Factors Influencing Bicycle Use in a Medium-Sized City: the Case of Iloilo City, Philippines

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Abstract:

This study aims to explore the factors that influence an individual's propensity to use bicycles. Using the results of a cross-sectional survey administered to 400 residents of Iloilo City, Philippines, the likelihood of using bicycles during pleasant weather, when travelling at night, during peak hours of traffic, and for recreation, were fitted with 28 explanatory variables comprising the socio-economic factors, psychological factors, environmental factors, and trip purposes. Models were generated using binomial logistic regression for each of the four outcome conditions. Socio-economic variables such as gender, and psychological factors consistently appeared as significant predictors, particularly the perception of self-efficacy and inherent preference to bicycle as a mode of transport. Environmental factors such as connectivity, bikeable destinations, and security are also significant predictors of propensity use bicycles. Practical ways to increase bicycling rates and recommendations to improve the predictive capacity of the models are also discussed.

Keywords: Non-motorized Transport, Factors Influencing Bicycle Use, Regression Analysis

1. INTRODUCTION

Bicycle use in Asia is steadily declining. As of 2015, mode share in cities like China and India have decreased to 25% and 17%, in large cities, and to 1% in smaller cities, respectively. Other Asian countries showed mode share of about 3% (Mason et al., 2015). Asian cities bicycling rates in 2008 were found to be around 7-15% in large Indian cities to 13-21% in medium-small sized cities. Chinese cities showed bicycle modal share at about 11% to 47% (Tiwari et al., 2008). In high income countries like Taiwan, mode share is at 1-2% as of 2003 (Chang et al. in Tiwari et al., 2008) while in Singapore it is at 0.8% but growing with the recent promotion of bicycle as a sustainable mode of transport (Barter in Tiwari et al., 2008). In large but low-income country like Bangladesh, mode share is at 4.3-7.1%. Cycling rates in Philippine cities are not well-documented but like most Asian cities, there is a growing concern from the negative impacts of increased motorization in its urban areas.

According to Bicycle Report (Tiwari et al., 2008) three factors are said to be affecting bicycle use in Asia: 1) the local bicycle manufacturing industry, 2) policy support from the government, and 3) socio- economic conditions. This conclusion falls short of the findings in

numerous bicycling literature on the effects of physical environment, attitude and personal beliefs of bicycling behavior, which this study will try to look into.

This study intends to investigate the effect of the psychological and physical environmental factors to cycling behavior referencing on the environmental perception framework (Ittelson, 1978; Patricios, 1976) to explain the spatial behavior and the environmental factors that lead to the performance of such behavior. Ecological frameworks (Pikora et al., 2003) were also referenced in consideration of the factors that support physical activity such as bicycling. The interest of this study is in finding out if the existing physical environment of Iloilo City is supportive of cycling behavior, to either current or potential bicycle users. Additionally, we are also interested to know if individual beliefs and attitude also impact cycling behavior. Are the mental images and visual experiences formed from these psychological and environmental factors able to contribute to an individual's decision to use bicycles?

Cycling is already known to have positive impacts to health, environment and economy that countries have been directed to set specific cycling targets, in addition to the list of commitments required by the UN Sustainable Development Goals (SDG) Goal 11 on creating inclusive, safe and resilient cities. One way to achieve high shift in cycling is through infrastructure development in favor of non-motorized modes of transport, development of bike share programs especially in medium-sized cities, and development of law and enforcement policies in protection of those walking and bicycling, among others (Mason *et al.*, 2015).

However, infrastructure and policy development alone would remain ineffective if policies fail to consider evidence required to respond to the needs of the target groups, in these case, the bicycle users. It is important that the perspective of the users are also taken into account when planning for effective sustainable transport polices and infrastructure. This study attempts to look into these users' perspectives on the current physical environmental conditions to determine if these are a factor in one's decision to use bicycles. The additional factors being considered are the personal attributes (socio-economic factors), trip purposes, psychological (attitudinal or individual) factors and the perceived physical environmental factors.

The influence of these factors on bicycle use is best explained by the ecological model on active living (Sallis et al., 2006). Similar framework that considers the effects pf these factors to see the influence on the behavioral intention to walk and cycle is by Pikora et al. (2003). Handy et al. (2010) proposed a similar conceptual framework to explain bicycling behavior.

Studies that look into the effects of the built environment to travel behavior normally use perceived and objective categories of measure. Each requires a different methodology with the information for perceived measures gathered through interview or questionnaires (Ma & Dill, 2017). On the other hand, objective measures are more accurate in the sense that built environment characteristics such as street width are measured and linked with the behavior under observation. This study uses perceived measures of environmental factors along with individual and external factors influencing the likelihood to use bicycles.

Cycling and walking are normally put together under the general category of active transport but the difference is that cyclists are able to travel faster, carry more loads and might be willing to travel longer distances than the pedestrians (Mcneil, 2009). With regards to distance, the distance a cyclist is willing to go depends on the trip purpose, with utilitarian trips generally being shorter than other trip purposes (i.e., recreation or exercise). Such variation would require different policy and infrastructure interventions, if the aim is to increase rates in either modes

albeit any improvements on either cycling or walking would have substantial positive benefits to both modes.

Iloilo City, the study site, has recently seen an upsurge in public investments for pedestrian and cycling infrastructure. It has also embarked on an annual bike festival to promote the functional and recreational use of bicycles in the city and its surrounding municipalities. Given these encouraging environmental conditions, and the literature that speaks of investments in cycling infrastructure as influencing factor on bicycle use, it can be assumed that bicycling rates in the city should substantially increase (Almec Corporation, 2015).

2. REVIEW OF RELATED LITERATURE

Researches on determinants bicycle use, have attempted to produce frameworks for properly assessing these factors. Pikora *et al.* (2003) developed a framework to streamline the assessment of environmental determinants of active travel. The systematic analysis resulted in the four (4) broad categories of features; i.e., functional, safety, aesthetic and destinations, each with its own specific features and components. Panter *et al*. (2008) developed a quite similar determinants framework from a study on active travel with youth participants. The determinants were also grouped into physical environmental factors, individual factors and external factors. Studies on physical environmental determinants tend to use ecological models (Sallis *et al.*, 2006)**,** which works on the assumption that environmental factors, both the physical and social aspects of it, public policies and existing social systems are influential to an individual's performance of certain activities.

