國立成功大學交通管理科學系

碩士論文

National Cheng Kung University

Department of Transportation and Communication Management Science

Master Thesis

以行為推理理論探討公共自行車之使用意圖－以 YouBike 為例

Exploring the Public Bicycle Adopting Intention with Behavioral Reasoning Theory－Taking YouBike as an Example

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July 2018

國立成功大學

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本論文業經審查及口試合格特此證明

論文考試委員：

指導教授：

系(所)主管：

中　華　民　國　107　年　7　月　6　日

ABSTRACT

Global warming caused by anthropogenic carbon emissions and traffic congestion caused by human activities make us hope to promote more people to use public bicycles and achieve the purpose of the transfer of private vehicles. The aims of this study are to understand what factors influence the adopting intention of public bicycle with the behavioral reasoning theory (BRT) and to realize how to encourage people to use public bicycle according to the key factors. This article explores the determinants and barriers of public bicycle adoption through five constructs: environmental values, factors for public bicycle adoption, factors against public bicycle adoption, global motives toward public bicycle adoption, and adopting intention of public bicycle.

This paper takes YouBike as an example, and survey the representative sample of Taipei City residents. There are 432 useful samples in total. The research methodology mainly has two sections. First, we apply the confirmatory factor analysis (CFA) to measure all latent variables via the manifest variables, and make sure the reliability and validity of the developed model are appropriate. Next, we apply the covariance-based structural equation model (CB-SEM) to evaluate the structure of constructs associated with the adoption of public bicycle. The results show the factors for public bicycle adoption do not affect the adopting intention of public bicycle. Besides, environmental values, global motives, and factors against are related to adopting intentions. In implications for policies, we suggest to guide people to have environmental values via education, improve global motives through enhancing attitudes, subjective norms and perceived behavioral controls, and raise the ease of use of public bicycle systems to increase adopting intentions of public bicycle.

Keywords: Bicycle-sharing, Green transportation, Behavioral reasoning theory, **S**tructural equation model

摘要

因應人為二氧化碳的排放造成全球暖化與人類活動造成的交通擁擠，促進並推廣更多民眾使用公共自行車，進而達到轉移私人運具的目的。本研究的主要是基於環境保護觀點下，應用行為推理理論探討哪些關鍵因素會影響公共自行車的使用意圖，並探討如何應用這些關鍵因素鼓勵民眾多加使用公共自行車。本研究利用五項潛在因素分析公共自行車使用的關鍵因素和障礙：包括環境價值觀、反對使用公共自行車之因素、支持使用公共自行車之因素、使用公共自行車之整體動機與公共自行車使用意圖。

本研究以台北市公共自行車 YouBike 為例，針對居住在台北市的居民進行調查，一共回收 432 份有效樣本。研究方法主要有兩個部分，首先，本研究應用驗證性因素分析經由外顯變數衡量潛在因素，並確保發展模型之可靠性和有效性是適當的。接著，本研究應用基於共變異數之結構方程模型來評估與公共自行車使用意圖相關之結構，試圖解釋多個潛在因素之間的影響關係。研究結果顯示，支持使用公共自行車之因素不影響公共自行車之使用意圖；另外，環境價值觀、整體動機與反對使用公共自行車之因素皆與公共自行車之使用意圖有關聯。本研究透過行為推理理論並探討在環境保護的觀點下，建議未來政策應從教育方面提升民眾對於環境價值觀的重視、加強騎乘自行車的整體動機、改善公共自行車系統的使用方便性，來提高民眾對於公共自行車系統的使用意圖。

關鍵字：自行車共享、綠色運輸、行為推理理論、結構方程模式

誌謝

兩年的時光過得很快，在追尋學問、實現夢想的過程中，絕非是一帆風順的，當象徵考驗的浪頭席捲而來，又呼嘯而去時，我的身旁總會牽繫著許多人，沒有他們的陪伴與幫助，我也無法安然地度過這些風風雨雨。

首先，感謝林佐鼎老師願意指導我，讓我自由自在地到處探索，深夜裏，系館有您的相伴使我在這條路上不再孤單，謝謝您培養我尋找、綜合、及整合資源的能力，並且有效率地解決問題；也在此感謝許多我兩年修過課的老師，在這裡，每一堂課都不輕鬆，卻也相當地精彩，一天一點都能從不同的老師學習到新的經驗與知識，讓這些新的事物激發我的靈感與想像，為難以預見的未來搭建看得見的基石。

再來，要感謝系上好朋友們的幫助，你們絕對是我能把這裡當作像家一樣溫暖的大功臣，謝謝台南吃吃團的令佳、佳汎、博建、揖安、宜庭、雨萱，填飽我在美食之都的口腹之慾，也幫我跑了好多雜事。謝謝翊暉的歌聲，鼓勵我對自己喜歡的事更加堅定；謝謝家瑋兩年的搞笑。也謝謝同窗的其他各位，這邊真的太多故事礙於篇幅無法一一寫上，但我想你們都懂得。謝謝學弟學妹們，育誠、柏宗、筑涵、珮鈴、芳伃、家偉、佑霖、佳瑄、亭葦、昱偉、竺瑾...等等，讓我參與你們的故事，分享彼此的生活與觀點，為讀碩士的時光增添不少色彩，你們一定都會順利畢業的。謝謝舊時的好朋友，雁升、承瀚、家銘、天保、哲瑋...等等，沒有你們我也沒辦法到成大經歷這麼多故事。

最後，當然要謝謝我的家人，讓我沒有壓力地在這裡盡情發展。我很幸運，也珍惜這樣的機會，秉持著心存善念、盡力而為的理念走向人生下一個階段，相信身旁所有的人都能做得比我更好，祝福各位都能實現心中盼望的夢。

劉廷毅 謹致

中華民國 107 年 8 月 18 日

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CHAPTER 1 INTRODUCTION

In this chapter, we introduce our research motivation, objective, research scope, and research content with research framework.

1.1. Research Background

According to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC), it discovered the global climate system was changing and existed the trend of warming, with many of the observed phenomena including warming of the atmosphere and the ocean, decreasing snow and ice, rising sea levels and increasing concentrations of greenhouse gases (GHG) (Stocker, 2014). For instance, the global average surface temperature of land and ocean had risen 0.85°C since 1880 to 2012. The report also mentioned that a crucial factor of observed global warming was mainly from human activity since the middle of the 20th century.

The result of excessive human activity, such as burning fossil fuels and clearing forests, caused that much anthropogenic carbon dioxide (CO_2) released into the atmosphere (Buis, Ramsayer, & Rasmussen, 2015). There are many greenhouse gases in the atmosphere, and CO_2 is one of them. It plays an important role to influence Earth's surface temperature through the greenhouse effect (Petty, 2006). Fig. 1-1 shows CO_2 data which measured at Mauna Loa Observatory (MLO) on the island of Hawaii from 1959 to 2017 (Dr. Pieter Tans, NOAA/ESRL and Dr. Ralph Keeling, Scripps Institution of Oceanography, 2018). This evidence indicates that the Earth's annual mean CO_2 level has been increasing every year and had reached 406.53 ppm in 2017. Besides, according to WMO Greenhouse Gas Bulletin (GHG Bulletin), the analysis of observations states that globally averaged CO_2 mole fraction in 2016 had reached a new high in 2016, with value at 403.3 ± 0.1 ppm. The record increase

of 3.3 ppm in CO_2 from 2015 to 2016 was larger than previous records.

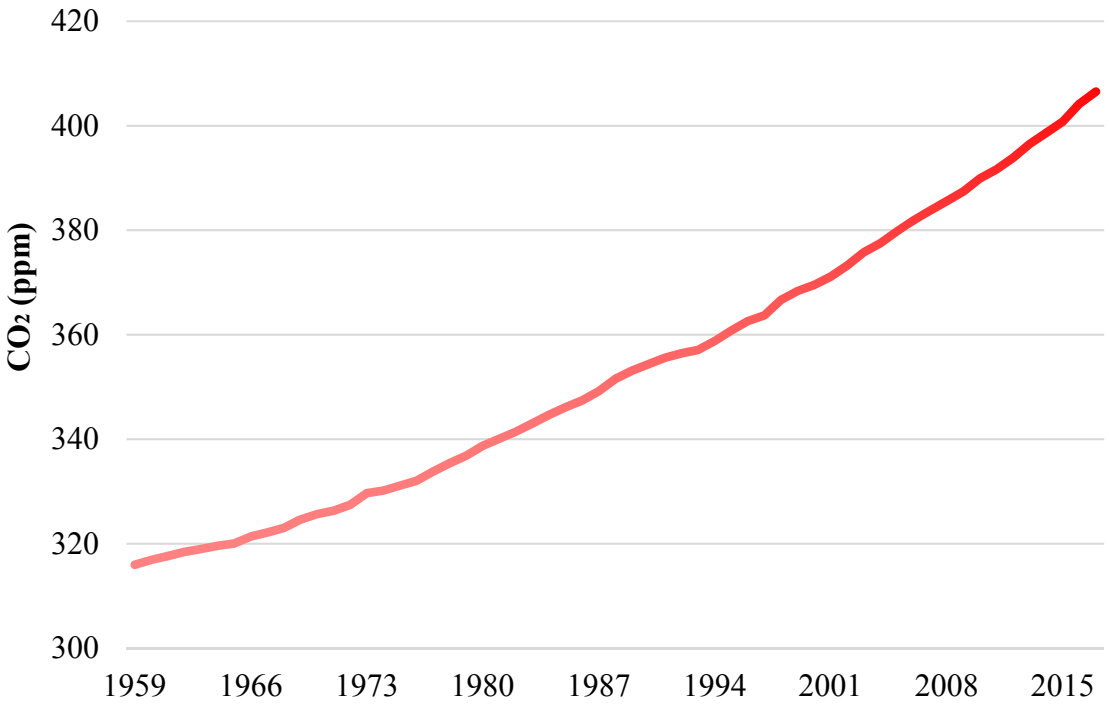

Figure 1-1 Annual mean atmospheric carbon dioxide at Mauna Loa Observatory (Source: Dr. Pieter Tans, NOAA/ESRL and Dr. Ralph Keeling, Scripps Institution of Oceanography, 2018)

In addition, Fig. 1-2 describes the annual mean CO_2 growth rate for Mauna Loa, the bar corresponds to a value of each mean rate of growth of CO_2 per year (Dr. Pieter Tans, NOAA/ESRL and Dr. Ralph Keeling, Scripps Institution of Oceanography, 2018). From the graph, The trend of growth is obvious. It confirms that all observation values are positive and annual CO_2 growth rate is getting faster and faster. The growing of CO_2 level means that the changing in Earth's environment is unambiguous owing of CO_2 emissions. Therefore, regulating CO_2 emissions becomes the vital way to mitigate the deterioration of global warming and curb extreme climate for human.

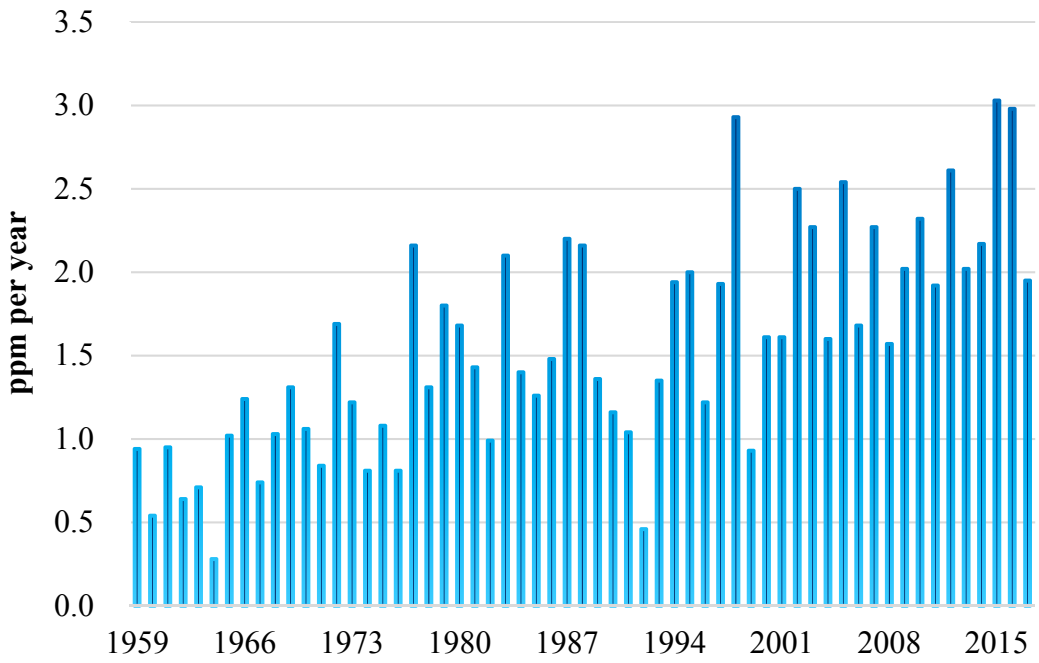

Figure 1-2 Annual mean carbon dioxide growth rate for Mauna Loa

(Source: Dr. Pieter Tans, NOAA/ESRL and Dr. Ralph Keeling, Scripps Institution of Oceanography, 2018)

1.2. Research Motivation

In order to curb global warming, most countries made efforts to reduce carbon emissions in the past few years. An international environmental treaty called the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992. Its objective was to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. In 2016, representatives of 196 parties at the 21st Conference of the Parties of the UNFCCC signed Paris Agreement which set more specific goals to replace the Kyoto Protocol of 1997 in Paris. Although Taiwan did not have a membership in United Nations, the government still led to the passage of the Greenhouse Gas Reduction and Management Act in 2015. The aims of this act are to establish strategies to reduce and manage greenhouse gas emissions, strengthen

environmental justice, and the shared responsibility of environmental protection and national development.

According to the report of the International Energy Agency (IEA), the global CO_2 emissions from fuel combustion by transport sector in the world account for about 24% in 2015 (International Energy Agency, 2017). The report of the Bureau of Energy, Ministry of Economic Affairs also mentions that the CO_2 emissions of transportation sector is slowly increasing and has 14.26% emissions in 2016 (Bureau of Energy, Ministry of Economic Affairs, 2017). Fig. 1-3 displays domestic CO_2 emissions by sectoral approach excluding electricity consumption emissions. It suggests that the transportation sector plays an important role in energy saving and has the obligation to reduce CO_2 emissions.

