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Thesis

Title: The Public Bicycle System in Hangzhou, China
Opinions from Providers & Users

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Abstract

Key words: Public Bicycle System, Arrangements, Users' satisfaction

Hangzhou, one of the most modernized cities in China, has experienced severe congestion, parking difficulties, as well as pollution problems since the boost of the car industry during the last decade. In order to ease traffic and parking difficulties, and to boost a sustainable transportation system, the local government introduced the Public Bicycle System (PBS) in 2008. Since its implementation, despite its popularity, drawbacks of the system, such as maintenance of the system, redistribution of the bicycles and technical problems became to emerge and arouse heated discussion among the users.

Since the PBS is a user oriented project, the failure or the success of it depends largely on whether the general public makes use of the service. It is crucial to sustain and improve the current system in Hangzhou by looking at the key factors which influence the users of PBS. Based on the analyses of interview with the government official, public transportation corporation manager, working staffs as well as questionnaires from the users and non-users, the paper attempt to provide an insight of the design of the PBS, running status of the PBS, challenges the PBS faces as well as the users' satisfaction towards PBS in the specific context of Hangzhou.

Finally, the paper proposes recommendations to improve the current PBS in Hangzhou as well as offer useful references to other cities which are interested in establishing similar systems, especially for cities that have relatively similar city context and travel behavior.

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Abbreviations

PBS	Public Bicycle System
GHG	Green house gas
BRT	Bus rapid transit
EU	European Union
WCED	World Commission on Environment and Development
OECD	Organization for Economic Cooperation and Development

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Chapter 1

Introduction

1.1 Background

With fast increasing urbanization and economic growth in the last few decades, the demand for mobility for people and goods grew rapidly. As a result, the number of vehicles and roads boosted at a tremendous speed, especially in developing countries like China. Despite the positive fact that transport system, especially motorized vehicles, serves as a generator for economic processes and an important stimulus for social activities, the externalities caused by the transport system has been receiving criticism through years. Primarily, transport has huge environmental impacts including GHG emissions, air pollution and noise pollution on the cities. Moreover, the traffic congestion has truly become a severe problem worldwide. Not only is more time wasted on the roads, but also is more pollution generated due to traffic jams. Furthermore, the health and safety of citizens are threatened by the increasing use of modern transportation. (Schoifer et. al. 2003)

In order to solve these problems, various attempts have been made by governments worldwide. Many governments favored to solve the problems by building more roads and making it more accessible for motorized vehicles. However, with more researches conducted in the field of urban transportation, it became clear that these increments in roads did not have a definite positive effect on solving the traffic congestion and its externalities. The newly built roads will temporarily release the pressure from traffic jams, but also increase the induced traffic demand. Consequently, roads will soon be packed again with numerous cars. Moreover, wide roads and expressways (especially the elevated section) discourage the use of other travel modes such as walking, cycling and bus by simply dividing the urban landscape into separate zones and increase the crossing time. Additionally, separated junctions make it even harder for commuters to cross (Tiwari 1999). Rapid transit systems such as metro, light-rail and bus rapid transit, which have a good passenger carrying capacity, also face the problem of less affordability as it compared to public bus systems, walking and cycling (Peng, Zhu& Song 2008).

Therefore, the concept of sustainable transportation was introduced to address these inefficiencies and pollution related problems in cities in a more integrated approach. It emphasizes the achievement of economical, environmental and social sustainability of transport systems. Economically, it considers the operational efficiency and financial feasibility. Environmentally, it focuses on lower energy consumption and less environmental impact of transport models. Socially, the main focus is on creating

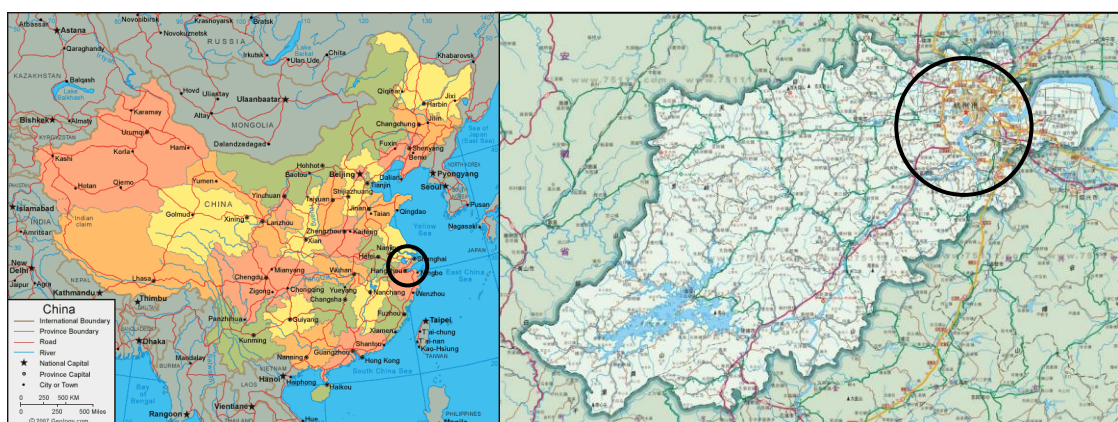
affordability by the urban poor, safety, comfort, and economic and social equity. (Laquian 2007)

In the light of sustainable transportation, many governments attempt to promote the old way of travelling—the use of the bicycle, as it is cheaper, greener and healthier for the users and the society. Among the bicycle-use promotion, one model is gaining popularity worldwide in recent years: the Public Bicycle System (PBS). A Public Bicycle System, which can be defined as a bank of bicycles, has service points scattered in a certain area and is offered to the general public for short-term usage free of charge or for a low cost. Many cities around the world have attempted to introduce the system in order to build a more sustainable urban transport model by solving economic, environmental and social problems. Generally speaking, a PBS could reduce congestions on the road system; provide an efficient linkage to other transport mode; diminish the environmental impacts of transport activities and lead a greener & healthier lifestyle. (DeMaio 2009)

1.2 Description of the research area

Hangzhou, the capital of Zhejiang province in Southeast China, covers an area of 16.6 thousand square kilometers, has a population of 6.6 million people. Nearly 2.2 million people live in the urban area which covers only about one twenty-fifth of the total area. The population density reached 3021 people per square kilometers in the urban area, while the traditional city center has reached a density of 17989. (Hangzhou Annual Government Statistics 2009) Although it is well-known as a green city and prosperous business city due to the commercial, tourism and light-industrial sector, the city is also facing severe congestion and environmental problems. Therefore, the government of Hangzhou takes up the ambition to develop a greener and more sustainable city.

Picture 1.1 & 1.2 Location of Research Area



Source: Wikipedia, 2009

Due to rapid economic growth, fast urbanization, increasing life quality and the national policy of promoting car industry, the number of cars has increased dramatically in recent years. The number of cars that the citizens hold has increased from a bit more than 91,000 (2000) to nearly 2,000,000 (2008) (Hangzhou Annual Government Statistics, 2009). Moreover, as a tourism city, the constantly additional cars and tourist buses from other cities put more pressure on the road system. Therefore, the construction of roads cannot catch up with the rapid boost of cars and congestion became more severe. As a result, carbon dioxide emissions and other related pollution increased due to the increasing volume of cars and congestion. In order to meet the needs of the increasing volume of motorized modes of transport and reducing congestion, more valuable open spaces are used for building roads. However, the newly built roads usually only released the pressure of congestion for a short period of time and then packed with cars again. Acting like a vicious circle, more pollution and GHG are released to the surrounding areas. Apart from air pollution, the noise pollution caused by the transport also became more severe than before.

For the past twenty years, due to the lack of a long-term development plan, building more roads was the prioritized option to reduce congestion in Hangzhou. Realizing building more roads is not the sole solution for reducing congestion, the government now attempts to address the problem by establishing a comprehensive transport system in recent years. By now, Hangzhou government attempted to establish the comprehensive public transport system by integrating buses, metro, taxis, waterbuses and PBS.

The normal bus lines, up to now, still serves as the main transport mode of the comprehensive public transport system, while other transport mode provide the citizens with different options and make the whole system more efficient. BRT (Bus Rapid Transit) lines were introduced for daily commute and were put into use in 2006. However, the BRT lines do not have completely-dedicated lanes, which significantly reduce its efficiency. Besides BRT lines, 13 special city tour lines were designed to fulfill the needs of tourism purpose, which greatly reduce the private-car use in the tourism zones. (Hangzhou transport department 2004) Other than bus system, metro is now under construction in the hope of releasing the pressure of current road system in the recent future. Taxis also serves as an important travel option especially during extreme weathers or late in the night. Moreover, governments see the waterway as an alternative of means of transport. However, the waterbuses are not favored by commuters as they are not punctual and always cause delay to reach work and school. Therefore, the waterbuses are struggling to survive by attracting tourists. (Hangzhou transport department 2008)

In order to mobilize the public transport system mentioned above and partly solve the congestion and parking problem, Hangzhou has initiated a PBS service as part of the

comprehensive public transport system in the summer of 2008. Since then, the system, with its increasing popularity and impact, has gained a good reputation throughout the country. However, as the project went on, despite its popularity, drawbacks of the system, such as maintenance of the system, redistribution of the bicycles and technical problems became to emerge and arouse heated discussion among the users. (Qian 2009)

1.3 Problem statement

PBS, as a mode of sustainable transport, has gained its popularities around the world in the recent years. Successful cases in Paris and Barcelona are always being mentioned in the reports on PBS. However, failed cases such as in Shanghai and Beijing, prove that not all PBS are being carried out successfully. Why does a PBS succeed in one city but fail in another? Different city context, as well as project arrangement, infrastructure and policies might affect the sustainable development of PBS (Transport Canada 2009). Hangzhou, as the first city in China which introduced PBS, is now operating the system for more than two years. Although the media claims it is a successful system, criticisms and negative feedbacks towards the PBS have spread over the internet. Since the PBS is a user oriented project, the failure or the success of it depends largely on whether the general public makes use of the service. It is crucial to sustain and improve the PBS in Hangzhou by looking at the factors influence the satisfaction of PBS usage. The result of this work attempt to provide an insight of the design of the PBS, running status of the PBS, challenges the PBS faces as well as the users' satisfaction towards PBS in the specific context of Hangzhou. Moreover, with this study, recommendation will be proposed to improve the current system as well as useful references could be offered to other cities which are interested in establishing similar systems, especially for cities that have relatively similar travel behavior.

1.4 Research objectives

As mentioned in the problem statement, preconditions, project arrangements and users' satisfaction will affect the implementation of PBS. However, a few academic researches have been conducted on this field. Therefore, this study aims to investigate:

- Project arrangements of the Hangzhou PBS;
- The running status of the Hangzhou PBS;
- The factors that influence the user satisfaction of the Hangzhou PBS;
- Improvement that could be made for the future development of the PBS from the users' perspective

1.5 Research questions

Main Question

To address the above objectives, the study will focus on the following main research questions: “How is the PBS functioning in Hangzhou and how is the PBS perceived from a user perspective.”

Sub-Questions

- What is the running status of the Hangzhou PBS?
- What are the major challenges in running the Hangzhou PBS?
- Is the user satisfied with the system so far?

1.6 Research methods

As a combination of descriptive and exploratory research, the work will be approached through methods such as literature and case studies review, interviews and survey. However, little researches have been conducted in the field of PBS. Therefore, part of the review work will be conducted through reviewing studies that focused on cycling. Interviews with provider including government official, public transport corporation manager and working staffs will be used to demonstrate the project arrangements, running status as well as challenges of the Hangzhou PBS, while interview with users and non-users will be used to identify the challenges users faced and the satisfaction of PBS usage in Hangzhou.

1.7 Thesis structure

This study is divided into six chapters. The first chapter introduces the problems caused by the transport, the idea of sustainable transportation, as well as the background information of Hangzhou. After that, it presents the problem statement, objectives and research questions of the study.

The second chapter presents a review of literature related to the concept of sustainable transport and to the preconditions and project arrangements for establishing a PBS. Moreover, it reviews the factors that influence the user perception and satisfaction towards transport, particularly a PBS.

The third chapter presents the research methodology including research sampling, methods, variables, indicators used in this study. Chapter four and five give the results of the research findings from perspective of provider and users respectively. The chapter six presents the answers to the research questions as well as recommendations to improve the current system.

Chapter 2

Literature review

2.1 Introduction

In this chapter, the concept of sustainable transportation will be reviewed the first in order to provide a linkage with sustainable transportation and bicycle use through comparing the criteria of sustainable transportation and the benefits of bicycle use. Secondly, previous researches and case study materials related to the Public Bicycle Systems will be reviewed with the perspectives of creating a better insight into the definition of a PBS, the motives for establishing PBS systems and the different types of project arrangements. Finally, the factors influence the user satisfaction toward PBS will be reviewed. This is done with the aim to increase the general and theoretical insights of PBS in relation to sustainable transport and to come up with a suitable conceptual framework for the planned research in Hangzhou.

2.2 Sustainable transportation

The concept of sustainable transportation was introduced in order to solve problems related to the traffic disturbance, transport efficiency, environment protection, safety issues and social welfare. (EU commission 2003) The term sustainable transportation originates from the ideas around sustainable development which indicate that development should meet the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). To be more specifically, sustainable transportation is used to describe the modes and systems of transport which are considered as sustainable from social, economic and environmental perspectives. (Council of EU 2001) Various definitions of sustainable transportation have been provided by researchers and scholars through the years.

Schipper (1996), provides the following definition: "Transportation is sustainable where the beneficiaries pay their full social costs, including those paid by future generations."(OECD 1996, pp81) In other words, the users of a transport system should pay for the externalities of the traffic such as noise, air pollution, congestion, accidents, damage to species and rise of oil demand, while they are enjoying the benefits of the transport. Although this definition highlights the concerns of paying social costs for the current and future generation, it is mainly focusing on the economic and environmental externalities of the system. Moreover, this definition is rather limited due to the fact that it is based on the idea that everything can be priced and has a market value. It too strongly emphasizes the pricing mechanism. It points to the fact the beneficiaries have to pay for the externalities, mostly negative, of transportation, without mentioning principles of reducing the negative externalities at the first place.

Another definition given by OECD (2000) concerns environmentally sustainable transportation: “An environmentally sustainable transport system is one that does not endanger public health or ecosystems and meets needs for access consistent with use of renewable resources at below their rates of regeneration, and use of non-renewable resources at below the rates of development of renewable substitutes.” This definition mainly focuses on the environmental perspective. Although it provides a comprehensive insight concerning people health, ecosystem and energy use, it neglects the social and economic sustainability of the transport system, which are also crucial for sustainable transport development.

The third definition, with much wider concerns for the word sustainability, is given by the European Union Council of Ministers of Transport and provided below:

- *“Sustainable transport allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.*
- *Sustainable transport is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.*
- *Sustainable transport also limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.” (Council of EU 2001,pp.16)*

The above definition covers social, economic as well as environmental dimensions related to the transport sector and pinpoints more specific targets of a sustainable transportation system respectively. Under this concrete and comprehensive concept, many innovative models and systems are and can be developed to address the targeted problems.

A great number of sustainable transport approaches are designed for mobilizing motorized transport, such as BRT, congestion pricing, pollution tax and etc. In addition, several countries particularly paid attention to the use of non-motorized transport, especially cycling, to realize targets of sustainable transportation.

Cycling as a model for sustainable transport is not only environmental friendly but also economically and socially beneficial. When looking at the principles of

sustainable transport provided by the EU Council, cycling is sustainable in the following ways.

