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Public Transit Station Design to Support Micromobility

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Executive Summary

Micromobility is well-suited to address first- and last-mile connectivity with public transit by extending the catchment area around transit stations and bridging gaps in the existing transit network, ultimately facilitating access to jobs and services. However, the uptake of micromobility depends on a variety of factors including environmental design features at and around public transit stations that support or inhibit access. This paper presents results from an online survey of public transit and micromobility users in the California Bay Area. Successes and challenges were highlighted, and recommendations made for station design, including greater availability of shared micromobility vehicles and more affordable secure parking for personal micromobility vehicles. Beyond the station proper, there is a need for protected bike lanes and consistent design standards for bike facilities throughout the region. Safety issues related to street infrastructure and crime far outweighed any other expressed needs for micromobility and public transit users. If these critical issues were addressed, users might be comfortable enough to notice other areas for potential improvement via station design features and amenities, such as signage, greenery, and public art.

Keywords: Micromobility, public transportation, bike lanes, shared mobility, scooter, bike

1 Introduction

Revolutionizing urban transportation on a massive scale is necessary to meet the climate goals set by the Paris Agreement and mitigate global warming [1]. Industry stakeholders, policymakers, and academicians are imagining a more sustainable transportation system where mobility-as-a-service (MaaS), including micromobility, shared mobility, and public transit, supplants personal cars as the dominant model [2-4]. However, public transit use in the US has decreased in recent years [5] and faces further challenges due to the COVID-19 pandemic [6].

Micromobility presents an opportunity for increasing public transit use. The US Department of Transportation defines micromobility as “any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances” [7] this includes both privately-owned vehicles and shared service models. In particular, micromobility is well-suited to address first- and last-mile connectivity with public transit by extending the catchment area around transit stations, enabling users to travel more quickly and easily to stations from further away (e.g., not relying on less flexible feeder buses), and bridging gaps in the existing transit network [8] ultimately facilitating access to jobs and services [9] [10] [11]. Recognizing this potential, shared micromobility companies and public transit agencies have formed partnerships [12].

Private ownership of light electric vehicles has also increased in recent years in the US (they have been popular in Asia since the 2000s [13], especially since the pandemic. According to Bennett and MacArthur (2022) e-bikes sold annually in the US increased from less than 300,000 to over 1 million between 2018 and 2021 [14], and the boom that occurred during the pandemic has been sustained for e-bikes whereas traditional bike sales have returned to pre-pandemic rates. Another benefit of personally owned micromobility can be a lower carbon footprint. Life cycle assessments of shared versus personal e-scooters, e-bikes, and e-mopeds have found that the latter generate less CO_2-equivalent emissions, due to the longer vehicle lifespan of personal micromobility [15].

The potential for personal and shared micromobility as a solution for first- and last-mile connectivity with public transit depends on a variety of factors related to shared service accessibility, ease of use, and safety, including user education and training; vehicle fleet size and charging and deployment practices; safe facilities for riding and parking; weather and road conditions; fitness of vehicles for diverse ages and abilities; and pricing. Many of these issues relate to the design of the built environment, which is the focus of this research. Specifically, this research is concerned with environmental design features at and around public transit stations that support or inhibit micromobility access. These issues are considered through a case study of the Bay Area Rapid Transit (BART) heavy rail system in the California Bay Area, in which an online survey was conducted to gain a better understanding of the influence of environmental design on travelers who use micromobility to connect with BART.

2 Literature Review

A good deal of attention has been given to built environment features that promote traditional active modes (walking, non-motorized bicycling, and public transit) for healthy and sustainable cities. These include designing secure networks of active travel paths and making active travel enjoyable by creating safe and attractive neighborhoods with convenient access to affordable public transit (Giles-Corti et al., 2016). For bikes in particular, separated bike lanes, mixed-use neighborhoods, and connectivity between local streets have been found to promote use [16].