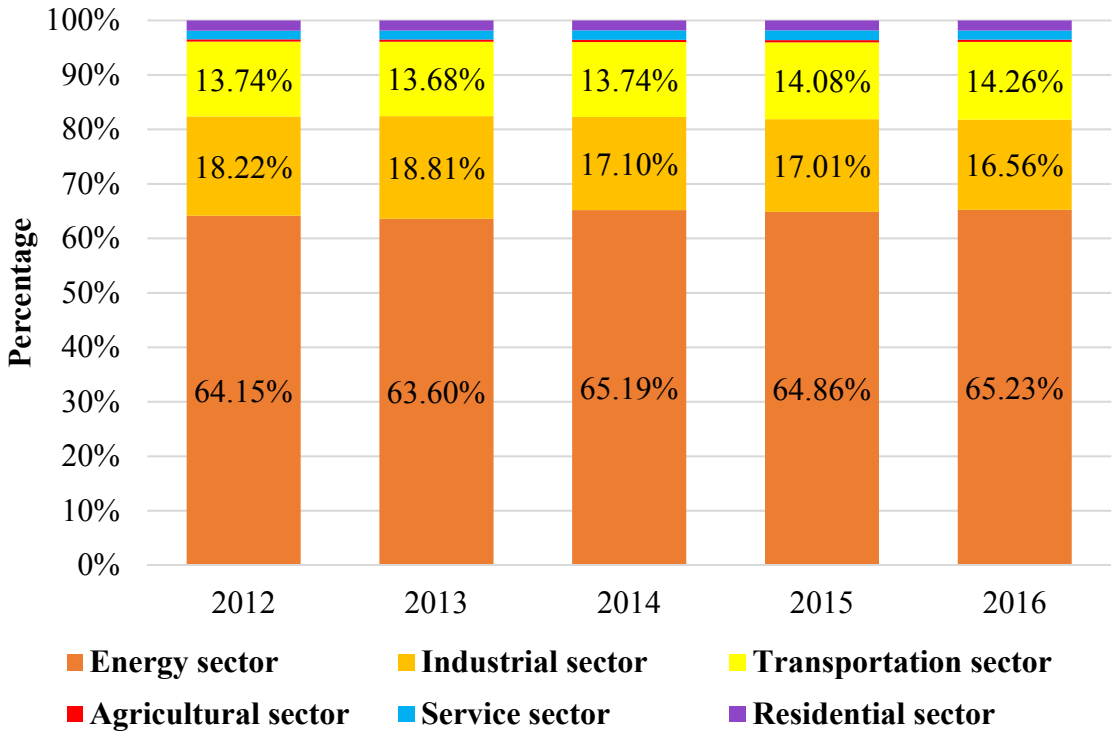

Figure 1-3 Domestic CO_2 emissions by sector

(Source: Bureau of Energy, Ministry of Economic Affairs, 2017)

Due to the human activity rapidly in the world, we have faced a huge challenge, such as climate changing, global warming, and the decreases of natural resources. In the transportation sector, the proportion of the private vehicle ownership and usage is getting higher and higher every year, it causes air pollution, noise, crowded cities, and traffic congestion. Therefore, the awareness of economic efficiency, environmental protection and energy saving gradually are taken seriously by the government and the public in recent years. For these reasons, the public bicycle sharing system is the sustainable mode of urban transportation in views of its the low-pollution and the low-energy-consumption, and it is a feasible solution of urban mobility.

In order to encourage citizens to use public bicycles as short-distance transit vehicles, Taipei City Government launched the Taipei public bicycle sharing system, also known as YouBike in 2012. However, the Taipei City Department of Transportation has begun charging YouBike riders for first 30 minutes of use in April 2015. The monthly rentals in Taipei City obviously stopped growing after reducing subsidy. The number of rentals dropped significantly by 20 percent immediately, and the monthly rentals have not been more than two million for twenty-three months continuously. Therefore, how to effectively promote people to use the public bicycle sharing system as a short-distance transportation mode and reduce or replace personal possession and usage of motor vehicles becomes an urgent issue.

1.3. Research Objective

According to the above research motivations, this study hopes to achieve three research objectives as follows:

(1) To explore the determinants and barriers of public bicycle adopting intention with the behavioral reasoning theory and the aspect of environmental protection from the empirical study.

(2) Based on the results of empirical study, the paper will put forward suggestions and implications for policies, hoping to provide reference opinions to the government so as to enhance the intention to use public bicycle systems.

1.4. Research Scope

According to the administrative division in the spatial domain, whether Taipei City residents have an experience using YouBike, they are eligible for the investigative target. In order to get the representative samples and ensure the behavior is an independent decision, the age of targets must be more than 5 years old at the same time. In the temporal domain, this research belongs to the cross-sectional study. The study will collect all questionnaires and analyze the data from December 2017 to April 2018.

1.5. Research Procedure

This section illustrates the research flow chart. Fig. 1-4 shows the research flow chart of this study. The main contents are structured as follows.

Chapter 1: Introduction

The chapter states the research motivation, the objectives, the scope, the methodology and the research content with research framework.

Chapter 2: Literature Review

The chapter presents the problem statement including the public bicycle system and the background of Taipei YouBike, review of the relevant literature both domestic and overseas including the public bicycle adopting intention, the introduction of relevant behavioral theories and the behavioral reasoning theory, and the comments on the reviewed literature.

Chapter 3: Methodology

The chapter discusses about the applied methodology, the background and contents of the applied methodology, the hypothetical relationships, the questionnaire design, the data collection plan , and the analytical method.

Chapter 4: Empirical Study

The chapter describes the data collection, the descriptive statistics from the data collected, the measurement model, the structural model, the hypothesis test, the results, the implications, and the discussions.

Chapter 5: Conclusion & Recommendation

The chapter gives the findings and contributions, implications for policies, limitations, future research, and recommendations.

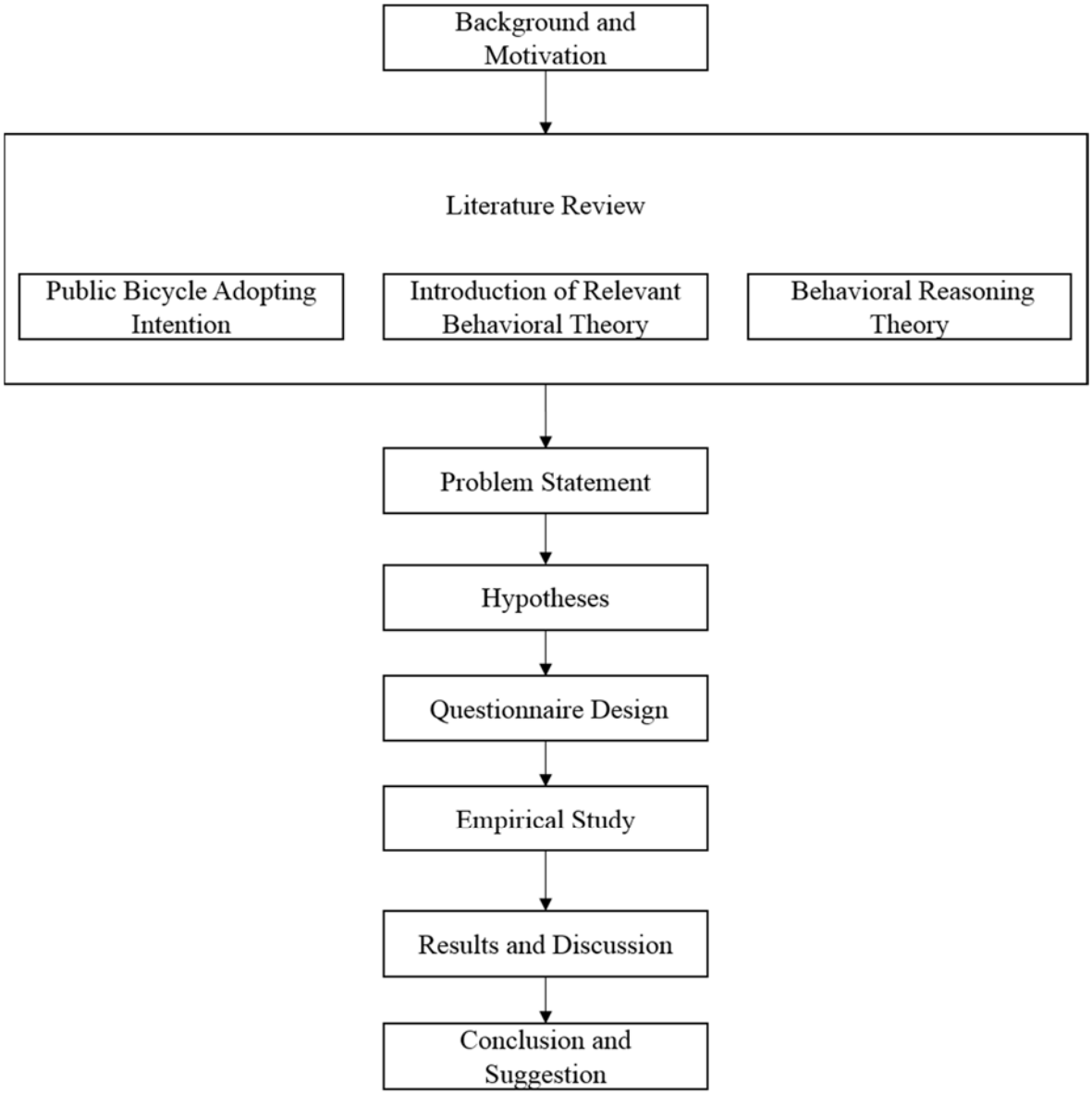

Figure 1-4 Research flow chart

CHAPTER 2 LITERATURE REVIEW

In the chapter 2, we will describe public bicycle systems evolution and background of Taipei YouBike. Next, we will review the relevant literature both domestic and overseas, including public bicycle adopting intentions, introduction of relevant behavioral theories, and Behavioral Reasoning Theory. In the end of chapter, we will make the comments and propose the research gaps on the reviewed literature.

2.1. Public Bicycle System

The section will state the definition, history, and development of public bicycle system in the world. Then, we will introduce the operation of YouBike recent years and realize the problem in the course of information collected.

2.1.1. System Evolution

A public bicycle system, bicycle sharing system, or bike sharing scheme (BSS) can be defined as a self-service short term, one-way-capable, bike rental offer in public spaces, with network characteristics (Büttner et al., 2011). It means the shared service that can allow individuals to use bicycles in a short term. When the users have commuting or leisure trips demand, they can take the bicycles and leave them behind when they reach their destinations (Yang, Lin, & Chang, 2010). They are usually charged very low price, or make bicycle rentals available without payment in the first certain period of time. The public bicycle system has many benefits, such as creating a larger cycling population, increasing transit use, decreasing greenhouse gases, and improving public health (DeMaio, 2009).

From the past research, the development of public bicycle systems could be divided into four different generations (Shaheen & Guzman, 2011). In the first generation, the idea

of the bike-sharing was begun since the mid-1960s in Europe. The first bike-sharing program, called White Bikes, was launched in Amsterdam. There were 50 bicycles for the public to use freely and set up in the inner city. The disadvantages of the system were the bicycles stolen or damaged. Therefore, the initial bike-sharing system did not succeed but this innovative concept had captured people's attentions. To improve the drawbacks of the first generation, Copenhagen launched the bicycle sharing service which had coin-deposit systems in 1995. If a user wanted to pick up and unlock a bicycle, he needed to pay 20 DKK coin deposit that was refunded on bicycle return. Compared to the previous system, it also had a new design, called the docking station to make users unlock/lock and borrow/return their bicycles. It could enhance a little bit of security. The third generation system was Rennes Vélo à la Carte in 1998, which emphasized the application of information technology. The recent improvement in bike-sharing was the demand responsive service, such as Montreal BIXI in 2009. Through advanced technology and data collection, it could accurately predict the demand of bicycles and understand how to allocate bicycles in rental stations. The development of public bicycle systems is arranged into the table 2-1.

Table 2-1 The development of public bicycle systems

(Source: Shaheen, Guzman, & Zhang, 2010)

Generations	The 1st Generation	The 2nd Generation	The 3rd Generation	The 4th Generation
System Type	Free bike	Coin-deposit system	IT-based system	Demand responsive, multimodal system
City & Country	Amsterdam, Netherlands	Copenhagen, Denmark	Rennes, France	Montreal, Canada
Start Date	July 1965	January 1995	June 1998	May 2009
Examples	Witte Fietsenplan (White Bike Plan)	Bycykler København (City Bikes)	Vélo à la Carte	BIXI Montréal

Table 2-1 The development of public bicycle systems (continued)

(Source: Shaheen, Guzman, & Zhang, 2010)

Generations	The 1st Generation	The 2nd Generation	The 3rd Generation	The 4th Generation
Components	1. Bicycles	1. Bicycles 2. Docking stations	1. Bicycles 2. Docking stations 3. Kiosks or user interface technology	1. Bicycles 2. Docking stations 3. Kiosks or user interface technology 4. Bicycle distribution system
Features	1. Identified by color 2. Randomly distributed in a specific area 3. Without lock design 4. Use freely	1. Identified by color and unique design 2. Docking station to lock bicycles	1. Identified by color, unique design, and ads 2. Docking station to lock bicycles 3. Intelligence technology to unlock and lock bicycles 4. Theft deterrent system 5. Membership service	1. Identified by color, unique design, and ads 2. Efficient docking station to save energy 3. Advanced lock system 4. Touch screen interface service 5. Bicycle redistribution system 6. Integration with public transit smartcard

Nowadays, many countries or cities have owned the public bicycle systems. In December 2016, around 1000 cities in the world have a program of public bicycle system (Gutman, 2016). For example, YouBike is an important experience in developing public bicycle systems in Taiwan.

2.1.2. Background of Taipei YouBike

The YouBike is the second public bicycle system in Taiwan. In 2008, Taipei City Government signed the “Plan to Promote Energy Saving & Carbon Reduction in Taipei City”

in accordance with the “Framework of Taiwan’s Sustainable Energy Policy Framework” approved by the Executive Yuan. Afterward Taipei City Government set up the “Greenhouse Gas Reduction Promotion Group” to actively promote the energy conservations and carbon reduction policies. It instructed the Taipei City Department of Transportation to take responsibility for the development of mass transit systems and the transportation of greenhouse gas reductions.

Then, the “Demonstrative Program of the Establishment, Operation and Management of the Bike Sharing System” was conducted in Xinyi District in March 11, 2009. Although it got the support of citizens after the launch, the usage amount did not effectively increase. The reasons why it was not used by most people were that it had only 11 service sites and provided 500 public bicycles at that moment. In order to continuously encourage people to replace private motor vehicles with green transportation and provide environmentally friendly services throughout Taipei City, Taipei City Government and Giant Manufacturing Co. Ltd. (Giant) signed a contract in December 2011 to set up 163 stations and provide 5,350 public bicycles within 7 years. After 9 months of planning and construction, the trial operation was executed on August 30, 2012. Taipei YouBike officially launched on November 30, 2012.