Theory-wise the most commonly-used to predict likelihood to cycle, which takes into account influences for decision-making and behavioral change, is the Theory of Planned Behavior. Applying the TPB and using its three (3) components along with a component of norm activation model and personal norms, Harland *et al.* (1999) found out that personal norms (attitudes) predicted intention to use transportation means other than the car.

2.1 Personal Attributes (Socio-economic Characteristics)

Using survey and daily travel diary of participants from five (5) Irish cities, Gatersleben & Appleton (2007) found out that gender, car ownership and journey distance have the largest effect on the use of NMT. Men and more educated participants are more likely to bike. This affirmed the gender-associated differences in cycling suggesting the need for gender-based measures to decrease the gap and make commute safer for women. Age is inversely associated with likelihood to use bikes. The type of employment is also inversely associated, with professionals less likely to use bicycles. However, certain factors such as bicycle ownership points to a positive effect on rates of bicycling (Heinen *et al.*, 2010), but the opposite effect was found in another study done by Sallis *et al*., 2013).

Some researchers cautioned against relying too much on socio-economic attributes to determine propensity of bicycle use. Heinen *et al*. (2010) mentioned that due to differing circumstances between countries, regions and populations, correlation between these factors and cycling is difficult to establish and are largely affected by non-tested factors. Additionally, they suggested to test for social and attitudinal factors instead.

2.2 Psychological Factors

Attitudinal characteristics were found to influence bike use particularly with cycling to work (Heinen *et al*., 2011; Heinen *et al*., 2010). In a study of the neighborhoods in San Francisco Bay area, attitudinal factors were found to be more strongly associated to travel than environmental factors such as land use characteristics (Kitamura *et al*., 1997), suggesting that in order to produce substantial change in travel patterns, the individual's perception and attitude must first be changed, along with environmental interventions. Attitudinal factors have also been found to be correlated with bike use in other areas in North America and Europe (Handy *et al*., 2010; Fernández-Heredia *et al*., 2014; Heesch *et al*., 2014). Habit was found to be a strong predictor of cycling behavior among the Dutch adults (de Bruijn *et al*., 2009) and in cases where habit was weak, attitude played a significant role in influencing cycling behavior suggesting that attitude-based interventions should be prioritized to encourage active travel. Habits also played a role in shaping an individual's perception of bicycles as viable modes (Aarts *et al*., 1997). Titze *et al*. (2007) indicated that habitual cyclists, more than the irregular ones, tend to view bicycle as a mode that could bring them the quickest to their destination, and with more ease. This suggests that habits do enhance positive perception towards this mode.

2.3 Physical Environment Factors

Review of studies on correlates of active travel, Panter & Jones (2010) found that attitudes and subjective norms (such as self-efficacy) tend to mediate the association between intention and environmental components such as aesthetics and travel behavior.

Sallis *et al*. (1997) found no association between perceived physical environment and rates of physical activity. However, numerous developments have been done in this field of transportation research particularly in the development of scales that could more accurately measure perception of the built environment. Current researches have established that features of the built environment indeed influences an individual's decision to mode choice, particularly the objectively-measured built environment (Ewing & Cervero, 2001; Troped *et al*., 2003, Troped *et al*., 2001; Humpel *et al*., 2002; Panter & Jones, 2010; Frank *et al.*, 2003; Dill & Carr, 2003; Sallis *et al*. , 2013). More specifically, these built environment features associated with cycling are a mixture of various functions, such as storage facilities, distance, parking facilities, traffic lights and stops, among others (Heinen *et al*., 2010).

The functionality features of the physical environment are known correlates of cycle use. Functionality here refers to the physical attributes of the neighborhood streets, the paths and other items related to the structural aspects of the environment or the neighborhood. Included in this are the bicycle paths, direct routes, and traffic volumes. Bicycle paths have shown association with bicycle use (Troped *et al*. , 2001). More specifically, utilitarian cycling also showed positive associations with perceived connectivity between and among various zones and land uses, and perceived presence of bicycle lanes (Nelson *et al*., 1997). Similarly, objectively-measured presence of bicycle lanes showed positive associations to utilitarian cycling (Mertens *et al*., 2017).

Ma & Dill's (2017) investigation on the mismatch between objectively and subjectively-measured physical environment factors of neighborhood bikeability showed that perception of the physical environment tends to be influenced by levels of social support - a feature of the social environment. Individuals who provided low rating of their cycling environments were

found to have low level of social support, suggesting that social marketing aimed at improving reputation of the bicycle as a mode of transport or tool for active travel be considered as a viable intervention to increase rates of bicycle use.

In terms of aesthetics, higher levels of urban canopy and greenness were found to positively enhance propensity for bicycle use (Cole-Hunter *et al*., 2015).The same also holds true for urban areas that provide good access to public bicycle stations and safe bicycle parking spaces. On the other hand, perceived crime rate showed negative associations with physical activity such as biking (Troped *et al*., 2011).

Other than the attitudinal and physical environmental factors, the likelihood to use bicycles is also influenced by external factors such as climate. Moderate temperature (not too hot or too cold) and little rain tend to increase modal share of bicycles. On the other hand, extreme and uncertain weather conditions tend to negatively affect an individual's decision to commute using the bicycles (Heinen *et al.*, 2010). Specific factors of weather and climate such as precipitation, temperature, and humidity significantly affect cycling rates, with comfortable weather doubling the ridership by as much as 50%, while an increase in humidity and temperature (60% and 28°C maximum) decreased the ridership (Miranda-Moreno & Nosal, 2011).

Studies in Asian cities also showed associations of bicycle use with the built environment. Elderly cycling behavior in Chinese cities showed associations with physical environmental characteristics such as compact urban forms, safe cycling environment, along with some attitudinal and socio-economic correlates (Zhang *et al*., 2016).

3. METHODOLOGY

3.1 Questionnaire Development and Data Collection

The cross-sectional survey was conducted in April 2016 to about 400 respondents proportionately sampled from the six districts of Iloilo City, one of the highly urbanized cities in central Philippines. The eight-man survey team conducted the interviews from April 6-14, 2016, from 8:00 in the morning until 5:00 in the afternoon. It covered at least one weekend to consider respondents who are not at home/not available for interview on weekdays because of work.