E-bikes and e-scooters may have unique needs for built environment supports regarding where users can and cannot ride and park, including the infrastructure itself and signage that communicates the rules. Some of these innovations are non-conforming to mainstream street designs, presenting challenges for cities tasked with regulating them, e.g., e-scooters sharing sidewalks with pedestrians (potentially dangerous for pedestrians) or riding in the street (potentially dangerous for scooter riders). Best practice guides have been developed to assist cities (National Association of City Transportation Officials, 2019; Transportation 4 America, 2020), but limited research exists on actual impacts of built environment factors and related policies. Exceptions include an evaluation of an e-scooter pilot in Portland (Portland Bureau of Transportation), which revealed a strong public preference for protected bicycle and/or scooter infrastructure and found that more protected infrastructure and lower street speed limits were associated with reduced illegal use of e-scooters on sidewalks. The study also found community concerns about dangerous and illegally parked scooters; however, in an observational study in San Jose, CA, researchers found that 97% of e-scooters were parked appropriately, not interfering with pedestrians [17].

3 Method

The survey was conducted in September and November 2022. The survey questionnaire was programmed in Qualtrics software. Five hundred postcard size laminated flyers were printed with an anonymous link and QR code to access the survey. The flyers were distributed at two BART stations and the surrounding streets. The two stations were MacArthur BART in Oakland and the Embarcadero BART in San Francisco because of their central locations. Flyers were attached to shared e-scooters and Lyft e-bikes and classic bikes parked on street bike racks and at the Lyft Bay Wheels Stations. In November 2022, BART and the San Francisco Bicycle Coalition pushed out the survey poster and QR code link on their Twitter. BART also shared it on their Facebook and Instagram social media accounts.

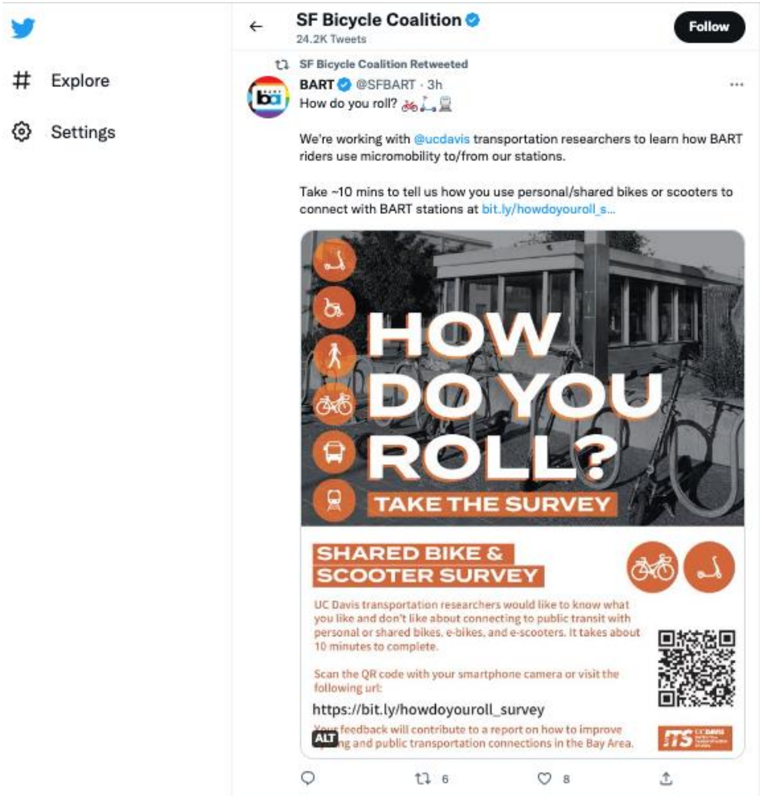

Figure 1. Survey social media push by BART and SF Bicycle Coalition on Twitter, Nov. 2022

Upon following the link or QR code, participants were asked whether they used any type of personal or shared micromobility to connect with BART stations. If they affirmed and declared they were at least 18 years old, they were allowed to continue with the survey.

The survey included questions about micromobility modes used to access BART stations and environmental design features of the stations and their surrounding neighbourhoods that facilitate or inhibit those first and last mile connections. More specifically, features considered included micromobility accessibility, bike parking and storage, bike lanes, and other environmental design affordances impacting rider safety, comfort, and enjoyment. Given the recent increase in fuel prices and in shared mobility services prices, we also included a few additional questions about cost factors related to micromobility and public transit.