Consequently, Taipei City becomes the first city to have YouBike public bicycle system in Taiwan. From the table 2-1, the YouBike system has been currently available in six cities of Taiwan including Taipei City, New Taipei City, Taoyuan City, Hsinchu City, Taichung City and Changhua City. Taipei City has 400 operational rental stations and provides around 13,000 public bicycles in March 2018. Compared with the other cities, the operation of YouBike in Taipei is the most comprehensive because its rental stations are intensive, abundant and averagely distributed in congested areas according to the Fig. 2-1.

Table 2-2 The summary of cities used YouBike system

(Source: YouBike Official Website, 2018)

Cities	Launch Date	Operational Rental Stations	Average Monthly Rentals in 2017
Taipei	March 11, 2009	400	1,829,216
New Taipei	January 1, 2014	473	2,081,612
Taoyuan	February 4, 2016	187	565,831
Hsinchu	May 26, 2016	55	100,344
Taichung	July 18, 2014	260	596,036
Changhua	May 22, 2014	68	192,906

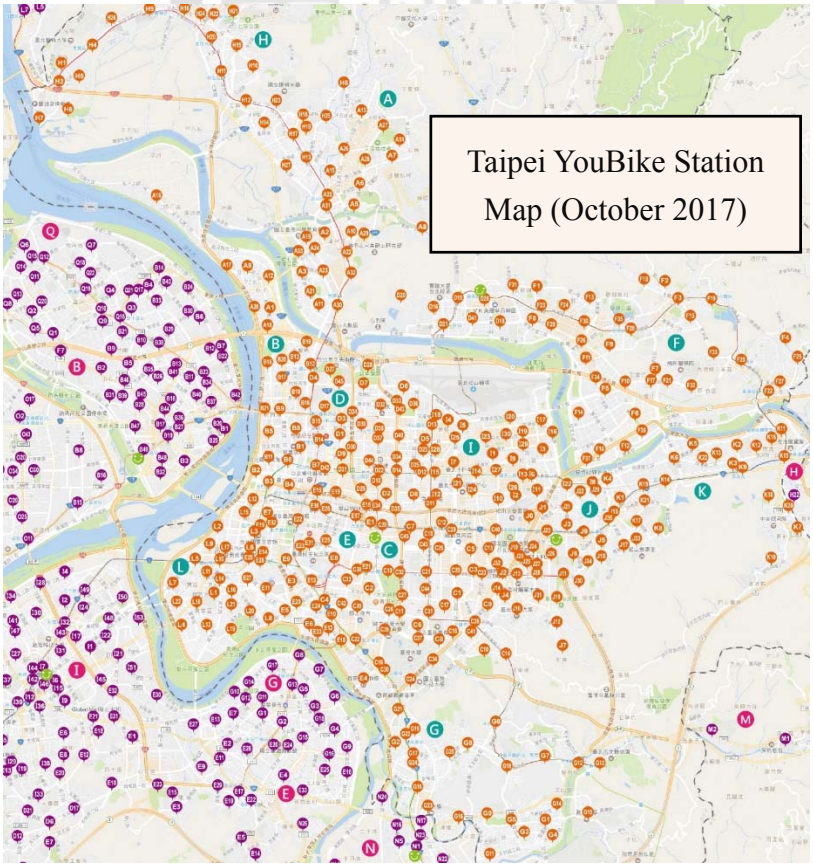

Figure 2-1 The operational station map of YouBike in Taipei

(Source: YouBike Official Website, 2017)

In the way of using, YouBike is considered to become the last-mile public transit vehicle. It adopts an electronic unmanned automated management system to allow users to borrow a bicycle from point A and return it at point B. It is a 24-hour self-service system. Each station has an automatic kiosk, which allows users to apply for membership, payment and rental of bicycles.

In rates information, the table 2-3 indicates the rates information of YouBike in Taipei City. It is divided into two main suitable users. One is the single rent. They need to register at any Kiosk and pay the fee through IC credit card. The other is the long-term users. They can register at the service centers, official website, official mobile application, and any Kiosk and pay the fee through contactless smartcard systems, namely EasyCard and iPASS. Two types of users are charged according to the following rules of progressive pricing rates: (1) Pay $10 NT per 30 minutes if the user uses YouBike within the first 4 hours. (2) Pay $20 NT per 30 minutes if the user uses YouBike between 4 to 8 hours. (3) Pay $40 NT per 30 minutes if the user uses YouBike exceeding 8 hours. In addition, if the user belongs to YouBike members, Taipei City Government will subsidize $5 NT as a grant for first 30 minutes since April 1, 2015. Initially, Taipei City Government provided full subsidies for first 30 minutes. Since starting to charge $5 NT dollars for the first 30 minutes, the usage situation of YouBike has been challenged.

Table 2-3 The rates information of YouBike in Taipei City

(Source: YouBike Official Website, 2018)

Item	Single Rent	Member
Suitable Audience	Single Rent	Long-term Users
Payment Option	IC Credit Card	EasyCard / iPASS
Registration	Any Kiosk	Service Center / Official Website Official Phone App / Any Kiosk
Charge Rates	$10 NT per 30 minutes within the first 4 hours* $20 NT per 30 minutes between 4 to 8 hours $40 NT per 30 minutes exceeding 8 hours	
*Taipei City Government will subsidize $5 NT to YouBike member for first 30 minutes since April 1, 2015.		

According to the Fig. 2-2 about the operational information of YouBike from August 2012 to March 2018 (Taipei City Department of Transportation Statistics, 2018), we obviously discover three things. First, the monthly rentals had reached a peak about 2.27 million in January 2015, but the average monthly rentals did not return to the original level since YouBike has begun charging for first 30 minutes of use in April 2015. Second, the operational stations were getting more and more in recent years, but the monthly rentals did not increase in proportion to the past. Third, there was a decline in January 2016, it might be affected by the climate and seasonal factor, especially a cold wave struck East Asia and brought the lowest temperatures in 44 years as low as 4 °C to Taipei (BBC News, 2016). Combined with the above three findings, the monthly rentals of YouBike absolutely have the possibility of growth.

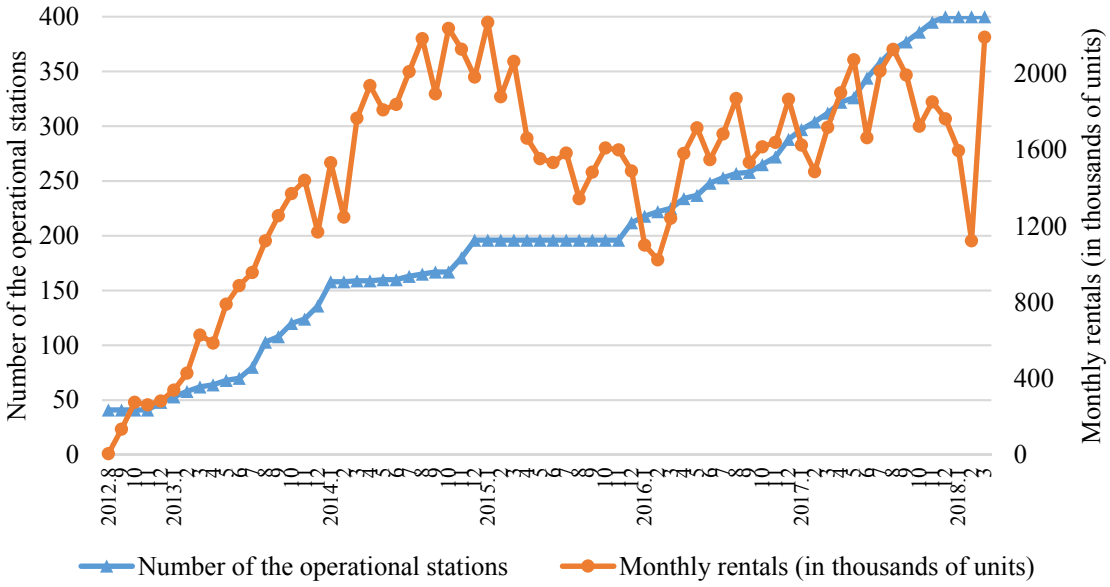

Figure 2-2 The operational information of YouBike from Aug. 2012 to Mar. 2018

(Source: Taipei City Department of Transportation Statistics, 2018)

In order to attract more people to use the system, this study will attempt to understand the determinants and barriers of public bicycle adoption and explore what motivations and obstacles are pivotal. We will take Taipei YouBike as an example of the empirical study. In the follow-up study, The “YouBike” will be referred to the public bicycle-sharing system of Taipei City.

In the next section, with the intentions to find out methods which effectively promote more people to using public bicycle systems in Taipei City, we will review the relevant literature to understand the past findings about public bicycle adopting intentions.

2.2. Public Bicycle Adopting Intention

This section will arrange the relevant literature and discuss the past findings both domestic and overseas about the public bicycle adopting intention. For the public bicycle adopting intention, we can be roughly divide it into three perspectives.

First, it belongs to the influence of system facilities and environment. One article referred to the factors leading to bike-sharing adoption and barriers to adoption in Hangzhou bike-sharing systems (Susan et al., 2011). It used an intercept survey and should improve the bike-sharing system included adding the stations and the real-time information and the parking availability technologies, improving the bike maintenance and the locking mechanisms, and extending operational hours. From these results, we knew the improving the physical services, including software and hardware, were important to enhance the public bicycle system service. A thematic analytic method had used to understand the barriers and facilitators to public bicycle scheme use in CityCycle of Brisbane (Fishman et al., 2012). It discovered the accessibility, topography, spontaneity, safety and weather were importance topics affecting the bike riders. In this research, it emphasized the characteristics of the system and the external environment. A hybrid model was constructed, through the structural equations model (SEM), the multiple indicator multiple causes (MIMIC) model and the binary logit model to comprehend key factors of bicycle system in the university campus in Madrid, Spain (Fernández-Heredia et al., 2016). It revealed four constructs, including convenience, pro-bike, physical determinants and external restrictions, were related to the intentions of the bicycle use.

Second, it belongs to the influence of user's perception. One research uses the technology acceptance model (TAM) as the basis to discover that perceived quality,

perceived convenience, and perceived value might contribute to adopt bicycle sharing programs in the direct relationships in Beijing, China (Hazen et al., 2015). The contribution of this research was especially from considering the user's point of view about perceptions. Another research focused on holiday was conducted and applied the theory of planned behavior (TPB) as a model in Copenhagen, Denmark (Kaplan et al., 2015). It attempted to realize the intentions of using urban bike-sharing for tourist. it considered the favorable attitudes toward cycling, the interest in bicycle technology, the favorable subjective norms toward cycling, and the perceived cycling ease. A research which also applied the technology acceptance model (TAM) added a construct, namely the trust, as an antecedent of the model in Taipei, Taiwan (Lai, 2015). It indicates that user's attitudes and the perceived usefulness lead to the occurrence of intentions toward the bike-sharing system.

In addition to the influence of the user's perception, the green, sustainable or environmental protection also be considered in response to global warming and curbing carbon emissions. The environmental protection can be defined as "any activity includes prevention (avoidance) strategies to protect the environment from future damage or degradation; and controls measures to restore and maintain environmental quality." (National Agricultural Library, 2017). One research considered the perceived green value, perceived green usefulness, perceived pleasure to use, subjective norms, perceived behavioral control on green loyalty to a public bike system (Chen, 2016). The results discovered that fun in people's lives and subjective norms had a stronger influence on the continuous use of public bicycles with the sustainable modified technology acceptance model (TAM) and the theory of planned behavior (TPB). Besides, another research applied the green technology acceptance model (TAM) to understand green intentions for YouBike users in Taipei, Taiwan (Chen & Lu, 2016). The results show that the green perceived

usefulness and the user attitude influence the green intentions. the green intentions do not be influenced by the perceived ease of use.

2.3. Introduction of Relevant Behavioral Theory

In order to understand how to describe about human intention and behavior in the past, we review relevant behavioral theories. This section will introduce several common theory which can explain human behavior.

2.3.1. Theory of Reasoned Action

Initially, Ajzen and Fishbein came up with the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1977). It aimed to explain the relationship of human action between attitudes and behaviors. It would find the individual's actual behavior deeply depended on the behavior intention. The theory also mentioned that the attitude and subjective norm would affect the behavior intention. Fig. 2-3 displays the framework of theory of reasoned action.

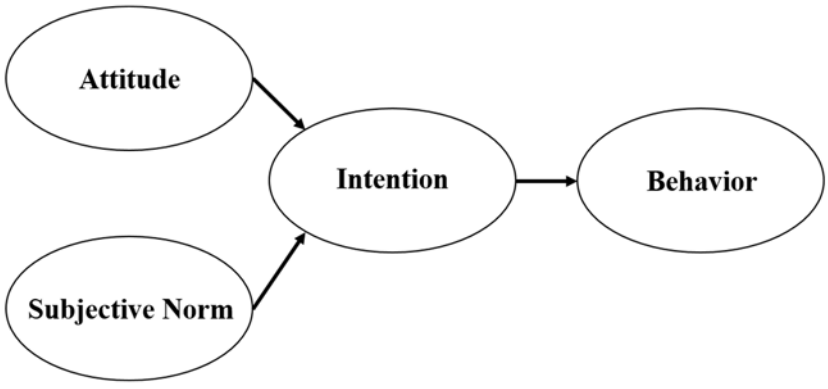

Figure 2-3 The framework of Theory of Reasoned Action
(Source: Ajzen & Fishbein, 1977)

2.3.2. Theory of Planned Behavior

However, TRA assumes that the behavior was controlled by the individual's willingness, it ignores that a lot of external factors might affect the controllability of individual's willingness. In order to solve this problem, the Theory of Planned Behavior (TPB) was proposed and it used TRA as the basis to additionally consider that the perceived behavioral control also affected the intention and behavior (Ajzen, 1985). Fig. 2-4 illustrates the framework of theory of planned behavior.

