



# **The Contribution of the Dockless Bike Sharing System to Enhancing Urban Sustainable Mobility: A Case Study of Beijing, China**

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## **Abstract**

Over the last three years, the dockless bike sharing scheme has become prevalent in the context of the booming of sharing economy, the widely use of mobile online payment, the increasing environment awareness and the inherent market demand. This research takes Beijing as a case study, investigates the users' characteristics, their behavior change, and perceptions of DBSS by the quantitative survey, and then analyzes the reasons behind it and how has it change the residents' life in Beijing. This new kind of dockless shared bikes, with great advantages of accessibility, flexibility, efficiency and cheapness, helps to solve the "last mile" problem, reduce the travel time, and seems to be very environmental-friendly and sustainable. However, with the help of interview and document analysis, this research finds that the shared bikes are not the alternative for the frequent car-users. Nevertheless, it also has numerous negative consequences such as "zombie" bikes blocking the sidewalks and vandalism of the bikes. Publics are also worried about their quality and safety, especially the issues of "right of way". How to coordinate and solve these problems is not only related to the future direction of dockless bike sharing scheme, but also related to the vital interests of the general public. Therefore, it is important to emphasize that governments, enterprises, and the public participate in multi-party cooperation and build a synergic governance networks to carry forward the advantages and avoid the negative effects of the new bike sharing system.



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# 1. Introduction

## 1.1 Background of the study

In recent years, growing concerns over climate change, deteriorating urban environment and unhealthy lifestyles have placed more attention on sustainable transportation alternatives such as bicycles. The bicycle, compared to other kinds of vehicle, has many advantages for both cyclists and society: it is a low-cost, low-polluting, health-improving way to travel (Handy et al. 2017). In light of these benefits, cycling has become a major component of visions of sustainable urban transport systems in Europe, supported by market-based instruments, command-and-control approaches, as well as soft policy measures (Gössling & Choi 2015).

China like many of other countries, has experienced a rapid growth of bicycles from 1970s -1990s. However, after the mid-1990, bicycle use steadily decreased as a result of economic growth, increased urbanization, expanded city areas and a gradually deteriorating cycling environment (Zhang et al. 2014). At the beginning of 21st century, the Chinese government realized that excessive dependence on cars has lead to serious environmental pollution and resource constraints. To preserve the environment and achieve a harmonious balance of economic growth, population, resources and the environment, the Chinese government put forward the new urban development mode of “a resource-conserving and environment-friendly society”, and had a major shift in fossil fuels to renewable energy (Zhijun & Nailing 2007, p95). Following the Chinese government's new approach, Chinese municipal governments have heavily subsidized the development of Public Bike Sharing Program (PBSP) to encourage non-motorized transport and offer a flexible, convenient, and low-cost mobility options to the people. However, one of the barriers that still hindered the traditional bike sharing services was the ease of access to docking stations (Fishman et al. 2013). Absorbing the advantage of a bicycle program with docks, a successful dockless bike sharing program may integrate the functions of docking stations directly into the shared bikes. In 2015, two start-up companies, Ofo and Mobike, initiated an innovative generation of fully Dockless Bike Sharing Scheme (DBSS) in China (Mead 2017).

This new generation of bike sharing schemes is different from the traditional public bike system since it is easily accessible, flexible and cheap. Before the existence of the DBSS, bikes needed to be docked at stations, whereas in this emerging service, bikes can be un-locked and paid for using a smartphone and can be picked up and left any parking area at users' convenience (Zhang & Mi 2018).

The DBSS becomes prevalent in the context of the booming of sharing economy, the widely use of smartphone, mobile Internet and online payment. Bike use dramatically increased within the recent years, when private companies start to combine digital technologies with sharing economy concepts. Until July 2017, the total amount of domestic shared bike accumulates about 16 million, and the daily orders of shared bikes have reached 50 million across China; and the rapid development of this dockless bike-sharing service has created 100,000 new jobs in China (Chinese National Information Center, 2017).

The DBSS has leaded a trend of “green travel” in China. Based on the research, bike sharing in Shanghai saved 8358 tones of petrol and decreased CO<sub>2</sub> emissions by 25,240 tones in 2016 (Zhang & Mi 2018). It seems that DBSS could significantly help China to achieve the declared goal in Paris Convention of reducing the CO<sub>2</sub> emission by 60%-65% per GDP before 2030 (Gao 2016). On the other hand, DBSS with its great advantages of flexibility in short trip is just the one to deal with commuters’ “first mile/last mile” problem - the movement of people from a transportation hub to a final destination in the home. This new integrated transportation mode, namely the bike+bus/metro+bike trip, has improved the efficiency of the traditional single mode.

The rapid development of DBSS has changed citizens’ lifestyle and transports preference, at the same time shaped the urban fabric and environment. However it also has already thrown up problems, including the mountains of discarded bikes and “parking anywhere” problem caused by the vicious competition within the industry and the dockless operation mode. It has raised urgent need for the evaluation about the sustainability of this new transportation mode as well as the sustainable approach for cities to coordinate it (Campbell 2018).

## **1.2 Research rationales and questions**

The new generation of bike sharing services without docking stations is currently revolutionizing the traditional bike-sharing market as it dramatically expands in China and even around the world. Many cities are not ready to welcome the mass of rubber and aluminum from blocking pedestrian walkways and piling up in the public space (Horwitz 2017). Though the DBSS is a fairly new trend, the concerns about the popularity, the benefits and potential harm behind it have prompted a hot debate among the public and the academic circle. However there is still a gap between the descriptions of phenomenon and the assessment of the practice. It thus raises a pressing question – does DBSS, this new scheme, really help cities to move towards a more sustainable mobility mode? This socio-political problem identified above, becomes the first rationales for this study. The societal



relevance of this study is to critically assess the contribution of the DBSS towards a city's sustainable development, especially in regard of mobility, meanwhile generating some advice for cities to utilize and manage the DBSS in a more sustainable way.

In addition to the societal relevance, this study also has a scientific relevance. Firstly, although a range of empirical studies has already reported a wide variety of findings on bike sharing, it has often been argued that there are distinctive inconsistencies across studies due to study design limitation, measurement bias and cross-country variations. Particularly, a majority of research is drawn from the European and American cities, while very little research concentrated in Chinese cases with a rapid growth of PBSS (Fishman 2016). To fill the gap in context-specific research, this thesis will use Beijing as a case to investigate the bike sharing development in China. Secondly, there is a growing literature on the earlier breed of docked bike sharing schemes, there is very few critical academic study of this new dockless bike sharing scheme (Spinney & Lin 2018). This research seeks to contribute to social scientific debates on the new DBSS and its impacts. Thirdly, there is a lack of theoretical scientific knowledge and method in existing research on DBSS. The current study of DBSS all use the data provided by the operation companies, which include the basic bikes' and users' information plus GPS information about the track, parking place (Zhang & Mi 2018; Shen et al. 2018; Pan et al. 2017). They normally focus more on the macroscopic usage and of DBSS by big data mining and ArcGIS analysis. This study however starts from the users' perspective, which means the data will come from the user survey with the supplement of expert interview. It tries to investigate people's perception and attitudes, at the same time explore the behavior change of people's travel mode engendered by these disruptive forms of bike sharing, and by using a mixed quantitative and qualitative method.