The instrument used in the study is a two-part, 23-item questionnaire comprised of 100 questions, developed from previous studies on active travel (walking and bicycling). Part 2 of the questionnaire focused on biking, which is what was utilized for this study. The initial step in the development of the questionnaire was to review available published active travel questionnaires such as the Neighborhood Environment Walkability Scale Confirmatory Factor Analysis Scoring (NEWS-CFA) (Cerin *et al*., 2006, 2009) and the Pedestrian and Bicycle Survey (PABS) (Krizek *et al*., 2010), which are both self-administered active travel survey instruments. Both were condensed in consideration of the respondents' survey fatigue maintaining comprehensibility and tested for reliability. The NEWS-CFA focused on perceived environmental conditions while PABS on measuring rates and purposes of cycling in a community.

Following the review, a list of psychological and physical environment items for cycling were identified. Some items required modification to fit in the local context and the resulting localized questionnaire items were then subjected to experts' review. The questionnaire was then translated to the local language *Hiligaynon*, and the translated questionnaire was pre-tested for comprehensibility. The enumerators of the survey team underwent orientation on the questionnaire before they were sent out to the field.

From the main questionnaire, five (5) categories or sub-scales were culled out to be used for the study: personal attributes (socio-economic characteristics), trip purpose, psychological factors, perceived environmental factors (physical environment and external factors), and likelihood of using bicycles. Personal attributes had six sub-questions while trip purpose had four. The sub-scales had the following items under it: five psychological factors, nine physical environments, two external factors, and four likelihoods of using bicycles. The sub-scale items were formulated in Likert-type scales (i.e., individual and environmental factors) with assigned values of 1 to 5 (1 = strongly disagree to 5 = strongly agree). These were then dichotomized for this study. The outcome variable, the likelihood of using bicycles, which the respondents previously rated on a 5-point scale of highly unlikely (1), moderate (3) and highly likely (5), were likewise dichotomized into 1 = likely (highly likely, likely and moderate) and 0 = unlikely (highly unlikely and unlikely). Age and income retained their continuous measure.

Responses were coded correspondingly; categorical variables were assigned their corresponding values (i.e., "0" for male and "1" for female), same with education level which were grouped into two and treated as categorical variables (high school undergraduate and at least high school graduate), and employment status (i.e., employed or not employed). Trip purpose was also treated as categorical variable. *Bike to work,* for example, was measured with a "yes" or "no", and coded 0 = no; 1 = yes. The same was done with car and bicycle ownership (0 = does not own; 1 = owns).

3.2 Selection of Factors Influencing Bicycle Use

3.2.1 Explanatory Variables (EV)

Environmental determinants were modified from the framework of Pikora *et al*. (2003). Table 1 shows the factors and the questionnaire items that comprise these factors and their corresponding features. The elements in each of the features are also indicated.

Table 1. Explanatory variables

	Predictors	**Elements**	**Features**
Social demographics			
1	Gender		Personal attributes
2	Age		
3	Income		
4	Employment status		
5	Education		
6	Owns bike		
7	Owns motorcycle		
8	Owns car		
Psychological factors			
9	I like to ride bicycles	Preference	

	Predictors	Elements	Features
10	I prefer commuting by bicycle over public transport	Mode preference	Personal preference and beliefs
11	Cycling is healthy way to travel	Health	
12	I am fit enough to cycle	Self-efficacy	
13	Cycling is safe	Safety	
Environmental factors			
14	There are alternative routes to get from one place to another	Permeability	Functional
15	Bike shares the same road as motor vehicles	Traffic	
16	High traffic makes cycling unpleasant	Volume	
17	Traffic speed in my neighborhood is low	Speed	
18	Cycling is quickest way to get around	Connectivity	
19	Bike parking facilities exist in my neighbourhood	Facilities	Destination
20	Distance to my destination is bikeable	Distance	
21	I bike even when it rains	Rainy weather	Comfort (external) factors
22	I bike even when it is hot	Hot weather	
23	There are of tree-lined paths in my neighbourhood.	Urban canopy (trees)	Aesthetics (physical environment)
24	My neighbourhood is crime free	Crime rate	security from crime
Trip purpose			
25	Biking for work		Activity-based travel
26	Biking to shop		
27	Biking for exercise		
28	Biking for recreation		

The predictors were analyzed individually but the categories of the factors and features which they belong to were retained so they can be analyzed using the socio-ecological models. Trip purpose is an uncommon determinant for bicycle use based on previous studies reviewed, but its influence on an individual's decision to use bicycles cannot be negated. Policy-wise it would facilitate in the crafting for specific interventions to get the population to start biking. If it appeared that biking for recreation is a determinant trip purpose, interventions pertaining to aesthetics should then be prioritized. Titze *et al*. (2011) showed that people biking for recreation tend to be more affected by streetscapes compared to those biking to work. In addition, Fernández-Heredia *et al*. (2014) mentioned bicycle ownership as one of the understudied factors, emphasizing further the need to include this variable in the study.

Preference for bicycle over public transport is also being investigated in consideration of mode choice since a previous study by Heinen (2010) mentioned that negative factors relating to car use or public transport and influential to an individual have a more positive perception on cycling. Currently, there is a national initiative to modernize the public transport system because it is outdated and unable to provide the kind of service expected of it. The choice to compare bicycle and public transport for this certain item is also in consideration of the high usage rate of public transport in Iloilo City.

3.2.2 Outcome Variables (OV)

There were four conditions presented on the likelihood for cycling, namely: likelihood to cycle on good weather, likelihood to cycle at night, likelihood to cycle for recreation and likelihood

to cycle on peak hours of traffic. Likelihood to cycle on good weather takes on a more general perspective on bicycle use while the three others present more specific conditions for cycling.

3.3.3 Data Processing and Analysis

Data were processed and analyzed using the Statistical Package for Social Science (SPSS) software. Since the outcome variable is dichotomous in nature, binomial logistic regression was used to analyze the data and predict the probability of the behavior happening, in this case, the use of bicycles, given the 28 explanatory variables (EV).

4. RESULTS

4.1 Respondents' Profile

Respondents profile is illustrated in Figure 1. Distribution of respondents in terms of gender was almost equal, with majority employed and at least have finished high school. The average monthly income of the respondents at PhP 17,000 is comparably lower than the national (PhP 22,000) and regional average (PhP 19,000) (Philippines Statistical Authority, 2016). Median income is much lower. However, since the income reported in this study is individual income, it can be assumed that household income of the respondents would be considerably higher than what is reflected here. Based on existing classification, majority of respondents would belong to lower income to lower middle income groups (Albert *et al*., 2015). Expectedly, very few respondents reported owning private cars (less than 10%) while 30% reported owning motorcycles. At least two in five people reported to be owning bicycles.