From the environmental perspective, promoting cycling greatly minimizes the environmental impact on land use and the generation of pollution as it is pollution-free. That is to say, bicycling does not create air and noise pollution as compared to motorized transportation. In other words, the more people are using cycles instead of cars, the more harmful emissions and contribution to GHG is reduced. (London Council, 2010)

Economically speaking, bicycling provide a choice of affordable transport mode and increase the transport efficiency. From an individual perspective, cycling involves relatively low purchasing and maintenance costs compared to private cars. From a public perspective, it cost less to build the required infrastructure for bicycle use than for motorized vehicles and this infrastructure also requires far less space. Moreover, it would reduce the demand for gasoline and petroleum. Another important argument in favor of bicycle use is that the promotion of cycling will optimize of the whole transport system in which reduce the traffic congestion. (London Council, 2010)

Socially, promoting bicycle use increases the human and ecosystem health directly and equity and safety indirectly. Primarily, bicycling is more affordable for the urban poor and greatly increases the mobility of people where public transport is not provided. Furthermore, it would vivify the city and make the city more livable as car uses are replaced by cycling and congestion is reduced. People would like to go out as the air quality is improved as well as less cars are used. Another impact is that increased use of bicycles would support the shift of a merely sedentary lifestyle, which causes obesity and other health problems, to a healthier lifestyle. This in turn would reduce the cost of the whole public health system. (London Council, 2010)

2.3 Definition of PBS

As a category of the bicycle use, the first Public Bicycle System (PBS) was carried out in 1967. Although forty-three years have passed since then, little researches have been conducted in this particular field. No definite definition has been provided by academia, but a number of reports and case studies have made an effort to come up with a proper definition of a PBS.

According to a definition by the *Victoria Transport Policy Institute*, PBS, also known as Bike Sharing, is a system that offers convenient rental bicycles to the public for short-term and urban trips. “A typical Public Bike System consists of a fleet of bicycles; a network of automated stations (also called points) where bikes are stored; and bike redistribution and maintenance programs.”(Victoria Transport Policy Institute 2010) One way trip is available as the bikes could be rented at one point and

returned to another. With an automated self-serve store system, stations usually accommodate 5-20 bikes which are located at major transit and transportation centers, spaced about 300m apart. Use is always for free or inexpensive for short periods.

Another definition is provided in a case study conducted by *Transport Canada*, a governmental sector that is responsible for the transportation policies and programs in Canada. “A public bicycle system is a bank of bicycles, with numerous pick-up and drop-off points, available to the general public for short term uses for free or for a small fee.”(Transport Canada 2009)

The third definition is offered by the CITYRYDE LLC, which is a consulting company specialized in the field of public bicycle system. “Bicycle sharing as it exists today is an emerging form of environmentally friendly public transport that fills the gaps for those trips too far to walk and too close to drive to take another form of transportation.” (CITYRYDE LLC 2009)

In this paper, the Public Bicycle System is defined as a bicycle system with a certain amount of service points scattered in the urban area which offers bicycles free of charge or for a low cost to the general public for short-term usage. The aim of a PBS is to offer a contribution to sustainable urban transport development by encouraging bicycle usage, reducing congestion, providing an efficient linkage to other mode of transportation, diminishing the environmental impacts of transport activities and improving the human and ecosystem health.

2.4 Motives/Objectives for PBS service

With the hundreds of PBS services implemented around the world, the major objectives of adopting a PBS system seem quite similar, namely, the reduction of traffic congestion and the environmental impact of traffic. However, the initial objectives might be different from project to project. Theoretically speaking, the objectives could be categorized as: drive for environmental improvement, economic improvement as well as social improvement. The environmental aim consists of the reduction of greenhouse gas emission and the reduction of noise pollution. The economic objectives focus on building a more efficient transport system, which in turn increase the productivity of the society by saving commute time. Meanwhile, due to the reduction of externality of traffic congestion, less expenditure will be used for the environmental and health treatment. Social objectives include the promotion of a healthier life style and the overall improvement of the health condition of citizens.

In the reality, most of the PBS projects follow a combination of different objectives and motives but the social objectives are usually least mentioned. In the case of Smartbike DC in the Washington, the initial purpose of the project was to provide an alternative option for citizens’ commute, short distance traveling, as well as leisure

and by that to improve and enhance the city's public transportation system. A key objective mentioned in the case of City Denver is to make the city greener, healthier and more sustainable. By promoting the PBS (Denver B-cycle), the Denver municipality aims to improve the health condition of the citizens and lower the carbon dioxide emissions. Reducing traffic congestion, another vital objective, appeared in design of the two projects in France (Paris and Lyon). By providing an alternative for car use, the PBS helps to minimize the congestion and also the environmental impact of the traffic on the city. Other projects around the world show similar motives of adopting the PBS service, although a few also mention that it could act as a project for improving the city's image and an incentive for tourism. (Transport Canada 2009)

Based on the different PBS worldwide, the ideal objective for adopting a PBS service would be a combination of the major points illustrated above: to reduce traffic congestion; to reduce environmental impacts of traffic; to improve the human and ecosystem health; and to act as a complementary means to other modes of private and public transportation.

2.5 Preconditions of setting up a PBS

In this section, reviews will focus on the precondition of setting up a PBS. As very limited scientific researches have been conducted in the field of PBS, preconditions are expected to be identified by reviewing barriers of bicycle use and policies to promote cycling together with case studies of PBS around the world.

2.5.1 Barriers of bicycle use

Despite all the benefits that cities could gain when promoting PBS, the design and implementation of a public bicycle system faces quite a number of obstacles to overcome. Starting from the findings of a research on bicycle use, the cycling reports of the city of London (UK), indentify, categorize and present these barriers into three groups: attitude towards cycling, physical barriers and barriers to deliver the service.

Attitude towards cycling:

Primarily, people have a feeling of fear of traffic and feeling of vulnerability during cycling compared to car use, particularly when traveling in unfamiliar areas. Moreover, cycling is considered incompatible with the view of the busy modern lifestyle. Besides these, uncertainties whether cycling is suitable for them also become a barrier for cycling promotion. A last concern is that the convenience and comfort of the car use prohibits the potential usage of the bicycles. (London Council, 2010)

Physical barriers:

Physical barriers include the high speed of the traffic, lack of cycle infrastructure and severance caused by main roads. High speed and volume of motorized traffic limits

the use of cycling. In turn, it also contributes to feelings of vulnerability and fear of the traffic. Moreover, lack of the basic infrastructure such as cycling lanes, parking and lockers, discourage people from using bicycles. Furthermore, the severance caused by roads, railways lines and waterways obstruct bicycle users to access to different areas. (London Council, 2010)

Barriers to deliver the bicycle service:

Little political support, insufficient fund and lack of trained staff are all consider barriers to deliver bicycle services. Lack of political support makes it harder to deliver effective cycling initiatives and infrastructure construction because it requires political will power to push cycling friendly policies. Meanwhile, insufficient funding usually causes reduction in investment. It greatly limits the capacity of long-term operations as less funding are provided for construction, maintenance and upgrade of the current infrastructure which sequentially reduce the initiatives of bicycle use. Moreover, lack of trained and experienced staff, which is crucial for the planning and maintenance, further contributes to the unsustainable chain of promoting bicycle use. (London Council, 2010)

Gong & Zhu (2008) highlights in their research on bicycle use that the natural condition of a city can also considered an important obstacle for bicycle use. Cycling is vulnerable to severe weather conditions such as heat, storm and snow. As a result, cities, which for a long period of time face these weather conditions, are considered not suitable for promoting bicycle use. However, rain and cold weather seems to be more affective to the cyclists than the hot weather. Wilde (2000) found that people are three times willingly to cycle in a “hot and dry” day than a “cold and wet” day, which cold causes for 20% of the reduction and rain cause up to 60% of the reduction respectively. Furthermore, the topography is considered a vital prerequisite for cycling use. The study shows with slopes of more than 50 meters and more than 2-3%, the danger of using bicycles would increase greatly and therefore prohibit people from using bicycles.

Researches of PBS show similar concerns about bicycle infrastructure, topography and climate condition before implementation of public bicycle system. Besides these factors, a research demonstrates whether a city is suitable for carrying out a Public bicycle system or not depends also on city size, potential for transit intermodality and levels of bicycle use (Transport Canada 2009). A city with more than a population of 200,000 is recommend for setting up self-service PBS while a manual PBS is more suitable for city with less population as it is cheaper. Another criteria regards to city size is density, PBS is suggested to be set up in the dense area or area with mixed land use of workplace, shops, services, schools and recreation. Furthermore, potential for transit intermodality is seen as a key condition of setting PBS in the sense of rapid transit systems can support and be supported by the use of public bicycles. The level

of bicycle use is also mentioned to have an impact on success of a PBS. From the cases of Denmark and the Netherlands, it seems high level bicycle use is favor the success of PBS. However, in the cases of Lyon, Paris and Barcelona, low level of bicycle use did not bar the successful implementation of PBS. It proves that high level of bicycle use is not a key precondition of setting up a PBS. (Transport Canada 2009)

Another study (NICHEs 2008) mentions some additional conditions of setting a PBS, including match the PBS with targeted group. The analysis of targeted group is need for selecting the service area and the payment design. For example, the OV-fiets in the Netherlands is specially designed for railway commuters and therefore all pickup points are located at the railway stations. Midgley (2008) pinpoints, besides minimum standard of bicycle infrastructure that ensures safe and convenient cycling, the existence of consist policy to support sustainable urban mobility and the bicycle use is also considered as a precondition of setting PBS.

To sum up, in order to carry out a PBS efficiently and effectively, it should first consider the barriers mentioned above in the local context as well as aspects concluded from researches on PBS.

- Topography
- Climate
- City size and density
- Basic cycling infrastructure
- Attitude towards cycling
- Potential for transit intermodality
- Level of bicycle use
- Analysis of targeted group
- Policies for promoting bicycle use

2.5.2 Policies for promoting bicycle use

As mentioned above, one of the precondition of setting PBS is the existence of consist policy to support sustainable urban mobility and the bicycle use. In this section, bicycle policies of Denmark and the Netherlands, both have a high reputation of bicycle use, will be reviewed to see how these countries manage to promote bicycle use and address the different barriers mentioned before.

A report on Danish policy (Road Directorate 2000) pinpoints the importance of linking soft policies with hard policies. Together, the combination of soft policies such as campaigns, instruction, education, etc. and hard policies such as infrastructure, taxation etc would result in transfer of traveling behavior, both in selection of transport mode and road safety. The report mentions two main soft policies to promote bicycle use. Campaigns aim to maintain the current bicycle users and attract potential bicycle users. The targeted group consists of mainly young and middle-aged

people. Meanwhile, instruction plays an important role for attracting the future generation to bicycle use, with children as the most important targeted group. The role is that instructions and lessons would bring the cycling culture to the future generation. With respect to hard policies, better physical conditions are needed for promoting cycling, as citizens would only keep on or start cycling if they have a positive feeling of cycling. Another hard policy is regulation. Petrol tax, parking charges and traffic calming, serve as sticks, discourage car use and in turn setting a more suitable environment for cycling and sequentially promoting bicycle use.

While the Danish policy focuses on the basic principles of designing integrated policies for bicycle use at city level, a study shows the Dutch focuses their policies on a multi-government oriented level. In the Netherlands, the Bicycle Master Plan was introduced in the year 1993. The goals of the master plan were to increase bicycle uses and decrease car uses. This policy paper, which stands at a nation level, pinpoints that the target to encourage the bicycle as the principal means of transport should be carried out by all provincial and municipal authorities. At the national level, the Netherlands state establish national plans to set out a framework and support the decentralization of the design and implementation of bicycle policies at regional and municipal levels. Meanwhile, the provincial level serves as an organization at regional level to ensure and promote the collaboration between municipalities. Specifically, they are responsible for the division of subsidy to bicycle related projects. The core of a bicycle policy is at the municipal level, where a majority of the facilities is provided and implementation of related policies is carried out. (Ministerie van Verkeer en Waterstaat 2009)

Box 2.1 Policies and approaches to promote cycling in the Netherlands

In Groningen, the government has integrated the planning for bicycle use with the local spatial planning. As the development of the city is supported by the consistent integrated policies, the city is built in a compact way and is easily reachable by bicycle. Besides these actions, regulations in favor of pedestrians, cyclists and public transport are implemented in the inner city. As a result, the city is very suitable for bicycle uses. The infrastructure such as bicycle paths and parking facility is of great importance of a bicycle promotion policy. In Zeeland, a Bicycle Action Plan has been set up in the purpose of stimulating cycling. Construction of complete and safe bicycle paths, a goal of the plan, is an important way to attract people to use the bicycle more frequently. In Gelderland, the provincial government attempts to mobilize cycling by integrating bicycle with other transportation means. Bicycle parking facilities were improved and expanded at the bus stops to encourage people to use bicycle and public transport. An experience in the Hague shows that the improvements of parking facilities at secondary schools greatly increase the bicycle use. After the installation of the guarded parking, the number of students who cycles have ten folded than the previous (Ministerie van Verkeer en Waterstaat 2009). In Delft, a project called 'Children more safely through Delft' is launched by the municipality cooperated with schools, police, traffic safety organizations and parents. At one side, the children would get related information from traffic teachers. At the other side, infrastructures to ensure a safer place for traveling is built and several acts are taken to ensure the safety of the children. (Ministerie van Verkeer en Waterstaat 2009)

Although the Danish and Dutch policies have different focuses on their bicycle policies, they share a similar idea which is the bicycles policies should integrate with land use planning. Studies from the both Denmark and Netherlands (CROW 2007, Road Directorate 2000) pinpoint that urban sprawl contributes to longer travel distance and lead to increase in car use. And the cycling willingness in Denmark largely depends on the travel distance from home to the city center and workplace (Road Directorate 2000). A similar phenomenon is also observed in the Netherlands. One point made by the Dutch Master Plan is that the main treat to bicycle uses is the increasing uncoordinated expansion of urban areas. Research shows that 27% of the people who lives in the center, where shops, schools and workplace are concentrated, tend to use the bicycle for short trips while there is 5% drop in cycling use for people live at the suburbs. It illustrates how land use could discourage the bicycle uses for inhabitants (CROW 2007).

In conclusion, important issues gained from the reviewing pro-cycling policies are:

- Reinforcement of Multi-level policies
- Link national, regional and city level
- Proper combination of hard and soft polices
- Link transport policy with land use planning to promote bicycle use
- Link to other transport modes
- Interconnection of integrated multi-transport mode

2.6 Project arrangements

Since the first attempt of a public bicycle system in 1967 in Amsterdam, the PBS has developed into different models. Although with the similar motives and objectives, different models might vary in terms of institutional arrangements, financial mechanisms, operational arrangements and marketing techniques.

2.6.1 Institutional arrangement

The institutional arrangements for a PBS, mainly focusing on the operation provision, can be divided into 6 categories, which are government, transport agency (quasi-government), university, non-profit, advertising company and for profit. (DeMaio 2009)

In the government provision model, there are two options. The first is solely run by the government, which means the system was built and operated by the municipality, as well as the fund. For example, the government of Barcelona, Spain, purchased and operates an off-the-shelf bike-sharing system called Bicing (Transport Canada 2009). Under this system, the government has a great control of the project, however, it may lack of the experience of operating the system. The second option is to sign a service

contract with private companies. In this system, the service and operation was provided by the companies but the major fund was provided by the municipality.

The transport agency model provides some advantage than the government model. Examples could be the Deutsche Bahn of Germany and Stationnement de Montréal. In this system, the service is usually provided at a wide range, regional level or even national level. The project could benefit from the experience of the transport agency. Moreover, the main aim of the transport agency is to provide service that is beneficial to the public rather than generate revenue from the project. The main fund of this model is also revenue from the municipality side.

The university model is mainly for campus usage and funded by the university. Example is the former program at the University of Portsmouth, England. Although it increase the mobility in the campus, due to the small scale and high theft and vandalism rate, few program could last for long period.

The non-profit model includes the first attempts of PBS in Amsterdam and the relatively recent case in Copenhagen. In this system, the service is often run by the NGOs and the fund is mainly generated by the membership and user fee, as well as sponsorships. The main constraint of this model is the lack of public funding as the Public Bicycle System is not really profitable in the economic terms.

Advertising company model is the most popular system among the all. The famous PBS in Paris and Barcelona are all supporters of this model. In this system, the operation and finance provider is the advertising company, which means the government does not have to provide large sum of subsidies to the PBS. However, the PBS advertising company do not have the same incentive to operate the PBS as government due to the fact that it is not profitable, the maintenance of the bicycles are usually at a lower level compare to provision by the government.

In the for-profit model, a private company provides the service with limited or no government involvement. The PBS in Beijing follows this model as private company runs the service within a certain area. One benefit of the model is that the private sector can start a service by its own, but not wait for the public sector to carry out the service. However, that also means it lacks the support from the public sector and has to do a lot of negotiations with public and other private sectors for setting up service points.