3.1 Participants

There were 115 participants, of which 70–74 answered the demographic questions at the end of the survey (age, gender, ethnicity and race). Age ranged from 18 to 84 years old [n =21; *Mean(SD)* = 37(14)]. Participants were 56% men, 37% women, and 5.5% other/non-binary (1.5% declined to state; n = 21). Sixty-two percent identified as White, 26% Asian, 7% multiracial, 3% Black, 3% declined to state. Fifteen percent identified as Hispanic, Latino, or Spanish ethnicity. Median household income was $75,000-99,999 (Figure 2), and the median number of automobiles per household was one [35%; 46% had no car]. For the majority of participants (91%), their "home" station was less than 3 miles from their home (n = 113, Figure 3) and the mode of travel time to home station was 10-20 minutes (n = 108; Figure 4).

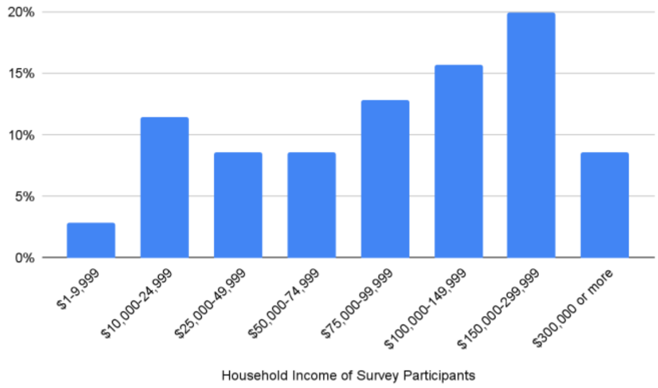

Figure 2. Household Income of Survey Participants

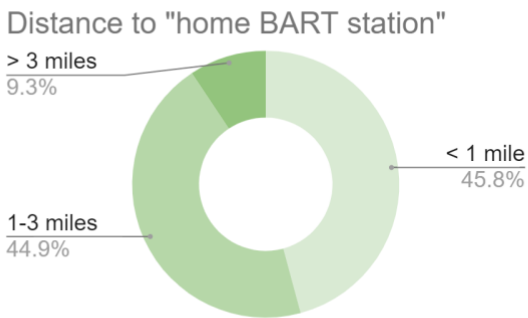

Figure 3. Distance to “home BART station”

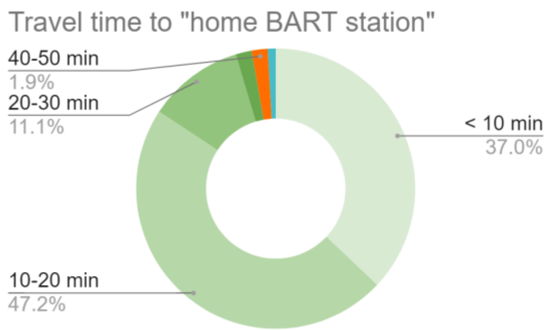

Figure 4. Travel time to “home BART station”

Figure 4 presents the modes participants reported frequently using to connect with their home station and destination stations; note that they could select more than one. Survey respondents most commonly reported connecting between BART and home by walking, biking, and/or using shared micromobility. Among those who indicated frequent use of shared micromobility, the most commonly used were the Lyft/Bay Wheels classic and e-bikes, followed by the Lime, Spin, and Link e-scooters (Figure 5).