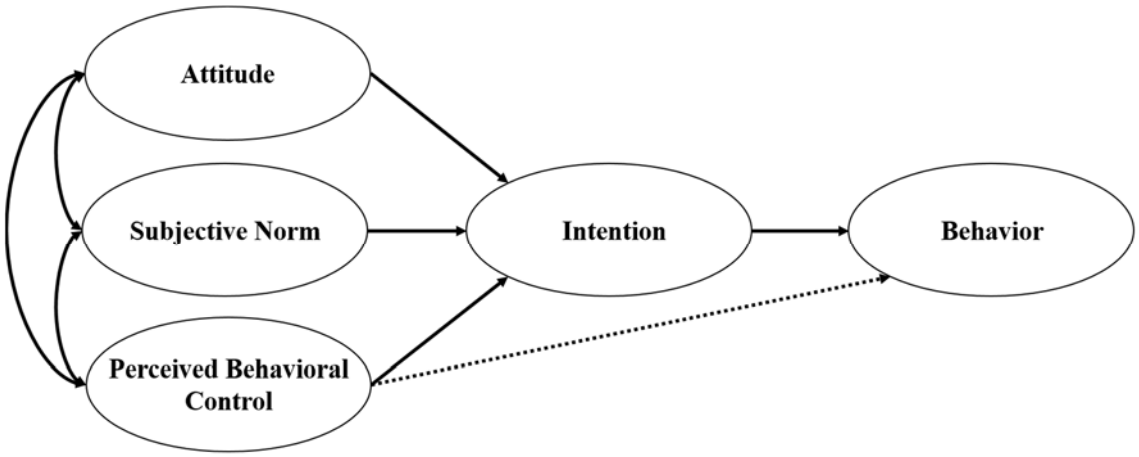

Figure 2-4 The framework of Theory of Planned Behavior
(Source: Ajzen, 1985)

2.3.3. Technology Acceptance Model

In 1989, a theory called the technology acceptance model (TAM) was proposed and it was base on TRA (Davis, 1989). The most obvious features in TAM were the additions of two determinants for individuals. One construct is the perceived usefulness. It could describe that a person enhanced performance degrees when he used a specific system. The other is the perceived ease of use. It could express the degrees to which a person thought easy to use a specific system. Fig. 2-5 illustrates the framework of technology acceptance model.

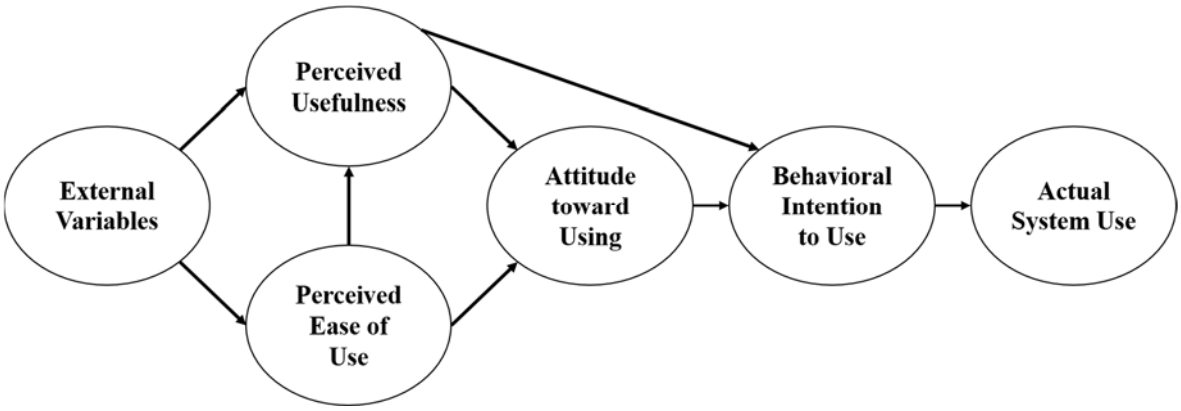

Figure 2-5 The framework of Technology Acceptance Model

(Source: Davis, Bagozzi, & Warshaw, 1989)

2.4. Behavioral Reasoning Theory

Based on the TRA and TPB for the behavioral theories, the Behavioral Reasoning Theory (BRT) was proposed (Westaby, 2005). Five constructs were used to explain the determinants of behavior, including beliefs and values, reasons, global motives, intention and behavior. Compared with the previous theories, this theory adds to the reasons of support and opposition on the behavior, it thinks beliefs and values affected the reasons and the global motivations (e.g., attitudes, subjective norms, and perceived control), and the reasons would indirectly affect the intention of human action. Therefore, it could be more specific to explain the process of human action and decisions. Fig. 2-6 illustrates the framework of behavioral reasoning theory. We will introduce constructs of conceptual definitions in BRT.

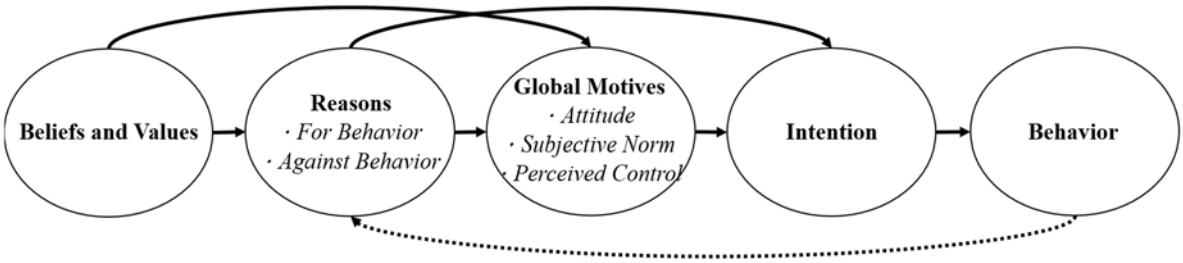

Figure 2-6 The framework of Behavioral Reasoning Theory

(Source: Westaby, 2005)

2.4.1. Beliefs and Values

The concepts of beliefs and values were from expectancy-value theory which was developed in the 1960s. Beliefs and values of BRT were stated "the person who keeps beliefs holds expected results, and the value of these results has a significant influence on the motivational process". Meanwhile, when you have the more positive beliefs and values, you may have more behavioral motives (Westaby, 2005).

2.4.2. Reasons

In contrast to other behavioral theories, reasons in BRT are the most special constructs. They are defined as "the specific subjective factors people use to explain their anticipated behavior" (Westaby, 2005). They can be divided into binary results – reasons for/against. In other words, they include the reasons toward performing the given behavior according to factors that people support or oppose.

2.4.3. Global Motives

In the global motives of BRT, they are defined as “the broad substantive factors that consistently influence intentions across diverse behavioral domains” (Westaby, 2005). Global motives include attitudes, subjective norms and perceived control because these concepts exist at a wider level of abstraction and have an impact on behavior from other scholars’ research (Ajzen & Fishbein, 1977; Ajzen, 1985). In conceptual definitions of BRT, attitude is “an individual's global positive or negative assessment to the given behavior”, subjective norms evaluate “a person’s global perceived social pressure from important others to engage in the behavior”, and perceived control represents “the degree to which a person perceives he controls the execution of the behavior or finds the behavior easy or difficult to perform” (Ajzen, 1991; Westaby, 2005).

2.4.4. Intentions

The intention of BRT refers to the definition of Ajzen & Fishbein. It is described as “a person’s location on a subjective probability dimension involving a relation between himself and some action” (Ajzen & Fishbein, 1977).

2.4.5. Behavior

The behavior is directly affected by the intention in BRT. It is assumed or predicted by scholars. It is regarded as the actual performance of the action (Ajzen, 1985). Past behavioral models explored the determinants of behavior, including TRA, TPB, TAM and BRT.

2.5. Comments on the Literature Review

This section describe research gaps discovered from the literature review. We discover that previous researches existed two research gaps. This paper hopes to make more contributions to understanding the public bicycle adopting intentions from them. Table 2-4 lists the context of the above reviewed literature about the public bicycle adopting intentions.

Table 2-4 Overviews of the reviewed literature

References	Research Locations	Applied Theories	Methods
Influence of System Facilities and Environment			
Susan et al., 2011	Hangzhou, China	-	Intercept survey
Fishman et al., 2012	Brisbane, Australia	-	Thematic analytic method
Fernández-Heredia et al., 2016	Madrid, Spain	-	SEM, MIMIC and binary logit model
Influence of User's Perception			
Hazen et al., 2015	Beijing, China	TAM	SEM
Kaplan et al., 2015	Copenhagen, Denmark	TPB	SEM
Lai, 2015	Taipei, Taiwan	Extended TAM	SEM
Consider the Green, Sustainable or Environmental Protection			
Chen, 2016	Taipei, Taiwan	Modified TAM and TPB	SEM
Chen & Lu, 2016	Taipei, Taiwan	Green TAM	SEM

The first research gap of explaining the public bicycle adopting intention is lack of the application of the behavioral reasoning theory (BRT). The reason why this research chooses it because we have noticed many researches using the theoretical framework of TPB and TAM in the past.

Meanwhile, the second research gap of public bicycle adopting intention less considered the aspect of environmental protection. The public bicycle belongs to the green transportation which is a part of sustainable transportation, taken environmental protection as a consideration, and belonged a kind of environmentally friendly and low-pollution mode of transport (Yun-Guei Huang, 2010), it also belongs to a pro-environmental behavior (Krajhanzl, 2010), so it is important to think over the influence about protecting the natural environment on individuals. Green transportation is a part of sustainable transportation, taken environmental protection as a consideration, and belonged a kind of environmentally friendly and low-pollution transportation mode.

Therefore, in the next chapter, we will apply the behavioral reasoning theory to construct a model about the aspect of environmental protection and use CFA and SEM to explore the determinants and barriers of public bicycle adoption intentions.

CHAPTER 3 METHODOLOGY

In this chapter, we introduce the problem statement and background of the applied methodology in this research. Then, we construct the hypotheses relationships of public bicycle adopting intention with behavioral reasoning theory. Meanwhile, we describe the questionnaire design, data collection plan, and analytical method.

3.1. Problem Statement

For alleviating the emission of greenhouse gases and promoting a larger use of YouBike. The aims of this study are to understand what factors influence the adopting intention of public bicycle with the behavioral reasoning theory (BRT) and to realize how to encourage people to use public bicycle according to research results.

In order to solve the above problem, the research will mainly apply the structural equation modeling (SEM), it is commonly justified in the social sciences because of its ability to impute relationships between unobserved constructs or latent variables from observable variables. SEM methodology is from early disciplinary specific developments of path analysis from genetics and later sociology, factor analysis from psychology, and simultaneous-equation models in economics (Matsueda & Press, 2012). It becomes the most important paradigm of a statistical method in current quantitative research of the social science and behavioral science (Byrne, 1994). Meanwhile, it is also commonly used in marketing, human resource management, business Management, psychology, etc. We can employ SEM methodology to construct latent variables via priori theoretical assumptions, and it has become a widely used methodology for empirical research because it is a useful statistical technique for examining the causal relations of latent variables through a combination of statistical data (Byrne, 2001). Therefore, SEM methodology is well-suited

for our research because we purpose to explore the determinants and barriers of public bicycle adoption with the framework of behavioral reasoning theory. After specifying these relationships, we will understand which factors are significant for public bicycle adopting intentions.

3.2. Hypotheses

In this section, we will introduce the hypothetical relationship which expresses the linkages between the constructs with the behavioral reasoning theory.

Based on the early behavioral model and relevant theories, Fig. 3-1 illustrates the hypothetical relationships in this research. The following eight hypotheses were tested in this research. We refer to the behavioral reasoning model (Westaby, 2005) and apply environmental values as antecedents that affect adopting reasons (e.g., factors for public bicycle adoption) and global motives toward public bicycle adoption. The environmental values are expected to have direct effects on global motives toward public bicycle adoption. There is a positive relationship between environmental values and factors for public bicycle adoption. There is also a negatively relationship between environmental values and factors against public bicycle adoption. Thus, we propose the hypotheses H1, H2, and H3.

H1. The environmental values negatively affect the factors against public bicycle adoption.

H2. The environmental values positively affect the global motives toward public bicycle adoption.

H3. The environmental values positively affect the factors for public bicycle adoption.

According to BRT, the support or opposite reasons are important antecedents of global motives. Westaby also propose that reasons may directly affect intention toward a behavior

(Westaby, 2005). Thus, we have the hypotheses H4, H5, H6, and H7.

H4. There are the factors against public bicycle adoption that negatively affect the global motives toward public bicycle adoption.

H5. There are the factors for public bicycle adoption that positively affect the global motives toward public bicycle adoption.

H6. There are the factors against public bicycle adoption that negatively affect the adopting intention of public bicycle.

H7. There are the factors for public bicycle adoption that positively affect the adopting intention of public bicycle.

BRT states that attitudes, subjective norm, and perceived behavioral control as "global motives". They are the key determinants in predicting individual intention, and intention is assumed to be the immediate antecedent of behavior (Ajzen, 2002). We establish the hypothesis H8.

H8. The global motives toward public bicycle adoption positively affect the adopting intention of public bicycle.

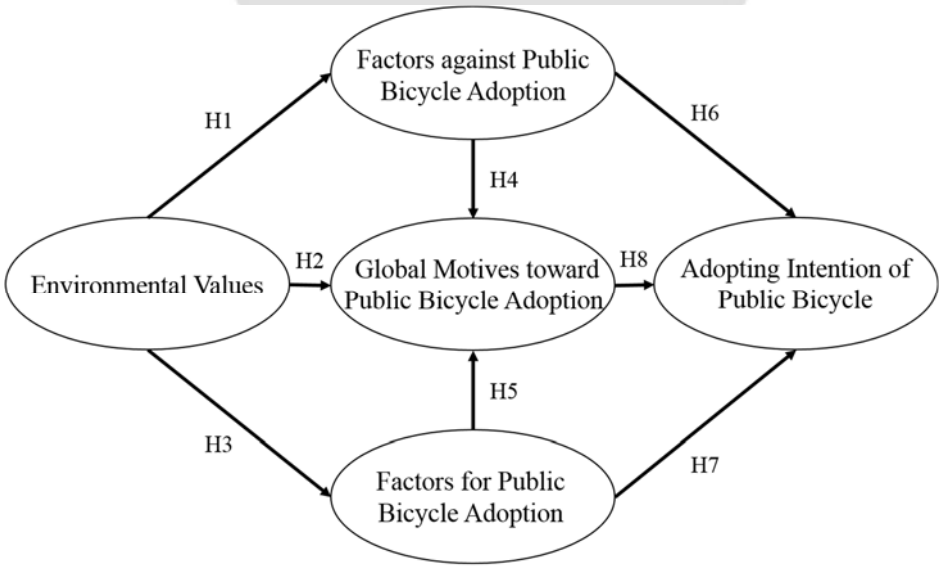

Figure 3-1 The hypothetical relationship

3.3. Questionnaire Design

The section will describe five constructs of operational definitions in this research, including environmental values, factors for public bicycle adoption, factors against public bicycle adoption, global motives toward public bicycle adoption, and adopting intention of public bicycle, and the questionnaire design based on the hypothetical model.

