IF YOU PROVIDE, WILL THEY RIDE?
MOTIVATORS AND DETERRENTS TO SHARED MICRO-MOBILITY

FINAL PROJECT REPORT

by

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16. 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 for and deterrents to the use of such systems in the Pacific Northwest by using a research framework from consumer behavior theory with secondary data, participant observations, in-depth interviews, and an on-line survey of users and non-users. The survey was administered in all cities in Washington, Oregon, and Idaho that have shared micro-mobility systems. Convenience and social good were found to be major motivators, but 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 weather cannot be changed and neither can hills. Nevertheless, the survey suggested that those issues might be addressed by promoting the popular motivators of exercise and enjoyment. Once riders have become accustomed to using and enjoying the shared services in favorable conditions, they may be more likely to figure out ways to deal with weather and hills. Any promotional activities should be targeted to the "interested but concerned" segment of the four types of cyclists, as it represents the greatest potential for increased ridership, and should emphasize personal benefits more than social appearances.			
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SI* (Modern Metric) Conversion Factors

APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

TABLE OF CONTENTS

List of Figures

List of Tables

LIST OF ABBREVIATIONS

AB:	Attitude toward the behavior
BI:	Behavioral intention
GPS:	Global Positioning System
OLS:	Ordinary least squares
PacTrans:	Pacific Northwest Transportation Consortium
SN:	Social norms
WSDOT:	Washington State Department of Transportation

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EXECUTIVE SUMMARY

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 for and deterrents to the use of such systems in the Pacific Northwest by using a research framework from consumer behavior theory with secondary data, participant observations, in-depth interviews, and an on-line survey of users and non-users. The survey was administered in all cities in Washington, Oregon, and Idaho that have shared micro-mobility systems.

Convenience and social good were found to be major motivators, but 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, weather cannot be changed, and neither can hills. Nevertheless, the survey suggested those issues might be addressed by promoting the popular motivators of exercise and enjoyment. Once riders have become accustomed to using and enjoying the shared services in favorable conditions, they may be 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 of the four defined types of cyclists, as it represents the greatest potential for increased ridership, and should emphasize personal benefits more than social appearances.

CHAPTER 1. INTRODUCTION

The first bike share programs in the United States appeared in 2010 (Baca, 2018), and there have been tremendous interest and activity since then. This study 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, in-depth interviews, and an on-line survey of users and non-users in these areas based on a research framework from consumer behavior theory. We studied consumers' motivators for and deterrents to using the systems.

1.1. 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 brought their offerings to market. There was considerable uncertainty about demand and about the best design of those offering. Some of the uncertainty was overcome during the growth stage. Many more providers entered the market, but there were still different versions of bike share offerings—and the optimal solution has not yet been determined (Lindsey, 2016). We believe that shared micro-mobility systems are currently still in the growth stage of the product life cycle. Many players are currently involved. Some markets are figuring out their own 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).

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 changes in stations indicate the growth stage of the product life cycle.

Likewise, the types of conveyance offered in the shared systems vary. There are bicycles, electrically assisted "e-bikes," and electric "e-scooters." Frequently more than one type is 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 opt to have one of the shared micro-mobility system companies administer it. The city of Portland uses different models for different types of conveyance (Portland Bureau of Transportation, 2018, 2019).

1.2. 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 follows.

$$BI = (AB)W1 + (SN)W2$$

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 for 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 were viewed by others for using the systems. Data from the survey provided data for the variables (dependent and independent). Those data were used to calculate the weightings. Once the weightings had been determined, we had a formula for predicting the likelihood of specific consumers adopting the use of shared micro-mobility.

1.3. 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 as a fear of automobiles on the roadway (Geller, 2006). On the basis of comfort levels regarding different cycling situations, he developed a typology of four kinds of cyclists. “Strong and fearless” cyclists are defined as hardcore cyclists who will ride regardless of conditions. “Enthused and confident” riders are relatively comfortable sharing the roadway with automobiles but prefer to use bike lanes. Geller found that 60 percent 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 but concerned," is the key target market for increasing bicycle ridership.