Against the above, the overall research aim can be concluded as below:

- A. to explore the reasons behind the popularity of the DBSS in China and investigate the users characteristics and their behavior change and perceptions of DBSS;
- B. to explore and critically assess the contribution of DBSS towards sustainable mobility in Beijing context;
- C. to propose recommendations for healthier DBSS development and governance in the future.

Based on the research aims, the research will take Beijing as a case study to investigate the following research questions:

**RQ1: Why has DBSS become increasingly popular in China in recent years?**

**RQ2: What impact has DBSS had to Beijing residents' daily life?**

**RQ3: What are residents' perceptions towards the DBSS in Beijing?**

**RQ4: To what extent could Beijing's DBSS contribute to its urban sustainable mobility development?**

**RQ5: How could cities coordinate DBSS in a sustainable way?**

## **1.3 Thesis structure**

This thesis is divided into five chapters to provide a systematic approach to fulfill the above research objectives.

Chapter 1 (this chapter) briefly introduces the background information of the DBSS and the motivation of the research. It also highlights the research aims and questions, and presents the structure of this thesis.

Chapter 2 is the critical literature review of previous relevant studies. A wide range of research in terms of sustainable mobility, the development of bikes and public bike sharing system, and the governance of them will be summarized. The theoretical framework is also included in this chapter.

Chapter 3 explains in detail the research strategy and methodology applied in this thesis. It includes the study design, the methods for data collection and analysis, and why the author chooses these methods.

Chapter 4 answers the five research questions raised in the beginning. It provides the result and analysis of the data collected from the survey and interview. It explains the reasons that why DBSS has become increasingly popular and illustrates the impact of DBSS towards residents' life and Beijing's transportation and environment. Meanwhile, it also explores residents' perceptions and experts' view to the development of DBSS. It discusses how does the DBSS contribute to city's sustainable development based on the data analysis and how could government, companies and citizens coordinate together to embrace the DBSS in a more sustainable way.

Chapter 5 summarizes the conclusion of this thesis and discusses the possible recommendations for future studies.

## **2. Literature review**

It is important to consider bicycle as an important modern transportation mode, especially when talks about the sustainable mobility. In this chapter, Section 2.1 reviews a wide range of literatures on sustainable transportation and how to measure and achieve it; Section 2.2 firstly introduce cycling and its benefits and promotion worldwide, then focus on the bicycle development in China, at last the development of public bike sharing program. The theoretical framework is also included in this chapter.

### **2.1 Sustainable transportation**

Sørensen et al. (2013) put forward three related but distinct aspects to be addressed in regard of sustainable transportation: (1) Normative dimension - fundamental ethical principles or value orientation of sustainability, i.e. what sustainable transportation is, and which goals to pursue; (2) Analytic dimension - determining whether an action is sustainable or not, i.e. having knowledge of the impacts of sustainability of various transportation projects or plans. (3) Governance dimension - system of governance, institutions, policies, and procedures promoting the integration of sustainability into the transportation sector. Thus, in this chapter, Section 2.1.1 introduces the definition of sustainable transport; Section 2.1.2 illustrates the different indicators to measure the sustainability of different transportation projects; Section 2.1.3 reviews the potential way to achieve the sustainable mobility.

#### **2.1.1 The introduction of sustainable transport**

Transportation is a major contributor to greenhouse gas emissions, affecting climate change and the environment. Building on the seminal Brundtland Report of 1987, a sustainable urban mobility system is one that satisfied current mobility needs of cities without compromising the ability of future generations to meet their own needs (Tolley 2003). Black (2010, p3) narrows the concept of sustainable transport system as “the one that provides transport and mobility with renewable fuels while minimizing emissions detrimental to the local and global environment, and preventing needless fatalities, injuries and congestions”.

Sustainable mobility provides an alternative paradigm within which to investigate the complexity of cities, and to strengthen the links between land use and transport. In the Global Report of Human



Settlement by UN-Habitat (2013), the idea of sustainability in urban mobility has moved beyond a focus on ecology and the natural environment to also include social, economic and institutional dimensions. Furthermore, it has moved beyond the preoccupation with movement and flows within urban settings to looking at enhancing proximity in space. A holistic and integrated approach to urban land-use and transport planning and investment is needed if urban areas are to become socially, environmentally and economically sustainable. The study of urban transport sustainability starts by identifying what makes urban transport unsustainable. Sultana et al. (2017) present a brief overview of the main problems: (1) material throughput and carrying capacity; (2) oil supply, reserves and prices; (3) air pollution; (4) climate change; (5) traffic congestion; (6) road safety; (7) transportation affordability; (8) equity; (9) physical activity and health.

Most reviews of policy attempt to clarify the definition of sustainability by identifying the principal objectives to be addressed in achieving sustainability. The 2000 European Conference of Ministers of Transport (ECMT) report on Sustainable Transport Policy (ECMT 2000) identifies a set of objectives, the principal ones of which are shown in Table 1 in relation to the sustainability “legs” which they support (May and Crass 2007).

Table 1 Transport objectives and their contribution to sustainability (revised by author refers to May & Crass 2007)

ECMT Transport Objectives (2000)		Sustainability “leg”		
		Economic	Social	Environmental
1	Improving transport safety	√	√	
2	Creating wealth	√		
3	Reducing congestion	√		√
4	Improving access		√	
5	Reducing severance, fear, intimidation		√	
6	Protecting landscape and biodiversity		√	√
7	Reducing noise			√
8	Reducing greenhouse gas emissions			√
9	Improving air quality			√

### 2.1.2 The assessment of sustainable transportation

A question that arises is how sustainability performance measures/indicators differ from other performance measures traditionally used by transportation agencies. Litman and Burwell (2006) distinguish between what are termed as conventional transport indicators and those that can be termed

as sustainability indicators. For example, there is a need to shift from using automobile-centric (and operations-focused) performance measures to assessing indicators that are more holistic, even if they are more difficult to measure. Similarly, Zietsman and Rilett (2002) note the paradigm shift required for capturing sustainability concerns – moving from measuring mobility to accessibility, and from outputs to outcomes.

