



If You Provide, Will They Ride? Motivators and Deterrents to Shared Micro-Mobility

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Abstract

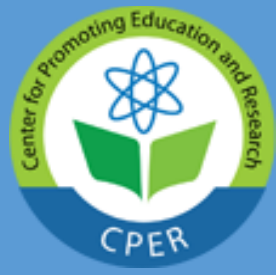
Bike share, e-bike share, and e-scooter systems (shared micro-mobility) are gaining popularity throughout the United States and internationally, but the optimal system design has not been determined. This study investigated motivators and deterrents to the use of such systems in the Pacific Northwest with secondary data, participant observations, depth interviews, and an on-line survey to users and non-users. The survey was administered in all cities in Washington, Oregon, and Idaho that have shared micro-mobility systems. The strongest motivators reported were exercise and enjoyment. The strongest deterrents were weather, danger from automobile traffic, and insufficient bike lanes and paths. The latter two deterrents might be alleviated through continued improvements to infrastructure; however, the weather cannot be changed, and neither can hills. Data were fitted to the Theory of Reasoned Action and the resulting recommendation is to promote popular motivators of exercise and enjoyment and emphasize personal benefits more than social appearances.

KEYWORDS: Bike Share, Deterrents, Motivators, Shared Micro-Mobility, Consumer Behavior

INTRODUCTION

The first bike-share programs in the United States appeared in 2010 (Baca,2018) and there has been

tremendous interest and activity since then. This study is focused on the Pacific Northwest region of the United States. As of 2019, 21 separate areas had bike share



and/or related systems within the states of Washington, Oregon, and Idaho, and at least two more were making plans for implementation. We conducted participant observations, depth interviews, and an on-line survey to users and non-users in these areas based on a research framework from consumer behavior theory. We studied motivators and deterrents for consumers to use the systems.

The Product Life Cycle

As with all goods and services that have market offerings, the evolution of shared micro-mobility programs can be placed within the product life cycle (Levitt, 1965). There are four stages to the product life cycle: introduction, growth, maturity, and decline (Cox, 1967). The introduction stage for bike share systems started in the United States in 2010. During this stage, one or a few providers bring the offering to the market. There is considerable uncertainty about demand and the best design of the offering. Some of the uncertainty is overcome during the growth stage. Many more providers enter the market, but there are still different versions of the offering the optimal solution has not yet been determined (Lindsey, 2016). We believe that shared micro-mobility systems are currently in the growth stage of the product life cycle. Many players are currently involved. Some markets are figuring out their optimal solution but there are many variations.

Bike share providers and community partners establish shared micro-mobility systems for various reasons. Community stakeholders hope to achieve goals that include flexible mobility, emission reductions, individual and municipal financial savings, reduced traffic congestion, reduced fuel use, health benefits, improved multimodal transport connections, “last mile” connection to public transport, and equity (greater accessibility for minority and lower-income communities) (Midgley, 2019; Schneider, 2017).

Bike share providers are increasingly entering new markets for financial profit. This is especially true since the advent of “dockless” systems that use global positioning systems (GPS) to help users locate available bicycles or scooters that might be scattered anywhere through a city. Dockless systems reduce the need for costly docking-station infrastructure. Many companies now create “virtual hubs” that appear on a digital map and implement pay structuring that incentivizes the clustering of bike/scooters at the hubs. The rapidly evolving pay structure, use of hubs, and stations indicate the growth stage of the product life cycle.

Likewise, the types of conveyance offered in the shared system vary. There are bicycles, electrically-assisted “e-bikes,” and electric “e-scooters.” Frequently there is more than one type offered in a particular municipality. There is also variation in who owns, operates, and funds the sharing system. Funding and ownership can be public or private. The municipality may choose to administer the system, but most have it done by one of the shared micro-mobility system companies. The city of Portland uses different models for different types of conveyance (Portland Bureau of Transportation, 2018, 2019).

Theory of Reasoned Action

The Theory of Reasoned Action is used to predict behaviors by measuring behavioral intentions (Fishbein, 1975; Hale, 2002). Behavioral intentions are a combination of (1) the individual’s attitude about engaging in a behavior and (2) social norms, or how the individual believes that others will view the behavior. The theory was developed to better predict consumer behavior. Before it was introduced, attempts to predict behavior were usually based on consumer preferences for a product or service, rather than how consumers felt about engaging in the behaviors of purchasing and/or consuming a product or service. In its simplest form, the Theory of Reasoned Action can be expressed as the following.

$$BI = (AB)W_1 + (SN)W_2$$

where:

BI = behavioral intention

AB = one's attitude toward performing the behavior

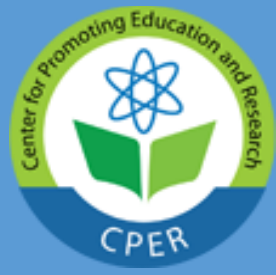
SN = one's subjective norm related to performing the behavior

W = empirically derived weights

In our survey, we asked respondents to rate motivators and deterrents to using shared micro-mobility systems. This enabled us to determine their attitudes about using the systems and how they perceived that they are viewed by others for using the systems. Data from the survey provided data for the variables (dependent and independent). That data was used to calculate the weightings. Once the weightings are determined, we have a formula for predicting the likelihood of specific consumers adopting the use of shared micro-mobility.

Types of Cyclists and Bike Share Research

Roger Geller, Bicycle Coordinator at the Portland (Oregon) Bureau of Transportation addressed deterrents to bicycle use and identified the greatest deterrent to



cycling is fear of automobiles on the roadway (Geller, 2006). Based on comfort levels regarding different cycling situations, he developed a typology of four types of cyclists. “Strong and fearless” cyclists are hardcore cyclists that will ride regardless of conditions. “Enthusied and confident” riders are relatively comfortable sharing the roadway with automobiles but prefer to use bike lanes. Geller found that 60% of Portland residents fit into the category of “Interested but concerned.” These people are interested in cycling but are afraid to ride where there is automobile traffic. Members of the “no way, no how” group are not interested in cycling at all. Research by Dill and McNeil helped to validate the model (Dill, 2013, 2016). They further proposed that the largest group, “interested by concerned,” is the key target market for increasing bicycle ridership.