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

Buck et al. (2013) reported that riders who were major users of bike share were different from regular cyclists . They found these riders more likely to be female and younger, and 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 our study, we investigated the differences between users of bike share, e-bike share, and e-scooter systems and non-users, which included both regular cyclists and non-cyclists. Buck et 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 conducted such that it was likely to include 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 its ability to complement bus travel. A study conducted in Montreal, Canada, also found 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 sharing to reduce the risk of theft of their own bicycles.

The City of Spokane, Washington, conducted a trial of dockless shared micro-mobility during a 74-day period 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 who had used one or more of the systems, 82 percent had used them to replace automobile trips. The study found that the most significant deterrent to 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 was also found to be a motivator for the majority of users. One might expect that novelty usage would drop off in time, but the survey also revealed that a significant percentage of users (21-46 percent) 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 who used the services used e-scooters, rather than the other modes, particularly for "fun" trips.

1.4. Expected Findings

The next two chapter of this report describe our study method and results. The final chapters 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 could be classified into the four types of cyclists just as other cyclists have been. We also expected to confirm the proposal that, of the four types, the "interested but concerned" group would have the greatest potential for growth and therefore should be targeted.

We predicted finding that some of the deterrents to use of bike share systems would be the same as the factors that prevent people from riding their own 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, such as the effort involved to pedal, especially on hills, could be alleviated by e-bike share,. We further expected to find that some of the deterrents to the use of bike share and e-bike share, such as the unsuitability of a person's work clothes for bicycle riding, could be alleviated by e-scooter share.

CHAPTER 2. 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 on-line 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 defined types of cyclists, and determine their motivators for and deterrents to using such systems. We modified the questions and method developed by Dill and McNeil (2013, 2016) to determine each respondent's cyclist type. The respondents were presented a list of potential motivators and potential deterrents as Likert scale items to allow them to indicate the strength of each. These items were developed from qualitative research methods that included 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. In-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 (figure 2-1).

Bicycle: powered only by pedaling | E-bike: pedaling assisted by an electric motor | E-scooter: powered by an electric motor

Figure 2-1 Images used in the survey to distinguish types of shared mobility

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

CHAPTER 3. RESULTS

3.1 Demographics of the Respondents

The survey was sent to individuals in Washington, Oregon, and Idaho. The percentage of respondents from Washington was 48 percent, from Oregon 44 percent, and from Idaho 8 percent. Respondents' ages ranged from 14 to 94 years old, although data were analyzed only from respondents aged 18 and older. After data from respondents under age 18 had been removed and data scrubbing had been performed, there were 1,502 usable responses. The sample was skewed toward females, as 64 percent of respondents identified as female and 35 percent as male. Only 1 percent identified as other than male or female, or declined to state.

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

The sample was also skewed toward higher levels of educational achievement, as 98 percent of respondents were high school graduates and 86 percent of respondents had at least some college. The population from which the sample was taken had a high school graduation rate of less than 77 percent (Governing.com 2019). Differences based on race, gender, income, and a number of other demographics were analyzed, especially when the sample and population were quite different. Significant differences between various demographic groups are reported in the results.

3.2 Descriptive Statistics—Frequency of Use and Usage Type

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

While a majority of respondents liked the idea of riding, fewer had done so recently, with 30 percent 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 percent having done so versus 25 percent of women. Latinx respondents were most likely to have ridden, with 42 percent of Latinx respondents having ridden a bike, e-bike, or e-scooter in the last 30 days, versus 29 percent of white, 31 percent of Black, and 35 percent of Asian respondents. Overall, 5 percent of respondents (6 percent of women versus 3 percent of men) would have ridden but were prevented by weather.

For all three types of conveyance (see figure 2-1), the most commonly reported usage was for recreation, with 37.5 percent of respondents using bike share or e-bike share, and 23 percent of respondents using e-scooter share with some frequency for that purpose (see figure 3-1).