To make progress on this matter first requires the establishment of performance measures that can then be used to define sustainability objectives (Kennedy et al. 2005). Ideally, such indicators are established with community participation (since communities are ultimately part of the solution). Lists of such sustainability performance measures should be expected to vary between regions reflecting differences in scale, geography and culture. Kennedy et al. (2005) attempt to capture the central attributes of sustainable transportation performance measures. In broad terms, movement to sustainable urban transportation involves the (1) accessibility, (2) health and safety, (3) cost effectiveness, (4) Impacts on competitiveness and generation of wealth, (5) Consumption of natural capital, and (6) Production of pollutants (local and global).

May (2013) provides a simple summary of the assessments, and of the potential contribution of each type of policy intervention, including technology, to each of the sustainability objectives. It can be seen in the Table 2, that no single type of instrument scores best against all objectives but that each has a significant contribution to make. This suggests that an effective strategy is likely to be based on a combination of different types of approach.

Table 2 The contribution of different types of intervention to policy objectives. Key: H=high contribution; M=moderate contribution; L=low contribution (revised by author refers to May 2013)

	Technology	Land use	Infrastructure	Management	Information	Pricing
Greenhouse gas	H	M	L	L	M	H
Air quality/ Noise	M	L	L	M	M	M
Safety	L	L	M	H	M	L
Access/ Exclusion		M	L	H	L	
Congestion	L	M	M	M	M	H
Wealth Economy	L	H	H	H	L	M

Potter (2007) undertakes a 'backcasting' analysis exploring strategic approaches for overall systems sustainability in personal transport. He use a simple equation modal, "Population $\times$ Car journeys per person $\times$ Length $\times$ Emissions per Vehicle Kilometre = Total Pollution", to provide an understanding to explore how the various combinations of transport technologies and changes in travel behavior can deliver more sustainability. He discussed that a combined strategy, seeking to optimize technical improvements with demand management addressing trip length, trip generation and modal share can deliver the necessary improvement in what could be a realistic package.

Goldman and Gorham (2006) discuss system-based approaches to sustainable transportation in an urban context classified into four clusters: (1) new mobility - focused on alternatives to automobile transport; (2) city logistics - focused on improved freight and logistics; (3) intelligent system management - improvement of transportation system efficiency and the use of technology; (4) liveability - strategies focused on reducing transportation demand through land use.

As for the measurement of specific projects, Bueno et al. (2015) classify the current methods and techniques for the assessment of transport infrastructure projects: (1) project appraisal methods for decision-making including the cost-benefit analysis (CBA) and multi-criteria decision analysis (MCDA); (2) techniques for assessing environmental/social impacts including the life-cycle assessment (LCA) and the social life-cycle assessment (SLCA); (3) Sustainability assessment methodologies including rating systems and frameworks and appraisal guidelines.

These literatures and studies greatly help the understanding of the analytic dimension of the sustainable transport. However, it is not enough to only notice the dimension that formed the sustainability in transport sector. To step forward and achieve the goals, the comprehensive governance of sustainable mobility from all stakeholders is urgently needed.

### **2.1.3 Moving towards sustainable mobility**

The problem is that how to move towards a more sustainable future, especially given the many interest groups involved, the complexity of urban systems and the fragmented nature of decision-making in most urban regions. According to the Global Report of Human Settlement by UN-Habitat (2013), in order to become more sustainable, cities should be more compact, encourage mixed land use and prioritize sustainable modes of mobility such as public and non-motorized transport. Furthermore, urban mobility systems need to be inclusive, providing mobility opportunities for all. This calls for a more holistic and inclusive framework for the planning, design and provision of urban mobility system and services. Accordingly, translating visions and plans for sustainable

urban transport futures depends on the presence of a supportive governance and regulatory structure (UN-Habitat 2013, p13).

Paradigm shift towards sustainable transport is necessary and not difficult to achieve at least in cities provided that there is both strong political and public support (Banister 2007). Because in these cities, a rebalancing of priorities away from an overriding concern with economic growth towards one that gives much greater prominence to social and environmental priorities. Banister (2007) outlines that sustainable transport can only be achieved with a strong combination of four separate sets of policy measures: (1) Technology and pricing, including investment in technology in transport modes, in information systems and in the transport system itself; (2) Regulation, including driver and vehicle licensing, taxation and pricing, standards and traffic regulations; (3) Land use development, including planning and regulations; (4) Information, including social pressure, awareness raising, demonstration, persuasion, and individual marketing.

Banister (2008) also argues that policy measures are available to improve urban sustainability in transport terms but that the main challenges relate to the necessary conditions for change. These conditions are dependent upon high-quality implementation of innovative schemes, and the need to gain public confidence and acceptability to support these measures through active involvement and action. May (2013) also emphasizes that the most important contribution is likely to continue to be made by cities which are willing to innovate, whether in policy instruments and packages, in governance, finance or the policy process.

Sultana et al. (2017) considered that the literature on sustainable transport solutions is often divided into narrow and broad approaches (see Figure 1). The narrower Sustainable Transportation Technology approach focuses on making each form of mobility more sustainable by reducing its resource use and pollution. The broader Sustainable Travel Behavior and Land Use approach is more holistic. It recognizes that moving people and goods more sustainably will require a reconfiguration of urban form to improve accessibility for more sustainable transport modes. While both approaches address concerns about the unsustainability of our current transportation system, they emphasize different solutions.