In addition to the four types of cyclists, other research that is about cycling in general, rather than bike-share specifically, has informed our research. A survey in Vancouver, Canada identified factors that have the greatest influence on the likelihood of cycling (Wintersl,2011). The factors are safety, ease of cycling, weather conditions, route conditions, and interactions with motor vehicles. Some deterrents that have prevented people from replacing automobile trips with bicycle trips include hills and the distance of the trip. Electrically-assisted bicycles alleviate those concerns to some degree and purchasers of e-bikes report car-trip replacement as the most common reason for the purchase (Sutton, 2018).

Bucket al reported that riders that are major users of bike share are different from regular cyclists (2013). They found a larger percentage of bike-share users to be female than other cyclists, but even among bike share users, female riders are far out-numbered by male riders with only about 25% of bike-share trips being made by women (The Conversation, 2020; Szczepanski, 2014), Bucket al also found major users of bike share to be less likely to own a car or a bicycle. Their bike share trips mostly replaced public transit or walking, or they were for recreation. In this study, we investigate the difference between users of bike share, e-bike share, and e-scooter systems and non-users, which include regular cyclists, and non-cyclists. Bucket al also concluded that bike-sharing can encourage cycling by new segments of the population.

The bike-share study conducted in Hangzhou, China by Shaheen et al (2011), was collected such that it is likely to have included non-cyclists. They found that the most important influence for using bike share was the

proximity of docking stations to the individual’s home and destinations, plus as a complement to bus travel. A study conducted in Montreal, Canada, also found the proximity of docking stations to be the most important influencer for bike share usage (Bachand-Marleau, 2012). The same study also determined that cyclists liked the idea of bike share to reduce the risk of theft of their bicycles.

The City of Spokane, Washington conducted a trial of dockless shared micro-mobility during 74 days in the fall of 2018 and commissioned a comprehensive study of the trial (City of Spokane,2019). The survey included responses from both users and non-users of the systems. Of those that had used one or more of the systems, 82% of them had used them to replace automobile trips. The most significant deterrent to the use of the systems was that the bikes or e-scooters were not available in the locations where they were needed. The second most common deterrent was insufficient infrastructure not enough bike lanes or trails. Recreational aspects of the systems were major motivators with trips for “fun” or to ride with friends or family being the most common. The “novelty” of the activity also motivated the majority of users. One might expect that novelty usage may drop off in time, but the survey also revealed that a significant percentage of users (21-46%) used the systems for more utilitarian purposes such as trips for work, school, errands, and going to restaurants or entertainment. The largest percentage of those that used the services used e-scooters, rather than the other modes, particularly for “fun” trips.

Expected Findings

The next two sections of this paper describe our study method and results. The final sections provide a discussion of the findings and conclusions. We expected that the information that we collected before the survey would be validated and clarified by the results of the survey. We also expected to provide some new information from our findings. We expected to find that current and prospective users of shared micro-mobility systems can be classified into the four types of cyclists just as other cyclists are. We also expected to confirm the proposal that, of the four types, the “interested but concerned” group is the one with the greatest potential and the group that should be targeted.

We predicted that some of the deterrents to using bike-share systems are the same as the factors that prevent people from riding their bikes, but others are specific to the use of bike-share systems. We expected to



find that some of the deterrents to the use of bike share are alleviated by e-bike share, such as the effort involved to pedal, especially on hills. We further expected that some of the deterrents to the use of bike share and e-bike share are alleviated by e-scooter share, such as the unsuitability of a person's work clothes for bicycle riding.

METHODS

To survey residents of the Pacific Northwest that have the opportunity to use a shared micro-mobility system, all zip codes in Washington, Oregon, and Idaho that have shared micro-mobility systems were identified. An online survey was conducted in the identified zip codes and zip code areas that are contiguous to them. The survey was developed by the researchers and administered by Qualtrics. Panel services provided the respondents according to selection instructions. Qualtrics performed data scrubbing to assure the validity of the data that were collected.

The survey was designed to obtain descriptive statistics of users and non-users of shared micro-mobility systems, classify them according to the four types of cyclist model, and determine the motivators and deterrents for them to use such systems. We modified the questions and method developed by Dill and McNeil (2013,2016) to determine the type of cyclist for each respondent. The respondents were presented a list of potential motivators and potential deterrents as Likert scale items, for them to indicate the strength of each. These items were developed from qualitative research methods including participant observation and meetings with transportation officials and professionals. For example, through participant observation, we discovered some of the difficulties of dealing with the systems and associated apps. Depth interviews gave us insights about uncertainty regarding laws and ordinances that apply to riders.

Where appropriate, responses were collected separately for bike share, e-bike share, and e-scooter share. To make sure that the respondents understood the distinctions, a photo of each type of conveyance was included in the survey.

The data analysis process included examining descriptive statistics and crosstabs. Factor analyses were performed to condense data from the many Likert scale items. Regression analysis was used to fit the data to the model for the Theory of Reasoned Action.

RESULTS

Demographics of Respondents

The survey was sent to individuals in Washington, Oregon, and Idaho. The percentage of respondents from

WA, OR, and ID was 48%, 44%, and 8% respectively. Respondent's ages ranged from 14 to 94 years old, though data were only analyzed from respondents aged 18 and older. After removing data from respondents under age 18, and performing data scrubbing, there were 1502 usable responses. The sample was skewed toward females as 64% of respondents identified as female and 35% as male. Only 1% identified as other than male or female or declined to state.