With all these models, there are no ideal and perfect system. The design of the PBS should take the local and national context into account, as well as finance capacity of the fund provider.

2.6.2 Financial arrangement

The financial arrangement plays an important role in the whole process of the PBS. As it has been partly mentioned above in the institutional arrangement, different model has various financial arrangements although some similarity has been shared among the PBS worldwide.

According to the *Transport Canada* (2009), the financial arrangement of PBS could be divided into Cost and Revenue. On the Cost part, it could be further divided into Startup Costs, Ongoing cost and additional cost for theft and vandalism.

Primarily, the startup costs of a public bicycle system includes basic infrastructure such as bicycles, locker system and service points. Besides the install of the basic equipment, the cost of information campaign is also included in the startup costs. The amount of investment is based on the scale and width of the project. The ongoing costs consist of the operation and maintenance costs. The operation cost includes running cost of system as well as the salaries and administration fee for the staffs and company, while the maintenance costs contains the maintenance of the bicycles and stations, as well as redistribution. Theft and vandalism is separately mentioned due to the fact that many PBSes has suffered from the theft and vandalism. Take Paris, for example, due to rampant theft and vandalism, the entire initial fleet of 20,600 bicycles has been replaced at a cost of £400 apiece (BBC News, 2009).

Meanwhile, the revenue of a PBS is mainly generated from user payments, billboards and sponsorships. Most PBSes require users to register or pay for a membership fee. However, in order to stimulate the use of PBS, the fees are usually low. For example, the PBS in V ðib (Paris) and Bicing (barcelona) charge around £30 annually. Beside annual membership fee, users are also being charged each time they use the system. The usage fee is usually designed to encourage short term trip. Therefore, in most cases, the first half hour of usage is for free, and the cost will increased exponentially with every additional half-hour of use. Compare to the user payments, revenues generated from billboard counts for a more significant part of the total revenues. Moreover, sponsorships are also applied in many PBSes. Besides the revenue generated from the operation of the system, many PBSes is supported by government funds as government sees PBS as welfare to the general public.

As it is mentioned in the institutional arrangement, different models might have different fund provider, including government, advertising company, non-profit organization and sometimes donator from some organizations.

2.6.3 Operational arrangement

2.6.3.1 System design

In term of system design for the operation of the project, the trend of three generation PBS is listed below:

The characteristics of 1st Generation PBS is defined as organic, unstructured and contains no technology arrangement. Within this system, re-conditioned bikes are painted in common color and placed throughout city free of charge with no restrictions. The disadvantage of this system is that the theft and vandalism are often happened. Examples include Amsterdam White Bikes (1969), Portland Yellow Bikes (1994-96), and Madison Red Bikes.

The 2nd Generation of PBS is characterized by a Low-technology design and moderate expenses. Under this system, a coin deposit lock was introduced to deal with theft, there was however no tracking system of the bicycles. Moreover, the systems seldom reached the need of masses. Examples include Copenhagen (City Bikes), Helsinki, and Toronto.

The 3rd Generation PBS is designed on basis of High-technology and therefore rather expensive (\$500 - \$4000/bike). Most of the PBS in use today belongs to the 3rd generation PBS which two bicycle systems, fixed and flexible, are mostly applied.

Fixed bicycle systems have permanent service points that consist of a set of bicycle locker (Picture 2.1 A) and a service terminal (Picture 2.1 B). Bicycles are locked to the rack with a special locker system. Smart card is always applied in the fixed bicycle system to rent and return the bicycles. By swiping the smart card at the terminal and sometimes the locker system installed at the bicycle rack, registered users can release a bicycle. Unregistered users are allowed in some systems to purchase a pass at the station that permit the use of a credit card.

Picture 2.1 2.2 &2.3 System design for fixed station



Source: JCDecaux Cyclocity

Ideally, bicycles are available for pick up and empty slots available for drop off at all times in a fixed system. In order to keep bicycles and empty slots available at all service points, bicycles are continuously redistributed through the instruction of a central monitoring system. Service points might become empty or full if redistribution did not keep up with the usage. To mitigate this problem, the distance between two nearby service points are designed within 300-500 meters. If a service point is empty or full, an inquiry system on the service points will inform users which nearby service points have available bicycles or empty slots. (Transport Canada 2009)

Flexible systems, just as its literal meaning, do not require fixed service points but rely on bicycles with locks, which enable them to be attached to any bicycle rack or other stationary objects. The flexible system usually use Cell phone activated system to rent or return bicycles. This is advantageous both to the provider and the user of the PBS: the provider saves a big amount of capital costs whereas the users do not have to travel only between service points. However, time and money cost on finding bicycle increased compared to the fixed system as users can drop bicycles at any points in a certain area. Bicycles are usually installed with GPS device, which allows both users and the provider to locate them automatically.

Picture 2.4 2.5 & 2.6 System design of flexible system



Source: Call a bike

2.6.3.2 Service point design

Generally speaking, the most important design of the service point is the locker system and service terminal. The service terminal usually provide basic financial transactions related to the purchase of user memberships, provides information about how to use the system, and about the availability of bicycles and docking spaces at other stations. The locker system contains smart card reader and a status indicator light. However, in some systems, there is no separate card reader on the bicycle locker and user must check in on the terminal. Additionally, advertizing space will be designed in order to generate supplemental revenue.

2.6.3.3 Capital and human resource

A PBS requires more than just bicycles and service points. A variety of equipments and working staffs is needed to keep the system functioning at an adequate level of service.

With regards to capital resources, this includes:

- A vehicle fleet for redistribution of bicycles between stations;
- Warehouse facilities for major bicycle maintenance, storage of spare parts and spare bicycles. In colder locations, storage of bicycles and other equipment if the system shuts down in the winter;
- A logistics centre for monitoring the status of the service points and bicycles, coordinating redistribution of bicycles, maintenance of the system, and repair operations as well as for customer service.

Since the design of 3rd generation PBS systems is based on self-service, the need for staff to handle bicycle pick up and drop off and monetary transactions is greatly reduced. However, significant human resources are still required to keep the system running. Staffs are required for the following general functions:

- Fieldwork: redistribution of bicycles, station maintenance and minor bicycle repairs;
- Workshop: major bicycle repairs;
- Warehouse: storage of spare parts, spare bicycles, and other equipment;
- Logistic center: membership management and customer assistance.

2.6.3.4 Project maintenance

Based on the case studies around the world, the project maintenance consists of the maintenance of the bicycle, facilities at service points as well as redistribution of the bicycles among different points. The largest maintenance problem faces in Barcelona is the bicycles with flat tire, that there are normally two or three bicycles with flat tire in each point. In Lyon, every bicycle would be checked roughly every eight days. More newly built system has an automatic check system which largely reduces the time for workers to check the status of the bicycles. The system maintenance and redistributions are managed by the provider of the project. (Transport Canada 2009)

2.6.4 Marketing/ user stimulation technologies

As the PBS is a user oriented project, the key element is the users. In order to let more people know and use the system, marketing and user stimulation technologies plays an important role in the whole process, especially at the initial stage.

As it is mentioned in the case studies conducted by the *Spicycles* (2009), a consulting company of bike sharing, several marketing approaches can be carried out by the provider and government.

- *Maps, pamphlets and brochures*
- *Information meetings—on the street or in schools*

- *Planning and construction projects*
- *Campaigns, bike weeks*
- *Bike-use lessons*
- *Reference group of cyclists reporting to the city*

In the case of Barcelona, events such as Bike Week and cycling conference were held during the last few years and an awareness-raising and information campaign was carried out with the cooperation of schools. Besides these measures, publication of Bicycle Guide was delivered to the citizens. While in Berlin, similar actions such as Bike Week and free publication were taken to promote the use of Public Bicycle System. Moreover, maps specially designed for cycling were distributed freely at a wide range. Commercial PBS providers have also conducted their own campaigns and bike rally was held and became a tradition. In Bucharest, besides the similar awareness campaigns, bike-usage study was carried out in order to identify the current status of the hardware of the PBS and users' background and also to see the barriers and incentives to the bike usage. The Goteborg municipality provides cycling learning courses for those who do not know how to ride a bike. While in Ploiesti, the media, namely, radio, local television, newspapers play a vital role in raising the awareness of the citizens. Generally speaking, the provider would improve the current infrastructure including bicycle paths, self-operated system and give incentives such as fee reduction for taking public transport after using the PBS or provide passes for hotel or recreation places. (Spicycles 2009)

2.7 Challenges of PBS implementation

There are three key challenges in the implementation of PBS including: hazards (property and liability), finance and operations. When the systems are run by the local government or transport agency, for example DB in Germany, it is easy for them to handle the problem of liability and insurance issues. However, for privately owned and financed systems, this can be a very problematic issue. With respect to the financial arrangements of most of the current systems, maintenance, theft and technology will be considered as the majority of financial risk. Paris reported that more than 250 bicycles were stolen in the first year of implementation and Barcelona is experiencing a higher than anticipated level of flat tires, which there are normally two or three bicycles with flat tire in each point. Although they report that theft has been minimal due to the system design has linked individual bicycles with individual users. Moreover, the monitor systems which register users and track system utilization in real time are hard to achieve. Bike re-distribution is another critical issue. In the first six months of operation more than a third of Barcelona PBS customers reported that no bicycle or no parking space was available at the service points. (Quay Communications Inc, 2008)

Table 2.1 Comparison of Public Bicycle Systems around the world

	Paris	Lyon	Barcelona	Washington	Frankfurt	Montreal
Operater	JCDecaux	JCDecaux	Clear Channel	Clear Channel	DBRent	Stationement Montreal
City population	2,153,600	466,400	1,605,600	599,657	652,600	1,039,500
Bicycles	20,600	4,000	6000	120	720	2,400
Service points	1,451	155	400	10	66	300
System	Fixed	Fixed	Fixed	Fixed	Flexible with some fixed points	Portable Fixed
Technology	Smart card	Smart card	Smart card Optional Credit card	Smart card	Mobile phone	Smart card
Operation model	Advertizing company	Advertizing company	Local government	Advertizing company	Transport agency	Transport agency
Financing model	User fee & outdoor advertising Revenues	User fee & outdoor advertising Revenues	User fee & Parking Revenues	User fee & advertising contact	User fee & Government Funding	User fee & parking revenues

Source: City Ryde Bicycle Sharing Systems Worldwide Selected Case studies

2.8 User perception and Satisfaction

As any other transport services, the success of the PBS largely depends on the users. However, as little research has been conducted particularly in the field of user perception and satisfaction of PBS, this section will focus on the experiences gained from the normal bicycle programs and travel behavior as well as some case studies related to PBS.

Kitamura (1997) mentions that besides the factors such as sex, age, income and household structure which are generally recognized, factors such as life style, related preferences and attitudes also have an impact on travel behavior. Wee (2002) highlights that the resistance faces during use the transport also play a role in influencing travel behavior. Specific factors including travel time, monetary cost, comfort and safety could be sum up as generalized transport costs and affect people's travel opinion. Moreover, level of cycling experience and trip purpose are categorized as factors that influence the bicycle use (Axhausen and Smith 1986). Private vehicle ownership is mentioned by Sacks (1994) as a factor that will influence the cycling use. Route length and directness, which are influential factors for other transport modes, seems are not often mentioned in the cycling behavior research (Ortuzar and Willumsen 1994). However, it is mentioned in the previous part that the lack of bicycle infrastructure definitely discourage people from bicycle use. (London Council 2010)

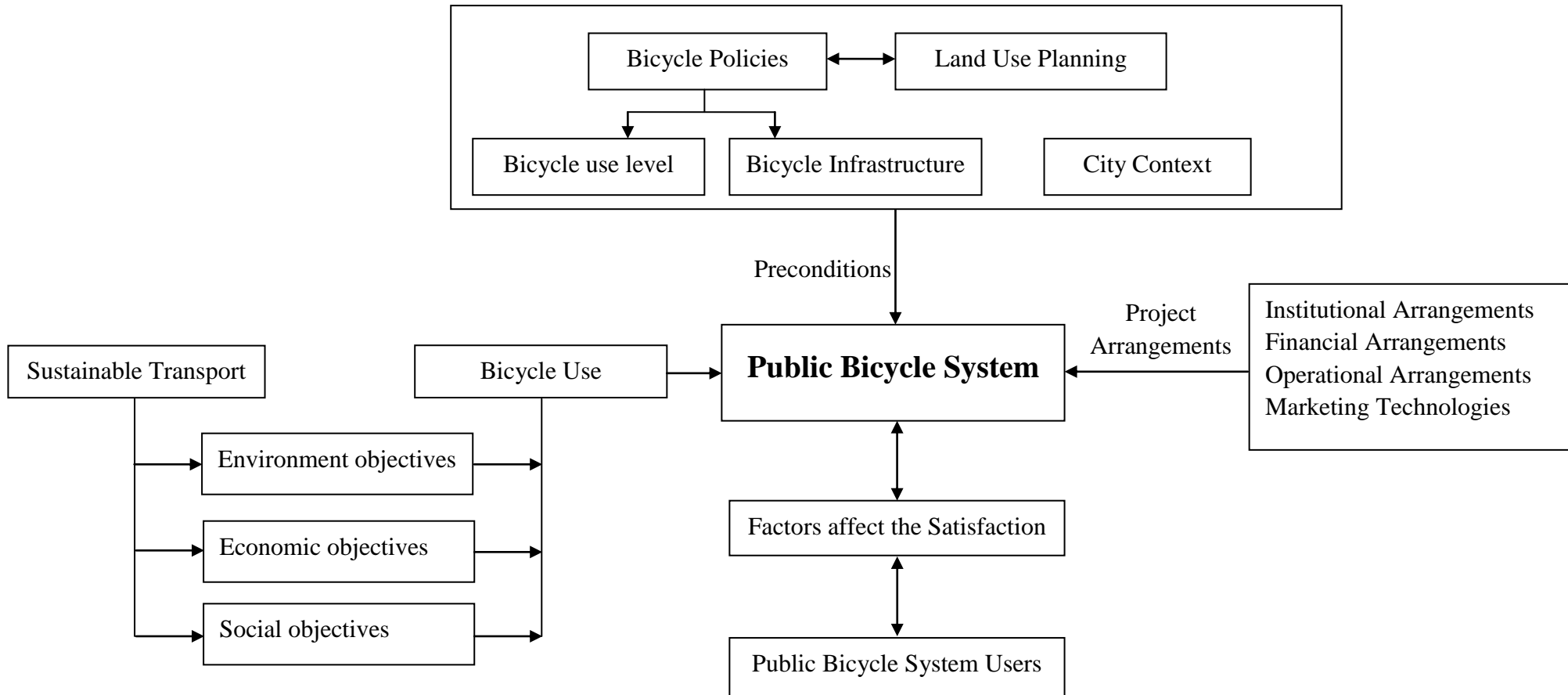
Bicycle Balance (CROW 2007), a method to evaluate the bicycle use in the Netherlands, mentions user satisfaction as an important criterion for evaluation of a bicycle system in a city. The evaluation method utilizes five perspectives to measure user satisfaction, which are list below: (CROW 2007, pp. 367)

- *Bicycle parking facilities(supervised and unsupervised);*
- *Cycling comfort(traffic nuisance, quality of the road surface);*
- *Cyclist road safety;*
- *Social safety of cyclists(threat of violence);*
- *Tackling bicycle theft (enforcement, detection, engraving).*

The criteria above cover mainly the quality and quantity of cycling infrastructure and the feeling towards cycling. Similar criteria are found in a study on a PBS. The study indicates that one of the main reasons for people not using a PBS is the lack of facilities (insufficient bicycles to rent, empty slots to return bicycle) and low level of safety and security. What is specifically mentioned in the study is the dire need for dedicated lanes for bicycle use (Spicycles 2009). However, the system of PBS works different from normal bicycle use. Therefore, there are some points that a PBS has to additionally care about and at the same time, some concerns will be avoided by using PBS. For many PBS, if a bicycle is being stolen, the user is not responsible for it as

long as he/she has returned it to the service point (Transport Canada 2009). Tackling bicycle theft is no longer a consideration of the users, but still remains to be tackled by the providers. In a survey related to the PBS in Paris, the users were asked to answer questions regarding to overall satisfaction, rental procedure, modes of payment available, costs, availability of bicycles at service points, availability of empty slots at service points for bicycle returns, quality of the bicycles and maintenance (Transport Canada 2009). Besides these factors, service time, service quality and attitude of the staffs should also be considered as well (Xiasha new town 2010). These factors could be applied to this research and formulate the questionnaire to measure the satisfaction of the PBS users in Hangzhou.