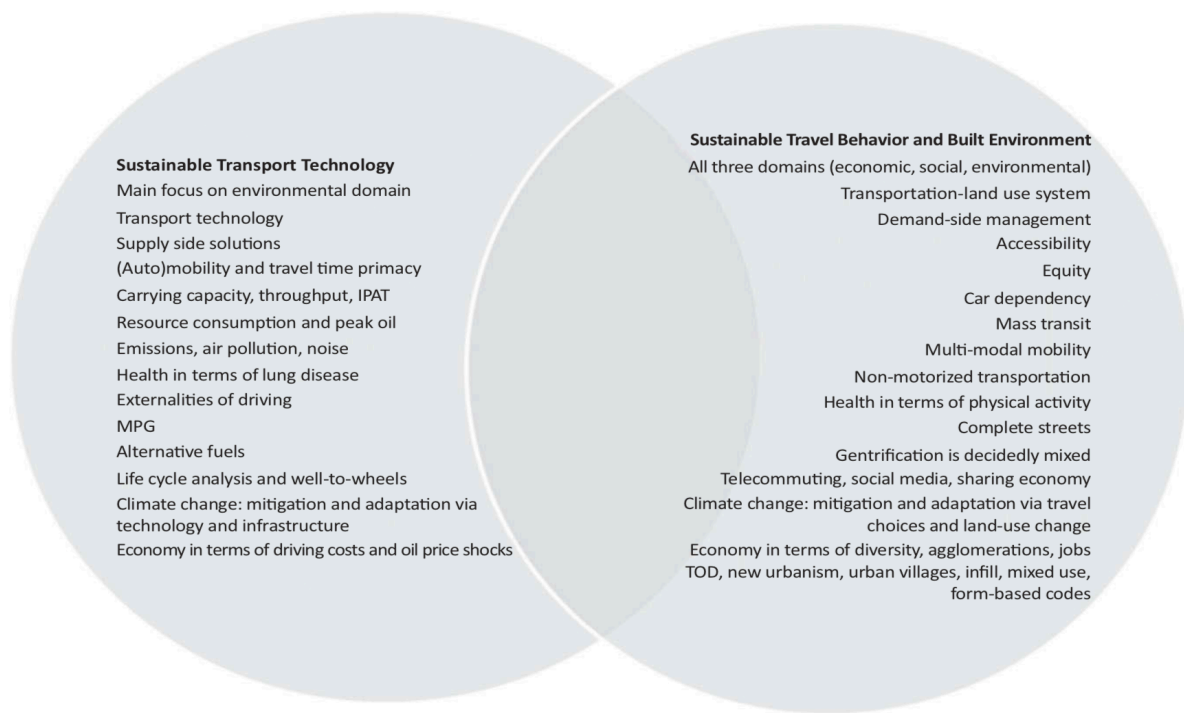


Figure 1 Two main approaches to urban transportation sustainability (left circle - narrow; right circle - broad) (Sultana et al. 2017)

In this research, the broader perspective of sustainable transport, which includes all three domains (economic, social and environmental), is carefully considered. The theoretical framework made by the World Bank has defined the three pillars of sustainable transport (safety & environmental, social, and economic). Under each pillar, there are respective indicators (see Figure 2). The three-pillar model is selected because it provides a good index to assess the DBSS's contribution to city's sustainable transport. It greatly helps the design of the questionnaire, since through this framework, we know what factors are needed and relevant when measuring and evaluating the sustainable transport.

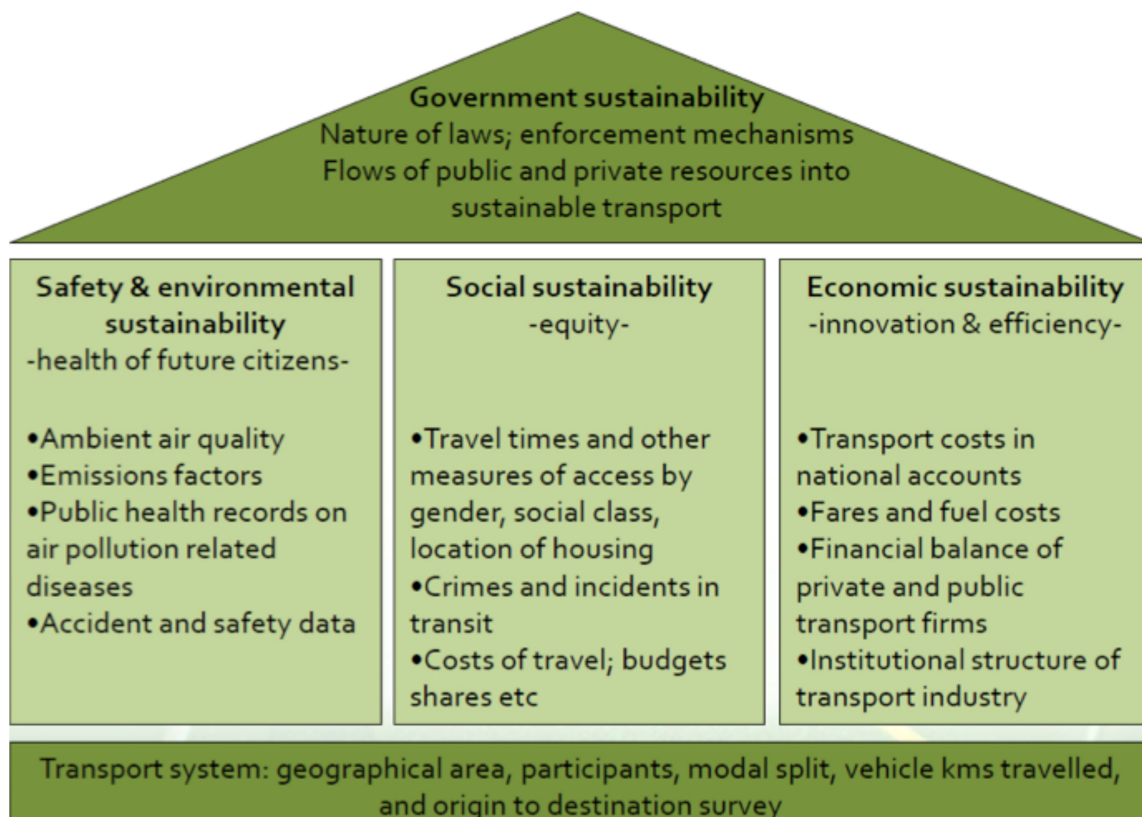


Figure 2 The three pillars of sustainable transport (Juhel 2012, p6)

Apart from this basic theoretical framework, the solution part for cities to enhance its capacity when coordinating the DBSS is based on the research framework of Kennedy et al. (2005). They think the process of achieving more sustainable transportation requires suitable establishment of four pillars: (1) governance - the establishment of effective bodies for integrated land-use transportation planning; (2) financing - the creation of fair, efficient and stable funding mechanisms; (3) infrastructure - strategic investments in major infrastructure; and (4) neighbourhoods - the support of investments through local design. This four-pillar formed the analysis of the governance on DBSS to optimally manage and utilize the DBSS, because of its comprehensiveness and feasibility.

After discussed the sustainable mobility and the theoretical framework used in this thesis, we need to have a closer look on cycling. Since cycling is one of the most important patterns of sustainable urban transport mode, its development and promotion will be discussed. Literatures about the public bike sharing will also be reviewed.



## **2.2 The bicycle as a sustainable mobility**

This section presents a general view for the bicycle as a sustainable mobility in modern world. Firstly, it introduces the benefits of cycling and why the bicycle is vital to sustainable mobility in Section 2.2.1. Then Section 2.2.2 illustrates how does it promoted in the modern society, and section 2.2.3 focuses on the bicycle development in Chinese context. Lastly, Section 2.2.4 talks about the public bike sharing program and its development history.

### **2.2.1 The benefits of cycling**

As a transport machine, the bicycle has many advantages both to society and individuals. It is environmentally friendly - it produces no noise or fumes. It provides door-to-door transport. It is cheap and can be used to access public transport (Cahill 2010, p63). Its role has now in many official circles come to be taken much more seriously with the increased importance of links between transport policy and issues such as sustainable development, climate change, health, air quality and social exclusion. This new wider appreciation of the importance of cycling adds new emphasis to the bike's basic importance as an affordable means of transport particularly suitable for short trips. It is also seen that it can contribute much to the enjoyment of travel and to the mental as well as physical health of riders (Hillman et al. 1992). Regular cycling can help protect against the risk of coronary heart disease, strokes and late onset diabetes in adults. It also has a role to play in building and maintaining healthy bones, muscles and joints (Cavill & Davis 2007).