The main mode of transportation used in Iloilo City is the jeepney, a derivative of the mini-bus (Cameña & Castro, 2016). People use this mode in going to work, for shopping or marketing, and for carrying out leisure-related activities. Walking, on the other hand, dominates exercise-related activities followed by bicycling. The 2015 Transport and Traffic Management Plan of Iloilo City (Almec Corporation, 2015) estimated that 80-85% of daily trips within the city proper are made using public transport. Additionally, about 40% indicated that they use bicycles (Figure 2), and majority of these users use it for exercise (Figure 3). Less than 10% of the bike users indicated that they use bicycles for work-related trips.

Bicycle ownership is of particular interest since its influence on bicycle use is not commonly studied (Handy *et al*., 2010) although bicycle ownership is found to significantly contribute to the possibility of a person to use a bicycle for commuting (Heinen *et al*., 2010). Iloilo City currently does not have any bike sharing programs. Owning or borrowing a bicycle is the only way for an individual to access this mode. In this consideration, a policy that encourages the private sector such as the bicycle shops to come up with some form of a loaning scheme to potential bicycle owners could be worked out. As of now, these kinds of schemes are common only to motorcycle sales. Providing such schemes to potential owners of non-motorized vehicles might be effective in promoting active travel in the city.

Majority of respondents reported intention to use bicycles when the weather is comfortable enough (see Figure 4). Traffic congestion and high volume of vehicles and characteristics of peak-hour conditions negatively impacts the respondents' decision to use bicycles. More than half of respondents indicated their intention to use bicycles for recreation.