Figure 2.1 Conceptual framework



Chapter 3

Methodology

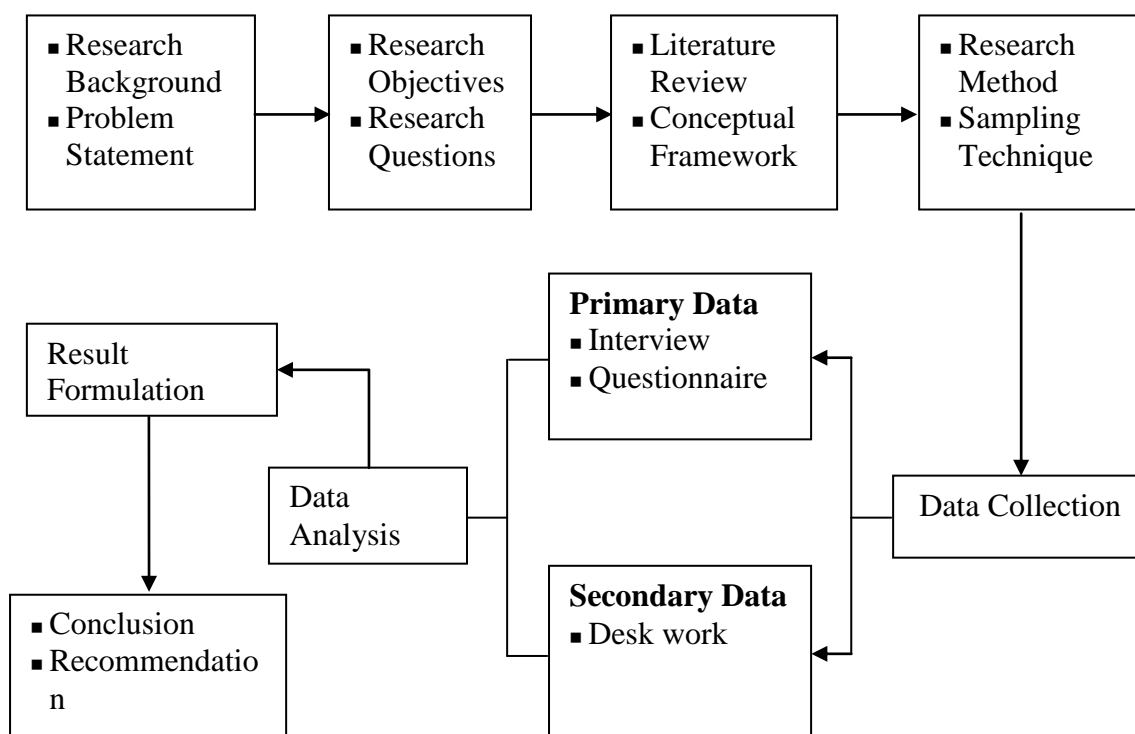
3.1 Introduction

This chapter presents an overview of the research methodology utilized in this study. It highlights the research type and strategy, research population and sampling methods, and variables and indicators related to the research questions. Furthermore, data collection and analysis methods would be addressed, as well as the limitation of this study.

3.2 Research design

The research is summarized in figure 3.1 which gives an overview of the research process.

Figure 3. 1 Research design



3.3 Research Type and Instruments

To identify and understand the functioning of PBS in Hangzhou and PBS users' satisfaction in Hangzhou needs a variety of research techniques. The research is a combination of descriptive and exploratory studies based on a single case study. A case study would be done through papers, reports, news and interview in order to demonstrate the project arrangements and the running status of Hangzhou PBS.

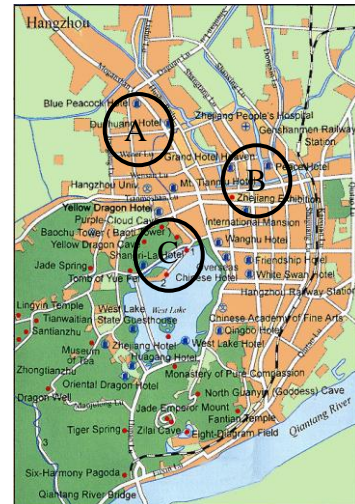
Meanwhile, more exploratory studies would be conducted to identify the users' satisfaction of the PBS in Hangzhou, which interviews and a survey among the users would be applied.

3.4 Research Population and Sampling

With respect to the study population, it includes the citizens of Hangzhou aged from 16 to 70 according to the age limit of PBS usage. However, due to limited time and research capacity, it is not feasible to conduct a research that covers the majority of the population.

In order to illustrate the problems faced and the users' satisfaction during PBS usage, a survey among the users and non-users of PBS will be carried out based on random sampling. The random sampling will avoid bias regards to ages, gender, income level and other aspects which snowball sampling might have. Three points are selected as the research area as indicated in the Picture 3.1. (Point A: the residential area; Point B: city center; Point C: tourist area) The selection of three different research area is based on the idea of avoid bias from one particular group and collected the data more scientifically as perceptions might differ from area to area.

Picture 3.1 Research area



For non-users, different methods will be applied for collecting the data. The researcher will go to the parking lots nearby the PBS service points in the research areas mentioned above as well as the area around PBS service points to collect data for non-users of PBS.

For the PBS provider, one Public transport corporation manager and one government official, as representative samples, will be interviewed to obtain the information about the development history, the project arrangements as well as the challenges faced of the PBS in Hangzhou. 13 working staffs include fieldwork staffs, repairman and staffs at service center and logistics center will be interviewed as representative sample to identify the frequency of PBS use and problems confronted during the operation. However, the result get from the interview with staffs is not the emphasis of this study.

Table 3.1 Data Collection Framework

Category of respondents	Sample Size	Sampling technique	Data type	Research instruments
Users	48	Random Sampling	Primary Data	Questionnaire
Non-Users	45	Random Sampling	Primary Data	Questionnaire
Corporation Manager	1	Representative Sampling	Primary Data	In-depth interview
Government official	1	Representative	Primary Data	In-depth interview

Workers	13	Representative Sampling	Primary Data	Interview
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3.5 Data Collection

This study uses qualitative data both collected from primary and secondary sources which include:

- **Primary data**

1. Data collected from in-depth interview with Public transport corporation manager and government official;
2. Data collected from interview with working staffs including fieldwork staffs, repairman, and staffs at service center and logistics center;
3. Survey among the users and non-users of Hangzhou PBS.

- **Secondary data**

1. Literature review
2. Case study reviews, news and reports related to the Hangzhou PBS
3. Government papers about the PBS Hangzhou

3.6 Data Analysis

From the primary data, as the information is given by corporation manager, government official, staffs, users and non-users, how the system is arranged and functioned and how the public react to this service would be found out through the qualitative data. Particularly, the result of user satisfaction is quantitatively analyzed.

3.7 Variables and Indicators

Based on the literature review, a table of variables and indicators is made and presented below:

Table 3.2 Variables and Indicators

Research Questions	Variables	Indicators	Source
What is the running status of PBS in Hangzhou?	Precondition	<ul style="list-style-type: none"> ● Topography ● Climate ● City size and density ● Basic cycling infrastructure ● Attitude towards cycling ● Potential for transit intermodality ● Level of bicycle use ● Analysis of targeted group ● Policies for promoting bicycle use 	In-depth interview with corporation manager; In-depth interview with government official;
	Institutional arrangement	<ul style="list-style-type: none"> ● Selection of operation and fund provider 	Desk work
	Financial arrangement	<ul style="list-style-type: none"> ● Revenue generation methods ● Fee system design ● expenditure 	
	Operation	<ul style="list-style-type: none"> ● System design 	

	arrangement	<ul style="list-style-type: none"> • Service point design • Capital and human resources • Maintenance 	
	Marketing	<ul style="list-style-type: none"> • Marketing approaches 	
	Basic information	<ul style="list-style-type: none"> • Number of bicycles • Number of service points • Bicycle use frequency per day • Number of bicycles needs repair per month • Number of bicycles faces theft and vandalism 	
What are the major challenges in running PBS service in Hangzhou?	Challenges	<ul style="list-style-type: none"> • Liability • Finance • Maintenance • Theft • Technology • Operation 	<p>Questionnaire survey with user and non-users;</p> <p>In-depth interview with corporation manager and government official;</p> <p>Interview with workers;</p> <p>Desk work</p>
Is the user satisfied with the system so far?	Socio-demographics	<ul style="list-style-type: none"> • Age • Gender • Income • Car ownership • Education level & occupation (are not mentioned in literature review, but interesting to look if it has a influence) 	Questionnaire survey with user and non-users
	Attitude towards PBS	<ul style="list-style-type: none"> • Familiarity with the system • Usage frequency 	Questionnaire survey with user and non-users
	Problems faced during PBS usage		Questionnaire survey with user and non-users
	User satisfaction	<ul style="list-style-type: none"> • Biking comfort • Biking Safety • sufficient service points • Easy rental procedure • Costs • Availability of bicycles at service points • Availability of empty slots at stations for bicycle returns • Quality of the bicycles • Service quality of staffs • Service attitude of staffs • Service time 	Questionnaire survey with user and non-users

3.8 Limitation

Since a few researches have been conducted in the field of PBS, the theoretical basis might be a limitation of this study. Moreover, due to the fact that interview are time-consuming, a relatively small group of people would be interviewed. Therefore, the sampling might be a constraint of this study. Moreover, the data will only be collected from a relatively small group of people. And that is insignificant compared to the

whole research population. Furthermore, using random sampling might be inefficient to collect data compared to snowball sampling.

Chapter 4

Context and the Project arrangements in Hangzhou PBS

4.1 Introduction

In this chapter, brief background information concerning the current situation in China and Hangzhou is described in the first section. Afterward, details on points of view taken from the organizers and providers of PBS in Hangzhou are discussed in the later sections to demonstrate the different arrangements in the whole process of Hangzhou PBS project.

4.2 The context of the focus country

Since 1978, when the reform and opening-up policy is applied, China has experienced a rapid urbanization and modernization with a high GDP increase. At 1978, when the central government started its reformation, the national GDP was only 364.5 billion yuan. Within 30 years, it has increased dramatically and the GDP has reached 30.3 trillion yuan at 2008. With increasing economic power, together with the tax reformation in 1993, which local governments generated more revenue from the taxes, the municipalities started to have more autonomy on its own local issues.

Due to rapid economic growth, fast urbanization and increasing life quality in China, the demand for mobility for people and goods grew rapidly. Together with the national policy of promoting car industry, the number of vehicles and roads boosted at a tremendous speed. Although the overall mobilization level in China is still low compared to the developed countries like America or Japan, the country enjoys the world highest growth rate of cars. At year 2006, the total number of cars has reached nearly 50 million while the private-owned cars have reached 29 million. Compare to the situation in 2000, the total number of cars enjoys a growth of 14.3% per year and the private cars even have a growth rate at 21.6% per year (National statistics bureau 2006). Due to the boost of cars in China, particular in mega cities like Beijing and Shanghai, congestion and air pollution has become a severe problem in everyone's daily life.

In order to release the pressure of congestion, attentions have been paid to the Public transport and non-motorized transport in the recent years. However, with increasing affordability and the preference for private cars, more people are eager to use private cars instead of public transport. As a result, the utilization of public transport and non-motorized transport has greatly decreased. The share of public transport decreased and the bus system account for only 10%-25% of the total daily travelling in big cities (Xinhuaawang 2007). The inadequate quantity and quality of the bus system discouraged the use of public transport and make people to use private cars more, which in turn contribute to the congestion indirectly. Beside bus system, mass transport such as light rail and metro are already in place or under construction in the big cities to meet the constantly growing needs. But it is worth mention that despite its massive carrying capacity, mass transport faces a challenge of balance between cost recovery and affordability for the public. Other than the motorized vehicles, cycling and walking

still account for an important means of transport, especially for people with lower income. However, cycling and walking are most ignored and discouraged by the policies. (Zhong-Ren Peng, et al., 2008)

4.3 Introduction to Hangzhou city

Hangzhou, the capital of Zhejiang province in Southeast China, covers an area of 16.6 thousand square kilometres, has a population of 6.6 million people. Nearly 2.2 million people live in the urban area which covers only about one twenty-fifth of the total area. The population density reached 3021 people per square kilometres in the urban area, while the traditional city centre has a density of 17989. (Hangzhou Annual Government Statistics, 2009) Although it is well-known as a green city and prosperous business city due to the commercial, tourism and light-industrial sector, the city is also facing a lot of environmental problems. Therefore, the government of Hangzhou takes up the ambition to develop a greener and more sustainable city.

Due to rapid economic growth, together with rapid urbanization and the national policy of promoting car industry, the number of cars has increased dramatically in recent years. From the official website of Hangzhou transport sector, the number of cars that the citizens hold has reached nearly 2 million by April 2010 (Hangzhou transport department, 2010). Moreover, as a tourism city, the constantly additional cars and tourist buses from other cities put more pressure on the road system. Therefore, the construction of road cannot catch up with the rapid boost of cars and congestion became more severe. As a result, carbon dioxide emissions and other related pollution increased due to the increasing volume of cars and congestion. Therefore, in order to meet the needs of the increasing volume of cars and to reduce congestion, more open space is used for building roads. However, the newly built roads usually only relieved the pressure of congestion for a short period of time and then filled with traffic jams again. Acting like a vicious circle, more pollution and GHG are released to the surrounding areas. Apart from air pollution, the noise pollution caused by the transport also became more severe than before.

4.4 History of the PBS in Hangzhou

4.4.1 Motives for the PBS

With the problems mentioned above as well as the climate change, which has become a universal problem that cities cannot ignore, the Hangzhou government put forward the idea of Green transport and encourages the citizens to use the public transportation by formulating preferential policies of public transportation and setting up a Comprehensive Public Transport System. The Comprehensive Public Transport System consists of metros, normal bus lines, BRTs (Bus Rapid Transit), taxis, waterbuses and the PBS. Being a part of the master plan of the Comprehensive Public Transport System, the PBS also targets at reducing the severe congestion situation and the parking problem in the city. In more specific term, The PBS helps to reach these objectives by providing efficient linkages to other mode of transportation to facilitate the whole Comprehensive Public Transport System. With higher efficiency, more citizens will choose to take public transportation rather than travel with their own cars. Other than the main objective of reducing traffic congestion and the parking problem,

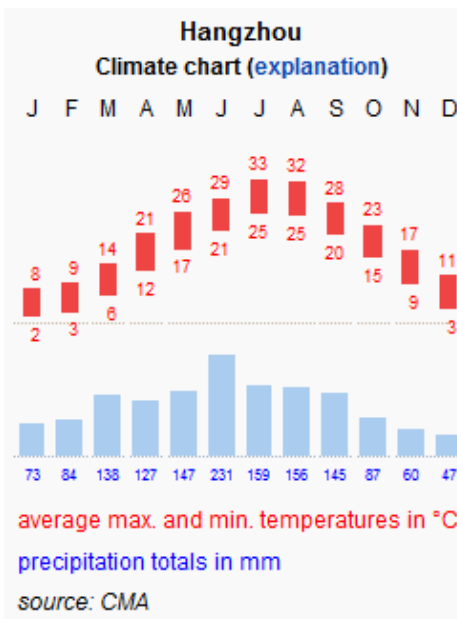
judging from the environmental perspective, the PBS aims at energy-saving, emission-reduction as well as reducing the other environmental impacts of traffic activities as the bicycle is a zero-emission transport mode. The promotion of PBS will also lead the shift of current lifestyle to a more low-carbon lifestyle. Last but not the least, the social objectives includes improve the health conditions of the citizens and as well as providing job opportunities for the redundant staffs at Hangzhou public transport corporation and laid-off workers from the society.