A variety of ethnicities are represented in the sample as 79% of respondents were white, 7% Asian/Pacific Islander, 3% Hispanic or Latinx, 2% black or African American, 1% Native American, 7% two or more races, and 1% prefer not to say, or other. Whites are over-represented; they are 71% of the relevant Pacific Northwest population and 79% of the sample. More significantly, the Latinx population is under-represented with 13% of the population, but only 3% of the sample (Statistical Atlas, 2019).

The sample was also skewed toward higher levels of educational achievement as 98% of respondents were high school graduates and 86% of respondents had at least some college. The population from which the sample was taken has a high school graduation rate of less than 77% (Governing 2019). Although the sample is not a perfect cross-section of the population, we were able to get data from respondents in all 23 of the communities with shared micro-mobility systems in the designated states, in appropriate proportions.

Differences based on race, gender, income, and many other demographics were analyzed, especially when the sample and population were quite different. Significant differences between various demographic groups are reported in the results.

Descriptive Statistics

Frequency of Use and Usage Type

Traveling by bicycle, e-bike, or e-scooter is an appealing idea to a majority of the sample, with 66% of respondents reporting that they would like to do so more than they do now (respondent somewhat agreed or strongly agreed to this statement). Broken down by race, 65%, 67%, 71%, and 67% of white, black, Latinx, and Asian respondents would like to travel by bicycle, e-bike or e-scooter more than they do now (respondent somewhat agreed or strongly agreed to this statement).

While a majority of respondents liked the idea of riding, fewer have done so recently, with 30% of respondents having ridden a bike, e-bike, or e-scooter in the last 30 days. Men were more likely to have ridden in

the last 30 days with 39% having done so versus 25% of women. Latinx respondents were most likely to have ridden, with 42% of Latinx respondents having ridden a bike, e-bike, or e-scooter in the last 30 days, versus 29%, 31%, and 35% of white, black, and Asian respondents. Overall, 5% of respondents (6% of women versus 3% of

men) would have ridden but were prevented by the weather.

For all three types of conveyance, the most commonly reported usage was for recreation, with 37.5% of respondents using bike share or e-bike share, and 23% of respondents using e-scooter share, with some frequency, for recreation.

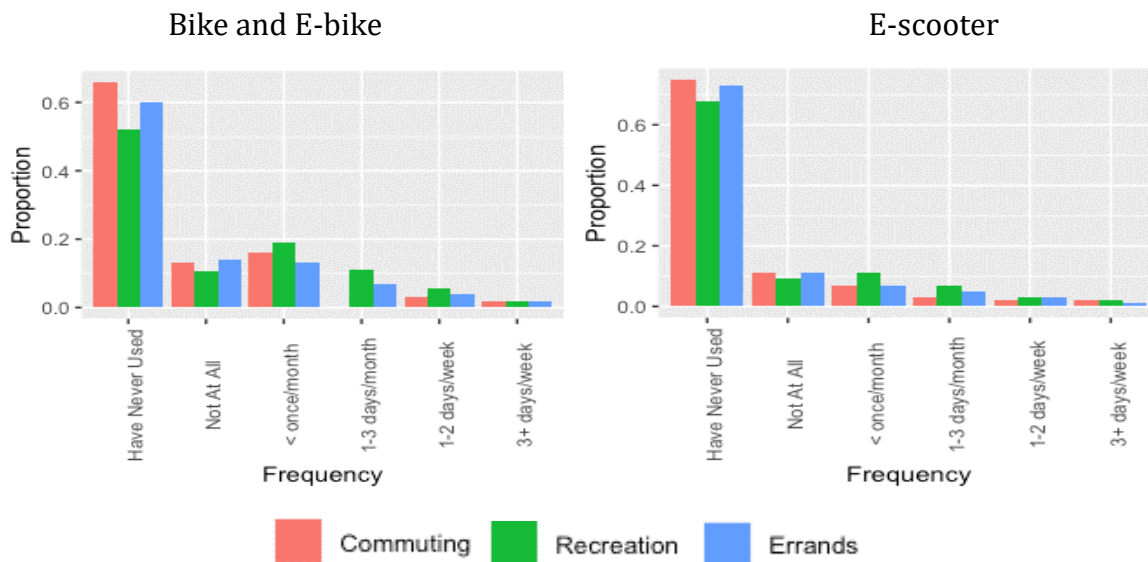


Figure 1 Frequency of use

Bike Share, E-Bike Share, E-Scooter Share Motivators

Factor analysis was used to simplify the data by combining the many motivators into fewer factors. This analysis revealed two major motivating factors: convenience (e.g., not driving in traffic, avoiding parking), and the overall enjoyment and social good (e.g., environment, exercise, enjoyment). Overall enjoyment and social good were the primary motivators for the bike, e-bike, and e-scooter share.

Looking at individual motivators instead of factors, male and female respondents ranked them similarly. Across all races, exercise and enjoyment were

the two biggest specific motivators, with 89% of respondents identifying exercise as at least a slight motivator and 86% identifying enjoyment as at least a slight motivator. Latinx respondents scored the highest with these as motivators with 97% of them identifying exercise and enjoyment as at least a slight motivator. For Latinx respondents, the third-largest motivator was avoiding driving in traffic with 97% of Latinx respondents identifying this as at least a slight motivator, versus 84%, 86%, and 87% of white, black, and Asian respondents respectively.