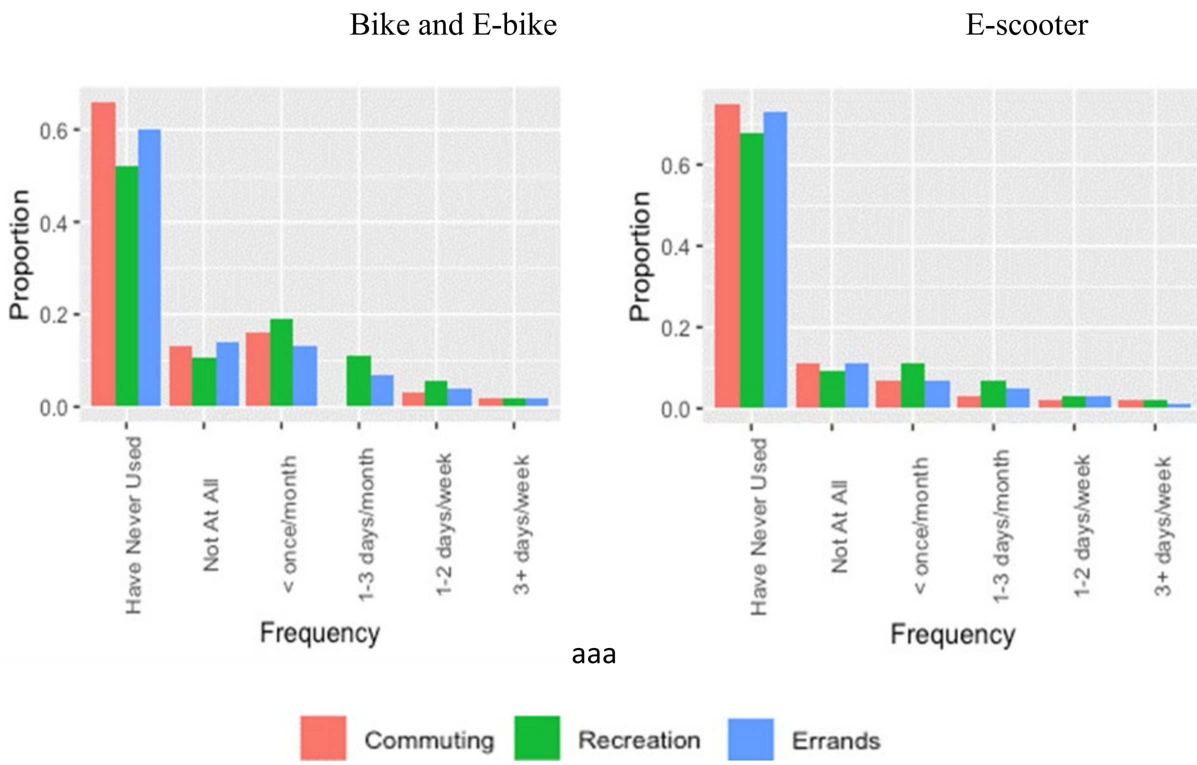

Figure 3-1 Frequency of use

<u>3.3 Bike Share, e-Bike Share, e-Scooter Share Motivators</u>

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 overall enjoyment and social good (e.g., environment, exercise, enjoyment). Overall enjoyment and social good were the primary motivators for bike, e-bike, and e-scooter sharing.

In looking at individual motivators instead of factors, male and female respondents ranked them similarly (figure 3-2). Across all races, exercise and enjoyment were the two biggest specific motivators, with 89 percent of respondents identifying exercise as at least a slight motivator, and 86 percent identifying enjoyment as at least a slight motivator. Latinx respondents scored the highest with these as motivators, with 97 percent 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 percent of Latinx respondents identifying this as at least a slight motivator, versus 84 percent of white, 86 percent of Black, and 87 percent of Asian respondents.