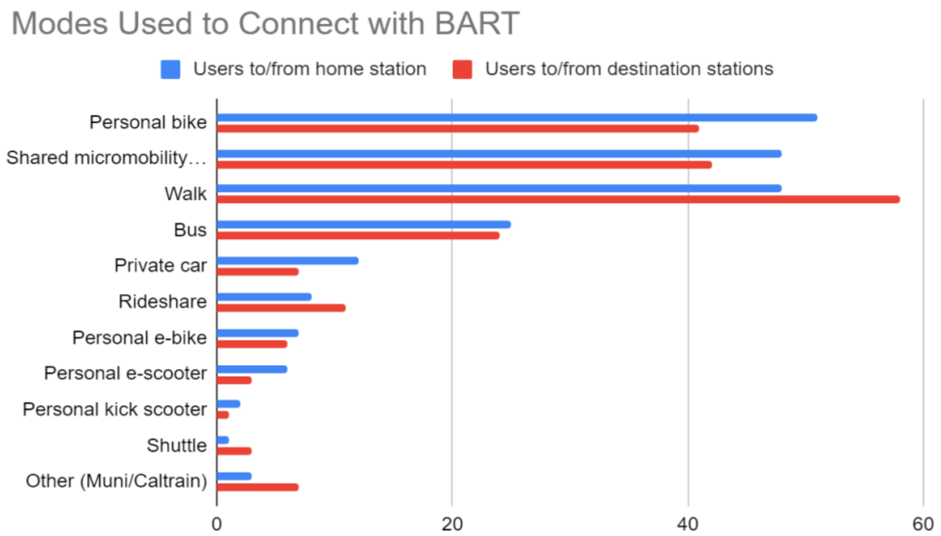

Figure 4. Micromobility Modes Used to Connect with BART

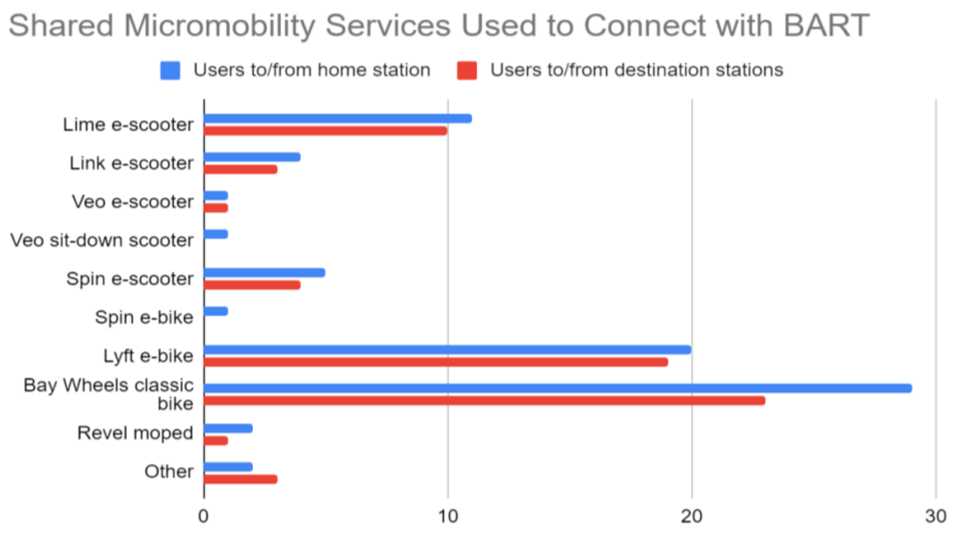

Figure 5. Shared Micromobility Services Used to Connect with BART

3.2 Micromobility access and parking

Of those who said they used personal micromobility (i.e., their own bikes or scooters) to connect between home and their home station, a slight majority (52%) said there was not enough parking for personal micromobility at the station, and 49% said they bring their vehicle onboard BART with them. We note that the question about parking sufficiency should be split into questions about quantity and quality in future studies. The researchers are aware of ample outdoor (i.e., less secure) bike parking at many stations (particularly in Oakland), as well as high levels of theft and other crime at BART stations, so some respondents may have been reporting on the sufficiency of safe bike parking.

Figure 6 shows the accessibility ratings (i.e., ease of finding vehicles) for those who used specific shared micromobility services to connect between home and their home BART station. Most micromobility users said they have on occasion been unable to find a shared vehicle to get from home to the BART station or the station back home (25% and 60%, respectively), and one-third said there was not enough parking for shared bikes and scooters at their home station. Of those who used Bay Wheels classic bikes (which can only be parked at the docking station) to connect with their home BART station, 42% said they had on occasion had trouble dropping off a bike because of lack of space at the Bay Wheels station nearest their home BART station.