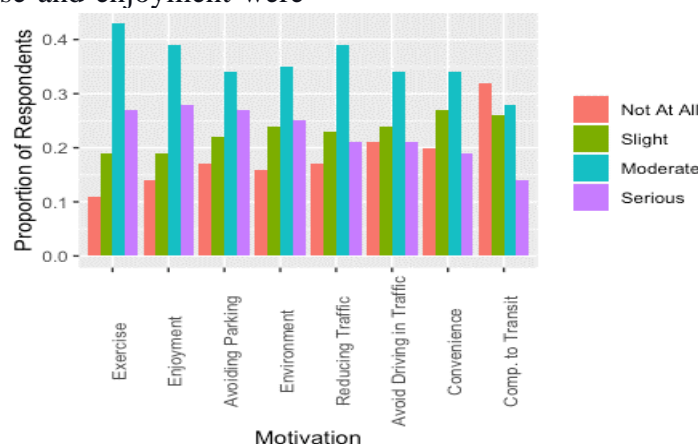


Figure 2 Bike, e-bike, and e-scooter motivators

Bike Share, E-Bike Share, E-Scooter Share Deterrents

Overall Deterrents

Factor analysis grouped deterrents into several categories, of which the most significant deterrents were: weather and road conditions, possible danger from auto traffic, inconvenience of terrain, and inconvenience of obtaining and returning bikes/scooters.

The strongest deterrent factor was weather and road conditions. In the survey, 95% of respondents said bad weather and 91% said insufficient bike lanes/scooter spaces were at least somewhat of a deterrent. Further, 48% of respondents said bad weather and 35% said insufficient bike lanes/scooter space was a *serious* deterrent.

Possible danger from auto traffic was the next major concern with 92% of respondents at least slightly concerned about possible danger from auto traffic while using the bike, e-bike, or e-scooter share. Approximately 32% of respondents, averaged across the bike, e-bike, and e-scooter share respondents, viewed this as a serious concern.

A third major factor was the inconvenience of terrain, which includes hills, and destinations being too far, and inconvenience carrying things (although this last doesn't seem as a terrain issue, it correlated so strongly as to appear in this factor). On average, across the bike, e-bike, and e-scooter share, 88% of respondents viewed inconvenience carrying things as at least a slight deterrent. For hills, 85% viewed it as at least a slight

deterrent. 88% of respondents viewed destinations being too far as at least a slight deterrent for using the bike, e-bike, and e-scooter share.

Unavailability of bikes/scooters was also a major deterrent, with 84% of respondents identifying that they cannot count on bikes/e-bikes/e-scooters being available as at least a slight deterrent, and 85% of respondents saying inconvenient location for obtaining and returning bikes/scooters is at least a slight deterrent.

Liability was another deterrent for respondents. The biggest liability concern was if anything happens to the bike, e-bike, or e-scooter with 82% of respondents being at least slightly concerned about this. It was a *serious* concern for 21% of respondents.

Laws and ordinances about bicycle and scooter use vary greatly from location to location (Pimentel, D., 2019) and respondents reported being concerned about uncertainty regarding laws, rules, or regulations concerning where one can ride; 74% of respondents rated this at least a slight deterrent, and 15% rated it a serious deterrent. However, 67% of respondents thought it was fairly unlikely or not at all likely that laws or ordinances regarding bikes, e-bikes, and e-scooters would be enforced.

Looking more specifically at individual deterrents, rather than the factors, our data showed them as ordered in Figure 3.

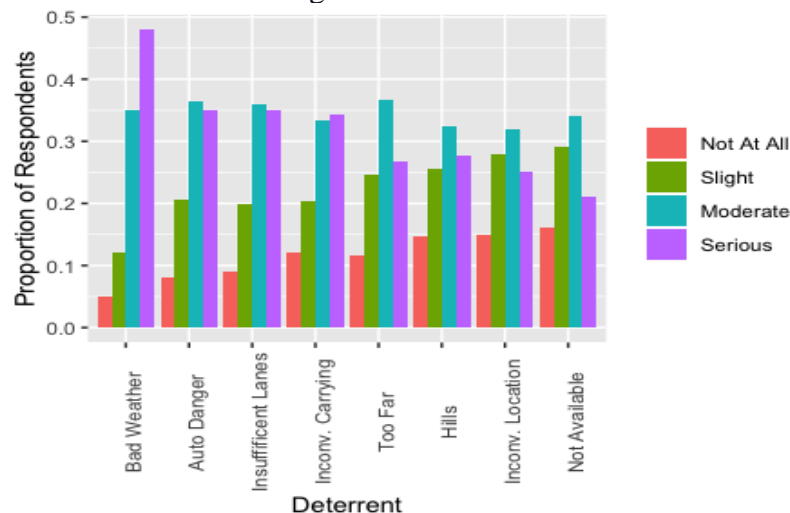


Figure 3 Major deterrents

A few anticipated deterrents turned out to not be concerned. Most respondents were not at all concerned with not having a smartphone to operate the system with (58% not at all concerned). The proliferation of smartphones makes this not a concern for most, but

systems that require them, automatically exclude anyone that does not have a smartphone. "Helmet hair" was also a lesser deterrent (43% not at all concerned), but it was the deterrent with the greatest difference between genders as will be explicated below.



Deterrents for Bike versus E-Bike versus E-Scooter Share

Many deterrents were expected to be equally serious regardless of which model of shared micro-mobility was considered. Others, however, were expected to have a greater influence on some modes than others. Performing factor analysis on these specific potential deterrents identified five deterrent factors to be a danger, disdain from others, over-exertion, appearance, and inconvenience of terrain. The largest deterrents were the danger and inconvenience of terrain. The relative ranking of deterrents was consistent for the bike, e-bike, and e-scooter share, although there were some differences in responses among these categories as detailed below.

The danger was a concern for all three modes with 92% of respondents at least slightly concerned about possible danger from auto traffic. This deterrent was largest for e-scooter share with 40% viewing it as a *serious* concern (versus 32% for e-bike, and 33% for bike share). Other dangers, not related to auto traffic, were also of concern, more for e-scooters than the other modes with 84% viewing it as a deterrent versus 81% and 83% for the bike, and e-bike respectively.

