TNC (too expensive) and only two would have considered driving for the trip, mostly because that would have entailed parking and parking was either hard to find or expensive.

Asked about route choice, most of the e-scooter users simply said they took the most direct route to their destination. Three had used bike lanes for their trips, but seven had not; six of the seven expressed surprise that e-scooters were allowed in bike lanes as did one of the bike lane users.

Nine of the ten thought e-scooters' main benefits were that they are fun, faster than walking, and don't require much exertion. Still, eight of the ten thought that riding was risky because of the potential for falls, especially on poorly paved streets, or feared crashes with motor vehicles. Eight of the ten also commented that they would not be interested in riding in bad weather, not only because of personal exposure but also because they feared traffic clashes would be worse when

the pavement is wet. Five did not want to ride after dark because they felt they would not be visible enough to drivers, especially in high traffic locations.

Two people commented that finding an e-scooter near their home was problematic even though they were within the service area. They also complained that scooters were sometimes parked on private property at the residential trip end and they were worried that they could be stopped for trespassing while retrieving one from such a location.

Nonusers of e-scooters were for the most part favorably inclined toward them even though almost all of the nonusers said that they did not anticipate ever using an e-scooter themselves (n=28). Only three of the 34 nonusers thought they might try them in the near future. Still, the vast majority saw e-scooters as an environmentally benign way for young people to get around (n=30). Many did express concerns about road safety (n=25) and parking (n=30) and several complained about e-scooters traveling on the sidewalk.

The parking issue was an especially touchy one, as all of the nonusers had seen e-scooters blocking a sidewalk or crosswalk and forcing pedestrians to detour around them or parked so that it was impossible to reach a parking meter without climbing over an e-scooter, or left in the landscaping along a street. One downtown Oakland worker commented seeing a woman with a baby carriage having to detour into the street traffic lane because e-scooters tossed on the sidewalk around a technical school did not allow her to get through. Another commented that scooters parked in the furniture zone had made it impossible to get his elderly passenger from a legally parked car to the sidewalk. Two commented that e-scooters sometimes caused ADA violations, in their view, noting that it only took a few bad actors to create a problem. Most thought it would be preferable to have designated parking spaces on the street rather than on the sidewalk for e-scooters.

Since the interviews were done during the pandemic, its impact weighed on the responses of e-scooter users and non-users alike. All of the respondents said their travel had changed and most were driving more than before the pandemic — a finding explained by their unwillingness to use transit as they had done previously. Some were biking more, both to get some exercise and for utilitarian trips. Most were not using enclosed collective modes (transit, Amtrak, air transportation) and expressed concerns about the risks involved with shared transportation. This carried over to some extent to e-bikes and e-scooters, with concerns about sanitation given the uncertainty about virus spread from contaminated surfaces and the companies' apparent reliance on gig workers (over whom they have little managerial control) to handle charging and redistribution.

Asked about what Oakland might do to make e-scooters work better, respondents had several suggestions: more bike lanes, lower speed limits on city streets and traffic calming to reinforce the speed limits, designated scooter parking areas on the street rather than the sidewalk in commercial districts, penalties for blocking pedestrian access, more attention to e-scooter availability at the residential end, possibly policies to provide designated parking in residential areas in cooperation with the neighborhoods, and possibly stricter rules on sanitizing vehicles between uses.

Overall, the interviews indicated general support for e-scooters, a need for better information on where they can be ridden and parked, a desire for more vigorous e-scooter parking management, and interest in providing infrastructure for e-scooters.

Conclusion

E-scooters are a relatively new addition to the urban transport field. Their benefits and costs depend on how they are deployed and both providers, users, and cities in which e-scooters have appeared are all learning what works well and what does not. The COVID-19 pandemic has further complicated the situation, drastically altering travel behavior and raising questions about when, and whether, conditions might return to pre-pandemic conditions.

Given this complex situation, we conclude that cities should continue to monitor e-scooter use not only in their own jurisdictions but in other peer cities. Learning from other cities and swapping good practices can help everyone advance. Active engagement of community members and the e-scooter providers can help identify practices that meet local needs as well as corporate objectives. Data from e-scooter providers and from user surveys is critical to effective management.

State and local policies that favor investment in bike lanes, multimodal street designs, and high-quality pavement management are important adjuncts to city regulations of e-scooter deployment and use and also can improve conditions for pedestrians, cyclists, and transit users. However, each city should be careful to determine what kinds of regulations or improvements are needed to support safe and respectful use of e-scooters in their city. While infrastructure is a common concern, other important concerns could come up such as the high costs of making frequent e-scooter rides.

We further advise that cities should be prepared to modify their regulations if the markets change drastically. It is too early to tell, but it is possible that the COVID-19 aftermath will see a reduced interest in shared mobility, and equally possible that just the opposite response will emerge — an increased interest in service offerings like bikesharing and e-scooters that are used one person at a time.

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