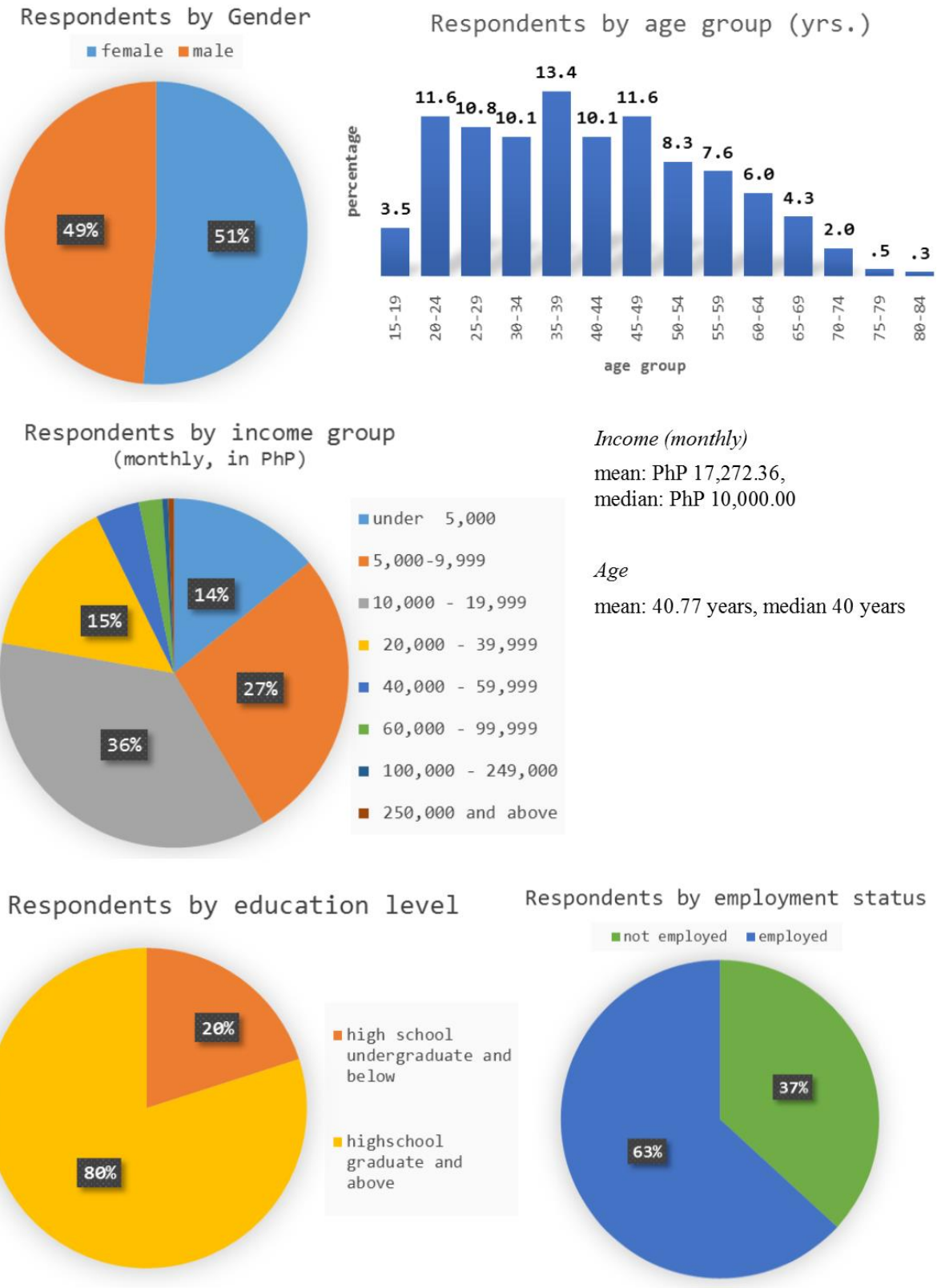


Figure 1. Socio-economic profile of respondents

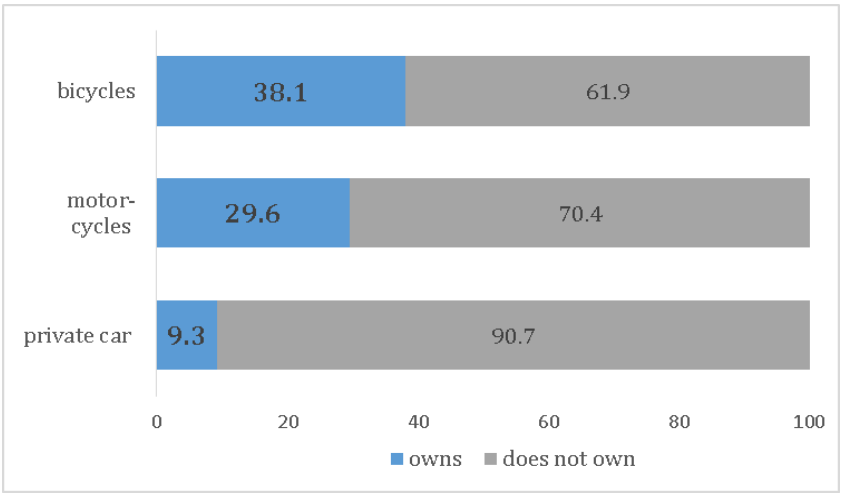


Figure 2. Vehicle ownership

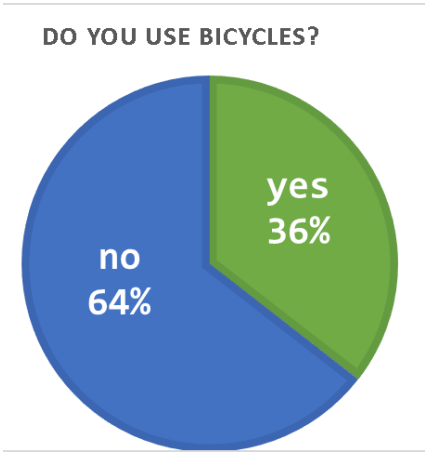


Figure 3. Bicycle users

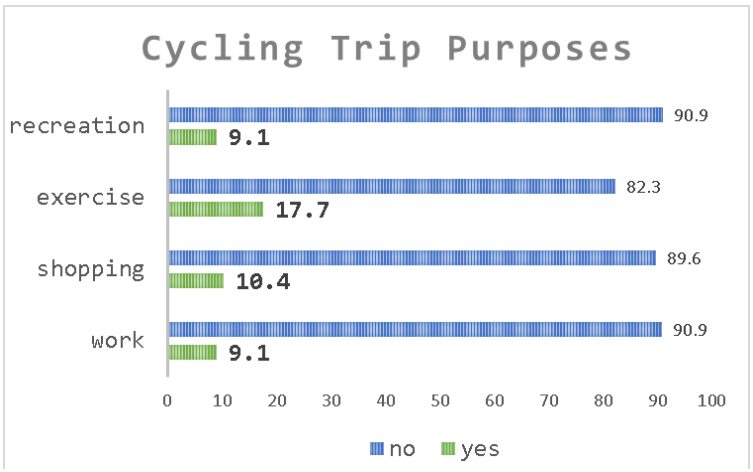


Figure 4. Cycling trip purpose

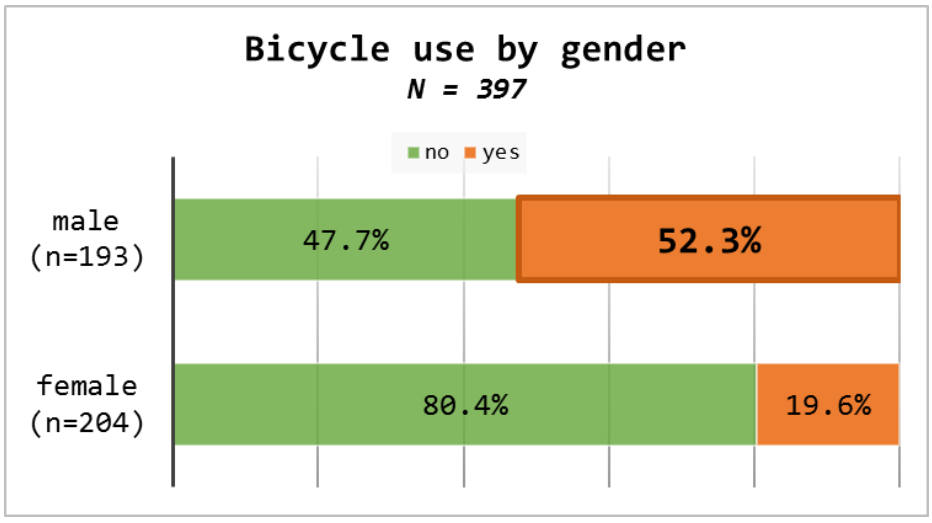
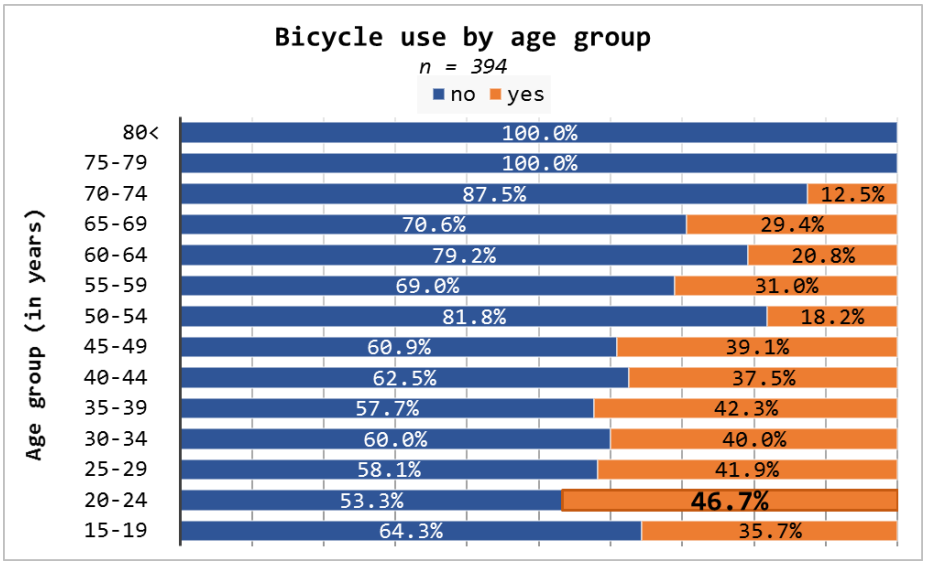
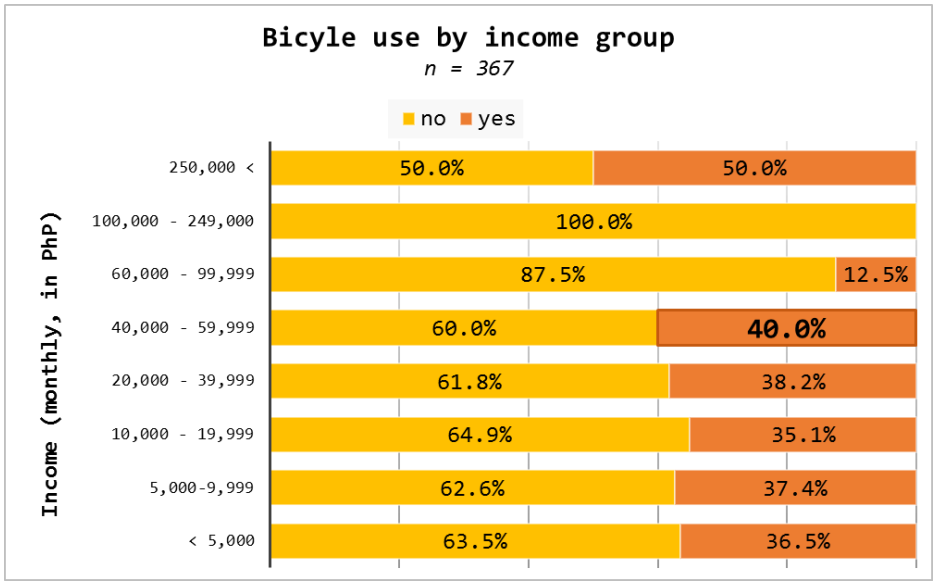