A second factor that included major deterrents was the inconvenience of terrain, which includes inconvenience carrying things, hills, and destinations being too far. There were differences reported for the three types of conveyance, but they went in different directions. For example, probably because the bikes are generally equipped with a basket, the inconvenience of carrying things was rated as more of a deterrent for e-scooters, 90% perceived it to be at least a slight inconvenience versus 87% and 88% for bikes and e-bikes. On the other hand, hills were less of a concern for the power-assisted e-scooters and e-bikes than for bicycles, with 89%, 84%, and 83% respectively, viewing it as at least a slight deterrent for bikes, e-bikes, and e-scooters respectively. The usage of power-assisted vehicles has reduced deterrence from too much exertion (64%, 52%, 48%), and from getting sweaty (62%, 55%, 48%). Being power-assisted did not, however, make a difference in the deterrent of destinations being too far. It was rated as being at least a slight deterrent for 88% for all three modes.

Respondents didn't seem particularly concerned about how they would appear to others while riding, but they were slightly more concerned about how they would appear on an e-scooter as compared to the other modes. For bikes and e-bikes, 63% and 60% indicated that

looking silly would not be a deterrent at all, but only 50% expressed the same about e-scooters. A related potential deterrent is that the individual's work clothes are unsuitable for using the particular conveyance. We expected that work clothes would be less impacted by scooters than by bikes, especially regarding dresses, skirts, and overcoats. The difference between modes, however, was not great with there being at least slight deterrence for bikes, e-bikes, and e-scooters of 63%, 62%, and 60%.

Differences in Deterrents by Gender

For the top deterrents previously identified, all differences between men and women were less than 6%. All other differences between men and women regarding deterrents were less than 8% other than the two deterrents listed next. The largest differences were helmet hair and not good at riding a bike or scooter as deterrents. Only 46% of men versus 63% of women viewed helmet hair as at least a slight deterrent. Between male-pattern baldness and current short hairstyles for men, many of our male respondents probably did not have enough hair for helmet hair to be a concern. For concerns about not being good at riding, averaged across the bike, e-bike, and e-scooter, 64% of women (61%, 63% and 68% for the bike, e-bike, and e-scooter respectively) versus 52% of men (48%, 49% and 60% for the bike, e-bike, and e-scooter respectively) viewed this as at least a slight deterrent.

Differences in Deterrents by Race

Relative rankings of deterrents by race were fairly similar with some slight differences. Bad weather and insufficient bike lanes/scooter space were the major deterrents for all races. Bad weather was at least a slight deterrent for 95%, 89%, 92%, and 98% of white, Latinx, black, and Asian respondents respectively. Insufficient bike lanes/scooter space was at least a slight deterrent for 91%, 95%, 86%, and 93% of white, Latinx, black, and Asian respondents.

Two notable differences were financial, specifically not wanting to use a credit card, and having no smartphone with which to operate the system were much larger deterrents for black respondents than other races. 62%, 68%, and 58% of white, Latinx, and Asian respondents viewed not wanting to use a credit card as at least a slight deterrent versus 83% of black respondents. 41%, 42%, and 42% of white, Latinx, and Asian respondents viewed having no smartphone to operate the system with as at least a slight deterrent versus 72% of black respondents.



At first thought, this might be partially explained by differing income levels of respondents (56% of black respondents had an income of less than \$35k versus 23%, 34%, and 0% of white, Latinx, and Asian respondents respectively). However, for respondents that made less than \$35k per year, 64% viewed not wanting to use a credit card as at least a slight deterrent, and 42% viewed no smartphone to operate the system with as at least a slight deterrent. These percentages do not seem to explain the race-based difference we see.

For bike share, danger and inconvenience of terrain were another of the biggest deterrents for each race, however, the magnitude of the deterrent varied. Notably, hills were at least a slight deterrent for 97% of Latinx respondents versus 89%, 81%, and 92% of white, black, and Asian respondents respectively. This deterrent decreased slightly for e-bike, and e-scooter with 92% of Latinx respondents viewing hills as at least a slight deterrent for e-bikes, and e-scooters. For bike share, danger from auto traffic was one of the top deterrents for each race with 92%, 89%, 78%, and 94% of white, Latinx, black, and Asian respondents finding this to be at least a slight deterrent. Black respondents seem less

deterred by bike, e-bike, and e-scooter, with the largest deterrent for bike share being hills, and destinations too far which is at least a slight deterrent for 81% of black respondents. In contrast, the largest bike-share deterrent is auto danger (94%) for Asian respondents, hills (97%) for Latinx respondents, and auto danger (92%) for white respondents.

Theory of Reasoned Action

An ordinary least squares (OLS) regression without intercept was fit to the data to fit the model of the Theory of Reasoned Action. Behavioral Intention (BI) was determined from an average of responses to questions about desiring to ride more and about current ridership. Attitude toward the Behavior (AB) was measured as an average of responses to questions about motivations and deterrents to riding that did not involve perceptions from others, such as getting exercise and enjoyment. Social Norms (SN) were taken as an average of questions about motivations and deterrents about how the riders believe they are perceived by others, such as disdain from drivers and looking silly. After getting the average scores, BI was regressed on AB and SN to get the following regression:

BI = 0.78 AB-0.08 SN

	Weight Estimate	Std. Error	P-Value
AB	0.780	0.047	<2e-16
SN	-0.081	0.041	0.05

Table 1 Summary information about the weights

AB’s weight is very statistically significant, but SN’s weight is not quite significant and rounds to zero effect. This indicates that social norms are not a significant predictor of behavioral intention but the attitude toward the behavior is. For each 1 increase in the AB score, BI increases by 0.78. For each 1 increase in the SN score, BI decreases by 0.08. The weighting for SN, considering statistical significance is essentially 0, so it is not a concern that the weight is very slightly negative. This is an interesting result because the Theory of Reasoned Action (Fishbein, 1975; Hale, 2002) is 45 years old and has been supported repeatedly. Generally, social norms (SN) are an important component of behavioral intentions. It is remarkable that, despite some concern about “looking silly,” most respondents in our sample, have virtually no self-consciousness about using shared

micro-mobility. We repeated the regression for various subsets of the data by gender, age, and ethnicity and found the same basic result.