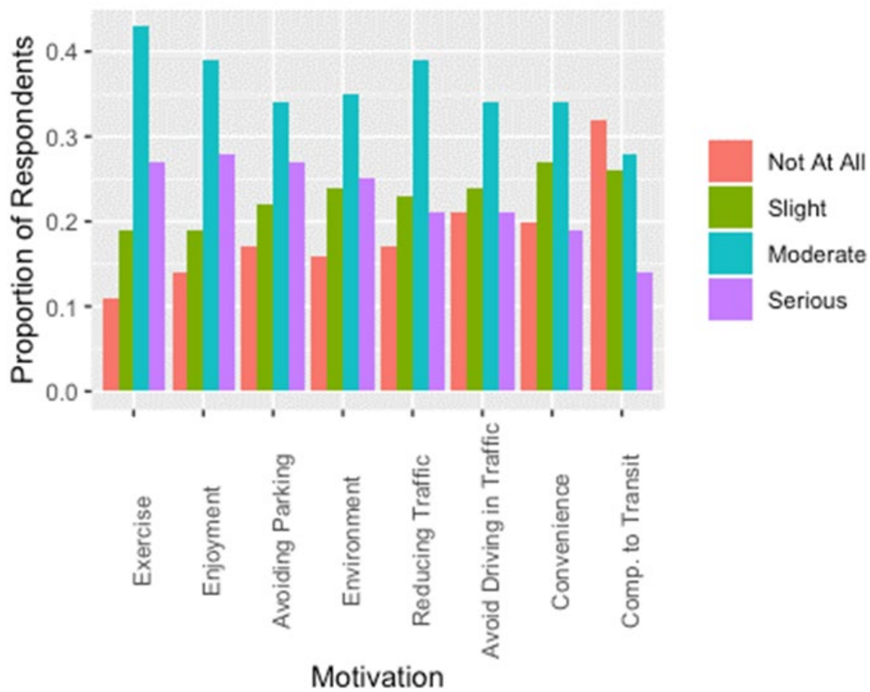

Figure 3-2 Bike, e-bike, and e-scooter motivators

3.4 Bike Share, e-Bike Share, e-Scooter Share Deterrents

3.4.1 Overall Deterrents

Factor analysis grouped deterrents into a number of 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 factors were weather and road conditions. In the survey, 95 percent of respondents said bad weather and 91 percent said insufficient bike lanes/scooter spaces were at least somewhat of a deterrent. Furthermore, 48 percent of respondents said bad weather and 35 percent said insufficient bike lanes/scooter space were a serious deterrent.

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

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

Unavailability of bikes/scooters was also a major deterrent, with 84 percent of respondents identifying not being able to count on bikes/e-bikes/e-scooters being available as at least a slight deterrent, and 85percent of respondents defining inconvenient location for obtaining and returning bikes/scooters as at least a slight deterrent.

Liability was another deterrent for respondents. The biggest liability concern was if anything happened to the bike, e-bike or e-scooter, with 82 percent of respondents being at least slightly concerned about this. It was a serious concern for 21 percent 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 percent of respondents rated this at least a slight deterrent, and 15 percent rated it a serious deterrent. However, 67 percent 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 3-3.