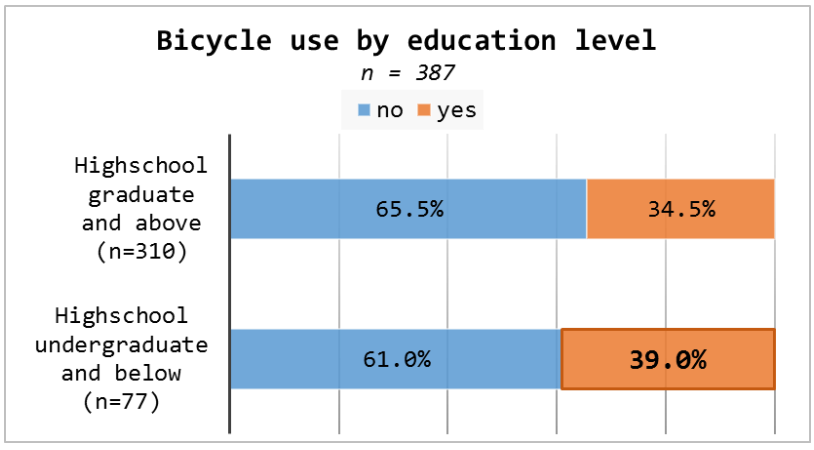
Figure 5. Distribution of bicycle users by gender



368 Figure 6. Distribution of bicycle users by age group



369 Figure 7. Distribution of bicycle users by income group



370 Figure 8. Distribution of bicycle users by education level

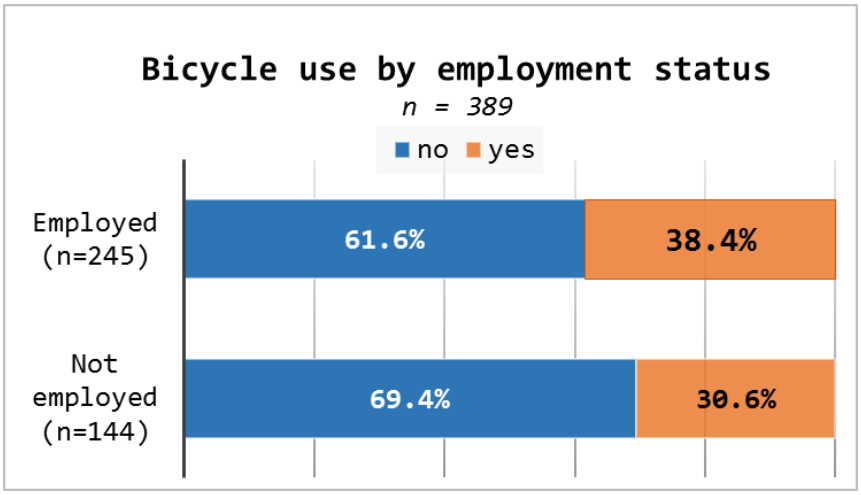


Figure 9. Distribution of bicycle users by employment status

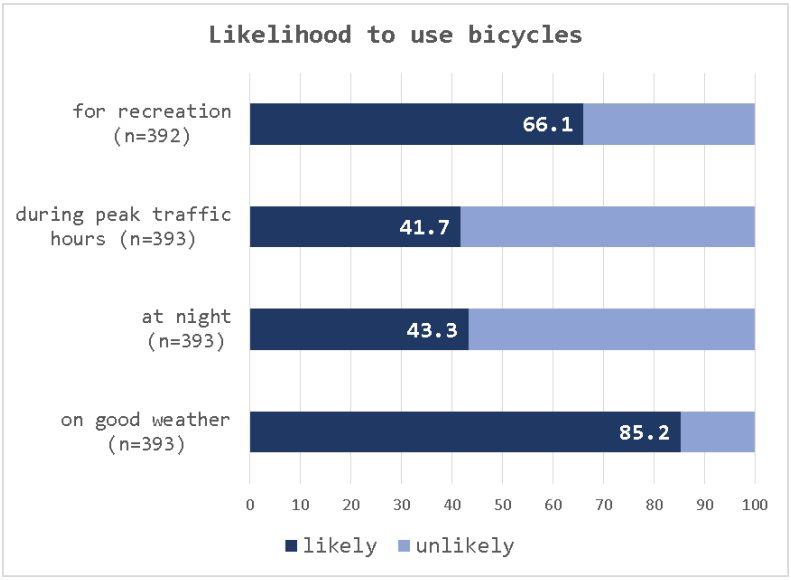


Figure 10. Respondents' likelihood to use bicycles

The bicycle users in Iloilo City tend to be male (Fig. 5), young and belonging to age groups 20-24 (Fig 6), within the middle income group (Fig. 7), employed (Fig. 9), and with low level of education (Fig. 8). Majority of the respondents are more likely bike during good weather, and least likely to do so during peak hours of traffic.