3.3.1. Environmental Values

This study uses environmental values as the antecedent of factors for/against, global motives toward public bicycle adoption, and the adopting intention of public bicycle. Environmental values are defined as "It belong to the human belief, attitude and value system in the environment, which can guide and regulate human environmental behavior, and it should have the spirit and connotation of environmental ethics." (Yang, 1997). Because using YouBike system is a kind of the environmental behaviors, we will use Yang's definition in this research.

According to the definition of perceived green value, it is the set of attributes associated with the environmental consciousness value (Chen, 2016). The indicators are employed to measure environmental values. The evaluation includes four statements: EV1. I consider that YouBike's environmental functions have much value for me; EV2. I consider that YouBike's environmental performance corresponds to my expectations; EV3. I consider that YouBike has more environmental concern than other forms of transportation; and EV4. I consider that I utilize YouBike because it is environmentally friendly. In the EV1., the "environmental functions" can be defined as the environmental service, including spatial functions, waste disposal, natural resource supply and life support (United Nations Statistical Commission, 1997). In the EV2., the "environmental performance" can be referred to the measurable

outcome of YouBike's ability to meet environmental objectives and targets set forth in the organization's environmental plan or policy (National Agricultural Library, 2017). In the EV3., the “environmental concern” means YouBike can be motivated to preserve nature and the environment, and seek ways how to behave more responsibly towards the environment (Krajhanzl, 2010). In the EV4., there is no specific definition of the “environmental friendly” (also known as eco-friendly or nature-friendly) in relevant agencies or organizations. We refer to the Green Mark which designed on the basis of ISO 14024 eco-friendly principles (Environmental Protection Administration, 2010), the “environmental friendly” in this research can be defined as a product or service that have less impact on environment. In order for interviewees to understand the contents, these definitions will be attached to the formal questionnaire. Table 3-1 describes the operational definitions and measures of environmental values.

Table 3-1 The operational definitions and measures of environmental values

The Operational Definitions of Environmental Values
The human belief, attitude and value system in the environment, which can guide and regulate human environmental behavior, and it should have the spirit and connotation of environmental ethics.
The Measures of Environmental Values
1. I consider that YouBike’s environmental functions have much value for me. 2. I consider that YouBike’s environmental performance corresponds to my expectations. 3. I consider that YouBike has more environmental concern than other forms of transportation. 4. I consider that I utilize YouBike because it is environmentally friendly.

3.3.2. Factors for public bicycle adoption

Combined with the original application (Westaby, 2005) about BRT and the problem of this study, the definition of factors for public bicycle adoption is used to assess reasons for using YouBike system.

To measure the factors for/against public bicycle adoption, we investigate the possible environmentally friendly advantages of public bicycle adoption (Jelmer et al., 2013; Muñoz et al., 2016), as stated in the following five items: FF1. I would be causing less environmental pollution; FF2. I would be improving the environment in cities; FF3. I would be decreasing the pay of gasoline; FF4. I would be reducing the use of fossil fuel; and FF5. I would conveniently transfer to other public transport systems (e.g., MRT). Table 3-2 describes the operational definitions and measures of factors for public bicycle adoption.

Table 3-2 The operational definitions and measures of factors for public bicycle adoption

The Operational Definitions of Factors for Public Bicycle Adoption
The reasons why individuals agree to use YouBike system.
The Measures of Factors for Public Bicycle Adoption
1. I would be causing less environmental pollution.
2. I would be improving the environment in cities.
3. I would be decreasing the pay of gasoline.
4. I would be reducing the use of fossil fuel.
5. I would conveniently transfer to other public transport systems (e.g., MRT).

3.3.3. Factors against public bicycle adoption

On the contrary, the definition of factors against public bicycle adoption is the reasons why individuals do not use YouBike system.

From the past literature, we have five items about the possible factors against public bicycle adoption (Bai and Liu, 2013; Jelmer et al., 2013): FA1. Most of the people around me don't care about eco-friendly features of YouBike; FA2. I am not concerned about eco-friendly features of YouBike; FA3. Riding a YouBike is not convenient for me; FA4. It is difficult to find a appropriate way to ride a YouBike for me; and FA5. It is unhelpful to mitigate greenhouse gas emissions. Table 3-3 describes the operational definitions and measures of factors against public bicycle adoption.

Table 3-3 The operational definitions and measures of factors against public bicycle adoption

The Operational Definitions of Factors against Public Bicycle Adoption
The reasons why individuals do not agree to use YouBike system.
The Measures of Factors against Public Bicycle Adoption
1. Most of the people around me don't care about eco-friendly features of YouBike.
2. I am not concerned about eco-friendly features of YouBike.
3. Riding a YouBike is not convenient for me.
4. It is difficult to find a appropriate way to ride a YouBike for me.
5. It is unhelpful to mitigate greenhouse gas emissions.

3.3.4. Global Motives toward Public Bicycle Adoption

Global motives toward public bicycle adoption are defined as the broad substantive factors that consistently influence intentions toward public bicycle adoption. In global motives of this research, they also consider attitudes, subjective norms and perceived control from BRT framework. Attitudes are defined as a person's global positive or negative evaluation toward public bicycle adoption. Subjective norms. Subjective norms evaluate a person's global perceived social pressure from important others to engage in public bicycle adoption. Perceived control represents the degree to which a person perceives he controls the execution of public bicycle adoption or finds public bicycle adoption easy or difficult to perform.

In the measurement of global motives toward public bicycle adoption, because they include attitudes, subjective norms and perceived control, we use the TPB questionnaire (Ajzen, 2002) to adopt nine indicators which describe the respondents' degree of these three constructs towards using YouBike, as shown in the following nine statements: GM1. To ride the YouBike is beneficial for me; GM2. To ride the YouBike is pleasant for me; GM3. To ride the YouBike is a good idea for me; GM4. To ride the YouBike is valuable for me; and GM5. To ride the YouBike is enjoyable for me; GM6. Most people who are important to me think that I should ride the YouBike; GM7. It is expected of me that I ride the YouBike extremely likely; GM8. For me to ride YouBike would be possible; GM9. If I wanted to I could ride YouBike definitely true. Table 3-4 describes the operational definitions and measures of global motives toward public bicycle adoption.

Table 3-4 The operational definitions and measures of global motives toward public bicycle adoption

The Operational Definitions of Global Motives toward Public Bicycle Adoption
The broad substantive factors that consistently influence intentions toward public bicycle adoption.
The Measures of Global Motives toward Public Bicycle Adoption
1. To ride the YouBike is beneficial for me.
2. To ride the YouBike is pleasant for me.
3. To ride the YouBike is a good idea for me.
4. To ride the YouBike is valuable for me.
5. To ride the YouBike is enjoyable for me.
6. Most people who are important to me think that I should ride the YouBike.
7. It is expected of me that I ride the YouBike extremely likely.
8. For me to ride YouBike would be possible.
9. If I wanted to I could ride YouBike definitely true.

3.3.5. Adopting Intention of Public Bicycle

The intention of BRT refers to past theories, namely TPB. It is defined as individuals want to engage in a particular act of action tendencies and degrees (Ajzen, 1985). In this research, adopting intention of public bicycle is used to predict whether the individual adopts YouBike system. In psychology, because the individual's intention has a relationship corresponds to a specific behavior under volitional (also known as the will) control (Ryan, 1970), the intention can be represent the occurrence of human behavior or action.

To evaluate the adopting intention of public bicycle, there are three indicators are used

to assess behavioral intentions from TPB questionnaire (Ajzen, 2002). The evaluation includes three statements: IN1. I intend to ride the YouBike in the future; IN2. I will try to ride the YouBike in the future; and IN3. I plan to ride the YouBike in the future. Table 3-5 describes the operational definitions and measures of adopting intention of public bicycle.

Table 3-5 The operational definitions and measures of adopting intention of public bicycle

The Operational Definitions of Adopting Intention of Public Bicycle
The reasons why individuals do not agree to use YouBike system.
The Measures of Adopting Intention of Public Bicycle
1. I intend to ride the YouBike in the future.
2. I will try to ride the YouBike in the future.
3. I plan to ride the YouBike in the future.

There are five constructs which are measured by multiple indicators, including the environmental values, global motives toward public bicycle adoption, factors for public bicycle adoption, factors against public bicycle adoption, adopting intentions of public bicycle. Environmental values, factors for/against public bicycle adoption, global motives toward public bicycle adoption, and adopting intention of public bicycle are all scored via a five-point agreement scale, namely strongly agree = 5, agree = 4, neither agree nor disagree = 3, disagree = 2, and strongly disagree = 1.

Meanwhile, we also investigates the socioeconomic status to understand the characteristics of samples, including the gender, age, monthly income, education level, living district, car ownership, motorcycle ownership, experience of using YouBike. Table 3-6 describes the measure of socioeconomic status. The Chinese version and English version of the questionnaire are presented in Appendix A and Appendix B respectively.

Table 3-6 The measure of socioeconomic status

Socioeconomic Status
1. Gender: □Male □Female
2. Age: □20 or below □21~30 □31~40 □41~50 □51 or above
3. Monthly Income: □20000 or below □20001~40000 □40001~60000 □60001 or above
4. Education Level: □Senior high school or below □Bachelor □Master or above
5. Living District: □Songshan district □Xinyi district □Da'an district □Zhongshan district □Zhongzheng district □Datong district □Wanhua district □Wenshan district □Nangang district □Neihu district □Shilin district □Beitou district
6. Car Ownership: □Yes □No
7. Motorcycle Ownership: □Yes □No
8. Experience of Using YouBike: □Yes □No

3.4. Data Collection Plan

A pre-test will be conducted before the formal investigation. A sample size of 30 participants is recommended (Perneger et al., 2015). It will be used to ensure that the questionnaire is reasonable and clear enough to read. We collect 30 samples from friends, classmates and family members through paper-based questionnaires and get many suggestions from the respondents who accept the pre-test, including the explanation of the special terms and improvement of typesetting.

In view of the research methodology, it is recommended to collect at least 200 representative samples to get a stable analysis (Hao-Jheng Ciou, 2011). We will adopt a convenience sampling through web-based questionnaires. The advantages of the sampling are that they are most commonly used, less expensive (Acharya et al., 2013). The web-based

questionnaires will be posted on the PTT, which is is the largest terminal-based bulletin board system based in Taiwan, so the sample will be evenly distributed in every district.

In the scope of data collection, we will survey 12 administrative divisions (i.e., Songshan district, Xinyi district, Da'an district, Zhongshan district, Zhongzheng district, Datong district, Wanhua district, Wenshan district, Nangang district, Neihu district, Shilin district, and Beitou district.) in Taipei City. In order to avoid non-Taipei residents to fill in the questionnaire, the web-based questionnaire has a filtered design that allows Taipei residents to access the website.

The empirical study will choose Taipei City residents, whose age are over 5 years old as research target because they are more capable of independent decision-making. This investigation plan will be implemented from December 2017 to April 2018.

3.5. Analytical Method

In this section, we will present the analytic method in next empirical study. According to the previous chapter of this research, behavioral reasoning theory (BRT) serves as the theoretical development of this study. Based on the theory, we have specified the hypothetical model. The sampling will be conducted by the data collection plan.

To examine the hypothetical model, in the measurement and parameter estimation, we perform two-stage procedure which includes the measurement model and the structural model. We will use SPSS Statistics 17.0 and Lisrel 8.52. In the first stage, we apply confirmatory factor analysis (CFA) to depict the relationships of observed variables for the latent variables (also known as constructs) in the hypothetical model, then calculating the reliability and validity of the measurement model of SEM. In this research, we use Bentler-Weeks method to describe the mathematical relations of SEM (Bentler & Weeks, 1980). Eqs. 3-1 to 3-2 display a set of p is the number of observable variables as multiple indicators and a set of m is the number of latent variables in confirmatory factor analysis. The p_1 is the number of observed exogenous variables. The p_2 is the number of observed endogenous variables. The m_1 is the number of latent exogenous variables. The m_2 is the number of latent endogenous variables. The exogenous variables are defined as the "latent, multi-item equivalent of independent variables" and the endogenous variables are defined as the "latent, multi-item equivalent of dependent variables" (Hair et al., 2010).

$$p_1 + p_2 = p \tag{3-1}$$

$$m_1 + m_2 = m \tag{3-2}$$

Eqs. 3-3 to 3-4 explain the relationship between observable variables and latent variables. The x and δ represent the column p_1 vectors which related to the observed exogenous variables and errors. The Λ_x is a $p_1 \times m_1$ structural coefficient matrix for the effects of the latent exogenous variables on the observed variables. The y and ε represent column p_2 vectors related to the observed endogenous variables and errors. The Λ_y is a $p_2 \times m_2$ structural coefficient matrix of the latent endogenous variables on the observed variables. The equations of the measurement model are as follows:

$$x = \Lambda_x \xi + \delta \tag{3-3}$$

$$y = \Lambda_y \eta + \varepsilon \tag{3-4}$$

In theory, it is considered significant if the factor loadings for the observed variables should be more than 0.5 (Hair et al., 2010). In order to verify the reliability, we use Cronbach's α that can describe internal consistency of the multiple indicators, and it has the reliability if it should be more than 0.7 (Nunnally, 2010). However, in the factors for/against public bicycle adoption of the behavioral reasoning theory (BRT), the high reliabilities are not theoretically necessary because there are often various factors or reasons to explains users' behavior (Westaby, 2005). In order to verify the validity, we use average variance extracted (AVE) to assess whether the latent variables can be effectively estimated by a set of observed variables. The convergent validity of latent variables can be accepted if AVE should be more than 0.5 (Fornell & Larcker, 1981). Another validity is the discriminant validity which describes the different constructs must be effectively separated, we use the comparative method of the AVE and the correlation coefficient, it has the discriminant validity if AVE is practically more than the square of the correlation coefficient between two

constructs (Fornell & Larcker, 1981).