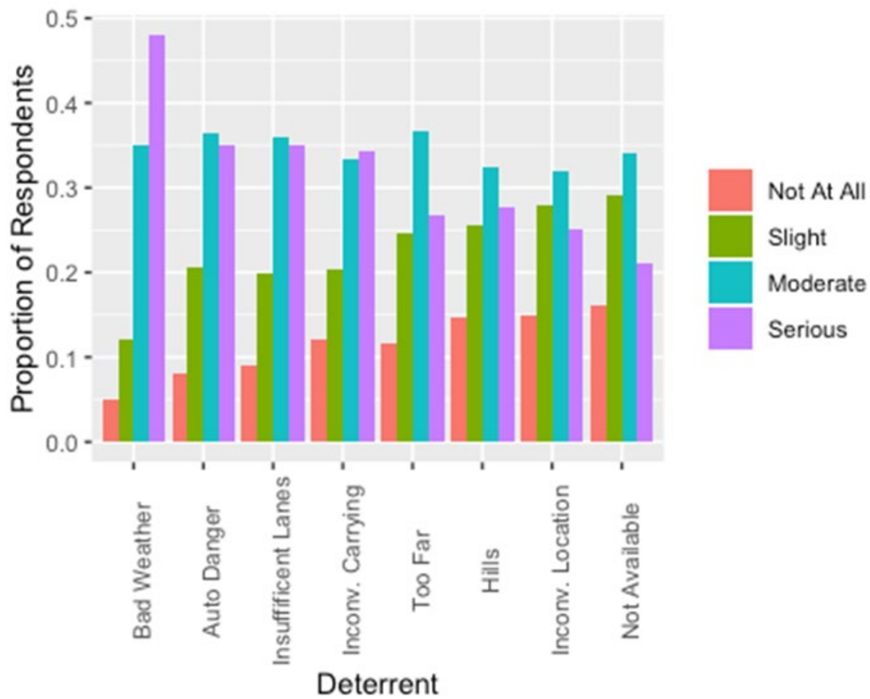

Figure 3-3 Major deterrents

3.4.2 Deterrents for Bike versus e-Bike versus e-Scooter Share

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

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

A second factor that included major deterrents was inconvenience of terrain, which included inconvenience carrying things, hills, and destinations being too far. Differences were reported for the three types of conveyance, but they went in different directions. For example, probably because bikes are generally equipped with a basket, the inconvenience of carrying things was rated as more of a deterrent for e-scooters; 90 percent perceived it to be at least a slight inconvenience versus 87 percent for bikes and 88 percent for 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 percent of respondents viewing them as at least a slight deterrent for bikes, 84 percent for e-bikes, and 83 percent for e-scooters . Too much exertion was less of a deterrence for power-assisted vehicles (64 percent for bikes, 52 percent for e-bikes, 48 for e-scooters), as was getting sweaty (62 percent for bikes, 55 percent for e-bikes, 48 percent for e-scooters). However, power-assistance did not make a difference in regard to the deterrence of destinations being too far. That was rated as being at least a slight deterrent for 88 percent for all three modes.

Respondents did not 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 in comparison to the other modes. For bikes and e-bikes, 63 percent and 60 percent of respondents, respectively, indicated that looking silly would not be a deterrent, but only 50 percent expressed the same concern about e-scooters. A related potential deterrent was that the individual's work clothes would be unsuitable for using the particular conveyance. We expected that work clothes would be less affected by scooters than by bikes, especially regarding dresses, skirts, and overcoats. However, the differences among modes were not great, there being at least slight deterrence for bikes for 63 percent of respondents, e-bikes for 62 percent, and e-scooters for 60 percent.

3.4.3 Differences in Deterrents by Gender

For the top deterrents previously identified, all differences between men and women were less than 6 percent. All other differences between men and women regarding deterrents were less than 8 percent—other than helmet hair and not good at riding a bike or scooter. Only 46 percent of men versus 63 percent of women viewed helmet hair as at least a slight deterrent. Between male-pattern baldness and current short hair styles 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 bikes, e-bikes, and e-scooters, 64 percent of women (61 percent for bikes, 63 percent for e-bikes, and 68 percent for e-scooters) versus 52 percent of men (48 percent for bikes, 49 percent for e-bikes, and 60 percent for e-scooters) viewed this as at least a slight deterrent.

3.4.4 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 percent of white, 89 percent of Latinx, 92 percent of

Black, and 98 percent of Asian respondents. Insufficient bike lanes/scooter space was at least a slight deterrent for 91 percent of white, 95 percent of Latinx, 86 percent of Black, and 93 percent of Asian respondents.

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

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

For bike share, danger and inconvenience of terrain was 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 percent of Latinx respondents versus 89 percent of white, 81 of Black, and 92 percent of Asian respondents. This deterrent decreased slightly for e-bikes and e-scooters, with 92 percent 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 of white, 89 percent of Latinx, 78 percent of Black, and 94 percent of Asian respondents finding this to be at least a slight deterrent. Black respondents seemed less deterred to use bikes, e-bikes, and e-scooters, with the largest deterrents for bike share being hills and destinations too far, which were at least a slight deterrent for 81 percent of Black respondents. In contrast, the largest bike share deterrent was auto danger (94 percent) for Asian respondents, hills (97 percent) for Latinx respondents, and auto danger (92 percent) for white respondents.

3.5 Theory of Reasoned Action

An ordinary least squares (OLS) regression without intercept was fit to the data in order 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 answers to questions about motivations and deterrents about how the riders believed they were 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:

$$\mathbf{BI = 0.78\ AB - 0.08\ SN}$$

Table 3-1 Summary information about the weights

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

AB's weight was very statistically significant, but SN's weight was not quite significant and also rounded to zero effect. This indicates that social norms were not a significant predictor of behavioral intention, but attitude toward the behavior was. For each 1 increase in AB score, BI increased by 0.78. For each 1 increase in SN score, BI decreased by 0.08. The weighting for SN, given statistical significance, was essentially 0, so it was not a concern that the weight was 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, reported 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.

3.6 The Four Types of Cyclists

The bar chart in figure 3-4 shows the proportion of respondents that fell into each type of the four types of cyclists. The four types of cyclists corresponded to 1 = strong and fearless, 2 = enthused and confident, 3 = interested but concerned, and 4 = no way, no how. The majority of respondents (71 percent) fell into type 3: interested but concerned.