The Four Types of Cyclists

We have extended Geller’s (2006) typology to apply to shared micro-mobility and e-bikes and e-scooters. Though this was not part of the original intent of the typology, we consider it to be an insightful way to organize our data. The bar chart below shows the proportion of respondents that fall into each type of the four types of cyclists. The four types of cyclists correspond to 1 = strong and fearless, 2 = enthused and confident, 3 = interested but concerned, and 4 = no way, no how. The majority of respondents (71%) fall into type 3: interested but concerned.

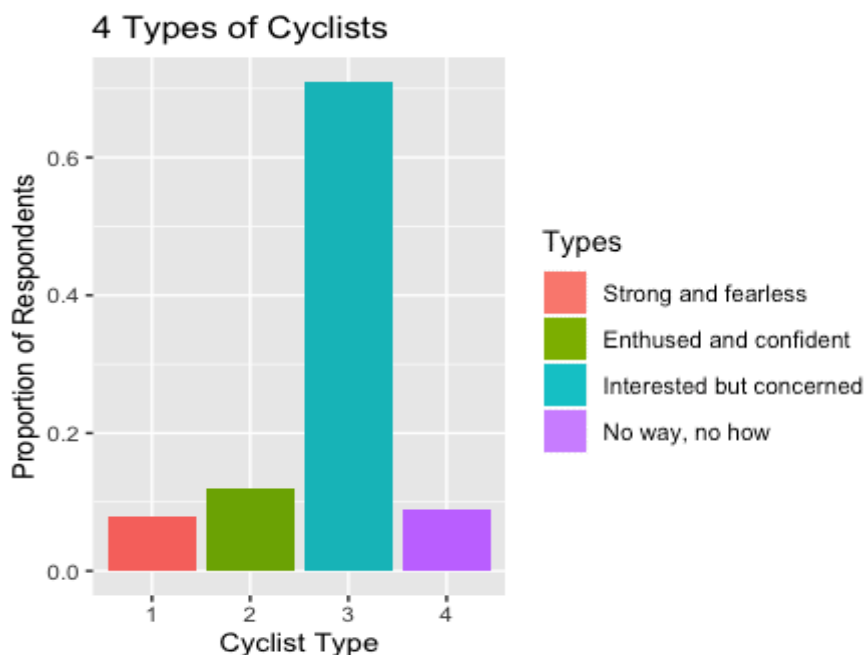


Figure 4 Four types of cyclists

Calculating the BI score, as described above, results in behavioral intentions for cyclist types 1, 2, 3, and 4 that are 2.90, 1.71, 1.77, and 1.71 respectively (these scores are only meaningful with each other). The strong and fearless group has the strongest behavioral intention to ride, with the other three groups at about the same lower level.

Looking specifically at the percentage of each type of cyclist that would like to travel by bike, e-bike or e-scooter more than they do now (somewhat or strongly

agree) the percentages for the four types are 82%, 61%, 64%, and 39% respectively.

According to this data, cyclist type 1 is most motivated to ride more. It is, however, the smallest of the four groups. To determine the potential of increased ridership per group, we also considered the size of the group. We created an index by multiplying, for each group, the percentage that want to ride more by the size of the group in our sample. Type 3, (interested but concerned) is the group with the highest total potential (73% of the total potential).

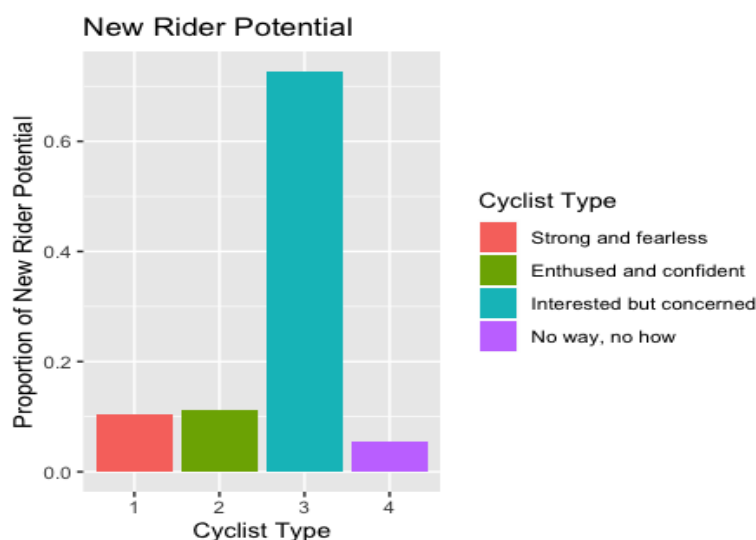
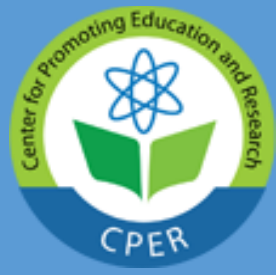


Figure 5 New rider potential by cyclist type



Differences in Motivators by Cyclist Type

Not surprisingly, there were quite a few differences in motivations by cyclist type. Cyclist type 4 (no way, no how) had the weakest motivation toward the bike, e-bike, and e-scooter share. The strongest motivator for type 4 was exercise, with 70% of type 4 cyclists identifying it as at least a slight motivator. On the other hand, cyclist type 1 (strong and fearless) were highly motivated (at least 86% of type 1 cyclists were motivated by each motivation presented). Type 1's strongest motivators were exercise and enjoyment with 93% of type 1 cyclists finding them to be at least a slight motivator.