In the next stage, we apply the structural equation modeling to test the all of the hypothetical relationships among latent variables involved in the analysis. It is a family of statistical models to seek the relationships among multiple variables and examines the structure of interrelationships expressed in a series of equations (Hair et al., 2010). Therefore, Eq. 3-5 displays the equation of the structural model. The η can represent a $m_2 \times 1$ vector of the latent endogenous variables. The ξ can represent a $m_1 \times 1$ vector of the latent exogenous variables. The B can represent a $m_2 \times m_2$ symmetric matrix of the coefficients associated with the latent endogenous variables. The Γ can represent a $m_2 \times m_1$ structural coefficient matrix associated with the latent exogenous variables. The ζ can represent a $m_2 \times 1$ vector of error terms associated endogenous variables. The equations of the measurement model are as follows:

$$\eta = B\eta + \Gamma\xi + \zeta \tag{3-5}$$

Covariance matrix will be put into Lisrel program. Then, the parameters will be estimated though the maximum likelihood (ML). Its function, F_{ML} is showed Eq. 3-6. The $\mathbf{\Sigma}$ matrix is a population variance-covariance matrix or a reproduced matrix. The $\mathbf{S}$ matrix is a variance-covariance matrix from sample observed.

$$F_{ML} = \log|\mathbf{\Sigma}| - \log|\mathbf{S}| + tr(\mathbf{S}\mathbf{\Sigma}^{-1}) - p \tag{3-6}$$

The reason why we use it is parameters have asymptotic unbiasedness, asymptotic consistency, and asymptotic efficiency if parameters follow the assumption of multivariate normal distribution (Hao-Jheng Ciou, 2011). Therefore, we will calculate the skewness and

kurtosis of indicators and test for normality by Shapiro-Wilk test to identify the characteristic of multivariate normal.

In the assessment of fit, we should estimate the structural model's goodness of fit. The fit of the model is estimated with the Chi-square (χ^2), the Normed chi-square (NC), the comparative fit index (CFI), the goodness-of-fit index (GFI), the normed fit index (NFI), the non-normed fit index (NNFI), the incremental fit index (IFI), the adjusted GFI (AGFI) , the parsimony goodness-of-fit index (PGFI), and the root mean square residual (RMR), the root mean square of approximation (RMSEA) (Hu & Bentler,1999; Hooper et al., 2008; Hair et al., 2010; Hao-Jheng Ciou, 2011). These indicators evaluated the fit of the model are listed on the table 3-3, including the abbreviation and critical value. If the assessment of fit is not accepted, we need to reconsider and modify the hypothetical model in the light of further literature.

Table 3-7 Assessment of fit

(Source: Hooper et al., 2008; Hair et al., 2010; Hao-Jheng Ciou, 2011)

Index of Assessment	Abbreviation	Recommended Values
Normed Chi-square	NC or χ^2/df	＜5
Comparative Fit Index	CFI	＞0.95
Goodness-of-fit Index	GFI	＞0.90
Normed Fit Index	NFI	＞0.90
Non-normed Fit Index	NNFI	＞0.90
Incremental Fit Index	IFI	＞0.90
Adjusted GFI	AGFI	＞0.90
Parsimony Goodness-of-fit Index	PGFI	＞0.50
Root Mean Square Residual	RMR	＜0.08
Root Mean Square Error of Approximation	RMSEA	＜0.08

The model starts from one exogenous construct measuring the impact of environmental values, then it is assumed to affect the global motives toward public bicycle adoption, the factors for public bicycle adoption, and the factors against public bicycle adoption. The factors for public bicycle adoption and the factors against public bicycle adoption are supposed to affect the global motives toward public bicycle adoption, then the three constructs also affect the adopting intention of public bicycle.

Each construct is based on the above instrument to measure. The structural model of constructs and their measurement models see the Fig. 3-3. In the next chapter, we will report the results of empirical study with the analytic strategy in Taipei YouBike system.

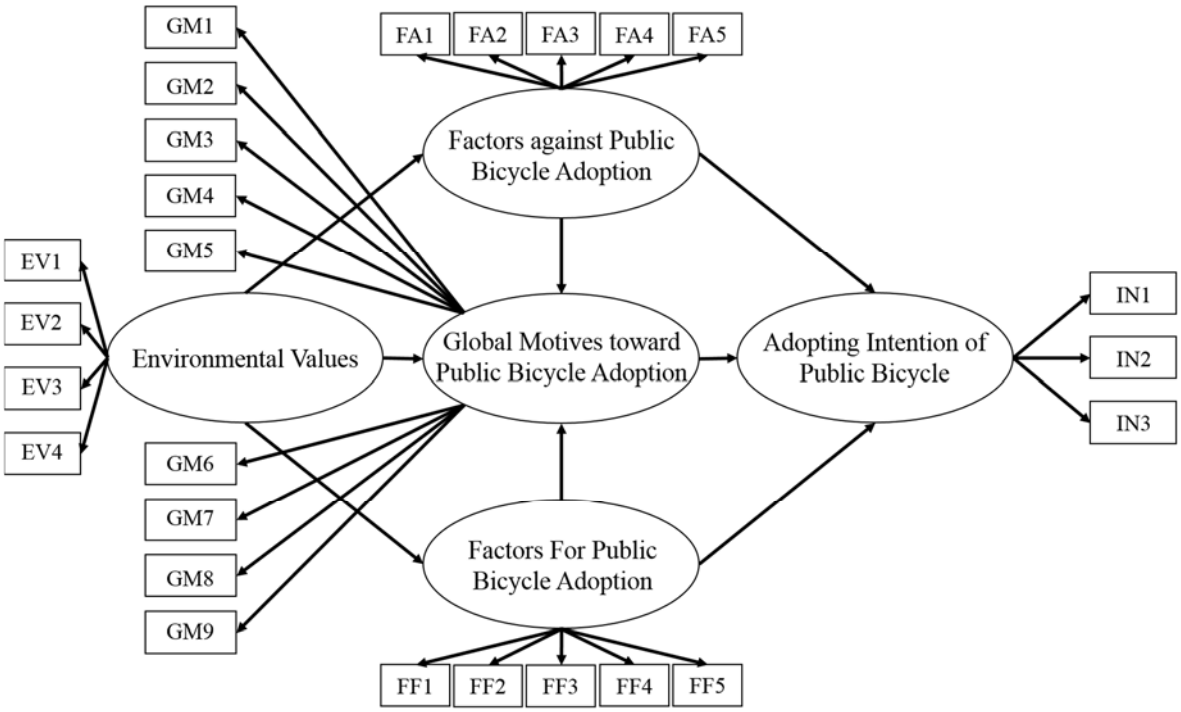

Figure 3-2 Structural model of constructs and their measurement models

CHAPTER 4 EMPIRICAL STUDY

In this chapter, we describe the characteristics of samples in descriptive statistics, measurement model, structural model and hypothesis test.

4.1. Descriptive Statistics

A sampling was conducted through web-based questionnaires from December 2017 to April 2018. The web-based questionnaires were posted on the PTT, which is is the largest terminal-based bulletin board system based in Taiwan, so PTT's users could access our questionnaires. A total of 442 questionnaires are collected, of which 10 are invalid because they have the same IP or the irrational response time. Therefore, there are 432 useful samples in total.

Table 4-1 describes the summary of sample demography. There are 65.5% of male respondents and 34.5% of female respondents. Most of respondents are about 21~30 years old. There are 22.7% below 20, 60.6% between 21 and 30, 12.5% between 31 and 40, 0.9% between 41 and 50, 3.2% older than 51. In monthly come, there are 57.6% below 20,000, 30.3% between 20,001 and 40,000, 7.6% between 40,001 and 60,000, 4.4% above 60,000. In education level, 10.9% respondents graduate from senior high school or below, 65.4% respondents hold bachelor degree, and 24.1% respondents hold master degree or above. It discovers 85.6% respondents do not have car ownership, but 58.3% respondents have motorcycle ownership. Finally, 92.8% respondents have experience of using YouBike in Taipei city.

Table 4-1 Summary of sample demography ($N = 432$)

Background		Frequency	Percentage (%)
Gender	Male	283	65.5
	Female	149	34.5
Age	< 20	98	22.7
	21~30	262	60.6
	31~40	54	12.5
	41~50	4	0.9
	> 51	14	3.2
Monthly income	< 20,000	249	57.6
	20,001~40,000	131	30.3
	40,001~60,000	33	7.6
	> 60,000	19	4.4
Education level	Senior high school or below	47	10.9
	Bachelor	281	65.4
	Master or above	104	24.1
Car ownership	Yes	62	14.4
	No	370	85.6
Motorcycle ownership	Yes	252	58.3
	No	180	41.7
Experience of using YouBike	Yes	401	92.8
	No	31	7.2
Total		432	100

Fig. 4-1 displays the distribution of samples in Taipei City. There are 52 samples collected in Da'an District, which is the district with the largest number of samples. There are 23 samples collected in the Nangang District, which is the district with the smallest number of samples. Based on this figure, we find that all samples are evenly distributed among the 12 administrative district.

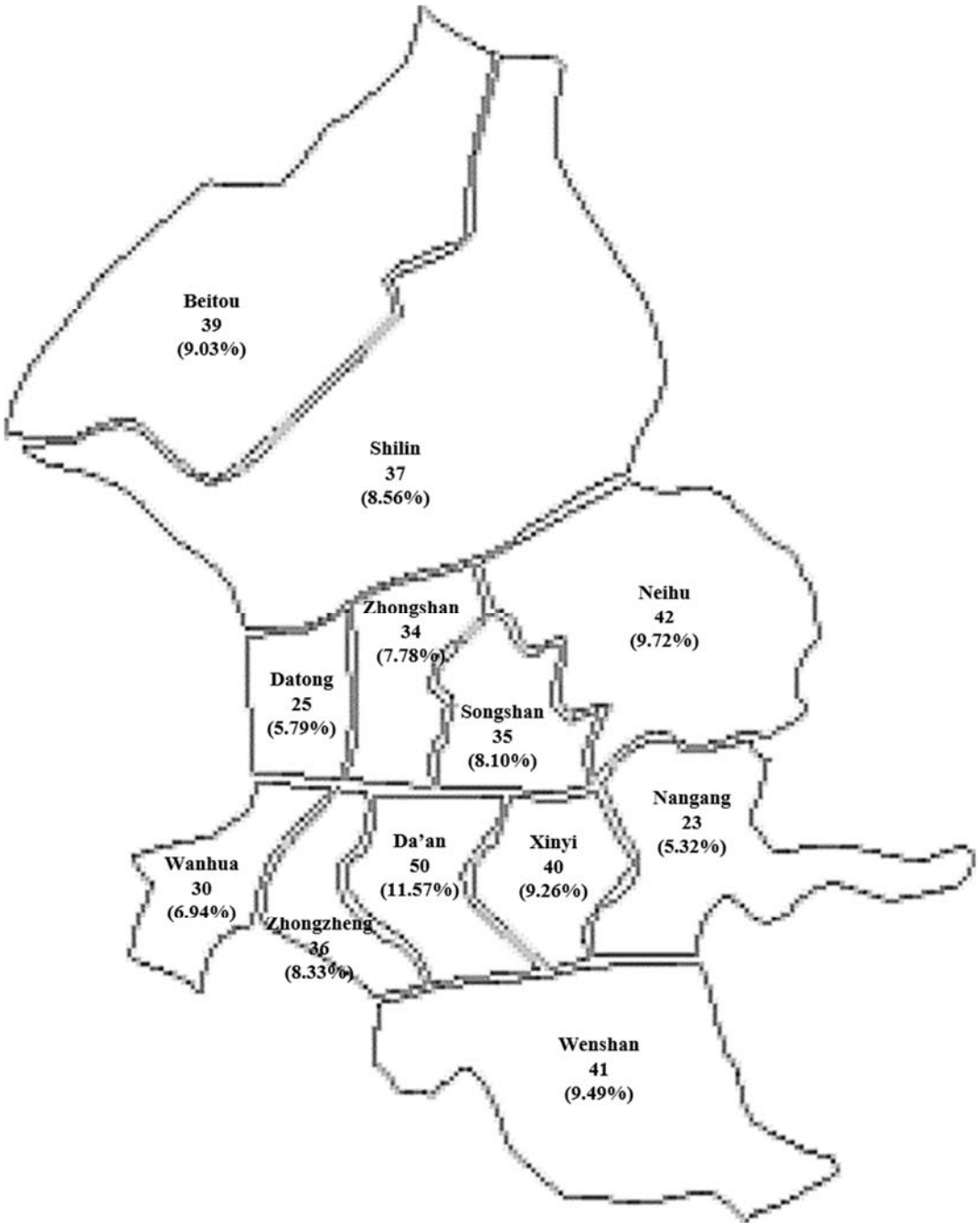

Figure 4-1 Distribution of samples in Taipei City (N = 432)

4.2. Measurement Model

This study analyzes the measurement model through confirmatory factor analysis. Table 4-2 calculates the standardized loadings, standard errors, and *t*-value to measure the correlation between each indicator and constructs. The loadings are between 0.45 and 0.93. The internal consistency reliabilities are also shown in Table 4-2. Cronbach's α of five constructs are between 0.822 and 0.899. In standardized loadings, we discover that the threshold of three indicators fail to reach 0.5 (Hair et al., 2010).

Table 4-2 The first analysis of confirmatory factor analysis

Constructs	Indicators	Standardized loading	Standard errors	*t*-Value	Cronbach's α
1. EV					0.822
	EV1	0.79	0.38	18.72	
	EV2	0.74	0.45	17.19	
	EV3	0.67	0.55	15.13	
	EV4	0.73	0.47	16.86	
2. GM					0.870
	GM1	0.79	0.37	-	
	GM2	0.77	0.40	17.47	
	GM3	0.81	0.34	18.68	
	GM4	0.78	0.39	17.71	
	GM5	0.72	0.48	16.13	
	GM6	0.51	0.74	10.60	
	GM7	0.45	0.80	9.24	
	GM8	0.57	0.67	12.19	

Table 4-2 The first analysis of confirmatory factor analysis (continued)

Constructs	Indicators	Standardized loading	Standard errors	t-Value	Cronbach's α
	GM9	0.46	0.78	9.66	
3. FA					0.824
	FA1	0.60	0.64	-	
	FA2	0.65	0.58	10.63	
	FA3	0.79	0.37	12.08	
	FA4	0.77	0.41	11.87	
	FA5	0.64	0.60	10.44	
4. FF					0.835
	FF1	0.81	0.35	-	
	FF2	0.78	0.40	17.52	
	FF3	0.77	0.41	17.33	
	FF4	0.79	0.37	17.98	
	FF5	0.48	0.77	9.85	
5. IN					0.899
	IN1	0.93	0.13	-	
	IN2	0.89	0.16	27.83	
	IN3	0.80	0.26	22.36	

EV = Environmental values; GM = Global motives toward public bicycle adoption; FA = Factors against public bicycle adoption; FF = Factors the public bicycle adoption; IN = Adopting intention of public bicycle.

Then, we delete three indicators because their loadings are less than 0.5, including GM7. It is expected of me that I ride the YouBike extremely likely; GM9. If I wanted to I could

ride YouBike definitely true; and FF5. I would conveniently transfer to other public transport systems (e.g., MRT). Table 4-3 shows the second analysis of confirmatory factor analysis. There is still one indicator less than 0.5.