4.4.2 Preconditions for setting up a PBS

Based on the review of several cities with PBS in Chapter 2, various preconditions have been identified.¹ These selected preconditions will be used below to analyse Hangzhou’s suitability for a PBS.

- *Topography:* Hangzhou is located in the Yangtze River Delta. The city centre is located at the flat area in eastern and northern sides of West Lake. Although hills take up a big part of the tourism zone, the city area is situated in a flat area without slope. At the meantime, research shows with slopes of more than 50 meters and more than 2-3%, the danger of using bicycles would increase greatly and therefore prohibit people from using bicycles (Gong & Zhu 2008). Therefore, in general the city is suitable for biking.
- *Climate:* From the literature view, it is known that severe weather conditions such as heat, storm and snow will affect the cycling. As a result, cities, which, for a long period of time, face these weather conditions, are considered not suitable for promoting bicycle use. Hangzhou has a humid subtropical climate with four distinctive seasons, characterized by long, very hot, humid summers and short, cool, cloudy and dry winters. With the chart on the right side, one can immediately see that the temperature goes up from May and only starts to cool down at September. In the winter, the temperature is also rather low. Moreover, on average, compared to Paris (607 mm), Lyon (739 mm), Amsterdam (780 mm) and Copenhagen (823 mm), the total precipitation in Hangzhou is more than double that of the average precipitation of these cities.(CMA 2010) During the month of June, the rainfalls double that of the winter months (December to February). June is in Hangzhou just a normal month and no information was provided that the use of PBS decreases. It was however been mentioned that during the hottest month of July and August, the use of PBS slightly decreases. This can also be attributed to the fact that schools close down for holidays during these months. Although the precipitation of Hangzhou is more

Chart 4.1 Climate chart of Hangzhou



¹ Although these precondition criteria are not the focus of this research, it remains interesting to see whether the identified criteria also stand for Hangzhou’s context.

than other cities with PBS, which makes Hangzhou unsuitable for cycling, no significant evidence have been found to prove that.

- *City size and density:* From the literature review, it is found that the logical PBS should be situated in high density area preferably with mix of activities although no specific criteria are given. Nearly 2.2 million people live in the urban area of Hangzhou which covers 728 square kilometers. The population density is 3021 people per km² in the urban area, while the traditional city center has a density of 17989. (Hangzhou Annual Government Statistics, 2009) Compared to Paris, which has a density of more than 20000 people per km² and Bacolona, which has a little more than 15000 people km², the density seems is lower.(Wikipedia 2010) But bear in mind that a large area in Hangzhou is hill situated in the tourism area, which means the density will be much higher. Therefore, in the sense of a PBS require a certain population density to make the system working; it is suitable to set up the system in the Hangzhou.
- *Basic cycling infrastructure:* It is clear from the case study review that a city requires the necessary infrastructure to enable a PBS to function successfully. Although no data are available on the total length of cycling paths in Hangzhou, the city has appropriate facilities. In the trunk road and secondary trunk road in the urban area, 84% of the roads use partition to separate the car lane and cycling path, 10.5% of roads have lines to separate the different functions and only 5.5% of them are mixed of transport modes. The basic infrastructure is suitable for carrying out the PBS.
- *Attitude towards cycling and level of bicycle use:* After the foundation the People's Republic of China, bicycles industries received strong support from the government through allowance. Moreover, bicycle paths became part of the street planning and workers can get subsidies by buying a bicycle (Amir 2003). These factors make China become a bicycle country and bicycle becomes a part of the daily life. Therefore, most of the people know who to ride bicycle and they use bicycle for commute, shopping and other daily activities. Although in the decade from 1997 to 2007, the share of bicycle use dropped from 60% to 33.5% in Hangzhou. However, the cycling still counts for a main transport model in the city. Therefore, setting up PBS is workable on the basis of these factors.
- *Potential for transit intermodality:* Although the city space is limited, the government managed to give the priority to public transport system. That means the planning of PBS and bus system, such as stations, is given the priority and enough space is left for the project. Moreover, the PBS in Hangzhou is designed in such a way that intermodality between Bus system and PBS is encouraged and facilitated through building the service points of PBS next to the bus station as well as giving discount of taking bus for those who use PBS. This design certainly adds up the successfulness of a PBS.
- *Analysis of target group:* Although it is mentioned in the literature review that analysis of the target group will raise the possibility of success, no data has been found that the government has done such a pre-research.

- Policies for promoting bicycle use: Learned from the literature review, it is definitely important that the government stand behind the project and fully supported the system. And in Hangzhou, in order to promote the cycling use as well as public transport, the private cars has been prohibited to access to some parts of the tourism area. Therefore, a better environment is built for the cyclists and more people are willing to use the bicycles. Moreover, the government provide large sum of funds to the system which make it working properly. Furthermore, the local government integrates the transport policy with land-use policy in long-term planning in order to promote public transport use as well as the bicycle use.

4.5 Institutional arrangements of the PBS

Classified according to the operation provision, the PBS in Hangzhou, which runs by a state-owned company- Hangzhou public transport corporation, belongs to the transport agency (quasi-government) model. However, it is still different from the other countries which applied the similar mode. In the Hangzhou system, the government plays the role of guide and the public transport corporation is in charge of operation and maintenance of the system.

At the planning phase, a special team called “Public bicycle promotion group” is founded in order to design the system. The members of the team come from different departments of the government, companies and including, electric power utility, , Landscape sector, Environmental Protection sector, Department of public Safety, public sanitation department, traffic department, planning department, construction department, public transport corporation, Network Company, community and neighbourhood. Through the cooperation of these sectors, the tasks can be settled down efficiently and effectively.

In the system of Hangzhou, the government serves as a guide and supporter. The whole planning is done by the government together with the cooperation with other sectors. For example, some tasks such as the location for the service point selection are done by the government department. Moreover, the government also serves as a promoter and supervisor. The government use the media to publicize the PBS at the initialization stage as well as the later phase.

According to the government official, as the system is considered to be a public service at the first place, therefore, the public transport corporation is eventually being chosen for the operation and maintenance of the system. Several considerations are taken into account at that stage. Primarily, the government considers the PBS as a commonweal and should be served for the public. Secondly, compared to private companies, a state-owned company will give priority to the beneficial for the public rather than generate revenues from the project. As a part of the comprehensive public transportation system, PBS should maintain the necessary level of the project scale and should not be sacrificed for revenue generating. Thirdly, the state-owned company is easier to negotiate and cooperate with the government.

4.6 Financial arrangements of the PBS

As a state-owned company, the Hangzhou public transport corporation is fully supported by the government. During the initial stage of the PBS, the local government through its municipal budget secured 70 million yuan as guarantee fund for setting up the PBS to the Hangzhou public transport corporation. With this fund, the corporation was able to apply for a bank loan that was sufficient to cover the initial investments, capitals and running costs. Not only has the government provided fund to the company, but also assigned the revenues generated from the billboards on the street to corporation to finance the PBS. Initially, the mayor assumed that revenue generated by the billboards on the buses, bicycles and service points and the user payment would be sufficient to operate the PBS and that no additional funds would be required on a yearly base.

However, during the implementation, gaps between the revenue and expenditure are found to be significant. Running for two years, the average operation and maintenance cost is around 70~80 million yuan per year, while revenue generated from the billboards is 28 million yuan at the first year, with a 10%~15% increase rate every year. Moreover, the revenue generated by users is relatively insignificant- generating 20,000 yuan during the first half year of 2010. This is partly due to the fact that the first hour of bike use is for free, and a majority of the users only make use of the system for 1 hour. It can be observed from the statistics that the revenue generated from the billboards and user payment is insufficient and only covers 35~40% of the total running cost. The large financial gap is currently filled by the government every year. It is hard to judge whether the current financial arrangement in Hangzhou is sustainable or not. The cause of current financial gap might be attributed to the fact that the Hangzhou PBS is primarily not designed for profit but as a part of the public transport system. Moreover, the government has considered the PBS as a long-term project that they will constantly work on and fund will be provided as long as the system needed.

4.7 Operational arrangements

4.7.1 System design

According to the literature review, the Hangzhou PBS belongs to the 3rd generation fixed PBS system. Similar to system in Paris, the project is first designed as automated that the users should rent or return the bicycles rely on self-service. A Z-card (Picture 4.1), can be applied by a citizen aged between 12~70 at service centre with their identity card or passport and 300 yuan (200 yuan for deposit and 100 yuan for charge). With the card, one can rent his/her bicycle at any service points during the service hour, which is 6:00~20:00 normally, and return the bicycle to the same point or another. The system seems well designed; however, as the implementation went on, both users and provider found system is not running properly without the help of staffs. Therefore, the corporation attempts to use labour force to make up for the incapacity of the system design. That means, when there are no empty slots at service points, the staffs will start take bicycle off the lockers (Picture 4.3) in order to let other users to return their bicycles. The picture 4.2 shows the bicycles that are being taken off the locker. Likewise, the staffs will put the bicycles back on the rack when there are no bicycles available.

With respect to fee system, it is different from any other system which the first half hour is free. In Hangzhou PBS, bicycles are free for the first hour, a period long enough to ride a bicycle around the West Lake for recreation purpose. Users are charged one yuan from the second hour to the third hour, two yuan from the third hour to the fourth hour, and three yuan from the fourth hour to the 24th hour. For those who neither return the bicycles nor report a bicycle loss within 24 hours, they will be charged 10 yuan each day from their deposit in addition to normal fees that should have been paid. If the users further refuse to pay the penalty, they will be blacklisted and lose the right to hire public bicycles.

Picture 4.1 4.2 & 4.3 System design of Hangzhou PBS



Source: the Author & Hangzhou PBS

4.7.2 Service Point Designs

The Service point contains the content listed below:

A shelter is installed to provide protection to the bicycles and other facilities from strong sunshine and rainfalls. Spaces for advertisement are reserved for revenue generation (Picture 4.4). However, service points around the tourism zone do not have the shelter and space for advertisement due to the consideration of urban aesthetics. In the picture below, the picture 4.4 shows a standard service point, while the service point in the picture 4.5 is specially designed for the tourism area.

Picture 4.4 & 4.5 Service point design



Source: the Author & Hangzhou PBS

At a service point, besides the shelter, there is a kiosk built for the working staff. On the wall of the kiosk, there is always a map of Hangzhou with service points printed on it, a service terminal, an instruction of the rent and return procedure as well as the

mobile phone number of the staffs and help hotlines. On the map one can find the service points around the city. However, it has been sometime that the map hasn't been updated. Therefore, the new service points could not be found on this map. For the service terminal, it has an inductive zone as card-reader and one can inquiry history of rents or returns, the card status and the card balance. Then the instruction contains the basic procedure for using the facility as well as when problem happens.

Picture 4.6 4.7& 4.8 Service point design



Source: Hangzhou PBS

4.7.3 Capital and Human Resources

Besides the facilities mentioned above, many other capital and human resources are required in the Hangzhou PBS.

With regards to capital resources, this includes:

- A vehicle fleet for redistribution of bicycles between stations;
- Warehouse facilities for major bicycle maintenance, storage of spare parts and spare bicycles;
- A logistics centre responsible for monitoring the status of the service points as well as the bicycles by means of cameras and network, and distribution of the bicycles;
- A call centre assisting bike users if required.

In order to run the system, the Hangzhou PBS requires the following staffs:

- Staffs at fieldwork: redistribution of bicycles, station maintenance and minor bicycle repairs
- Staffs at warehouse: major bicycle repairs, storage of spare parts, spare bicycles, and other equipments
- Staffs at service centre: deal with error with cards, application and cancelation of z-card,
- Staffs at office: monitor the system and distribution of the bicycles
- Staffs at call centre: assistant help
- Staffs at Kiosk: helping people with rent or return the bicycles

- Staffs at some service points: provide information for the tourists, help the tourists to book tickets for event, train or airplane and sell maps, drinks and other goods.

4.7.4 Maintenance

The maintenance mainly includes the maintenance of the bicycles, facilities, equipments and redistribution of the bicycle among different service points. Now, there are 70 staffs in charge of the maintenance of the bicycles. For 2000 service points, the repair man has to patrol from point to point, which means one staff have to manage around 30 service points every day. For simple problems such as flat tire, chain that fallen off can be fixed at the service points. But for bicycles that has a big problems such as damage of the bicycle body will be distribute to the repairing centre and be checked and repaired there. Technical experts are in charge of the maintenance of other facilities, such as locker system, service terminal, etc, while a group of works mainly deal with the redistribution of the bicycles. According to the manager, theft is seldom occurred in the system because the bicycles have a uniform design. Most of the bicycles reported a loss is actually being occupied by somebody and is always being found some days after. Therefore, the actual loss is relatively small.

4.8 Marketing of the PBS

The Hangzhou government not only serves as a guide and a fund provider, but also acts as promoter of the system. Before the PBS is put into use, the government has started publicize information about PBS through the media and let the public get to know about the system. Through the media, information such as why is the PBS implemented and how the system works are delivered to the public and give them a basic idea of the system. Later on, besides the successive information publicized through television, newspaper, radio and internet, the government also make small brochure that can be delivered to the citizens. Moreover, the special outlook of the service point could also arouse the interest of pedestrian and take a look at it. In the running process, the government also publicize the steps that the company will take and ask for the recommendation and advise from the citizens, of which it give the citizens a sense of ownership of this project. Furthermore, the government use the “No car day” as an opportunity to promote the system by invite people to use the Public bicycle and let them give their opinions on the system.

4.9 The Running Status of the PBS

The PBS in Hangzhou started in May in 2008 and has been running for more than two years. Starting with 61 service points and 2500 bicycles, it has now reached 2177 service points and 50000 bicycles. In total, there are now 66 “24/7” service points scattered throughout the city. Besides the normal service points which only provide the service of rent and return bicycles, some service points are opened with other functions. 14 points are located in the city centre for business service. Moreover, 54 service points which provide tourism information are located in the city centre and tourism zone.

The table below shows the distribution of the service points and the city centre, mainly the area in Xiacheng and Shangcheng District, is the most dense area of service points as well as population. While the Jianggan district in the east and Xihu district in the west has less service points and the Gongshu district in the north has a median level.

Table 4.1 The service points location

District	Area (km ²)	Population	Number of service points	Service points per km ²
Xihu District*	308.70	628,000	557	1.8
Xiacheng District	31.46	405,000	418	13.2
Shangcheng District	18.30	362,000	385	21
Jianggan District	210.22	404,000	431	2
Gongshu District	87.49	288,000	386	4.4

(*Tourist zone is included in Xihu District)

Source: Hangzhou Statistics Bureau/ Hangzhou PBS website

Among the 50,000 bicycles, 40,000 bicycles are put into daily use and the other 10,000 bicycles are in reserve in case of damage or loss. The daily rent number has reached 312,000 at the peak while average daily rent is 250,000, which means that a bicycle is being used nearly 7 times on an average per day compare to only 0.93 times a day at the beginning. 90% of the users are the citizens of Hangzhou or migrant workers from other places, while the rest are domestic and foreign tourists. Moreover, the points near the residential area, hospital and supermarket are frequently used. And the largest group of users are the commuters and they use the system mainly at the week days. Additionally, lots of people also use it for shopping, exercise and recreation purpose.

From the implementation of the PBS in Hangzhou, it is proved that the PBS, as a mode of sustainable transport, can ease the congestion and parking problems in the city. Moreover, by using PBS instead of cars, an estimate of 31,000 kilo GHG and pollution is reduced every day. The PBS further contribute to the improvement of human and ecosystem health, increase of employment as well as the city image.

4.10 Challenges of running the PBS

Running for two years, as the scale of the system expanded, many problems occurred during the PBS operation and usage. There are now five primal issues that need the highest priority to handle.

Primarily, it is hard to rent and return bicycles during the peak hour². Although with the help of staffs, it is hard to rent a bicycle at service points nearby the residential area at morning peak. At the meantime, it is hard to return bicycles to the service points around the working areas as users kept returning the bicycles and no empty slots are available. During the evening peak, the similar situation occurred as well. Lack of staff also worsens the situation. While more than 2000 service points are being established, there are only around 100 staffs working at the service points. That means one staff has

² 7:00~9:00 in the morning and 17:00~19:00 in the evening

to in charge of 20 service points, not mentioning some big points needs a specific staff to stay at the point all day.