When so many current transport trends are so clearly unsustainable, for example in terms of demands on fossil fuels and other non-renewable resources, cycling, stands out as having many positive sustainability attributes. The wide range of sustainability benefits to which cycling can contribute have been particularly stressed by Levett (1996). These include: (1) reducing resource depletion and pollution through a modal shift from cars to bikes without offsetting increases in traffic; (2) local environmental quality, through safe streets, new public spaces and urban vitality; (3) pleasure in both utility and recreational travel; (4) fairness in access to amenities; (5) job creation, in route construction and maintenance and tourism.

## 2.2.2 The promotion of cycling

Since various benefits of cycling are obvious and valued by public, how to bring bicycles to citizens' daily life and gradually substitute the motor vehicles becomes an issue for cities. To efficiently promote the cycling, firstly, we need to know what are the factors that impact people's choice of cycling.

There are many variables that influence bicycle use. Heinen et al. (2010) investigate the determinants for commuting to work by bicycles. They divide the determinants to four big categories: (1) built environment (urban form, infrastructure and facilities at work); (2) natural environment (hilliness and landscape, the seasons and climate, weather); (3) socio-economic factors (gender, age, income, vehicle ownership, employment situation, household structure and others); (4) the psychological factors (the attitudes and social norms, perceived behavioral control, habits, reasons for (not) cycling).

Apart from the preconditions like the climate, landscape and other force majeure, there are 3 main aspects that influence the cycling level of a city: hardware, software, and system. First of all, to increase the bicycle use, the first step is to enhance the hardware, namely the infrastructures and facilities. Hull and O'Holleran (2014) try to posit the question that good design of bicycle infrastructure in a city will encourage more people to cycle. They highlight eight categories for a properly designed cycle network and capture the rider's overall experience of the ride-along and their perception of how well the routes (see Table 3).

Table 3 Cycle categories used to evaluate the cycle-ways (Hull & O'Holleran 2014)

	<b>Category</b>	<b>Definition</b>
<b>1</b>	Coherence	Continuity, logically connected destinations Directness
<b>2</b>	Directness	Infrastructure provides cyclists with shortest fastest routes while taking into account all costs of travel time
<b>3</b>	Attractiveness	The cycle infrastructure is designed, furnished and illuminated with personal safety in mind to make cycling socially safe and attractive
<b>4</b>	Traffic Safety	Infrastructure design ensures the traffic safety of all users
<b>5</b>	Comfort	The cycle infrastructure allows cycle traffic to circulate smoothly e.g. flat, smooth pavement, minimum of inclines
<b>6</b>	Spatial Integration	Cycle Infrastructure integration into spatial context (city centre, suburbs, historic areas, modern development)
<b>7</b>	Experience	Enjoyable? Stressful?
<b>8</b>	Social economic value	Routes take into account user facilities and developments (commercial, residential and industrial)

It is not enough to rely solely on hardware to attract people cycling. Software, namely the bicycle culture, people's attitudes towards cycling and behavior control, is also important on creating a cycling atmosphere (Larsen 2017). It is not enough to rely solely on hardware to attract people cycling. Software, namely the bicycle culture, people's attitudes towards cycling and behavior control, is also important to creating a cycling atmosphere (Larsen 2017). How to change people's behavior and make people feel convenient, safe and comfort to bike is not only depended on the bike infrastructures, but also impacted by the perception of acceptability (Piatkowski & Marshall 2015).

Thirdly, as developing a bikeable city (a city suitable or safe for cyclists) is a long-term steady political commitment, the system, namely the planning, regulation and investment could provide a solid ground for development (Koglin, 2015). Planners and policymakers could increase bicycling mode share via the strategic infrastructure development, meanwhile put bicycle in priority. Framing the 'bicycle' as a constructive solution to rising petrol prices, peak oil and traffic congestion, coupled with actual cycling infrastructure to make urban transport cycling easier, could be an important strategy for urban and transport planners in the forthcoming decades (Daley & Rissel 2011).

Today, the interest in cycling is increasing worldwide and in many countries' authorities are faced with the question how cycling can be promoted efficiently. However without a long-term vision and consistent strategy, it is difficult to see how a significant change may be achieved. Pucher and Buehler (2009) analyze the key to achieving high levels of cycling in the Netherlands, Denmark and Germany, three of the best countries in encouraging and promoting cycling. It appears to be the provision of separate cycling facilities along heavily travelled roads and at intersections, combined with traffic calming of most residential neighborhoods. Extensive cycling rights of way are complemented by ample bike parking, full integration with public transport, comprehensive traffic education and training of both cyclists and motorists, and a wide range of promotional events intended to generate enthusiasm and wide public support for cycling. In addition to their many pro-bike policies and programs, these three countries make driving expensive as well as inconvenient in central cities through a host of taxes and restrictions on car ownership, use and parking. Moreover, strict land-use policies foster compact, mixed-use developments that generate shorter and thus more bikeable trips. It is the coordinated implementation of this multifaceted, mutually reinforcing set of policies that best explains the success of these three countries in promoting cycling. In summary, evidence from these three countries indicates three crucial elements interact, in a powerful way, to foster cycling as a healthy, clean, efficient transport mode. These are urban design, as it favours or limits cycling trips by diverse users; urban rules and policies, ranging from responsibility in the event of accidents through traffic calming and requirements for short-and long-term cycle parking; and accepted norms of

behavior, including the social infrastructure and social capital that support cycling culture (Savan et al. 2017).

### **2.2.3 Bicycle development in China**

The bicycle has developed in China since the 1900s and has been a mainstay in the nation's transportation system since the late-1970s due to relatively low incomes, compact urban construction, and short trip distances. After the mid-1990s, however, bicycle use steadily decreased as a result of economic growth, increased urbanization, expanded city areas, and a gradually deteriorating cycling environment. This decline was also accelerated by governmental policies, which have focused primarily on motor vehicle use and resulted in a negative attitude toward bicycling. However, since dramatic motor vehicle growth has resulted in increased energy consumption, traffic congestion, traffic accidents, and environmental concerns in Chinese cities, doubts and criticisms against motorized transport have arisen (Zhang et al. 2014). In the past few years, the Chinese government has realized that excessive dependence on the car lead to the serious environmental and resource constraints; hence it put forward the new urban development mode of "a resource-conserving and environment-friendly society", and had a major shift in fossil fuels to renewable energy (Pan, 2011). However, at present, the central government has not yet announced an explicit plan for bicycle transport, and local government bicycling policies vary from city to city.