4.3 Regression Models

This study aimed to explore the factors that influence the likelihood of using bicycles, utilizing the factors identified in the previous discussions. There were four conditions of the outcome variables tested: likelihood to use bicycles on good weather, likelihood to use bicycles at night, likelihood to use bicycles during peak traffic hours, and likelihood to use bicycles for recreation. The first condition represents the general condition for using bicycles.

Tables 2-5 show the results of the binary logistic regression analysis using 28 explanatory variables comprising the personal attributes (socio-economic characteristics), psychological

factors (attitude), physical environmental factors (under the functional, aesthetic, destination, security from crime features), external factor (weather), and trip purpose.

Seven out of the 28 explanatory variables showed statistically significant associations with the outcome variable likelihood of bicycle use on a good weather (Table 2). The model shows that the odds of biking in good weather decreases with females, about 87% less likely this behavior would take place, and that the males are about 8 times more likely to use bicycles under this condition. Income showed associations with the outcome but its odds ratio value indicates that the odds across various income groups do not vary. Zacharias & Yang's (2014) study on bicycle use in three Chinese cities, on the other hand, showed no positive association with income. The odds of car owners biking under this condition is 97% lower than those who do not own cars. Remarkably, the model shows that those who own motorcycles are about 12 times more to use bicycles, implying the possibility of motorcycle owners trading in use of their vehicles in favor of bicycles. Those who like to bike and prefer to use bicycles for commuting are 12 times and 14 times more likely to use bicycles, respectively. Positive perception on the convenience of using bicycle to travel around also increases the likelihood of using bicycles. Unexpectedly, biking to work showed a decrease in odds for using bike when the weather is pleasing, which warrants further investigation. One possible explanation could be that the odds for doing other activities using bicycles (i.e., recreational or leisure biking, biking for exercise) may be influencing the effect of the variable in this mode. However, the other three trip purposes considered in this study showed no significant association with the outcome. This model showed the highest value for pseudo R2 than the models of the three other outcome variables generated, accounting for about 44%-79% of the variability in the outcome.

Table 2. Binary logistic models for likelihood to use bicycles in good weather

Significant variables in the equation	Sig.	Exp(B) (odds ratio)	95% CI for EXP(B)	
			Lower	Upper
Individual attributes				
Gender	.036	.126	.018	.876
Income	.004	1.000	1.000	1.000
Car ownership	.007	.025	.002	.365
Motorcycle ownership	.013	11.886	1.700	83.088
Psychological factors				
I like to bike	.004	11.636	2.225	60.852
I prefer to commute by bicycles than by PT	.002	13.757	2.610	72.510
Functional features				
Cycling is the fastest way to travel around	.000	32.125	6.267	164.689
Bike trip purpose				
To work	.014	.004	.000	.318
Constant	.999	2.053E-07		
Model summary				
-2 log likelihood	80.61			
Pseudo R2	.441			
	.792			

Table 3 shows that the odds of males using bicycles at night is 5 times more than females. Positive perception on the destination features also increases the odds of using bicycles at night by 5 times. On the other hand, low traffic speed appeared to be decreasing the odds of using bicycles at night, which is unexpected. One explanation for this could be that people who notice the low traffic speed of vehicles in their neighborhood tend to recognize not the low traffic

speed of the vehicles, but its presence, and are therefore more aware and sensitive to deterrents related to motor vehicles. Similarly, the odds of using bicycle at night decreases when issue of crimes in neighborhood is considered; the odds of those who see their neighborhood as crime-free will bike is about 79% less, but this may be due to the fact that a crime-free neighborhood is more inviting to another mode, which is walking. Weather is also a factor in this model, and the results say that those who do not prefer to be biking in hot weather are six times more likely to bike at night. People who like to bike for exercise are also twice more likely to do it at night. About 36%-48% of the variances in the outcome is explained by the model.

Table 3. Binary logistic models for likelihood to use bicycles at night

Significant variables in the equation	Sig.	Exp(B) (odds ratio)	95% CI for EXP(B)	
			Lower	Upper
Individual attributes				
Gender	9.614E-07	.209	.111	.391
Psychological factors				
I am fit to cycle	.045	.529	.284	.985
Functional features				
Traffic speed in my neighborhood is slow	.022	.346	.140	.858
Destination features				
The distance to my general destination is bikeable	.000	5.041	2.099	12.103
Security features				
My neighborhood is crime free	.000	.197	.100	.389
External factors				
I like to bike even when it is hot	.003	.154	.045	.533
Bike trip purpose				
For exercise	.047	2.552	1.012	6.434
Constant	.999	5.163E-08		
Model summary				
-2 log likelihood	321.743			
Pseudo R2	.356			
	.478			

During peak traffic hours (Table 4), people who perceive themselves as not fit to bike are at least two times more likely to use bicycles. Those whose prefer less to bike in hot weather have increased odds of using the bicycles under this condition, about four times more. Perhaps these groups perceive bicycle as a more convenient way of getting through traffic congestion, though the variable on connectivity features (i.e., cycling is the quickest way to travel around) failed to show significant association with the outcome variable in this model. Expectedly, males showed higher odds of using bicycles during peak hours, at least three times more than females. The odds are also higher for those who use bicycling as a form of exercise. Pseudo R2 values shows that 30%-40% of variability of the outcome is accounted for by this model.

Table 4. Binary logistic models for likelihood to use bicycles at peak hours of traffic

Significant variables in the equation	Sig.	Exp (B) (odds ratio)	95% CI for EXP(B)	
			Lower	Upper
Individual attributes				
Gender(1)	.000	.314	.177	.555
Psychological factors				
I am fit to cycle	.007	.442	.244	.799
External factors				

I like to bike even when it is hot	.019	.279	.096	.812
Bike trip purpose				
For exercise	.007	3.420	1.395	8.385
Constant	.999	1.121E-08		
Model summary				
-2 log likelihood	346.399			
Pseudo R2	.303			
	.408			

Car ownership is the only socio-economic variable which showed significant association with the outcome likelihood to use bicycles for recreation (Table 5). Those with cars are about 70% less likely to be biking for recreation. Positive attitude on bicycles and positive perceptions on environmental features of the neighborhood also increases the odds of using bicycles for recreation. Individuals who prefer to commute by bicycles are three times more likely to do the same for recreation, and those who view their neighborhood to have connectivity features and crime-free are four times and three times, respectively, more likely to use bicycles for recreation. About 36%-50% variability in the outcome is accounted by this model.