Table 4-3 The second analysis of confirmatory factor analysis

Constructs	Indicators	Standardized loading	Standard errors	*t*-Value	Cronbach's α
1. EV					0.822
	EV1	0.79	0.38	18.73	
	EV2	0.74	0.45	17.17	
	EV3	0.68	0.54	15.18	
	EV4	0.73	0.47	16.86	
2. GM					0.869
	GM1	0.80	0.36	-	
	GM2	0.77	0.41	17.49	
	GM3	0.82	0.33	18.87	
	GM4	0.79	0.38	18.02	
	GM5	0.72	0.47	16.19	
	GM6	0.48	0.77	9.98	
	GM8	0.55	0.70	11.66	
3. FA					0.824
	FA1	0.60	0.65	-	
	FA2	0.65	0.58	10.61	
	FA3	0.79	0.37	12.07	
	FA4	0.77	0.41	11.86	

Table 4-3 The second analysis of confirmatory factor analysis (continued)

Constructs	Indicators	Standardized loading	Standard errors	t-Value	Cronbach's α
	FA5	0.63	0.60	10.43	
4. FF					0.869
	FF1	0.80	0.35	-	
	FF2	0.77	0.41	17.05	
	FF3	0.78	0.38	17.49	
	FF4	0.81	0.34	18.19	
5. IN					0.899
	IN1	0.93	0.14	-	
	IN2	0.89	0.21	27.84	
	IN3	0.80	0.36	22.37	

EV = Environmental values; GM = Global motives toward public bicycle adoption; FA = Factors against public bicycle adoption; FF = Factors the public bicycle adoption; IN = Adopting intention of public bicycle.

We find “GM6. Most people who are important to me think that I should ride the YouBike.” still less than the threshold of 0.5. After deleting it, Table 4-4 is the final results of confirmatory factor analysis in this research. The loadings are between 0.55 and 0.93. It is considered significant and acceptable because the loadings are more than 0.5 (Hair et al., 2010). The internal consistency reliabilities for the results are also shown in Table 4-4. Cronbach's α of five constructs are between 0.822 and 0.899. It means that the items for constructs have the reliability because α are more than 0.7 (Nunnally, 2010).

Table 4-4 The final results of confirmatory factor analysis

Constructs	Indicators	Standardized loading	Standard errors	*t*-Value	Cronbach's α
1. EV					0.822
	EV1	0.79	0.38	18.72	
	EV2	0.74	0.45	17.17	
	EV3	0.68	0.54	15.18	
	EV4	0.73	0.47	16.87	
2. GM					0.877
	GM1	0.80	0.36	-	
	GM2	0.77	0.41	17.52	
	GM3	0.81	0.34	18.82	
	GM4	0.79	0.38	18.14	
	GM5	0.72	0.48	16.18	
	GM8	0.55	0.70	11.58	
3. FA					0.824
	FA1	0.60	0.65	-	
	FA2	0.65	0.58	10.61	
	FA3	0.79	0.37	12.06	
	FA4	0.77	0.41	11.86	
	FA5	0.63	0.60	10.43	
4. FF					0.869
	FF1	0.80	0.36	-	
	FF2	0.77	0.41	17.04	
	FF3	0.78	0.38	17.49	

Table 4-4 The final results of confirmatory factor analysis (continued)

Constructs	Indicators	Standardized loading	Standard errors	t-Value	Cronbach's α
	FF4	0.81	0.34	18.19	
5. IN					0.899
	IN1	0.93	0.14	-	
	IN2	0.89	0.21	27.85	
	IN3	0.80	0.36	22.35	

EV = Environmental values; GM = Global motives toward public bicycle adoption; FA = Factors against public bicycle adoption; FF = Factors the public bicycle adoption; IN = Adopting intention of public bicycle.

Table 4-5 examines the validities of measurement model. we apply the average variance extracted (AVE) which appears as bold numbers along the diagonal of the matrix to measure the convergent validity. All AVE are between 0.479 and 0.764. The values are close to 0.5 and mean multiple indicators of constructs should be related (Fornell and Larcker, 1981). In discriminant validities, we compare the AVE and the values in parentheses which are square correlations between two constructs. We discover all of AVE are more than the square correlations. It means that there are discriminant validities between the two constructs.

Table 4-5 Correlation matrix of research constructs

Constructs	Mean	Std. D	1.	2.	3.	4.	5.
1. EV	4.159	.603	**.541**				
2. GM	4.120	.606	.708**	**.555**			
			(.501)				
3. FA	2.219	.756	-.499**	-.535**	**.479**		
			(.249)	(.286)			
4. FF	4.275	.673	.694**	.624**	-.443**	**.626**	
			(.481)	(.389)	(.196)		
5. IN	4.298	.724	.567**	.664**	-.619**	.529**	**.764**
			(.321)	(.441)	(.383)	(.280)	

**Correlation is significant at the .01 level (2-tailed).

Average Variance Extracted (AVE) appears as bold numbers along the diagonal.

Values in parentheses are square correlations between two constructs.

EV = Environmental values; GM = Global motives toward public bicycle adoption; FA = Factors against public bicycle adoption; FF = Factors for public bicycle adoption; IN = Adopting intention of public bicycle.

4.3. Structural Model and Hypothesis Test

Fig. 4-2 presents the structural path estimates in the structural model. It explains a series of behavioral processes which Taipei residents have an intention on adoption to the YouBike from the aspect of environmental perception with the framework of the behavioral reasoning theory. We discover that two initial hypotheses (H5 and H7) are not significant when α is 0.05. In other words, there is no sufficient evidence to confirm the factors for public bicycle

adoption that positively affect the global motives toward public bicycle adoption (β_{H5} = 0.08, t = 0.90) and the factors for public bicycle adoption that positively affect the adopting intention of public bicycle (β_{H7} = 0.09, t = 1.52). Then, the results show the respondents' environmental values positively affect the global motives toward public bicycle adoption (γ_{H2} = 0.65, t = 6.52) and the factors for public bicycle adoption (γ_{H3} = 0.83, t = 15.53). Environmental values negatively affect the factors for public bicycle adoption on the same time (γ_{H1} = -0.59, t = -9.02). Finally, the global motives toward public bicycle adoption positively affect the adopting intention of public bicycle (β_{H8} = 0.41, t= 5.93). The factors against public bicycle adoption negatively affect the global motives toward public bicycle adoption (β_{H4} = -0.22, t = -4.39) and the adopting intention of public bicycle (β_{H6} = -0.42, t = -7.04). These six hypotheses are true because coefficients are significant at the 0.001 level (2-tailed).

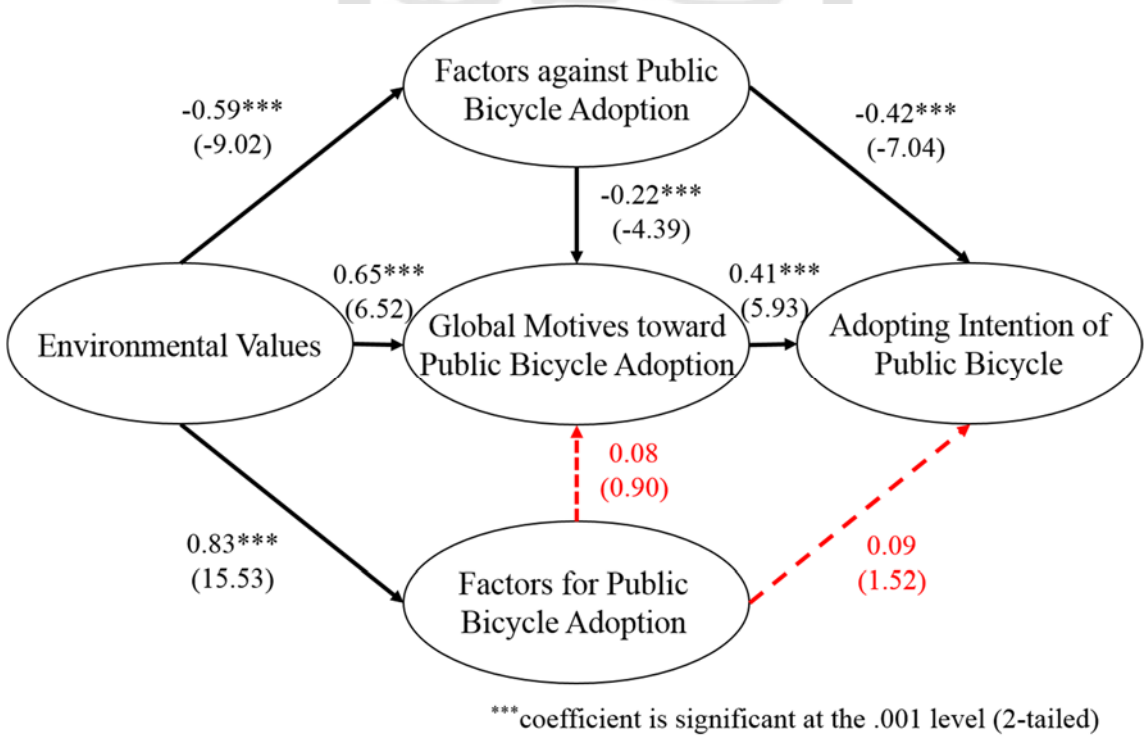

Figure 4-2 Structural path estimates in the structural model

Table 4-6 describes the standardized coefficients for the direct and total effects of independent variables on dependent variables. The environmental values exist the indirect effect on the adopting intention of public bicycle, and exist the direct effect on the global motives toward public bicycle adoption, the factors against public bicycle adoption, and the factors for public bicycle adoption. Then, the global motives toward public bicycle adoption and the factors against public bicycle adoption have the direct effect on adopting intention of public bicycle. Finally, the factors against public bicycle adoption exist the direct effect on the global motives toward public bicycle adoption and exist the indirect effect on adopting intention of public bicycle.

Table 4-6 Standardized coefficients for the direct and total effects of independent variables on dependent variables

Dependent variables	Independent variables	Direct effects	Indirect effects	Total effects
IN	EV	-	0.67***	0.67***
	GM	0.41***	-	0.41***
	FA	-0.42***	-0.09***	-0.51***
	FF	0.09	0.03	0.12
GM	EV	0.65***	0.20*	0.84***
	FA	-0.22***	-	-0.22***
	FF	0.08	-	0.08
FA	EV	-0.59***	-	-0.59***
FF	EV	0.83***	-	0.83***

Table 4-6 Standardized coefficients for the direct and total effects of independent variables on dependent variables (continued)

*coefficient is significant at the .05 level (2-tailed). **coefficient is significant at the .01 level (2-tailed). ***coefficient is significant at the .001 level (2-tailed).
EV = Environmental values; GM = Global motives toward public bicycle adoption; FA = Factors against public bicycle adoption; FF = Factors for public bicycle adoption; IN = Adopting intention of public bicycle.

From the model fit indices of table 4-7, $\chi^2 = 916.32$ ($p < 0.001$), $\chi^2/df = 4.559$, CFI = 0.97, GFI = 0.84, NFI = 0.96, NNFI = 0.96, IFI = 0.97, AGFI = 0.80, PGFI = 0.67, RMR = 0.055 and RMSEA = 0.091. GFI, AGFI, and RMSEA do not satisfy recommended cut-off values. However, once the model has a large number of parameters to be estimated, sometimes GFI and AGFI will be difficult to reach 0.9. Therefore, one scholar suggested that 0.8 is acceptable (MacCallum & Hong, 1997). RMSEA is considered to be an appropriate value in the range of 0.05 to 0.10 (MacCallum, Browne, & Sugawara, 1996). According to the results, it denotes an acceptable model fit for the structural model.

Table 4-7 the model fit indices

Model Fit Indices	Recommended Values
Chi-square = 916.32 (df = 201, p < 0.001)	
Chi-square / df = 4.559	＜5
Comparative Fit Index (CFI) = 0.97	＞0.95
Goodness of Fit Index (GFI) = 0.84	＞0.90
Normed Fit Index (NFI) = 0.96	＞0.90
Non-normed Fit Index (NNFI) =0.96	＞0.90
Incremental Fit Index (IFI) = 0.97	＞0.90
Adjusted Goodness of Fit Index (AGFI) = 0.80	＞0.90
Parsimony Goodness of Fit Index (PGFI) = 0.67	＞0.50
Root Mean Square Residual (RMR) = 0.055	＜0.08
Root Mean Square Error of Approximation (RMSEA) = 0.091	＜0.08

CHAPTER 5 CONCLUSION & RECOMMENDATION

In this chapter, we describe the findings and contributions, implications for policies, limitations, and future research and recommendations.

5.1. Findings and Contributions

This study is based on Westaby's behavioral reasoning theory (BRT) to explore what factors affect the public bicycle adopting intention of Taipei's residents from the aspect of environmental perception. We evaluate six constructs, including environmental values, factors for public bicycle adoption, factors against public bicycle adoption, global motives toward public bicycle adoption, and adopting intention of public bicycle, through the confirmatory factor analysis (CFA) and apply the covariance-based structural equation model (CB-SEM) to examine relationships among constructs. According to results of Fig. 4-2 and Table 4-6, the findings are described as follows.

(1) The factors for public bicycle adoption do not positively affect people's adopting intention of public bicycle.
(2) The factors for public bicycle adoption do not positively affect people's global motives toward public bicycle adoption.
(3) The environmental values will positively affect the factors for public bicycle adoption.
(4) The environmental values will negatively affect the factors against public bicycle adoption.
(5) The environmental values will positively affect the global motives toward public bicycle adoption.
(6) The factors against public bicycle adoption will negatively affect the global motives toward public bicycle adoption.

(7) The factors against public bicycle adoption will negatively affect the adopting intention of public bicycle.

(8) The global motives toward public bicycle adoption will positively affect the adopting intention of public bicycle.

From the first and second finding, they are related to the insignificant relationships among constructs. Compared to the reasons for opposition, we discover that the reasons for support are not related to adopting intention of public bicycle. As for the third to eighth findings, they are related to the significant relationships among constructs. We discover the environmental values positively affect the factors for public bicycle adoption, the factors against public bicycle adoption, and the global motives toward public bicycle adoption. We also discover the factors against public bicycle adoption negatively affect the global motives toward public bicycle adoption and the adopting intention of public bicycle. Finally, we discover the global motives toward public bicycle adoption positively affect the adopting intention of public bicycle.

We make contributions to understand the determinants and barriers of the public bicycle adopting intention through these findings. This study focuses on what factors influence the adopting intention of public bicycle. See the figure 5-1, we successfully get three paths related to the adopting intention of public bicycle. The paths are rearranged from our research findings. Their common characteristics are to use environmental values as antecedents and use the adopting intention of public bicycle as consequences. We get a structure to explain people's behavioral process about the public bicycle adopting intention.