Increasing scholars has focus more on the empirical practice of bicycle development in different Chinese cities. Zhu et al. (2017) take Shanghai as a case to understand Chinese cycle users' current preferences regarding environmental factors and their implications for the evaluation and planning of the local bikeway network. The analysis of the measures for improving the bikeway network according to different levels of priority suggests that guaranteeing cycle users' road rights is the central issue for promoting bicycle travel in the city of Shanghai (Zhu et al. 2017). On the other hand, Zhao (2014) examine that, in Beijing, bicycle commuting is significantly associated with some features of the built environment when many demographic and socioeconomic factors are taken into account. Higher destination accessibility, a higher number of exclusive bicycle lanes, a mixed environment and greater connectivity between local streets tend to increase the use of the bicycle. These effects differ across gender, age and income groups. The results imply that the drastic changes in the built environment are a major reason for the demise of 'the kingdom of bicycles' in China.

Sun and Zacharias (2017) explore the potential of using bicycle to relieve overcrowded metro for short-distance travel in Beijing. They demonstrated the willingness of a proportion of transit riders to

use the bicycle for short duration trips even under current road condition which are the major reason for ceasing to bicycle in the first place. The highest potential for bicycle replacement was for travel distance equivalent to two stations, approximately 1.5km–2 km, with 13% of current metro riders and 10% of bus riders willing to switch. Several perceptual aspects of the bicycle and bicycling environments were revealed that influence intentions to shift to bicycling, including desires for a separated cycle lane, worries about exposure to air pollution and better travel time control. Zhao and Li (2017) also find that travel distance is the most important influence on rates of cycling for transfer trips between metro stations and home or workplace. There are also socioeconomic influences, with young people being less likely to cycle and more likely to use buses. Middle- and high-income earners were more likely to drive than cycle, while low-income earners were more likely to take the bus. Personal attitudes are also influential - those who prefer cheap travel were more likely to cycle.

Just like in other countries, the promotion of the bicycle in China for short trips involves improving the quality of the cycling experience, building dedicated facilities for cyclists, enhancing safety at intersection crossings, and conducting spatial planning that takes into account the overall patterns of short trips in the city. In the rush to meet the growing mobility needs of a large and expanding city, the street will require thorough redesign and macro-level planning of the mass transit system also needs to be emphasized (Sun & Zacharias 2017).

#### **2.2.4 Development of public bike sharing program**

Growing concerns over global motorization and climate change have led to increasing interest in sustainable transportation alternatives, such as bike sharing (the shared use of a bicycle fleet). While cycling growth and trends vary worldwide, Public Bike Sharing Program (PBSP) offers a transportation alternative to increase bicycle use by integrating cycling into the transportation system and making it more convenient and attractive to users. The principle of PBSP is - individuals use bicycles on an “as-needed” basis without the costs and responsibilities of bike ownership. As a short-term bicycle access, PBSP provides its users with an environmentally friendly form of public transportation. This flexible scheme targets daily mobility and allows users to access public bicycles at unattended bike stations (Shaheen et al. 2010).

Bike sharing’s evolution is categorized into four generations by Shaheen et al.(2010): (1) White Bikes (or Free Bike Systems); (2) Coin-Deposit Systems; (3) IT-Based Systems; (4) Demand-Responsive, Multi-Modal Systems. It has been around 50 years since the first unsuccessful PBSP called “White Bikes” was implemented in Amsterdam. This ‘free’ scheme was to suffer theft and vandalism that led

to its subsequent failure shortly after opening (DeMaio 2009). The PBSP concept then lay dormant until the 1990s when the idea was revitalized in Copenhagen with the “Bycyken” system, the first coin-deposit system. Building upon this innovation, third-generation programs gained worldwide popularity by incorporating advanced technologies for bicycle reservations, pick-up, drop-off, and information tracking with the effect of suppressing the previously experienced issues of loss and damage (Shaheen et al., 2010). The fourth generation of PBSPs that promise to include features such as solar powered docking stations, real-time availability information and the capacity to make a bicycle reservation via mobile phone apps, electric bicycles, and Global Positioning Systems (GPS) to locate any bicycle within the scheme. Until 2012, there has been extensive to cover 100 cities around the globe and in excess of 200 schemes (Corcoran & Li 2014).

The success of third-generation programs has made it the most prominent bike sharing model worldwide until the last few years. Figure 3 shows the development of PBSP in 5 continents from 2001 to 2012. Furthermore, third-generation successes have increased the number of bike sharing vendors, providers, service models, and technologies. Bike sharing providers, for instance, range from local governments to transport agencies, advertising companies, for-profit, and non-profit groups; Bike sharing is funded through advertising, self-funding, user fees, municipalities, and public-private partnerships. Table 4 below provides an overview of bike sharing business models (Shaheen et al. 2010).

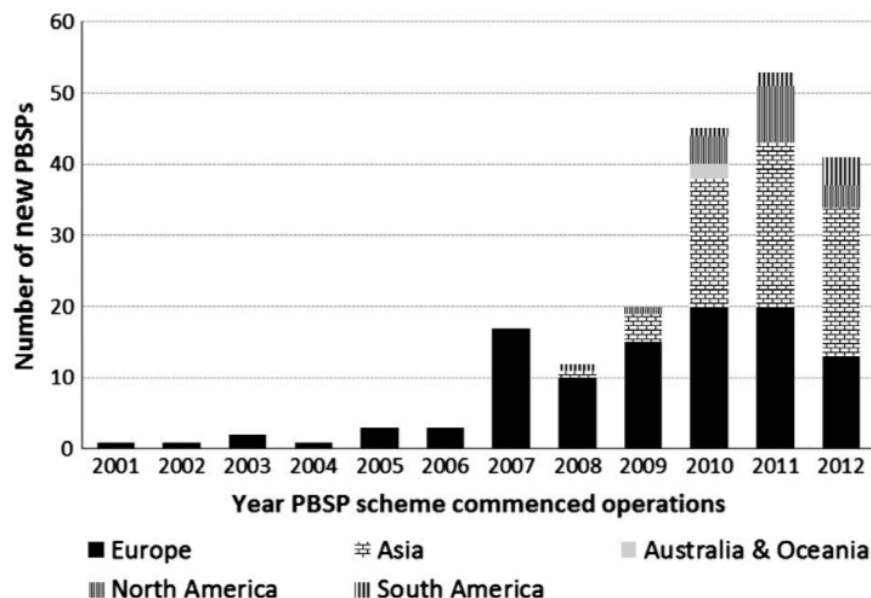


Figure 3 Growth in PBSPs in 5 continents 2001-2012 (Corcoran & Li 2014, p269)



Table 4 PBSP providers and business model (Shaheen et al. 2010, p12)