Table 5. Binary logistic models for likelihood to use bicycles for recreation

Significant variables in the equation	Sig.	Exp(B) (odds ratio)	95% CI for EXP(B)	
			Lower	Upper
Individual attributes				
Car ownership	.027	.303	.105	.873
Psychological factors				
I prefer to commute by bicycles than by public transport	.002	3.219	1.563	6.628
Functional features				
Cycling is the fastest way to travel around	.001	4.005	1.717	9.345
Security features				
My neighborhood is crime free	.000	3.346	1.753	6.386
Constant	.999	1.101E-08		
Model summary				
-2 log likelihood	286.635			
Pseudo R2	.363			
	.503			

Results of the study also affirmed the other socio-economic factors associated with bicycle use such as gender, car and motorcycle ownership. Although the models did not indicate positive associations with bicycle ownership, the odds of using bicycles tend to be higher in those who own neither of the two motorized vehicles. This somehow affirmed past studies which indicates that habitual car owners tend to cycle less than those without personal vehicles (Bergström & Magnusson, 2003). On the other hand, education and employment failed to show any association with likelihood of bicycle use, inconsistent with the findings of Heinen *et al.* (2010), which showed association with employment status and bicycle commuting particularly among part-time employed living near their work places. Education also showed no association or an inverse association with participation to physical activity related to bicycle commuting in a study by Beenackers *et al.* (2012). Nevertheless, Heinen *et al.* (2010) cautioned against the use of socio-economic attributes to explain rates of cycling as these tend to differ per country and region, and tend to be highly influenced by cultural and social beliefs.

Psychological factors consistently appeared as significant predictors of the likelihood to bike given the four conditions. These psychological factors include individual's self-efficacy towards bicycle use and modal preference. Attitudinal factors such as self-efficacy as a subjective norm does influence one's propensity to use bicycles. Hence, programs that improve an individual's skills and confidence in using this mode is of importance. In Iloilo City, some cycling groups have attempted to conduct bicycling classes to interested individuals aimed to improve their bicycle handling skills and their confidence to ride through the city streets. Same approach could be adopted by the community to initiate bicycle use in their area, targeting younger members of the community to promote healthy and active travel behavior to children of the community.

Choice factors such as trip purpose is considered a relevant factor in understanding characteristics of bike use (e.g., Fernández-Heredia *et al*., 2014). Decisions on when to take up cycling tend to differ among individuals depending on the purpose of the activity related to bicycle use. In this case, these showed associations with the four conditions of likelihood to use bicycles. This is also in consonance with past studies that recreational and exercise-related trip purposes are associated with likelihood to use bicycles (Bergström & Magnusson, 2003) and for recreation (Fraser & Lock, 2011).

Security features are an important factor to influencing bicycle use. Negative perception on neighborhood peace and order situation tends to adversely affect the odds of using bicycle. Functional features of environmental factors showed positive associations with the four outcomes implying that connectivity features also significantly influence ones decision to take on cycling. However, such perception can only be made by individuals who know the benefits of cycling. It is therefore imperative that the benefits of cycling in terms of decreased travel time and convenient travel are given emphasis in social marketing.

5. DISCUSSION

This study attempted to look into the factors that predict likelihood to cycle in Iloilo City, given the four common cycling conditions an individual encounters daily. While there are countless studies identifying the correlates and determinants of bicycle use, most of these are focused on developed countries in North America and Europe, and higher income Asian countries like China, India and Japan. The bicycle situation in small cities in developing countries is seldom looked into despite its potentials for transformation into more active transport modalities. By establishing determinants to bicycle use in Iloilo City, this study is able to identify the factors that either decrease or increase the odds of bicycle use in urban population of cities in developing countries. It is also able to compare results from previous studies and looked into the possibility of using the existing frameworks, measures and scales in identifying the determinants to using bicycles as a form of transport.

Considering that many of the bicycle users in the city are recreational bike users, the needs of these segment of population must be given attention to. Recreational bicycle use serves as a transition point for individuals shifting to utilitarian bicycle use. This is the point where the positive perceptions towards bicycle are able to work their way and result in potential shifting of mode, turning hobby into habits. However, caution must be observed when promoting bicycle use and formation of bicycle culture. Iloilo City has been labelled as one of the most livable and bicycle-friendly cities in the Philippines (Ranada, 2014) and was even compared to Copenhagen in its way to become a city of cyclists (Enriquez, 2016). But observing the lack of coherence and connectivity of its very limited number of cycling infrastructures, and the fast

disappearing pedestrian facilities, labels such as this might do more harm than good. Educating the population on what a bikeable city should be must also be a priority, beyond simply informing them on the benefits of cycling. "Bike-friendly city" labels would only serve their purpose in promoting bicycle use if it is coupled with sufficient scientific groundwork, and that the labels accurately tell the reality of the bikeability index of a city. This, along with subjective measures could provide effective tools for the city to come up with policies, agenda and development plans to enhance bicycle use.

One of the limitations of this study is that the social environmental factors (i.e. support from family) were not considered, and must therefore be included in future studies. Peculiarities in the inherent to cultural and social beliefs and traditions have been found to influence rates and likelihood for cycling, and create a different imagery and visual experience to a bike user. In this case, its exclusion could have possibly confounded the findings of this study.

There have been developments to models for explaining bicycle use, such as those that tried to include costs, use of other modes, travel time and distance. To make a more comprehensive analysis of the factors affecting bicycle use, these elements must also be considered in future studies, to see if it improves the predictive power of the model. Rietveld & Daniel (2004) have provided an explanatory framework on how individual features, socio-cultural factors and policy environment determine bicycle use, but added the aspect of generalized costs of other transport modes. The cost factor might be able to explain the reason behind the possible shifting of motorcycle user to bicycle during good weather. Additional explanatory variables comprising the psychological and physical environmental factors should be tested to see if it improves the predicting ability of the models.

This study have shown that the known factors on likelihood of bicycle use are also applicable to use for Asian cities, such as Iloilo City. However, it is also essential that future researchers develop bicycling metrics that take into account the social and cultural peculiarities of the developing Asian cities. Majority of indices were developed from studies which were conducted in developed countries, where cycling infrastructure are up-to-date and more in numbers, and the socio-economic conditions are in direct contrast with that of the cities in developing countries. Nevertheless, it remains important that the results of this study are considered in the future policies for the development of a cycling culture of a city in a developing country.

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