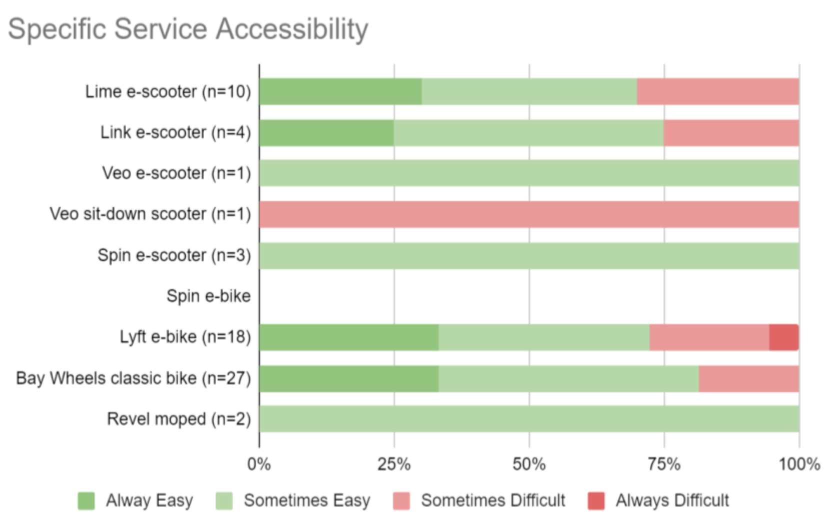

Figure 6. Specific Service Accessibility

Averaging across destination stations (rather than across all responses which varied in number for the different stations), 38% of respondents said shared micromobility vehicles were always difficult to find around their destination stations (Figure 7), 67% said they had on occasion been unable to find a shared vehicle, and 51% said there was insufficient parking for shared micromobility.

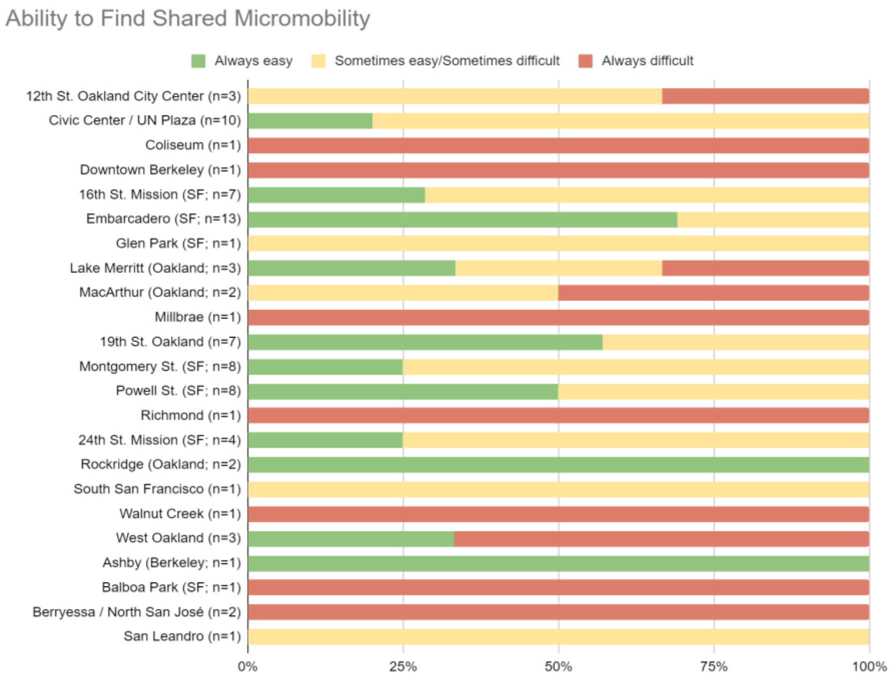

Figure 7. Ability to Find Shared Micromobility

Table 1 summarizes data on shared micromobility access, station safety, and bike lanes across responses for home destination stations and presents an index of those variables (unweighted average of percentages, with reverse-scoring of negative items) to reflect shared micromobility supportive design at each station. This index is only given for stations represented by at least 10 survey respondents (i.e., the sample size for each question comprising the index is 10 or more). This is provided as an example of an aggregate metric for micromobility-supportive station design that could be more useful if more data were available. A similar index could be created for personal micromobility, or for both personal and shared micromobility combined.