Type 2 cyclists (enthused and confident) were most motivated by exercise (89%), protecting the environment (86%), and enjoyment (84%). They were least motivated by complement to public transit with only 65% at least slightly motivated by this.

Type 3 cyclists (interested but concerned) were generally motivated by the various choices of motivators as well. For each motivator, at least 80% of type 3 cyclists were motivated by that reason, except for complement to public transit which only motivated 68% of type 3 cyclists. Top motivations for type 3 cyclists were exercise (91%), and enjoyment (88%).

Differences in Overall Deterrents by Cyclist Type

The relative ranking of deterrents was very similar for each cyclist type. For each cyclist type, the biggest deterrent for the bike, e-bike, and e-scooter share was bad weather. This was at least a slight deterrent for 88%, 97%, 96%, and 99% of cyclist types 1, 2, 3, and 4 respondents respectively. The next largest deterrents were insufficient bike lanes/scooter spaces, and inconvenient locations for obtaining and returning bikes/scooters. Insufficient bike lanes/scooter space was at least a slight deterrent for 78%, 93%, 94%, and 76% of cyclist types 1, 2, 3, and 4 respondents respectively. Inconvenient locations for obtaining and returning bikes/scooters was at least a slight deterrent for 78%, 88%, 87%, and 80% of cyclist type 1, 2, 3, and 4 respondents respectively.

Docked versus Dockless Systems

We asked questions about the availability of bikes, e-bikes, and e-scooters, and about the convenience of locations to obtain and return the vehicles. We expected the responses to indicate a likely preference for docked or dockless systems. The responses tend, instead, to cancel each other out, indicating that overall, neither solution is likely to be preferred over the other.

DISCUSSION

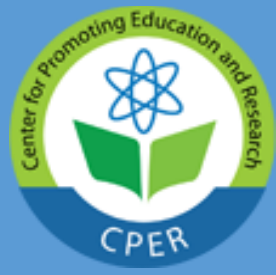
Many goals have been identified to be addressed by shared micro-mobility systems (Levitt, 1965; Cox, 1967). Our data provide insight regarding consumer perceptions of the level of fulfillment of some of these goals. Respondents reported exercise and enjoyment as the strongest motivators to use shared micro-mobility, but they also acknowledged aspects of social good as strong motivation.

Respondents liked the idea of using bikes, e-bikes, and e-scooters but a large majority have not done so in the last 30 days. Along with the motivators that encourage them to ride we also examined the deterrents that discourage them.

We predicted that e-scooters would alleviate some of the deterrents for bicycles and be revealed as a superior model for shared micro-mobility. The distinctions were not as clear cut as we had anticipated. The deterrents of too much exertion and getting sweaty were less of a concern for e-scooters than for non-powered bicycles. But there was no difference regarding concerns of destinations being too far. Some deterrents were more pronounced for e-scooter share travel. Since the scooters do not have baskets, the inconvenience of carrying things is more of a deterrent than for bikes. Respondents are more concerned about looking silly riding an e-scooter than a bicycle. While danger is a major concern for all modes of shared micro-mobility, e-scooters were judged to be the most dangerous.

E-scooters may be perceived to be more dangerous than they are because their danger is made more salient due to news reports that highlight accidents that include scooters. This is the same effect as when people think of air travel as being dangerous after seeing news reports of a horrific plane crash. In June 2019, a young man was killed in Nashville when he was struck by an SUV while riding an e-scooter (Hawkins, 2019). While it was determined that the accident was caused by the intoxicated behavior of the young man, the scooter took the blame. The mayor banned e-scooters in Nashville and an opinion writer for the *New York Times* wrote an article that was very negative toward e-scooters and e-scooter share operators (Renkl, 2019). The death of the man was tragic, but to put things in perspective, there were 21 pedestrian deaths in Nashville in 2018, and there had been 8 in 2019 before the scooter accident (Nashville Pedestrian Death Registry, 2019).

Consistent with the Spokane study (City of Spokane, 2019), infrastructure concerns such as insufficient bike lanes and trails, were identified as a major deterrent.



Such deterrents take long term solutions and a great deal of funding. More insurmountable, however, are the major deterrents of weather and difficult terrain. The two largest markets in our study are Seattle, WA, and Portland, OR. Both cities are built on hills and both have more rain days than sunny days per year.

Application of the Theory of Reasoned Action (Fishbein, 1975; Hale, 2002) led to an interesting finding. One of the two independent variables in the model was irrelevant in our study. The respondents' behavioral intentions were based entirely on their attitudes and not at all on how they believed others perceived them. We do not know if this result would be the same outside the Pacific Northwest, where individualism seems to be especially valued and tolerated.

We were able to classify our respondents into the categories of the four types of cyclists. As compared with an earlier study in the city of Portland (Dill and McNeil), our distribution included much more of the "interested but concerned" group (71% versus 56%) and less of all the others. Based on the numbers in that group and their calculated behavior intentions to use share micro-mobility systems, they appeared clearly as the group with the greatest potential for an increase of usage.

Our data did not support Buck et al's assertion that young females who do not own an automobile or a bicycle are more likely to use shared systems (City of Spokane, 2019). We identified respondents in our sample that met those descriptions but did not find their behavioral intention to use shared micro-mobility to be different from the sample as a whole.

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REFERENCES

- Baca, A. (2018): What cities need to understand about bikeshare now. Citylab. <https://www.citylab.com/transportation/2018/04/a-complete-taxonomy-of-bikeshare-so-far/558560/>. Accessed May 10, 2019.
- Bachand-Marleau, J., B.H.Y. Lee, and M. El-Geneidy (2012): Better understanding of factors influencing likelihood of using shared bicycle systems and frequency of use. *Transportation Research Record: Journal of the Transportation Research Board*, 66-71.