Moreover, redistribution of bicycles is still a weakness of the system due to different demands of the public. That means the need for public bicycles is not only come from the commuters, but also from people with other travelling purpose. Therefore, due to the various needs, it is really hard to build a model for redistribution of the bicycles through scientific analysis. In order to ease the problem, the Hangzhou PBS has already developed a monitoring system, which alarm will be on if more than 80% or less than 20% of the total slots are occupied in a service point. Moreover, surveillance camera is installed in every service point so that the situation in the service points can be monitored and supervised.

Secondly, the selection of the location of service points is another key issue needs to be tackled. Three vital elements should be taken into account in this issue. First of all, the issue of demand needs to be considered. The selection of a location of service point should first consider whether demand for the facilities exists in the area. Secondly, In order to install a service point, the surrounding should fulfil the basic criteria for software and hardware. That means, there should be enough space for the installation of the service points and at the meantime leaves enough space for the pedestrian and the blind. Moreover, the place should have electric and network linkage to supply the equipments. The urban aesthetics is another aspect that should be considered. Principally, the green space should not be taken up for installation of the service points.

Last but not the least, participation of the citizens is critical in this project. At the start-up stage, several service points are built without consulting the citizens. Later on, tons of complaints have been received regarding to set-up of these points. Therefore, the government put forward the slogan “Four consultation and four rights” and decided to involve the citizens in choosing the service points. The slogan “Four consultation and four rights” means the government should consult the citizens about the situation, the demand, the recommendation and the satisfaction level. The citizens have the right to know, to participate, to choose and to monitor the project. To be more specific, the government should first ask the citizens about the situation of the area; then ask whether the citizens have the needs of the facilities through community level; afterward consult the citizens about the location of the service point; and then ask the running situation of the system and get feedback from the citizens. Through this democratic procedure, the citizens became more satisfied with the whole system. At the first year, the government staffs always have to explain to the neighbourhood committees and the citizens why and how the PBS would facilitate their lives. But in year 2010, the government office always receives requirements from the neighbourhood or citizens of installation a service point at their communities.

The third task of the project is the financial status of the PBS. Although with strong supportive policy and political will from the government side, the project is still not making profit. Now, revenues generated from the advertisements on the bus and bus shelters as well as the street billboards are all used to support the PBS. However, compare to its expenditure, the big gap between the two still existed. Therefore, the government have to constantly subsidize the system. However, this is not a permanent solution. Therefore, a more proper way of operating and supporting the system should

be developed and carried out. However, the manager remarks that “The system is still at a starting point, the project still has the potential to generate revenue to cover its expenditure. Moreover, the government is fully supportive for the system.”

Fourthly, the maintenance of the PBS is now getting complicated. As the system exploded from 2500 to 50000 bicycles in two-year time, the pressure of maintenance has definitely increased. This is partly due to the lack of staff but also due to the fact that some of the problems of bicycles can only be detect during the usage. Users usually do not report to the staffs when they find problems. Therefore, it takes more time for the repairman to identify the broken-down bicycle and fix it. Moreover, redistribution of bicycles becomes even harder as the bicycle number has increased 20 times in two-year time.

Last but not the least, improper operation of the user is also issue that the corporation need to cope with. The word improper operation refers to the mistake that users might have made during the using process of the bicycles, particularly in the process of renting or returning a bicycle. When rent a bicycle, one needs to swipe their Z-card on the inductive zone of the locker. Afterward, with a beep and green light, the user can take the bicycle off the locker. With similar procedure, when user want to return the bicycle, the bicycle has to firstly put back on the locker and then again swipe the Z-card on the inductive zone of the locker. The bicycle is successfully returned with a beep sound. Although the procedure is quiet simplified, there are always some people get confused and went wrong. Therefore, the operation company started help lines for people needs emergency helps and as well as put labour force to patrol around the service points. However, the manager claim that “It is a problem at this stage, when the system are being used more frequently, the problem will be solved”

4.11 Conclusions

In conclusion, with the main purpose of solve the congestion and parking problems and sub-purpose of achieving energy-saving, emission-reduction, health improvement and job provision, Hangzhou government has carried out PBS in 2008. After running for two years, 2,177 service points has been built and 50,000 specially designed bicycles are put into use. The daily rent has reached an average of 250,000, while 312,000 at the peak, which is nearly 7 times per bicycle per day. By analysing the selected precondition of PBS, it is found that Hangzhou is basically suitable for the implementation of PBS.

Leading by the government, public transport corporation, which is a state-owned company, is in charge of the operation and maintenance of the system. The government provide the initial funds of carrying out the system and hope revenue can be generated to support the system. However, the revenue generated from the billboards and user payment is far less than the expenditure. Therefore, funds have been constantly subsidized to the corporation to run the project. Besides being a fund provider, the local government also act as a strong promoter, which publicizes information about the PBS through media such as TV-program, newspaper, radio and etc. to let the citizens aware of the system. With respect to operational arrangements, the project is initially designed as automated system. However, it failed to run automatically without the working staffs. The service point design and the arrangement of capital resources and

human resources are quite similar with the system in Paris, but the Hangzhou PBS has its own originality. For instance, kiosks are built at the service points and some of them are used to provide tourism information and other services as a way of revenue generation.

Although with increasing popularity, challenges are still exist in the system. Hard to rent and return the bicycle, selection of the location of service points, financial status, maintenance and improper operation of the users are the five urgent challenges that should be tackled. With all these problems, the manager and official still believe they can make the system running well and let the citizens enjoy the convenience of the system.

Chapter 5

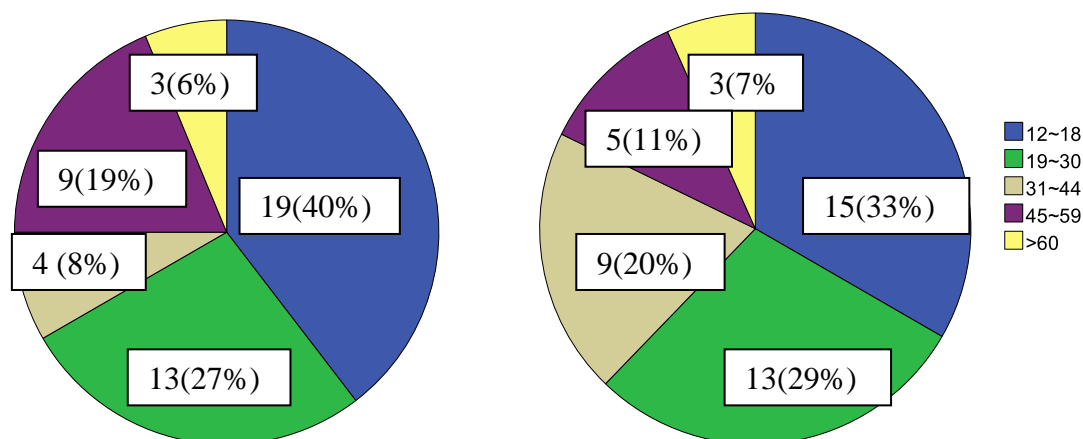
The functioning of the PBS

5.1 Introduction

In this chapter, data deriving from the survey among PBS users and non-users will be analyzed and presented. Specific findings on whether the users are satisfied with the system will be revealed. In addition, opinions from the manager, government officials and PBS ground staffs will be highlighted. Contradictions between opinions of the implementing agency, staffs and users will be presented.

5.2 Background of the respondents

Figure 5.1 Age category of User group & 5.2 Age category of Non-user group



Source: fieldwork

During the fieldwork, 48 filled-in questionnaires from users of the PBS and 45 questionnaires from non-users have been collected. A majority of the respondents of both groups belongs to the age categories 12~18 years and 19~30 years. The rest only counts for nearly one third of the total respondents. However, the age composition of the user group doesn't represent the age composition of the PBS users, which according to the manager the major user group is aged between 20 and 40.

Concerning the gender, the number of male and female respondents is almost equal. The user group has 24 male and 24 female respondents, while non-user group consist of 22 male and 23 female respondents.

With regards to income, both groups have a large number of respondents who has no income due to the fact that they are students. Although the user group has more respondents who earn an income between 2000~4000 yuan, the non-user group has more respondents who earns an income less than 2000 and more than 4000 yuan per month.

Considering the education level of the user group, 2 of them did not go for high school, 22 of them has past high school, 9 entered junior college, while 12 people went to the college and 3 has a degree higher than college. Similar composition has also been showed in the non-user group. With respect to the occupation, 23 respondents are students, while 18 are employed and 7 are retired in the user group. While in the non-user group, 17 respondents are students, 25 are employed and 3 are retired.

Moreover, respondents were approached in three research areas: a residential area, the city center and a tourist zone where respectively 30, 33 and 30 respondents were interviewed. Main emphasis for analysis will be given to the user group while essential attention will give to the non-user group.

5.3 The functioning of PBS from user perspective

5.3.1 How many people are using the PBS

The table below indicates that the user group, the most frequent used travel mode is the bus, followed by the public bicycle. Walking and car ranks the third and fourth. While for the non-users, bus is equally indicated as the most important travel mode, but the private car and walking ranks the second. For both groups, the least used travel mode is private bicycle, which only 8 respondents out of 93 chosen to use it. It can be demonstrated as where the user makes use of the public bicycle, the non-user use the private car and walking.

Table 5.1 Main travel mode for user and non-user group

Main travel mode for user and non-user group	User group		Non-user group	
	N=48	Percentage	N=45	Percentage
Bus	18	37.5%	16	35.6%
Car	6	12.5%	13	28.9%
Walking	8	16.7%	13	28.9%
Private bicycle	5	10.4%	3	6.6%
Public bicycle	11	22.9%	0	0%
Total	48	100.0%	45	100.0%

Source: fieldwork

5.3.2 Familiarity with the PBS

In general, almost all respondents (users and non-users) are aware of the PBS. There is however a difference between how they get to know the PBS. A large majority of the users confronted with the PBS on the street while the remaining became familiar with the system through TV and newspapers. Respondents also claim to see the information about PBS on internet, outdoor advertisement, radio and brochure. For non-user group, only one non-user doesn't know the PBS. Of the remaining 44 (92%), only 6 respondents (13%) got to know the system by having seen a PBS on the street. The other non-users heard about the system via respectively newspaper, TV, internet and outdoor advertisement and finally a small percentage through from their relatives and

friends.

From the data, TV and newspaper seems to be equally important to both groups, which also confirms the government official's saying that all kinds of promotion is carried out and the emphasis is put on to the television and newspaper. However, much more respondents claim to know the system by confronting with a PBS in the user group. It might attribute to the situation that as a potential user, the respondents pay more attention to the PBS on the street.

5.3.3 Purpose of PBS usage

When asked for which purpose the PBS is predominantly used, 18 (37.5%) of the users claim the non leisure activities, which includes go to work and school. Followed by entertainment and shopping, which receives 13 (27.1%) and 11(22.9%) votes respectively, counts for another two main reasons for using PBS. Furthermore, only 5 respondents vote for use the facilities for working out.

Table 5.2 Main purpose of PBS usage

Main purpose of PBS usage	Responses	
	N=48	Percent
school	8	16.7%
work	10	20.8%
entertainment	13	27.1%
shopping	11	22.9%
Working out	6	12.5%
Total	48	100.0%

Source: fieldwork

Linked to the age group and using time period, it is found that the group aged between 12~18, which are students, use the PBS for commute purpose in the weekdays and daily use and entertainment purpose at the weekends. No student uses it for the exercise purpose. And for age group older than 60, respondents only use the facilities for shopping and daily use. For other group, no significant relevance is found. One thing could be found is that respondents who use the PBS for recreation purpose such as entertainment and exercise are mostly found in the younger group, from 12~30. While the rest are quiet similar from group to group.

Further linked to income, it is found that the respondents who use the PBS as exercise purpose gathered around the income group from 2000~4000 yuan. This group is also the users who use the public bicycle as their commute transport. The low income group, including the no income group and income lower than 2000 yuan, treats the PBS as a good transport mode for entertainment and daily use. The higher income group, which has an income higher than 4000 yuan, seems to use it only for working, shopping and daily use. Moreover, this group does not use the PBS for entertainment, neither for exercise.

From the table below, it can be observed that most of the trips are conducted within

duration of 1 hour. This is especially the case for going to work. Within 2 hours, there are still respondents who use the PBS for commute and shopping. But above 2 hours, respondents are only using it for entertainment or exercise purposes. For these purposes, people obviously have and take more time while renting a bicycle.

Table 5.3 Duration of PBS usage

Duration of PBS usage (Hours)	purpose of PBS usage				
	school	work	shopping	entertainment	exercise
within 0.5	2 (4%)	2 (4%)	3 (7%)	0 (0%)	0 (0%)
0.5~1	4 (8%)	8 (17%)	5 (10%)	5 (10%)	2 (4%)
1~2	2 (4%)	0 (0%)	3 (7%)	4 (8%)	2 (4%)
2~3	0 (0%)	0 (0%)	0 (0%)	3 (7%)	2 (4%)
>3	0 (0%)	0 (0%)	0 (0%)	1 (2%)	0 (0%)

Source: fieldwork

5.3.4 PBS Usage frequency and time period

Regarding the frequency of PBS use, only 8 respondents use the facilities daily. 21 respondents use it occasionally and 12 use it 1~3 times a week. Moreover, 7 users claim to use the public bicycle 4~5 times a week. That means more than half of the respondents still do not consider the PBS as a regular travel mode. The result of another question demonstrates the same phenomenon. In the separated question, 27 respondents think the PBS has changed their travel behaviors while the rest still cling on to their old travel behaviors.

Related to the purpose of PBS use, respondents whom use the PBS more than 4 times a week tend to use the system for non-leisure purpose, which is go to work and school. Most respondents use the facilities for working out utilize the system 1~3 times a week and for entertainment more respondents use the facilities occasionally. Moreover, no specific relevance has been found on respondents who use the facility for shopping.

Table 5.4 Frequency of PBS usage

Frequency of PBS use	Response	
	N=48	Percent
occasionally	21	43.8%
1~3 times a week	12	25.0%
4~5 times a week	7	14.6%
Once or more than once a day	8	16.7%
Total	48	100.0

Source: fieldwork

With regard to the timing of PBS usage, the PBS are mostly being utilized at the time period of 6~12 and 14~20. Only a few respondents choose to use it during noon and night. Linked it to the purpose of using PBS, it is clear that respondent who use the

facilities for commute purpose are most grouped at time period of 6~9 and 17~20. This is because the school usually started at 8 o'clock and ended at 17 o'clock, while the normal work started at 9 o'clock and ended around 17~18 o'clock. The working staff around the office building also confirmed it by saying "the time period between 8:30 to 10:30 in the morning and 17:30 to 19:00 in the evening is extremely busy."

5.3.5 Costs and its Effects

With respect to cost, the majority of respondents claimed that the PBS cost almost nothing and a relatively smaller percentage claimed that it will cost within 20 YUAN per month. Only one respondent spend 20~50 YUAN per month and another respondent spend between 50 and 100 YUAN. For these two special cases, both are included in the working group aged between 19~30 which has bachelor degree. However, both of them use the PBS at the weekends instead of weekdays. One use it for working out and the other use it for entertainment. Other than that, no significant relevance has been found concerning the other aspects.

When asking whether the ladder-type price has an effect on the users, 28 respondents (58%) replied that they will return the bicycle within one hour, while 7 respondents (15%) claimed that they can afford to pay one YUAN for the second hour and return the bicycles within 2 hours. But never the less, 13 respondents (27%) claimed that the price did not affect them at all. Taken other aspects into consideration, it is found that among the 18 respondents interviewed in the tourism zone, 5 people vote for no affect and 5 people vote for willing to return within 2 hour. While in the city center, 12 out of 16 respondents vote for willing to return within 1 hour. This might be a difference of research area, however, comparing the research area and purpose of using PBS does not find a relevant linkage. Other than that, no significant relevance has been found regarding to age, income, occupation and education level.