Table 1. Index comprised of shared micromobility access, station safety, and bike lane adequacy (n ≥ 10)

	Always difficult to find a shared vehicle	Have been unable to find a shared vehicle	Sufficient shared vehicle parking	Station safety rated good or excellent	Bike lanes rated good or excellent	Micromobility supportive station score (grade)
16th St Mission (SF)	0%	50%	85%	12%	24%	54%
Civic Center/UN Plaza	0%	67%	71%	19%	62%	57%
MacArthur (Oakland)	20%	70%	60%	28%	28%	45%
Montgomery St. (SF)	0%	25%	83%	33%	50%	68%
Powell St. (SF)	0%	46%	71%	48%	43%	63%

3.3 Safety, bike lanes, and other environmental design features

Participants rated their home station and other frequently used stations in terms of their overall safety for bikers and scooter users and the quality of bike lanes in the surrounding neighbourhoods. In terms of overall safety, they most commonly rated their home and destination stations as "average" ("average" was the mode and median; Figure 8). In terms of quality of bike lanes in the surrounding neighbourhoods, they most commonly rated their home station as "average" (mode and median) and other stations as "good" ("good" was the mode, the median was "average"; Figure 9).

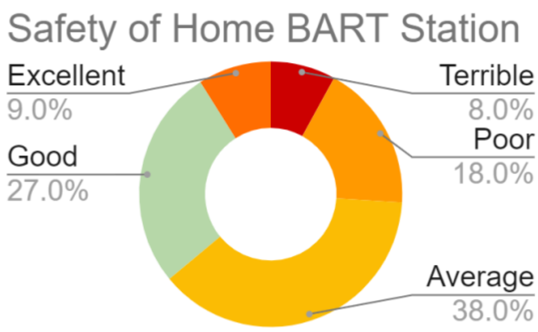

Figure 8. Station Safety

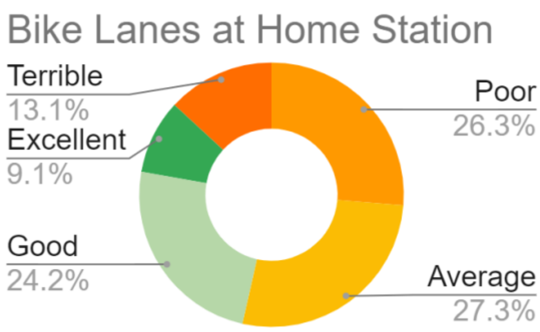

Figure 9. Bike Lane Quality around Home Station

Figure 10 presents the frequency with which participants indicated each of four proposed strategies would enhance safety for bikers and scooter users coming and going at their home station. Figure 11 presents the frequency with which participants indicated each of a wider range of (primarily environmental design) features, including those related to safety, could improve their experiences biking or scooting to and from BART stations. In both cases participants could select as many options as they wished, and enter comments in an "other" field. Protected bike lanes topped both lists. Open-ended responses for "other" included car-free streets, secure bike boxes/parking, more police, more elevators/escalators in stations, and less on-street car parking.