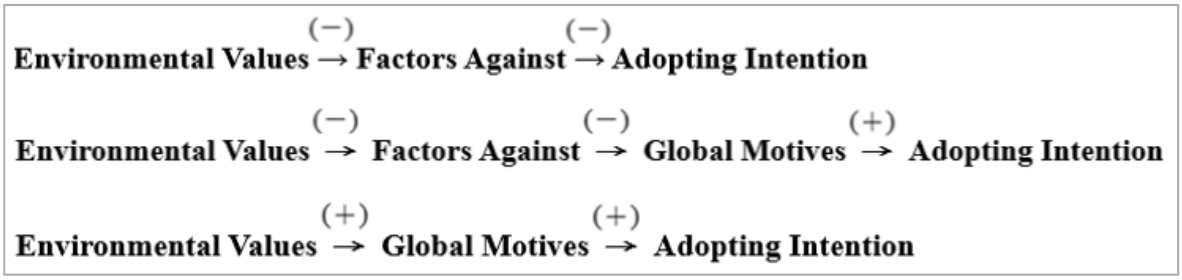

Figure 5-1 Three paths which affect the adoption intention of public bicycle

The first path is “the environmental values negatively affect the factors against public bicycle adoption, then the factors against negatively affect the adopting intention of public bicycle”. The second path is “the environmental values negatively affect the factors against public bicycle adoption, then the factors against negatively affect the global motives. After that, the global motives positively affect the adopting intention of public bicycle”. The third path is “the environmental values positively affect the global motives toward public bicycle adoption, then the global motives positively affect the adopting intention of public bicycle”. In the next section, we will discuss implications and suggestions for policies based on these important contributions.

5.2. Implications for Policies

In this paper, to provide reference opinions to the government so as to enhance the willingness to use public bicycle systems, we will put forward suggestions and implications for policies through the aforementioned results of empirical study. According to above findings, in consideration of the concept of environmental protection, we rearrange into three key points to strengthen the adopting intention of public bicycle. Fig. 5-1 shows three paths which affect the adoption intention of public bicycle. There are a total of three constructs that will affect the adopting intention. The minus sign in parentheses represents the negative influence, and the plus sign represents the positive influence.

According to the Fig. 5-1, we discover the factors for public bicycle adoption are not involved in the adopting intention. In this regard, we propose some policy ideas. The government always emphasized on the public bicycle's advantages from environmental protection in the past, but it had no influence on the intention directly. If the department concerned wants to increase the public bicycle usage in the future, this study suggests that other factors that significantly affect the intention should be improved first, instead of emphasizing the benefits of riding a public bicycle for environmental protection, including causing less environmental pollution, improving the environment in cities, decreasing the pay of gasoline, reducing the use of fossil fuel, and transferring to other public transport systems conveniently.

From the Fig. 5-1, in order to increase the adopting intention of public bicycle, this study will suggest improving the environmental values, the global motives toward public bicycle adoption and the factors against public bicycle adoption.

First, to guide people to have the environmental values, it can start getting a concept about the environmental protection from environmental education because one scholar believes that the exploration of environmental values is to provide a direction for the connotation of environmental education (Lin, 2001). Taiwan has enacted the Environmental Education Act in 2010. To culminate the citizens to understand their ethnical relationship to the environment and enhance the citizens' environmental values, we must guide the citizens to pay attention to the environment and adopt public bicycle systems through the adaptation of educational means. Education is the common responsibility of families, schools, and other social organizations (Peng, 2000). Therefore, we suggest trying to link riding a public bike with environmental values through multiple educational methods.

Second, to improve the global motives toward public bicycle adoption, we can try to enhance the positive attitudes, subjective norms, and perceived behavioral control of riding a public bicycle because the global motives include these three concepts in this research model. In the attitudes, we can create the image advertising to increase a sense of happiness or enjoyment to influence people' intention instead of stressing on its superiorities of the environmental protection only. In the subjective norm, it emphasizes the influence of significant others (e.g., parents, friends.) on behavior. We suggest to enhance emotional connections for important people through activities related to riding public bicycles. For example, when citizens ride public bikes, we encourage them to share their activities on the social network and check in a rental station to make a rental station a popular landmark. In the perceived behavioral control, according to our questionnaire item, it mentions that riding a public bicycle is inconvenient. Therefore, we suggest that the goal of improvement is to increase the convenience of use. For example, continue to increase the density of rental stations and consider shortening the distance between rental and mass transit stations when setting up stations in the future.

Finally, the factors against public bicycle adoption will become the barrier of the adopting intention of public bicycle, so this result proposes that we should focus on reducing the disadvantages such as improving the accessibility of the public bicycle system to increase the convenience. In addition, to improve the factors against public bicycle adoption, we can enhance the antecedent of the opposite factors. Namely, we must continue to promote citizens' environmental values.

5.3. Future Research and Limitations

This study only discusses from the aspect of environmental protection, so we difficulty explore the all determinants or barriers about the adopting intention of public bicycle because there are many factors which affect people's thought and behavior. In the behavioral reasoning theory (BRT), once it considers too many kinds of reasons in the support or opposite factors, it will cause the constructs become difficult to measure. In this limitation, once we understand opposite factors are a vital factor for the adopting intentions to ride a public bicycle, we suggest to investigate in detail the people's reasons for opposition in the future.

In addition to understanding the factors that may influence people's support or opposition to riding a public bike through a literature review, other qualitative research methods can also be considered to understand possible reasons in the future research, such as the depth interview or focus group. At the same time, the research scope can also be extended to other cities with public bicycle systems. It may be able to take shape a more comprehensive research framework. Additionally, the trip purpose (e.g., commuting, leisure, and business) can be considered. We can classify the model according to different trips. It is possible to develop new models and obtain different results.

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Appendix A Questionnaire (Chinese version)

親愛的先生和小姐：

您好！這是一份學術性問卷，目的在於了解影響臺北市 YouBike 微笑單車的使用意圖，本問卷共分為兩個部份，且僅供學術研究使用，不會移作他用，請您放心填答。在此感謝您撥冗協助！

敬祝　平安快樂

國立成功大學交通管理科學所

指導教授：林佐鼎　博士

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第一部份、（各項單選，請在適當的□內打勾）

「YouBike 微笑單車」使用電子無人自動化管理系統，提供甲租乙還的租賃服務，盼以低汙染、低耗能的公共自行車，做為大眾運輸系統最後一哩的接駁工具，藉此鼓勵更多民眾樂意使用大眾運輸系統，並減少及移轉私人機動車輛之依賴及使用，同時達到環保與節能的目的，打造全新的台北通勤文化。

問　項	非常不同意	不同意	無意見	同意	非常同意
1. 我認為 YouBike 提供的**環境功能**具有價值 （**環境功能**：對於空間、廢棄物、自然資源與生態的環境保護服務）	□	□	□	□	□
2. 我認為 YouBike 提供的**環境績效**符合我的期望 （**環境績效**：達成組織、計劃或政策中設定的環境指標或目標）	□	□	□	□	□
3. 我認為相較於其他交通工具，YouBike 提供更多的**環境關懷** （**環境關懷**：可以被用來激勵保護自然與環境，並尋求如何更加負責任地對待環境的方式）	□	□	□	□	□
4. 我認為騎乘 YouBike 是對**環境友善**的 （**環境友善**：指的是對環境影響較小的產品或服務）	□	□	□	□	□

問　　項	非常不同意	不同意	無意見	同意	非常同意
5. 對我來說，使用 YouBike 是件有益的事	□	□	□	□	□
6. 對我來說，使用 YouBike 是件開心的事	□	□	□	□	□
7. 對我來說，使用 YouBike 是一個好點子	□	□	□	□	□
8. 對我來說，使用 YouBike 是有價值的事	□	□	□	□	□
9. 對我來說，使用 YouBike 是很享受的事	□	□	□	□	□
10. 我身邊對我來說重要的人(父母、朋友…等等)認為我應該使用 YouBike	□	□	□	□	□
11. 我是被期望去使用 Youbike	□	□	□	□	□
12. 對我來說，使用 YouBike 這件事是可能的	□	□	□	□	□
13. 如果我想使用 YouBike，那肯定是能做得到的	□	□	□	□	□
14. 使用 YouBike，我將能有較低的環境污染	□	□	□	□	□
15. 使用 YouBike，我將能改善都市的環境	□	□	□	□	□
16. 使用 YouBike，我將能減少油費的支出	□	□	□	□	□
17. 使用 YouBike，我將能減低石化燃料的使用	□	□	□	□	□
18. 使用 YouBike，我將能更方便地轉乘其它大眾運輸工具	□	□	□	□	□
19. 我周遭的大多數人並不在乎 YouBike 對於環境保護的功能	□	□	□	□	□
20. 我不關心 YouBike 對於環境保護的功能	□	□	□	□	□
21. 使用 YouBike 對我來說不方便	□	□	□	□	□
22. 我很難在日常生活中，找到適當的時機使用 YouBike	□	□	□	□	□
23. 即使我使用 YouBike，對於減少溫室氣體的排放仍然沒有幫助	□	□	□	□	□
24. 我有意願使用 YouBike	□	□	□	□	□
25. 我未來會使用 YouBike	□	□	□	□	□
26. 我有計畫使用 YouBike	□	□	□	□	□

第二部份、基本資料（單選，請在適當的□內打勾）

1. 性別：□ 男 □ 女
2. 年齡：□ 20 歲以下 □ 21~30 歲 □ 31~40 歲 □ 41~50 歲 □ 51~60 歲 □ 61 歲以上
3. 月所得：□ 20,000 元以下 □ 20,001~40,000 元 □ 40,001~60,000 元 □ 60,001 元以上
4. 教育程度：□ 高中職以下 □ 大學、大專 □ 研究所(含)以上
5. 居住地區：□ 松山區 □ 信義區 □ 大安區 □ 中山區 □ 中正區 □ 大同區 □ 萬華區 □ 文山區 □ 南港區 □ 內湖區 □ 士林區 □ 北投區
6. 小汽車持有：□ 有 □ 無
7. 機車持有：□ 有 □ 無
8. 使用過 YouBike 的經驗：□ 有 □ 無

請再檢查是否有漏填的地方，感謝您對本研究的協助。

Appendix B Questionnaire (English version)

Dear Mr. and Mrs.

Hello! This is an academic questionnaire designed to understand what factors influence the adopting intention of YouBike in Taipei. The questionnaire is divided into two parts. This survey is only for academic research and will not be used for other purposes. Thank you for your help!

National Cheng Kung University
Department of Transportation and Communication Management Science
Advisor: Dr. Tzuoo-Ding Lin
Student: Ting-Yi Liu

Part I. (Multiple choice questions)

YouBike uses an electronic unmanned automated management system to provide " A Leases and B Returns" bike rental service. We hope that bikes will be chosen as the last-mile public transit vehicle and more citizens will be glad to use the mass transit system and meanwhile, environmental protection and energy conservation will be achieved and a new commuting culture will emerge.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. I consider that YouBike's **environmental functions** have much value for me. (**Environmental functions** are defined as the environmental service, including spatial functions, waste disposal, natural resource supply and life support.)	☐	☐	☐	☐	☐
2. I consider that YouBike's **environmental performance** corresponds to my expectations. (**Environmental performance** are referred to the measurable outcome of YouBike's ability to meet environmental objectives and targets set forth in the organization's environmental plan or policy.)	☐	☐	☐	☐	☐

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3. I consider that YouBike has more **environmental concern** than other forms of transportation. (**Environmental concern** means YouBike can be motivated to preserve nature and the environment, and seek ways how to behave more responsibly towards the environment.)	☐	☐	☐	☐	☐
4. I consider that I utilize YouBike because it is **environmentally friendly**. (**Environmental friendly** are defined as a product or service that have less impact on environment.)	☐	☐	☐	☐	☐
5. To ride the YouBike is beneficial for me.	☐	☐	☐	☐	☐
6. To ride the YouBike is pleasant for me.	☐	☐	☐	☐	☐
7. To ride the YouBike is a good idea for me.	☐	☐	☐	☐	☐
8. To ride the YouBike is valuable for me.	☐	☐	☐	☐	☐
9. To ride the YouBike is enjoyable for me.	☐	☐	☐	☐	☐
10. Most people who are important to me think that I should ride the YouBike.	☐	☐	☐	☐	☐
11. It is expected of me that I ride the YouBike extremely likely.	☐	☐	☐	☐	☐
12. For me to ride YouBike would be possible.	☐	☐	☐	☐	☐
13. If I wanted to I could ride YouBike definitely true.	☐	☐	☐	☐	☐
14. I would be causing less environmental pollution.	☐	☐	☐	☐	☐
15. I would be improving the environment in cities.	☐	☐	☐	☐	☐
16. I would be decreasing the pay of gasoline.	☐	☐	☐	☐	☐
17. I would be reducing the use of fossil fuel.	☐	☐	☐	☐	☐
18. I would conveniently transfer to other public transport systems (e.g., MRT).	☐	☐	☐	☐	☐

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
19. Most of the people around me don't care about eco-friendly features of YouBike.	☐	☐	☐	☐	☐
20. I am not concerned about eco-friendly features of YouBike.	☐	☐	☐	☐	☐
21. Riding a YouBike is not convenient for me.	☐	☐	☐	☐	☐
22. It is difficult to find a appropriate way to ride a YouBike for me.	☐	☐	☐	☐	☐
23. It is unhelpful to mitigate greenhouse gas emissions.	☐	☐	☐	☐	☐
24. I intend to ride the YouBike in the future.	☐	☐	☐	☐	☐
25. I will try to ride the YouBike in the future.	☐	☐	☐	☐	☐
26. I plan to ride the YouBike in the future.	☐	☐	☐	☐	☐

Part II. (Multiple choice questions)

Socioeconomic Status

1. Gender: ☐Male ☐Female
2. Age: ☐20 or below ☐21~30 ☐31~40 ☐41~50 ☐51 or above
3. Monthly Income: ☐20000 or below ☐20001~40000 ☐40001~60000 ☐60001 or above
4. Education Level: ☐Senior high school or below ☐Bachelor ☐Master or above
5. Living District: ☐Songshan district ☐Xinyi district ☐Da'an district ☐Zhongshan district ☐Zhongzheng district ☐Datong district ☐Wanhua district ☐Wenshan district ☐Nangang district ☐Neihu district ☐Shilin district ☐Beitou district
6. Car Ownership: ☐Yes ☐No
7. Motorcycle Ownership: ☐Yes ☐No
8. Experience of Using YouBike: ☐Yes ☐No

Please check if there is a missing form and thank you for your assistance in this study.