A goal of many shared micro-mobility systems is to provide equity (greater accessibility for minority and lower-income communities) (Levitt, 1965; Cox, 1967). Since the population in Washington, Oregon, and Idaho is so heavily white, representative samples of ethnic minority groups appear as small subsets of our data. Also, our sample was under-represented in Latinx respondents. This is a matter for future study with a different methodology.

CONCLUSIONS

There is not a quick fix to increasing the usage of shared micro-mobility. The issue of safety must be addressed by improving infrastructure with more bike lanes and paths. Also, there needs to be a campaign to educate the public. Safety and the perception of safety can be enhanced by informing the public of the laws in place and that they will be enforced. Potential riders are likely to have a distorted version of the risks and need to be educated otherwise.

Based on the motivations and deterrents identified, usage can be encouraged by having a variety of options available: docked and dockless, bikes, and scooters.

Some deterrents cannot be fixed, such as the weather and the hills. Our recommendation is to promote the popular motivators of exercise and enjoyment. Once riders have become accustomed to using and enjoying the shared services in favorable conditions, they are more likely to figure out ways to deal with the weather and the hills. Any promotional activities should be targeted to the "interested but concerned" segment as it represents the greatest potential for increased ridership. Promotion should emphasize personal benefits to riders as social norms do not seem to be a consideration.



Buck, D., R. Buehler, P. Happ, B. Rawls, P. Chung, and N. Borecki (2013): Are bikeshare users different from regular cyclists? *Transportation Research Record: Journal of the Transportation Research Board*, 112-119.

City of Spokane, (2019): *spokane shared mobility study final recommendations*. Report by Toole Design for the City of Spokane. <https://static.spokanecity.org/documents/projects/shared-mobility/spokane-shared-mobility-report.pdf>.

Cox, W.E. (1967): Product life cycles as marketing models. *The Journal of Business*, 40:375-384.

Dill, J. and N. McNeil (2013): Four types of cyclists? Examination of typology for better understanding of bicycling behavior and potential. *Transportation Research Record: Journal of the Transportation Research Board*, 129-138.

Dill, J. and N. McNeil (2016): Revisiting the four types of cyclists: findings from a national survey. *Transportation Research Record: Journal of the Transportation Research Board*, 90-99.

Fishbein, M. and I. Ajzen (1975): *Belief, attitude, intention, and behavior: an introduction to theory and research*. Addison-Wesley, Reading, MA.

Geller, R. (2006): Four types of cyclists. Portland Office of Transportation.

<https://www.portlandoregon.gov/transportation/article/264746>.

Governing.com (2019): High school graduation rates by state. *Governing the states and localities*. <https://www.governing.com/gov-data/high-school-graduation-rates-by-state.html>. Accessed July 31, 2019.

Hale, J., B. Householder, and K. Green (2002). *The theory of reasoned action. The persuasion handbook: developments in theory and practice*.

Hawkins, A. (2019): Nashville is banning electric scooters after a man was killed. *The Verge*.

<https://www.theverge.com/2019/6/21/18701299/nashville-electric-scooter-ban-man-killed>.

Levitt, T. (1965): Exploit the product life cycle. *Harvard Business Review*, 43:81-94.

Lindsey, J. (2016): Do bike share systems actually work? *Outside Online*,

<https://www.outsideonline.com/2136406/do-bike-share-systems-actually-work>.

Midgley, P. (2019): *Global consultation for decision-makers on implementing sustainable transport: bike sharing*. United Nations,

<https://sustainabledevelopment.un.org/content/documents/4803Bike%20Sharing%20UN%20DESA.pdf>. Accessed July 6, 2019.

Nashville Pedestrian Death Registry (2019): *Honoring the lives of those we've lost*.

<https://www.nashvillepedestriandeathregistry.org/the-registry/>. Accessed July 22, 2019.

Portland Bureau of Transportation (2019). *2018 Biketown annual report*.

<https://www.portlandoregon.gov/TRANSPORTATION/article/725323>. Accessed July 9, 2019.

Portland Bureau of Transportation (2019): *New mobility—shared electric scooters*. TRN-15.01.

<https://www.portlandoregon.gov/citycode/article/690212>. Accessed July 9, 2019.

Renkl, M. (2019): *Scooter madness*, *The New York Times*.

<https://www.nytimes.com/2019/06/17/opinion/electric-scooters-nashville.html>: June 17, 2019.

Shaheen, S.A., H. Zhang, E. Martin, and S. Guzman (2011): China's Hangzhou public bicycle: understanding early adoption and behavioral response to bikesharing. *Transportation Research Record: Journal of the Transportation Research Board*, 33-41.

Statistical Atlas (2019): *Race and ethnicity in Idaho*. <https://statisticalatlas.com/state/Idaho/Race-and-Ethnicity>. Accessed July 22, 2019.

Statistical Atlas (2019): *Race and ethnicity in Oregon*. <https://statisticalatlas.com/state/Oregon/Race-and-Ethnicity>. Accessed July 22, 2019.

Statistical Atlas (2019): *Race and ethnicity in Washington*. <https://statisticalatlas.com/state/Washington/Race-and-Ethnicity>. Accessed July 22, 2019.



Sutton, M. (2018): Electric bike purchases pulling people from private cars, Finds NITC Study. Cycling Industry News.

<https://cyclingindustry.news/electric-bikes-purchases-pulling-people-from-private-cars-finds-nitc-study/>.

Szczepanski, C. (2014): Bike share's gender gap. News from the League, The League of American Bicyclists. <https://bikeleague.org/content/bike-shares-gender-gap>. June 27, 2014

The Conversation (2020): Bike share programs are on the rise, yet the gender gap persists.

<https://theconversation.com/bike-share-programs-are-on-the-rise-yet-the-gender-gap-persists-126996> .January14, 2020/

Winters, M., G. Davidson, D. Kao, and K. Teschke (2011): Motivators and deterrents of bicycling: comparing influences on decisions to ride. *Transportation*, 38:153-168.