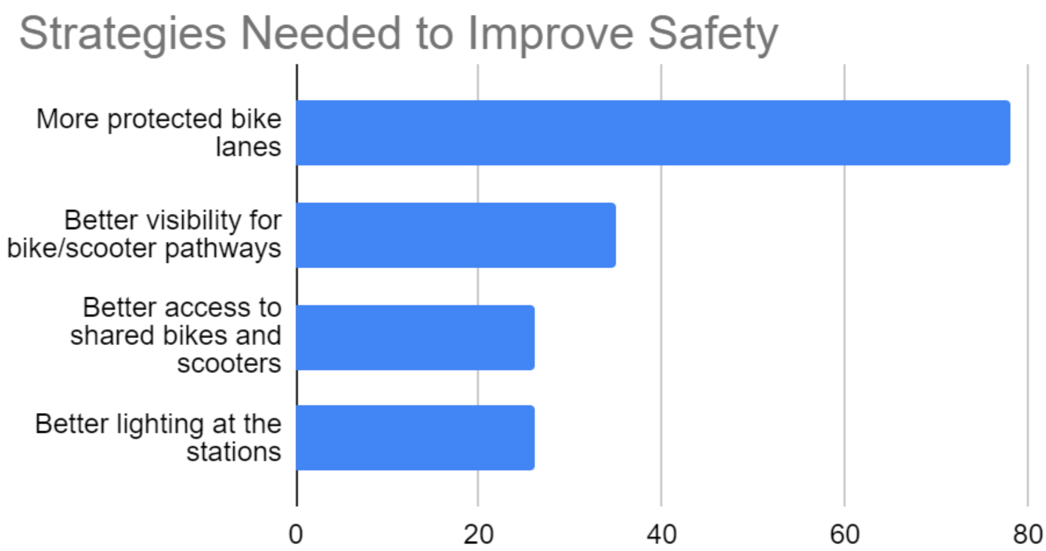

Figure 10. Strategies to Improve Safety

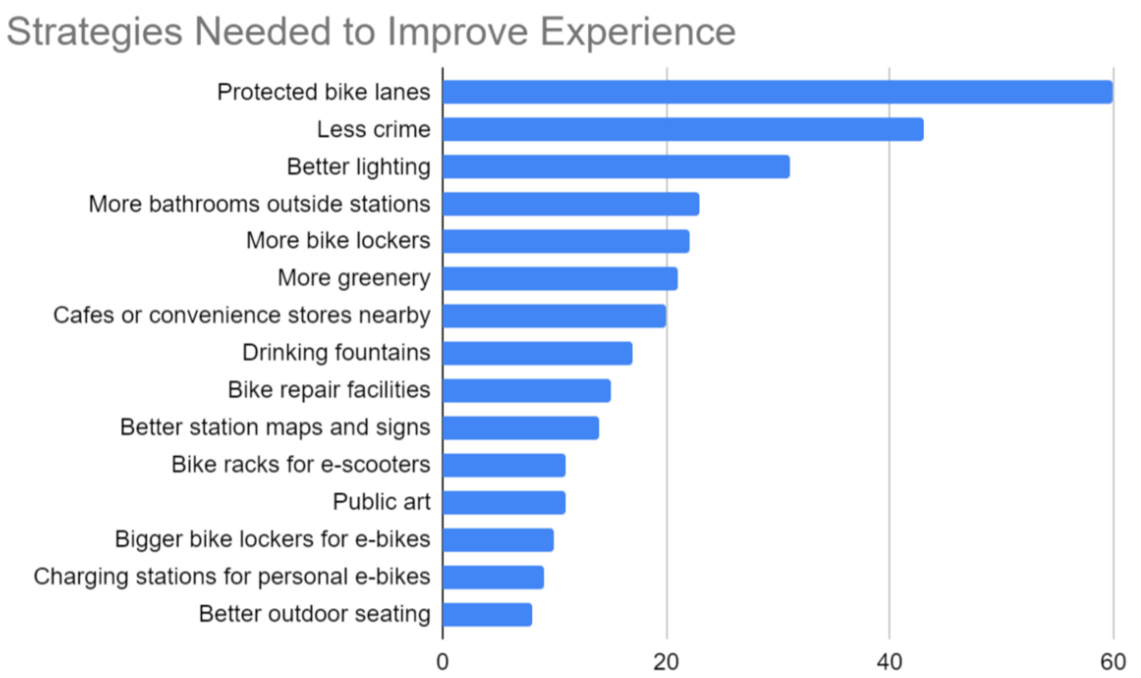

Figure 11. Strategies to Improve Micromobility Experience

3.4 Cost factors

A majority of participants (78%) reported that they had increased their use of public transit and/or micromobility since the recent rise in fuel prices (84 respondents answered this question; Figure 12). Also, 60% said they would use shared bike, e-bike, and/or scooter services (more) if they were cheaper (n = 84). Those who use shared micromobility most reported that they spend less than $5 in a typical day of use (52%; n = 54). Among those who used Bay Wheels bikeshare, 100% said their membership with Bay Wheels made shared bikes more affordable (n = 30).