5.3.6 Combination with other transport model

Regarding to the question of do you use combination of public bicycle and other transport mode, 30 respondents (62.5%) give an affirmative answer and 18 (37.5%) give negative replies. Taken other aspects into consideration, respondents from age group 19~30 and 45~59 prefer to use combination of PBS and other transport model while the other age group did not have such a clear trend. However, a strong linkage is found between the using frequency and the combination of different transport model. The majority of respondents who make use of the PBS more than 3 times a week use the combination of transport mode. Meanwhile, the respondents who use the facilities occasionally give more negative replies on this question. This might attribute to the preference of respondents' travel behavior and habit.

Among those who make combine public bicycles with other transport modes, bus is still the predominate choice of the respondents, followed by taxi, car and other transport mode.

5.3.7 Key factors for PBS usage

Respondents were asked to indicate the most important factor that encourages them to use the PBS. Since respondents could indicate more than one factor, a categorization had to be made. The first category attracted 15~30% of all respondents, while second category attracted 10~15% and the third is 1~10%.

Table 5.5 Key factors for PBS usage

Key factors for PBS usage	Responses	
	N	Percent
Near departure point & destination	33	28.2%
Easy to rent and return	22	18.8%
Near bus station	18	15.4%
Enough bicycles	16	13.7%
Environmental friendly	13	11.1%
Costs	7	6.0%
24 hour service	6	5.1%
Staff attitude	2	1.7%
Total	117	100.0%

Source: fieldwork

33 respondents (28.2%) indicate that it is most important for them that the service points are located near to their departure points and destinations. 22 users (18.8%) feel that it should be easy to rent and return a bicycle, while 18 people (15.4%) remark that the service points should be near to the bus station. All these three factors relate to the convenience of the system: efficient connection between locations; ease of use; and effective connectivity with the public bus system.

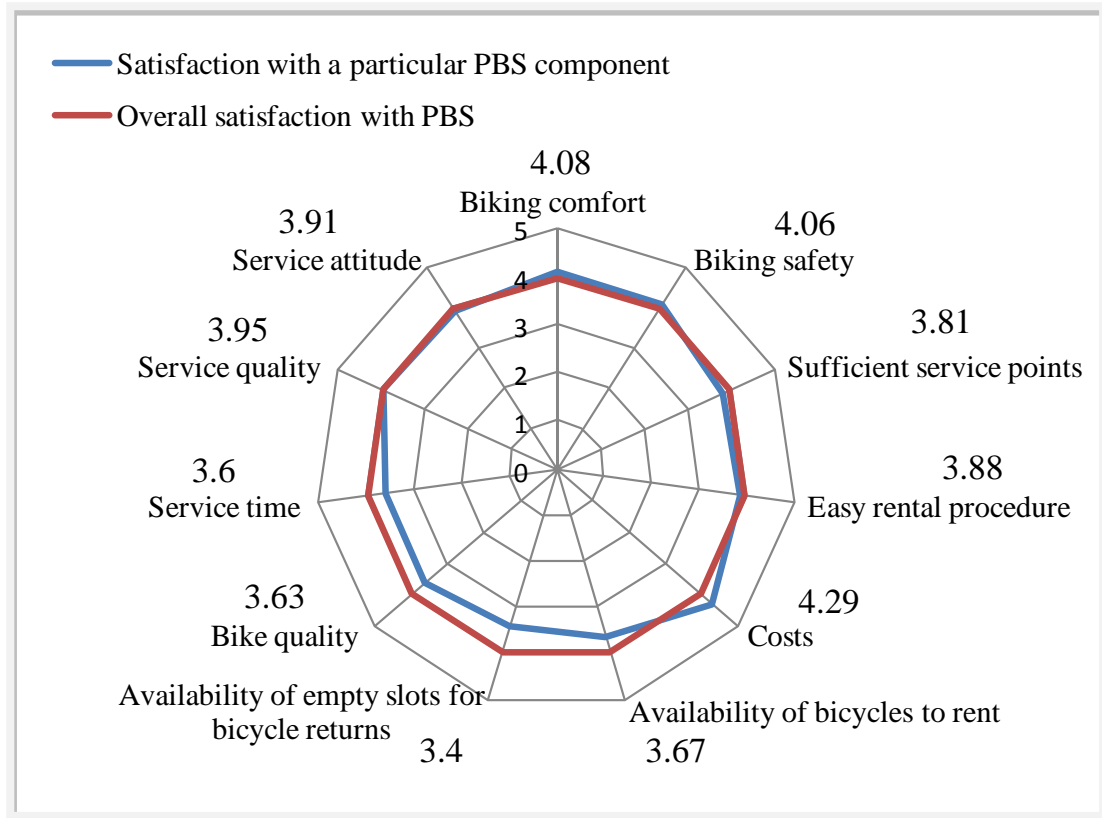
With regard to the second category, respondents find it important that sufficient number of bicycle is available at each service point. Moreover, the concept of environmental friendly attracts people to use the PBS which might attribute to the new lifestyle of the citizens and the government's effort on introducing the society about the low-carbon lifestyle.

The third category contains the least mentioned three options: 24 hours service points, costs and attitude of the working staff. Although many respondents mentioned they need 24 hours service points, it seems that 24 hour service is not a vital factor. That might occurred due to the fact that most people use the facilities during the time between 6~20 o'clock. Moreover, it is surprising to see that the rental costs are not considered an obstacle for users. This might attribute the fact that respondents are not in the position to compare price since there is only one PBS in Hangzhou. Furthermore, the actual costs is not high compared to the bus fare and seems to be satisfactory at the moment. Only 2 respondents (1.7%) consider the attitude of PBS staff at service points a factor of importance. This low response is probably due to the fact that users hardly interact with staff since the system is based on self-service.

5.3.8 User Satisfaction

User respondents were during the survey asked to indicate their satisfaction with particular aspects as well as overall satisfaction concerning the present PBS. They could do to by providing a score (Ranging from 1~5) for each particular aspect. Score 1 points to very low satisfaction whereas score 5 indicates a high satisfaction level. The results are shown in the figure 5.3.

Figure 5.3 Satisfaction with components of present PBS



Source: fieldwork

The overall satisfaction with the system is rather high (3.96). Aspects can be grouped in categories of how it differs from the baseline of overall satisfaction score. The first categories are the aspects higher than the overall satisfaction, the second is slightly lower than the baseline and the third is lower than the baseline.

In the first category, the results show a relatively high satisfaction with the costs for renting a bicycle. This is in line with the findings under a separate question on whether the users think the charge system is reasonable, which 44 respondents (92%) give a positive answer while only 4 (8%) disagree with it. The preset rental charge seems to perfectly fit the users. Users are also satisfied with biking comfort and biking safety.

The second category includes the service quality, service attitude, easy rent procedure and enough service points. These aspects get a score slightly lower than the overall satisfaction, but still are satisfying. What is worth mentioning is that 4 (8%) respondents point out that they have never met a working staff at the service points.

Although the service attitude gets an average point of 3.91, some respondents complain about the attitude of the staffs. Similar situation is observed during the fieldwork that some staffs are not patient towards the users. This might attribute to the poor working conditions, especially in the hot weather during summer, which makes the staffs in a bad mood. For easy rent procedure, the result of another question shows that 26 users (54%) can rent a bicycle within 2 minutes, while 16 (33%) can manage the progress within 5 minutes and another 10 respondents (20%) usually take more than 10 minutes to rent a bicycle. This may attributed to some users are still not familiar with system and problem of the locker system.

The group of aspects score the least as compared to the overall satisfaction are availability of bicycles to rent, bike quality, service time and availability of empty slots for bicycle returns. For aspects of rent, return as well as the maintenance of the bicycle, it is expected have a lower score as information concerning these problems has been informed from managers of the project. For the service time, although respondents indicate it as a non-critical factor as it shows under the 5.3.7, still respondents are not satisfied with the current service time. Even though these are the least satisfactory factors of the system, they still get an average above 3, which means it is averagely satisfying.

5.3.9 Problems faced during PBS usage

For the question” which problem did /do you face during PBS usage”, respondents indicated a variety of issues that are shown in the table below. As respondents could indicate more than one problem, groups are made by the responses of the users from high to low.

Table 5.6 Problems faced during PBS usage

Problems faced during PBS usage	Responses	
	N	Percent
Rent & return during peak hours	21	22.8%
Maintenance of the system	16	17.4%
Insufficient service points	13	14.1%
Distribution of service points	12	13.0%
Complicated application procedure for card	11	12.0%
Technical and hardware design of the system	9	9.8%
Insufficient bike lane	6	6.5%
Ethical standard of the citizens	4	4.3%
Total	92	100.0%

The most mentioned problems by the users are in line with the priority of the provider mentioned in Chapter 4. 21 users (22.8%) consider it is difficult to rent and return bicycles during at the peak hour. According to the corporation manager, this is a frequently received complaint from users. The corporation treats it as a priority that should be tackled. Maintenance of the system is considered by 16 users (17.4%) a point of attention. They refer to broken-down-bicycles at service points as well as to

problems with the locker system. During the fieldwork, it was observed that one service point is without power and the lockers were not functioning.

Insufficient service points and distribution of the service points, which considered by 13 (14.1%) and 12 (13%) respondents respectively, concern about the issue of service points. The former one mainly concerns the problem that the current service points are insufficient to cover the place where has the demand for the system, while the later deals with the unreasonable location of some service points. This result also confirms the manager's saying of that the selection of the location of the service points and relevant process is a difficult task in the system.

The complicated application procedure for a z-card ranks the fifth. The same problem is also mentioned by the non-users group, which considers it as one of the reasons for not using the PBS. Other than that, the technical design of the system, mainly the locker system, is not satisfying. One respondent explained that the current locker system is not efficient since one locker can only lock one bicycle. This design also contributes to the difficulty of rent and return at the peak hour. If GPS and separate locker are installed on the bicycle, the system will be more convenient.

While most of problems mentioned are internal, which means the problems of the system itself, the two issues mentioned below are external. 6 respondents (6.5%) think that there are insufficient bike lanes and more lanes should be built for facilitating the system. Moreover, 4 respondents (4.3%) think that the vandalism and theft still exists and problem can be only solved by improve the ethical standard of the citizens through education and information campaign. However, these two issues are external, which means outside the control of the provider. The targets can only be achieved through cooperation with government and other institutions.

Other than the problems listed in the table, several other issues mentioned the users. A few respondents think that there are too few 24 hour open service points and they found it extremely annoying when they reached service point but it is already closed. They have to place the bicycle to a nearby 24 hour open service point or they have to leave the bicycle there but still paying for it. Insufficient service centers which provide the top-up service is mentioned by a respondent. Only four points can top-up the card in the whole city. Another respondent think the bicycle is too heavy and too tall for the female users. Maybe different sizes and types of bicycles should be introduced. At last, similar responds have been received from the respondents of the non-users group.

5.3.10 Improvements that should be taken

When asked about the improvements that should be taken, both the users and non-users offer their opinions. From the users group a table of improvement opinions is made and for the non-users group, the opinions differ from the user group will be mentioned. Categories will be made according to the problems mentioned under the 5.3.9.

In order to solve the crucial problem of rent and return at the peak hour, suggestions such as installation of inquiry system and redistribution of the bicycles are mentioned. 19 respondents (13.3%) remark that is necessary to install an inquiry system in every service point. So that users can check the available number of bicycles and return

points in another service points and therefore mitigate the problem of hard to rent and return. Moreover, a better redistribution system of bicycles is mentioned by 16 respondents (11.2%) to solve the problem.

Check bicycles regularly is mentioned by the 21 (14.7%) respondents to solve the problems with the maintenance of the system. Moreover, a few respondents from the non-user group remark that the corporation should strengthen the supervision and monitor of the system and make more efforts on the propaganda against vandalism to ensure the facilities staying in good quality.

With regarding to the issues of the service points, 22 respondents (15.4%) think more service points should be established to facilitate the system as well as mitigate the situation at the peak hours. Moreover, a few respondents claim that the selection of the location of service points should be reasonable. Surprisingly, although a few respondents mentioned the problem of lack of 24 hour open service points, as much as 21 respondents (14.7%) claims that more 24 hour open service points are needed.

Concerning the application procedure for a card, some respondents from the non-user group claim the necessity to simplify the application procedure to facilitate the migrants and tourists. Moreover, 13 users (9.1%) mention that more people, especially the migrants and tourists, will utilize the facility by introducing other payment methods.

With respect to technical and hardware design of the system, 14 users (9.8%) think that the bike with different size and types is necessary. Improvement of the locker system is mentioned by 9 respondents (6.3%). They think the locker should have a screen which shows text message so that the users can know directly if they have rented or returned the bicycle successfully. Moreover, 8 respondents (5.6%) remark that a map with service points should be provided with the bicycle so that users can easily find the road and service point nearby his/her destination.

Table 5.7 Improvements that should be taken

Improvements that should be taken	Responses	
	N	Percent
Establish more service points	22	15.4%
Establish 24/7 service points	21	14.7%
Check bicycles regularly	21	14.7%
Installation of inquiry system	19	13.3%
Redistribution of bicycles	16	11.2%
Bike with different size and type	14	9.8%
Increase other payment methods	13	9.1%
locker with text message	9	6.3%
Provide maps with the bicycle	8	5.6%
Total	143	100.0%

Source: fieldwork

5.4 Comparing concerns of providers and users

During the fieldwork, government officials were confronted with the criticism of the users and there upon asked for their response. Generally speaking, the problems mentioned by the users in the previous subchapters, are also a concern for the government and public transport corporation. For instance, problems regarding rent and return of the bicycles and of maintenance are both mentioned by the users and providers. However, there still are differences in the way both groups experience and evaluate the present PBS.

First contradiction involves the number of service points. Although more than 2000 service points have been established, users are asking for more service points. Government respondents revealed that a lot of requests were received for new service points, which shows in fact the popularity of the system. The government feels however that the construction of extra service points involves a long process, which cannot be completed immediately. They feel that users do not realize the logistics this would take. Providing more service points requires finding suitable spaces, locations, proper connections to electricity, network and most of all no rejections from nearly living citizens. It remains however a point of attention that government will take up when the situation permits.

Another issue is the demand for the 24 hour open service points. Users strongly indicated the need for this service, but the provider only builds 66 points that functions all day so far. The provider remark that operational costs will go up if all the points runs 24 hours a day. Moreover, the operation of the system is not profit making at this stage. However, the provider does promise that more 24 hour service points will be built. Therefore, choose the location of 24 hour open service point selectively and scientifically is needed

The last mentioned issue is the maintenance of the system, especially the bicycles. Both user and provider are aware of the problem. The provider remarks that repairmen are sent out to patrol from point to point and the visible problems such as flat tire or broken chains are mostly being solved. However, many problems could only be observed while using the bicycle. This makes the maintenance procedure quiet difficult. Meanwhile, many users did not inform the staff when they see a broken bicycle. Therefore, although the users are the customer of the service, they should also care about the public property by letting the staffs know the problems of the bicycle.

From the survey, non-users reveal the following reasons for not making use the PBS: cannot ride a bicycle; use car or bus instead; not familiar with the system. These are important insight which will be taken up for consideration in Chapter 6.

5.5 Summary

Although the public bicycle is ranking lower than other transport modes (bus, car and walking), over one-quarter of all respondents is using the PBS as their main travel mode, but still only a small part of them use the facilities daily. Three quarters of the users combine PBS with another transport mode. Moreover, users tend to utilize the system for commute and shopping for short-term trips less than one hour, while those

who use it over one hour do so for recreation purpose such as entertainment and exercise. A large majority of the respondents are satisfied with the charge system. They spend relatively little money on it every month as most of them use the bicycle for less than 1 hour (first hour of use is free).

Regarding to the key factors of PBS usage, the first category as well as the most important factors are: the PBS service point should be near to departure point, destination as well as bus station and easy to rent and return a bicycle. The overall satisfaction with the system is relatively high (3.96 out of 5), although the respondents are not satisfied with the bike quantities and qualities as well as the service time. The most satisfying aspect is the costs of the system, while users are not satisfied with the fact that there are not enough slots to return the bicycle. This result confirms the respondents' remark that the difficulty for rent and return bicycle is the most crucial problem during PBS usage. The respondents also found problems of the maintenance as well as insufficient service points for the system. Correspondingly, relevant suggestions (redistribution of bicycles, Installation of inquiry system, check bicycles regularly, establish more service points and etc.) are given to improve the system.