<b>Provider</b>	<b>Standard Operating Model</b>	<b>Revenue Sources</b>	<b>Program Example</b>
<b>Advertising Company</b>	Provide bikesharing services in exchange for rights to advertise on city street furniture and billboards	<ul style="list-style-type: none"> <li>• Advertising funding from city street furniture, billboards, bikes, and bikesharing stations</li> <li>• Member/non-member usage fee</li> </ul>	<ul style="list-style-type: none"> <li>• SmartBike (U.S.)</li> <li>• Cyclocity (France)</li> </ul>
<b>Public Transport Agencies</b>	Provide bikesharing services under the guidance of a public authority to enhance the public transportation system	<ul style="list-style-type: none"> <li>• Government subsidies</li> <li>• Member/non-member usage fee</li> <li>• Ads on bikes and bikesharing stations</li> </ul>	<ul style="list-style-type: none"> <li>• Hangzhou Public Bicycle (China)</li> <li>• Call a Bike (Germany)</li> </ul>
<b>Local Governments/Public Authority</b>	Directly design and operate a bikesharing program for the well being of cities or a local government purchases bikesharing services that are provided by others	<ul style="list-style-type: none"> <li>• Municipality funding</li> <li>• Member/non-member usage fees</li> <li>• Ads on bikes and bikesharing stations</li> </ul>	<ul style="list-style-type: none"> <li>• City Bikes (Denmark)</li> <li>• OV-fiets (Netherlands)</li> <li>• Nubija (South Korea)</li> <li>• YouBike (Taiwan)</li> <li>• Shanghai Public Bicycle (China)</li> </ul>
<b>For-Profit</b>	Provide profitable bikesharing services with minimal government involvement	<ul style="list-style-type: none"> <li>• Member/ non-member usage fee</li> <li>• Ads on bikes and bikesharing stations</li> </ul>	<ul style="list-style-type: none"> <li>• Next bike (Germany)</li> </ul>
<b>Non-Profit</b>	Provide bikesharing services under the support of public agencies or councils	<ul style="list-style-type: none"> <li>• Public-private partnership funding</li> <li>• Member/non-member usage fees</li> <li>• Bank loans</li> <li>• Local funding</li> </ul>	<ul style="list-style-type: none"> <li>• BIXI (Canada)</li> <li>• Hourbike (UK)</li> <li>• Bicincittà (Italy)</li> <li>• Wuhan Public Bicycle (China)</li> </ul>

The rapid growth in PBSPs has attracted a great deal of attention across the media, policy debates and academic circles concerning their role and future prospects in providing a viable sustainable transportation alternative. Potential bike sharing benefits include: (1) increased mobility options; (2) cost savings from modal shifts; (3) lower implementation and operational costs (e.g., in contrast to shuttle services); (4) reduced traffic congestion; (5) reduced fuel use; (6) increased use of public transit and alternative modes (e.g., rail, buses, taxis, carsharing, ridesharing, etc.); (7) increased health benefits; and (8) greater environmental awareness (Shaheen et al. 2010).

Despite bike sharing's ongoing growth, obstacles and uncertainty remain, including: future demand; safety; sustainability of business models; limited cycling infrastructure; challenges to integrating with public transportation systems; technology costs; and user convenience (e.g., limited height adjustment on bicycles, lack of cargo space, and exposure to weather conditions) (Shaheen et al. 2010). Five key lessons which need to be learned are: (1) bicycle theft and vandalism; (2) bicycle redistribution; (3) information systems; (4) insurance and liability considerations; (5) prelaunch considerations (Shaheen

et al. 2010). The success of the public bicycle systems heavily depends on the network of bike paths and the locations of bike stations where the bikes can be picked up and returned. The optimal design of such a system requires an integrated view of the travel costs of users, the facility costs of bike stations, the setup costs of bicycle lanes, as well as the service level, which is measured by the coverage range of both the origins and destinations and the availability rate of pick-up bike requests at stations (Lin & Yang 2011).

Reviewing the previous literatures about the sustainable transportation/mobility helps the author to clarify what influence a city's sustainable mobility development and how to assess the PBSS's contribution to a city's sustainable mobility development. This offers solid relevance to answer the RQ4. In addition, based on the literatures of bicycles as a sustainable mobility, especially the development of bicycles and public bike sharing program, it is better to understand why the RQ1, namely why DBSS become increasingly popular in China recently. Overall, by digesting the predecessors' study, the RQ5- how could cities coordinate DBSS in a sustainable way could be resolved logically and profoundly.

### 3. Methodology

In this chapter, the methodology is discussed to create a fundamental research process. Basic research strategies such as quantitative and qualitative research, comparative research are discussed firstly. This kind of research design is for a better understanding to address the different research questions. Next, research methods including document analysis, survey, and semi-structured interview will be explored in detail and the justification of the selected methods will be shown. Finally, ethical issues and limitations are also explained in this section.

#### 3.1 Research strategies

##### 3.1.1 Ontological and Epistemological Consideration

Ontology, epistemology, and methodology together constitute a basic belief system or worldview that guides the investigator in a social research (Guba & Lincoln, 1994). Ontology is the science of being. Ontological issues concern the question of “what is, or what we believe to exist”, “what assumptions do we make about how the world works”. Epistemology is the theory of knowledge and knowing. Epistemological issues concern “view of what we can know about the world and how we can know it”, and “what sort of statements will we accept to justify what we believe to exist” (Dieronitou 2014).

They both act as the foundations of the approach to a research question and range from positivist stances (deductive and more scientific views) to interpretivist stances (inductive “deeper truth” reasoning views) (Crotty 1998). Apart from these two main stances, critical realism and pragmatism also took a place in growing number of social science research paradigm (see Table 5). Critical realism considered that reality exists and has been created; critical realism makes core assumptions about the nature of reality and epistemological issues. Pragmatism paradigm tends to be an intervention and the empirical research in a natural context, where researchers and practitioners build a partnership and develop and design principles (Shannon-Baker 2016).

Table 5 Four paradigms in social science research (revised by author refers to Crotty 1998; Shannon-Baker 2016)

Paradigm	Ontology	Epistemology	Question	Method
Positivism	Hidden rules govern teaching and learning process	Focus on reliable and valid tools to undercover rules	What works?	Normally Quantitative

<b>Interpretive/ constructivist</b>	Reality is created by individuals in groups	Discover the underlying meaning of events and activities	Why do you act this way?	Normally Qualitative
<b>Critical</b>	Society is rife with inequalities and injustice	Helping uncover injustice and empowering citizens	How can I change this situation?	Ideological review, civil actions
<b>Pragmatic</b>	Truth is what is useful	The best method is one that solves problem	Will this intervention improve learning?	Mixed methods, design-based

Put this research into the social research paradigms, it sits in the positivism paradigm, with a more realist ontology and an empiricist epistemology, as the approach deals with verifiable observations and measurable relations between those observations. When it comes to this specific project, the ontological questions might be “is sustainable mobility objective and observable?”, and “can the sustainable mobility easily be measured?”; while from the epistemological perspective, the knowledge about sustainable mobility of destination includes “observable and measurable ‘sustainability’ of bike sharing based upon the users’ survey”. On the other hand, the research is also standing in the interpretivism paradigm due to the quantitative open questions in the survey mixed with the semi-interview afterwards. These help to answer the question “why and how the DBSS helps with the city’s sustainable mobility” and “how could city improve their coordination with the DBSS”. The study also fits the philosophical orientation of pragmatism, which associates with the question of “will the DBSS improve a city’s sustainability”.