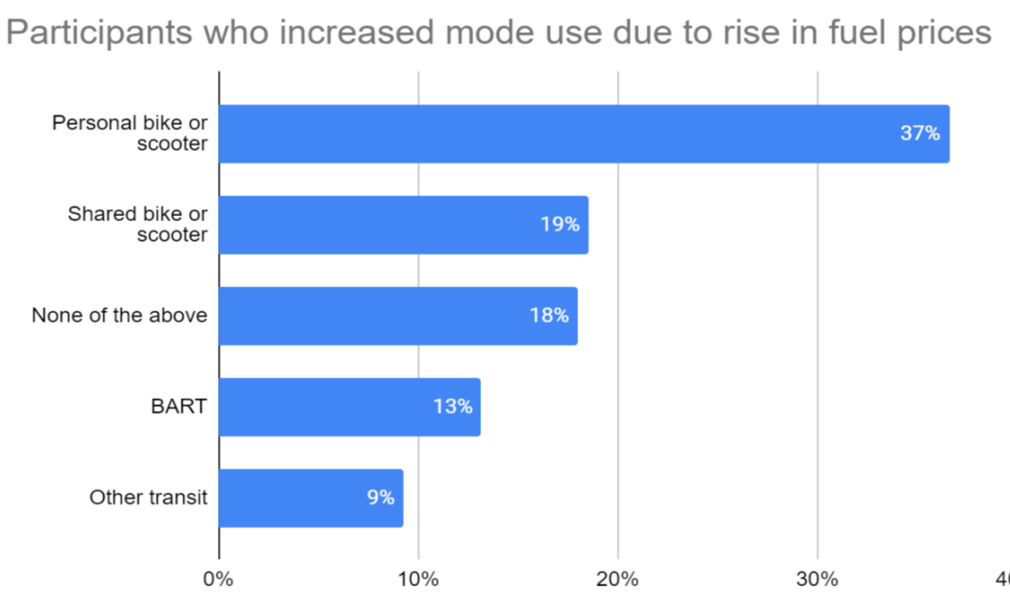

Figure 12. Participants who increased mode use due to rise in fuel prices

4 Discussion

Limitations of this research include the small sample size of 115 people given the attempt to represent all 50 BART stations. The survey participants also may not accurately represent the distribution of personal and shared micromobility users. In particular, since some of the recruitment methods targeted shared micromobility users and communications materials emphasized share micromobility use, shared micromobility users may be overrepresented relative to personal micromobility users. However, oversampling shared micromobility users was deemed necessary in order to adequately capture their experiences.

Consistent with prior research, the findings establish the importance of protected bike lanes and bike parking in supporting the integration of public transit and micromobility. In addition to separating bike lanes from car traffic, they need to be coherently and consistently marked across the region to enable easier interpretation and navigation by users, and ultimately safety, as well as car drivers interacting with them.

Regarding parking, adequate capacity is not sufficient. Security and crime are a major concern. There needs to be ample accessible and secure parking. Currently, secure parking facilities are not easy to find or access and it takes an extra step to sign up for a bike locker service and a credit card is required. More bike lockers and racks are needed at stations in both San Francisco and the East Bay. There is also limited above-ground space at San Francisco BART stations to install racks or to locate bike stations or corrals for more shared vehicle parking.

Signage was not a high priority selected for features to improve stations for micromobility, but some did note that it could be better. BART station maps show riders where shuttles and bus routes leave from, but do not orient travellers to micromobility facilities. BART should include bike lanes, BART valet bike stations, bike lockers, shared micromobility bike rack drop off areas in their station wayfinding signs and maps. Safety issues related to street infrastructure and crime far outweighed any other expressed needs for micromobility and public transit users. If these critical issues were addressed, users might be comfortable enough to notice other areas for potential improvement via station design features and amenities, such as signage, greenery, and public art.

Conclusion

The micromobility landscape continues to evolve as business models and private-public partnerships gain experience and travel behaviours find a new normal in the wake of the pandemic. Regardless of the shape it takes (personal or shared vehicles; scooters, bikes, or other), micromobility holds tremendous promise for facilitating first and last mile connections with public transit. Taking the California Bay Area Rapid Transit system as a case study, this research documented current micromobility use patterns and user experiences at stations. Successes and challenges were highlighted, and recommendations made for station design, including greater availability of shared micromobility vehicles and more affordable secure parking for personal micromobility vehicles. Beyond the station proper, there is a need for protected bike lanes and consistent design standards for bike facilities throughout the region. Further research and design solutions such as integrated payment systems can help cities support the integration of micromobility and public transportation.

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