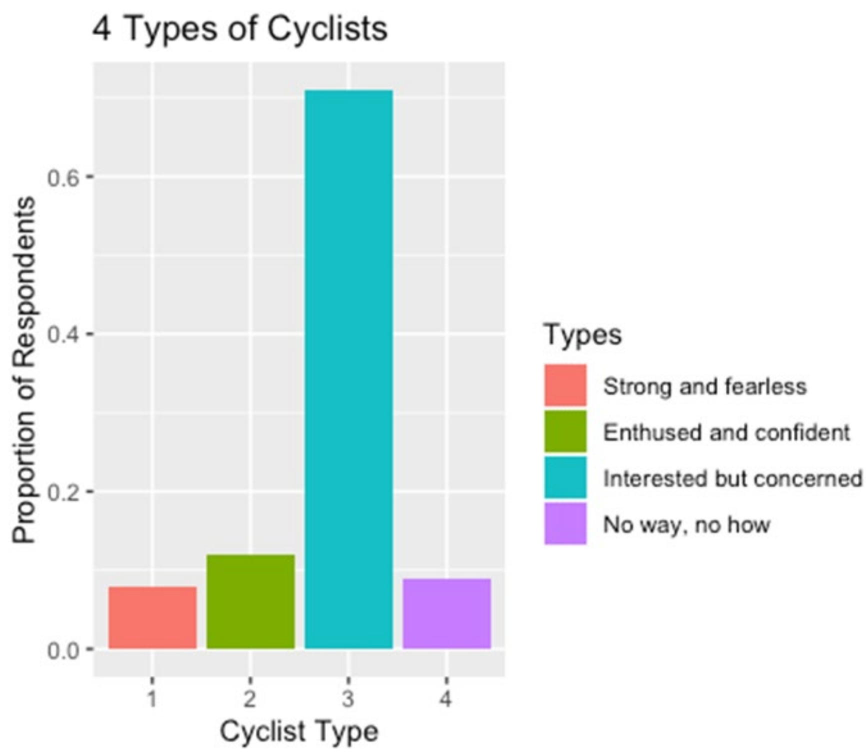

Figure 3-4 Four types of cyclists

Calculating the BI score, as described above, resulted in behavioral intentions of 2.90 for cyclist type 1, 1.71 for cyclist type 2, 1.77 for type 3, and 1.71 for type 4 (these scores are only meaningful in relation to each other). Clearly, the strong and fearless group had 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 were 82 for cyclist type 1, 61 for type 2, 64 for type 3, and 39 for type 4.

According to these data, cyclist type 1 was most motivated to ride more. That group is, however, the smallest of the four. 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 indicated wanting to ride more by the size of the group in our sample (figure 3-

5). Type 3 (interested but concerned) was clearly the group with the highest total potential (73 percent of the total potential).