Last but not the least, there are some contradictions between the provider and the users. It might attribute to the different point of view of both sides. The problem might be solved, if the provider can provide much clear information about the operation procedure to the public.

Chapter 6

Conclusions and Recommendations

6.1 Introduction

Chapter six presents an overview of the research, the conclusion and recommendations. The chapter is divided into three sections. Section one provides answers to the research questions and highlights the key findings. In section two, findings of this study will reflect upon the literature review. Finally, recommendations regarding to the PBS will be presented.

6.2 Answering the research questions

Based on the analysis carried out in the literature review and in the fieldwork, the answers to the research questions will be present. The sub research questions are answered first and then concluded by answer to the main research question. Following are the findings from the research:

1. What is the running status of PBS in Hangzhou?

Hangzhou PBS is run by the public transport corporation and funded by the local government. Based on the interview with the service provider, it can be stated the PBS in Hangzhou is rather successful in terms of its operational status. This indicates there is a high demand for the system. This becomes even more clear when realizing the daily trips of PBS has increased from 0.93 times per bike per day to nearly 7 times. It is positive to notice that the local government is very keen on making the PBS a success. Moreover, the government is open to complain from users and try to find feasible alternatives to improve the functioning of the system. On the other hand, it should be noticed that the government has during the 2 years the project is running constantly subsidized the system. The revenue generated from the billboards and user payment is insufficient to cover operational cost, capital investment that is needed for running the system. Furthermore, the Hangzhou PBS eases the congestion and parking problems in the city as well as contributes to the improvement of human and ecosystem health, increase of employment and the city image.

2. What are the major challenges in running a PBS in Hangzhou?

Five major challenges are mentioned by the government official and company manager. Firstly, during peak hours, there is insufficient number of bicycles and parking places available since so many citizens are making use of the system. This causes the problem of hard to rent and return bicycles and results in frustration among users which is clearly demonstrated from the survey. Secondly, the selection of location of service points is a difficult task to handle. It not only involves a feasibility study on potential locations, but also concerns the voice and opinions of the residents, shop owner, etc. who will be affected by the construction of new service point. The study reveals that there is a disagreement between the provider and users. The users express the need for more service points, but according to the government official, it is not a real reasonable

demand. The users lack the insight of what it takes in terms of finance, logical procedure to establish a new service point. .

The third challenge concerns the financial gap between PBS expenditure and incoming revenue. Only 35~40% of the expense is currently covered by the revenue generated from billboards and users' payment which implies that the local government yearly has subsidy an enormous part of expenditure. It is to be hoped that the system can continue since change of political system and finance situation might influence the running of PBS. Fourthly, as the system expanded, maintenance becomes more complicated. This is partly due to the lack of staff but is also closely linked to improper use of bicycles by users, which is the fifth challenge. As a result, more capital and human resource are required.

Except for the financial operation of the PBS, the challenges mentioned above are also concerns of the users. Other than these challenges, the users find it essential to simplify the application procedure for a z-card as well as improve the technical and hardware design of the system.

3. Is the user satisfied with the system so far?

Judging from respondents through the result received from the questionnaire, the users are basically satisfied with the Hangzhou PBS. On the scale of 1~5, the overall satisfaction is scored 3.96, which is rather high. The fee system turns out to be the most satisfying aspect, as indicated by 92% of the respondents. Factors such as bike comfort, bike safety, service attitude and quality of the staffs also highly scored with regards to satisfaction. Most respondents feel that the rental procedure is easy to handle which enable them to rent a bicycle within 5 minutes. Although respondents indicate the need for more service points, the satisfaction with the number of service point still score 3.81, which is satisfying. As what is already indicated in the previous part, the users are not satisfied with the situation of insufficient number of bicycles and parking places during the peak hour. Therefore, the score is lower than the overall satisfaction. Service time turns out to be another unsatisfying element of the system which requires improvements according to the users.

In conclusion, it can be stated that although with challenges, the Hangzhou PBS is functioning well as citizens are making use of the system and are satisfied with it. However, it should be noticed that government support plays an important role in making the Hangzhou PBS a success. Without the support of local government, the system might fail to achieve today's outcome.

6.3 Reflection upon the literature

While the study is based on the review of former literatures, the findings from this study will again reflect on the literatures.

Regarding to the motives of PBS, the Hangzhou PBS is similar to the PBS in Lyon. Both cities regard the main motive of the PBS is an approach of creating a sustainable transport system as well as achieving environmental and social goals. However, the

Hangzhou PBS attempts to achieve a more comprehensive goal which includes almost all the objectives mentioned by other systems.

With respect to the preconditions, most of the findings are similar with the previous literatures. The flat city area, city size and density, basic cycling infrastructure of Hangzhou are in favour of the establishment of the PBS. Moreover, it is convinced from the working staffs that heavy rain will discourage people from cycling than hot weather in a particular day. However, although the yearly precipitations in Hangzhou double than that of Paris, Lyon, Amsterdam and Copenhagen, the total rental does not seem to be affected greatly. Regarding to the attitude towards cycling and cycling level, it is hard to judge whether it is an essential precondition of establishing a PBS with the current data. Never the less, it is certain that with the PBS, the share of cycling in Hangzhou is increased. The design of PBS with a good potential of intermodality might contribute to the success of the system. Later on, the lack of analysis of target group doesn't seem to have negative impact on the implementation of the system. Furthermore, judging from the case of Hangzhou, strong support from the government in favour of PBS is likely to make the system functioning successfully.

With respect to project arrangements, the Hangzhou PBS is different from any other modes around the world but still share some similarity in some aspects. Same as the system in Germany, the provider of the PBS is the transport agency that is stated-owned. However, the two systems are also similar from the perspective of financial arrangement. The revenue is both provided from the government as well as the user payment, but the Hangzhou PBS also generated revenues from the billboards which are also the case in Paris and Lyon. The project design in Hangzhou PBS is very similar to that of Paris due to reason that the government officials have done a research in Paris. Both systems used fixed station design as well as smart card to rent bicycles. However, the system in Hangzhou requires more staffs to coordinate the running of the system. Moreover, the Hangzhou mode has its own originality. Kiosk at the service points is designed not only for assisting the users, but also provide tourism information and other services, which can be seen as another way of generating revenues. Besides the design of the system, marketing is vital for the PBS. Without proper information, the lack of acknowledge will discourage the citizens from using the system and prevent the system from growth. The Hangzhou government act as an active supporter which uses different methods such as media, brochures and awareness campaigns to promote the PBS.

Concerning the challenges faced during the implementation of the system, similar challenges has confronted compared to other systems. Maintenance is truly a challenge, while situation of theft doesn't seem to be a major problem in Hangzhou PBS. Improper operation, which is not mentioned in any other system, appears to be an obstacle of PBS operation. It is worth notice that the service points should be scientifically selected through democratic ways and the designer should bear in mind to avoid problem of hard to rent and return bicycles at peak hours. Moreover, in a PBS which the purpose of it is to facilitate the public transport system, the service points should be built near other public transport stations such as bus or metro.

With regards to the findings from users and non-users, some similarities as well as differences have been found compared to other cases. Regarding to the problems faced

during PBS use, the Hangzhou PBS share similar problems that of in Paris and Barcelona: the issue of rent and return difficulty during peak hour and the maintenance of the facilities. Considering the key factors of PBS use, the convenience of the system, which includes easy to rent and return a bicycle as well as service points should be near to the departure point, destination and bus station, is the most influential factor to PBS use. Meanwhile, service quality and attitude of the staffs, which receives critics from users, turn out to be not a key factor. Surprisingly, cost is not a key consideration of the users in Hangzhou, while it is mentioned in the literature review that cost has an influence on the travel behaviours. Moreover, service time, which is seldom mentioned in cases of other cities, seems to be a crucial weakness of the Hangzhou PBS.

From the implementation of the PBS in Hangzhou, it is proved that the PBS, as a mode of sustainable transport, can ease the congestion and parking problems in the city. Moreover, by using PBS instead of cars, an estimate of 31,000 kilo GHG and pollution is reduced every day. The PBS further contribute to the improvement of human and ecosystem health, increase of employment as well as the city image. Compared to the other sustainable transport mode which mainly focused on motorized transport, PBS is zero-emission and more environmental friendly. Therefore, PBS should get more attention from researchers and government which is not currently the case, especially under the situation of environment deterioration due to climate change.

6.4 Recommendation

Based on the analysis of challenges and problems during PBS use, satisfaction level of the system as well as opinion of improvement that should be made, the following recommendation are proposed:

Regarding to Challenges from the provider perspective, several improvements should be improved. The public transport corporation do not have to consider the expenditure of the system as the government will provide funds to cover the operation costs. However, it cannot operate in this mode for a long period because this financial mode will cause inefficient operation of the corporation. Therefore, the public transport corporation should optimize its operation and maintenance procedure as well as find other way of revenue generation and finally reach the target of covering its expenditure by its own. Moreover, a better distribution system of the bicycle should be built not only to solve the problem of hard to rent and return bicycles in the peak hour, but also manage to cope with the difficulty of setting up 24 hour open service points. As there are still problems on the maintenance of the bicycles and other facilities, it may attribute to the lack of working staffs. Maybe more staffs should be employed to cope with this problem.

With respect to the problems faced from the user perspective, some additionally recommendation will be proposed. Due to different gender and age demand, the bicycles should be designed with adjustable seat which is not the case now. Therefore, other than adjustable seat, different sizes and types of bicycles should be introduced to facilitate and attract more people. Moreover, different payment methods should be applied to facilitate the migrants, domestic and foreign tourists. For example, other than applying for a z-card, other bank card or credit bank should be accepted for

payment. So that more people will be attracted to use the facilities instead of use private cars.

Concerning the reasons of which non-users do not make use of the system, three improvements can be made. First of all, extra information campaign should be carried out to reach the citizens who are still not familiar with the system. Secondly, the price of car use could be increased so that more people are more willingly to use PBS or bus. Thirdly, biking lessons can be provided weekly or monthly by volunteers to help those who do not know how to ride a bicycle.

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Annex 1: Questionnaire for Users of PBS

Since the implementation of PBS in 2008, the Hangzhou PBS draw the attention of the public. Under the appeal of leading a low-carbon lifestyle, PBS has generally become a symbol of Hangzhou. The questionnaire survey aims to investigate the functioning of Hangzhou PBS as well as collect opinions and recommendations from the public.

1. What age group do you belong to?

- 12–18 19 – 30 31 – 44 45 – 59 > 60

2. Gender

- Male Female

3. What income group do you belong to?

- No income 0 – 2000 2000 – 3000 3000 – 4000 > 4000

4. What is your education level?

- Below High school High school junior College College higher than college

5. Current occupation?

- Student Working Retired

6. Indicate your main travel mode:

- Bus Car Walking Private bicycle Public bicycle

7. Have you ever heard of the PBS?

- Yes No

8. In what way did you get to know about the PBS?

- TV Radio Internet Newspaper Outdoor ads
 Brochure PBS on the Street

9. Indicate the frequency of PBS usage:

- occasionally 1-3 times a week 4~5 times a week once or more than once daily

10. Indicate your main purposes of using PBS:

- school work shopping recreation working out
 other _____

11. Do you use the PBS at week days or weekends?

- Weekdays Weekends

12. At what time period of the day do you usually use the system?

- 6:00~9:00 9:00~12:00 12:00~14:00
 14:00~17:00 17:00~20:00 20:00~

13. How much time will you used to release a bicycle from the locker?

- Within 2mins 2~5mins 5~10mins More than 10mins

14. Generally, how much time do you take on PBS use each time?

- Within 0.5 hour 0.5~1 hour 1~2 hour 2~3 hour >3 hour

15. Do you think the ladder pricing of PBS has an effect on your usage behavior?

- Return the bicycle within one hour Return the bicycle within two hours
 Return the bicycle within three hours No effect

16. How much do you spend on PBS monthly?

- Almost nothing Within 20 yuan 20~50 yuan 50~100 yuan >100 yuan

17. Do you think of the fee system?

- reasonable unreasonable

18. Do you always combine PBS with other transport mode? (Three times a week)

- Yes No

19. If yes, which transport mode do you use?

- Bus Taxi Private car Other _____

20. Do you think the PBS has changed your travel behavior?

- Yes No

21. Do you have a private car?

- Yes No

22. What factors do you consider important when you use a PBS?

23. What Problems has you meet during using the PBS?

24. Are you satisfied with the aspects of Hangzhou PBS listed below?

(1 very low satisfaction 2 low satisfaction 3 ok 4 high satisfaction 5 very high satisfaction)

	1	2	3	4	5
Biking comfort					
Biking safety					
Sufficient service points					
Easy rental procedure					
Costs					
Availability of bicycles at service points					
Availability of empty slot at service point for bicycle returns					
Bike quality					
Service time					
Service quality of staffs					
Service attitude of staffs					
Overall satisfaction					

25. What suggestions do you have for improvements?

26. Do you support the development of PBS?

Annex 2: Questionnaire for Non-Users of PBS

1. What age group do you belong to?

- 12–18 19 – 30 31 – 44 45 – 59 > 60

2. Gender

- Male Female

3. What income group do you belong to?

- No income 0 – 2000 2000 – 3000 3000 – 4000 > 4000

4. What is your education level?

- Below High school High school junior College College higher than college

5. Current occupation?

- Student Working Retired

6. Indicate your main travel mode:

- Bus Car Walking Private bicycle Public bicycle

7. Have you ever heard of the PBS?

- Yes No

8. In what way did you get to know about the PBS?

- TV Radio Internet Newspaper Outdoor ads
 Brochure PBS on the Street

9. Why do you not use PBS?

10. What suggestions do you have for improvements?

11. Do you support the development of PBS?

Annex 3: Questions for interview with Staffs

1. What are your major tasks?
2. Do you work full-time or part-time?
3. Do you like your job?
4. What was your pervious job?
5. What is the percentage of bicycles on loan during different time of a day?
6. What are the most common problems users meet in using PBS facilities?
7. What are the major problems you face in your work?
8. How often is above problems occurred in the system?
9. What is your opinion about the further improvement that could be made?

Annex 4: Questions for In-depth interview with government official and corporation Manager

History of the project

1. When and how were the initial discussions?
2. When did it take to design and set-up the system?
3. How do the government consider issues of safety, costs, ease of use and selection of points?
4. Is there any collaboration with national government/ other municipalities/ private sectors?

Basic information of PBS

1. How many users per day?
2. How many service points and bicycles are there?
3. What is income/age group the major users belong to?
4. Which areas are the services used more often?
5. Which time period of a day is the service used more often?
6. Are there any difference between the usage of the system in week days and weekends?

Operation Phases

1. What are the policies to promote bike use in Hangzhou?
2. How did and do you promote bike use at city level?
3. What are according to you the barriers for people to use the PBS?
4. What are the objectives of PBS in Hangzhou?
5. Are the facilities state-owned or company-owned?
6. Who is responsible for operation and maintenance?
7. Is the government is the main fund provider?
8. Financial arrangements:
 - Investment
 - Operation and maintenance
 - Overheads
 - Income
9. How was the project designed?
10. Why the current system is being chosen?
11. How was the service points selected?
12. Was and in what manner the public informed and involved about the PBS?

Problems meet

1. Is PBS in Hangzhou functioning well? If yes, Why and How?
2. What are the most common problems faces for using the PBS?
3. Not all service points are 24 hours open. What is the reason behind it and is there any plan to make all service points 24 hours open?
4. How do you deal with the theft and vandalism?
5. The staff attitude is not quite good according to some feedbacks. Is there any plan to deal with this problem?
6. For many cases in western countries, the users can access to Google map and check the availability of bicycles at the service points. But this is not the case in Hangzhou, are there any plans to set up similar systems? If no, why not?

7. Is there an evaluation & monitor system for the program?
8. If yes, how does it function and are user involved?
9. How do you measure user's satisfaction?
10. What are the factors that affected the use of PBS?
11. Is/was the public involved in designing the project?
12. What are the future plans for the PBS?