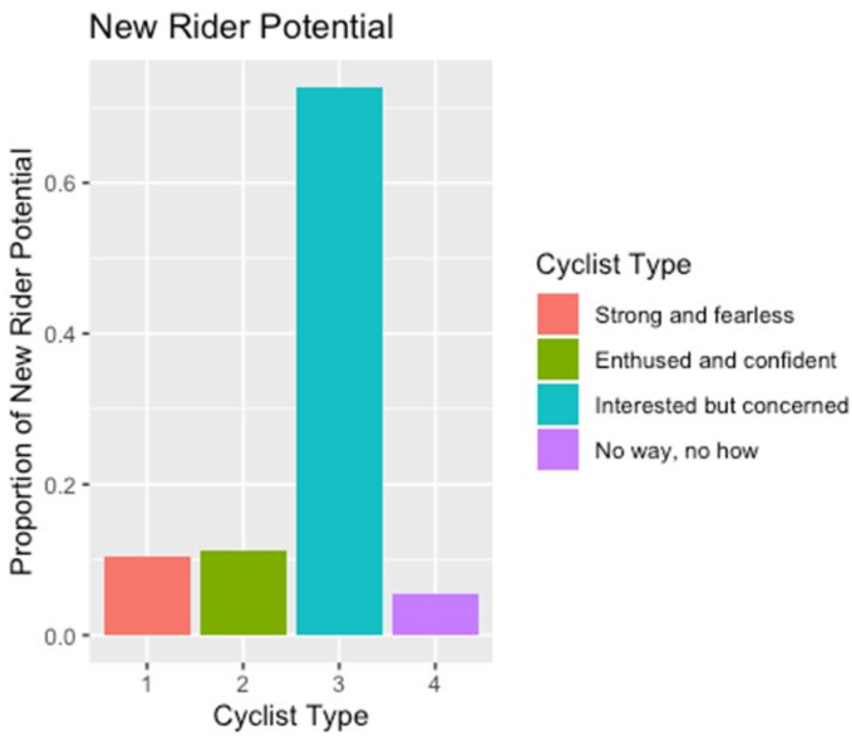

Figure 3-5 New rider potential by cyclist type

3.6.1 Differences in Motivators by Cyclist Type

Not surprisingly, there were quite a few differences in motivations by cyclist type. Those in cyclist type 4 (no way, no how) had the weakest motivation to use bike, e-bike, and e-scooter share. The strongest motivator for type 4 was exercise, with 70 percent of type 4 cyclists identifying it as at least a slight motivator. On the other hand, those in cyclist type 1 (strong and fearless) were highly motivated (at least 86 percent of type 1 cyclists were motivated by each motivation presented). The strongest motivators for type 1 were exercise and enjoyment, with 93 percent 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 percent), protecting the environment (86 percent), and enjoyment (84 percent). They were least motivated by a complement to public transit, with only 65 percent 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 percent of type 3 cyclists were motivated by that reason, except for a complement to public transit, which only motivated 68 percent of type 3 cyclists. The top motivations for type 3 cyclists were exercise (91 percent) and enjoyment (88 percent).

3.6.2 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 bike, e-bike, and e-scooter share was bad weather. This was at least a slight deterrent for 88 percent of type 1 cyclists, 97 of type 2, 96 percent of type 3, and 99 percent of type 4 cyclists. 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 percent of type 1 cyclists, 93 percent of type 2, 94 percent of type 3, and 76 percent of type 4 cyclists. Inconvenient locations for obtaining and returning bikes/scooters was at least a slight deterrent for 78 percent for type 1 cyclists, 88 percent of type 2, 87 of type 3, and 80 percent of of type 4 cyclists.

3.7 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. However, the responses tended, instead, to cancel each other out, indicating that overall, neither solution is likely to be preferred over the other.

CHAPTER 4. DISCUSSION

Shared micro-mobility systems have been proposed to address many goals (Levitt, 1965; Cox, 1967). Our data provided insights 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 had 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 would be revealed as a superior mode for shared micro-mobility. However, 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 in regard to concerns about destinations being too far. There were also deterrents that were more pronounced for e-scooter share travel. Because scooters do not have baskets, the inconvenience of carrying things with scooters is more of a deterrent than for bikes. Respondents were more concerned about looking silly riding an e-scooter than a bicycle. While danger was reported to be 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 actually are because their danger is made more salient by news reports that highlight accidents that involve scooters. This is the same effect that occurs 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 eight 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 require 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 were Seattle, Washington, and Portland, Oregon. Both cities are built on hills and both have more rainy 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 own 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 four types of cyclists. In comparison to an earlier study in the city of Portland (Dill and McNeil), our distribution included many more in the "interested but concerned" group and fewer in all the others (71 percent versus 56 percent). On the basis of the numbers in that group and their calculated behavior intentions to use shared micro-mobility systems, they appear clearly to be the group with the greatest potential for increased 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 who met those descriptions but did not find their behavioral intention to use shared micro-mobility to be different from that of the sample as a whole.

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

CHAPTER 5. CONCLUSIONS

There is not a quick fix to increasing usage of shared micro-mobility. The issue of safety must be addressed by improving infrastructure with more bike lanes and paths. Also a campaign to educate the public is needed. 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 distorted views of the risks and need to be educated otherwise.

On the basis of the motivations and deterrents identified, usage can be encouraged by offering a variety of options: docked and dockless, bikes and scooters.

Some deterrents cannot be fixed, such as weather and 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 weather and hills. Any promotional activities should be targeted to the "interested but concerned" rider 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 in the Pacific Northwest.

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