### 3.1.2 Research Design

#### 3.1.2.1 Quantitative and qualitative research

Research strategies can be basically divided into two parts, quantitative and qualitative (Bryman 2016). Quantitative research is often described as an objective search for singular truths that relies on hypotheses and variables, and is large-scale. On the other hand, qualitative research is said to be a subjective, value-laden, biased, and ad hoc process that accepts multiple realities through the study of a small number of cases (Neuman 2002).

The mixed methods research was defined as “research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study” (Tashakkori & Creswell 2007). It guide investigations and is answered with information that is presented in both narrative and numerical forms (Teddle & Tashakkori 2009).

According to the research aim discussed in Chapter 1, this research will use both ‘quantitative research’ and ‘qualitative research’. Generally speaking, the survey is used to answer the RQ2 and RQ3, because these questions require the quantitative counting and measuring; while, interview and document analysis are used to answer the RQ1, RQ4 and RQ5, since they require qualitative study to discover the deeper truth. Second hand data research is a supplement method in this research when the raw data or resources is not sufficient and inapplicable. The mixed methods viewed each other as a complementary in this study.

Table 6 Research questions and corresponding methods

<b>Methods</b> <b>Research questions</b>	<b>Survey</b>	<b>Semi-struct ured interview</b>	<b>Document analysis</b>	<b>Second hand data research</b>
RQ1: Why has DBSS become increasingly popular in China in recent years?			Qualitative	Qualitative
RQ2: What impact has DBSS had to Beijing residents’ daily life?	Quantitative			Quantitative+ Quantitative
RQ3: What are residents’ perceptions towards the DBSS in Beijing?	Quantitative			
RQ4: To what extent could Beijing’s DBSS contribute to its urban sustainable mobility development?	Quantitative	Qualitative	Qualitative	Qualitative+ Quantitative
RQ5: How could cities coordinate DBSS in a sustainable way?		Qualitative	Qualitative	

### 3.1.2.2 Case study

Case study is a method of intensively studying a phenomenon over time within its natural setting in one or a few sites. Case study can be employed in a positivist manner for the purpose of theory testing or in an interpretive manner for theory building (Kelly 2016). As Gillham (2000, p2) explained, “case study is to answer specific research questions, and seeks a range of different kinds of evidence setting in the case and which has to be abstracted and collated to get the best possible answers to the research questions”. The case study tells the story of the case, provides a sense of present, and offers the thick description for easier and impressive understanding (Mabry 2008, p219).

A case may be selected because its analysis will reveal conclusions that can be taken as representative

of a wider class of cases (May 2011). As Yin (2017, p40) classified in his book, the single-case study is an appropriate design under several circumstances with five rationales- having a critical, unusual, common, revelatory, or longitudinal case. In this research, Beijing is selected as a common but revelatory single case, because the objective is to capture the circumstances and conditions of an everyday situation and the descriptive information of the empirical study will be insightful because there is no previous study of DBSS in Beijing. Meanwhile, the outcome of Beijing would have referential meaning to other cities especially those who want to develop the DBSS in the future.

The identification of the case to be studied is largely depend on the researcher's interest - in this article, Beijing is the suitable and typical case worth studying. Beijing is suffering from the strong air pollution, which is a serious threat against the health of the residents and the environment. Beijing, with its 21.5 million inhabitants, is one of the most crowded cities in the world, and the huge population has exacerbated the problem. To assess the contribution of DBSS to city's sustainability and analyze the potential solutions for cities to cope with the challenges of the new bike boom, a single case study is adopted for both methodological and pragmatic reason. First of all, Beijing was a pioneer in the new bike-sharing approach - by September 2017, there are 15 Shared bike bicycle enterprises, on the operations of 2.35 million shared bikes. In addition, the two biggest operators, Ofo and Mobike, both chose to locate their headquarter in Beijing (Campbell 2018). On the other hand, in September 2017, the Beijing Municipality just announced new regulation to encourage the development of a standardized bicycle sharing system, to implement the holistic governance and control of the DBSS providers, and to keep a dynamic balance on the quantity of shared bicycles that have been put into the market.

## **3.2 Research methods**

In this section, research methods are illustrated in the order of 3.2.1 document analysis, 3.2.2 survey, 3.2.3 semi-structured interview. Specifically, in Section 3.2.2, the survey design, the sampling and distribution method are explained in detail. Each method is introduced first, and then why this method is selected for which research questions is explained. Their strength and weakness are also noted.

### **3.2.1 Document analysis**

Document analysis is used to answer the RQ1, RQ4 and RQ5, namely the WHY, WHAT and HOW questions. The documentary research is employed to better understand the background and provide support. It is a "low-cost" and effective method to obtain reliable information from former studies

(Bryman 2016). In spite of the occurrence of potential bias issues of documents as pointed out by Abraham (1994), documents still have a significant value in qualitative research. However, the representativeness issues need to be considered.

The document sources can vary between public sources and official documents (May 2011). In this study, both official documents and private documents are reviewed. The documentation in this research is from media and news reports relating to the growth, investment and impacts of DBSS in Beijing and China more broadly. For example, Mobike, one of the major company provide DBSS service, together with some academic institutions, has published certain reports which include many useful information and user's travel data. Data about infrastructure could be found from the government's yearbook and official website. The list of relative documents that is used in this research could be found in Annex 1.

### **3.2.2 Survey**

#### **3.2.2.1 Survey design**

The survey is used to answer the RQ2, RQ3 and RQ4 by collecting the users' respondents of quantitative questions. The survey is one of the most common research methods to collect data. It can be divided into several types according to the conductive methods such as face to face, postal and telephone (Bryman 2016). There are many advantage of survey, for example, compared with a focus group, using questionnaires is more convenient, easy to organise and costs less. A large volume of data can be collected within a short time (May 2011). Survey has strong external validity, is able to capture and control for a large number of variables, and is able to study a topic from multiple perspectives or using multiple theories. However, there are issues regarding the internal validity of the selected design. Survey may be subject to respondent biases. As the respondent may provide a "socially desirable" response rather than their true thoughts further reducing internal validity (McLafferty 2010).

The survey in this study has four parts, and the full Internet survey used to gather data for this thesis is presented in Annex 2. Firstly, The classification questions, namely the "personal" section of the questionnaire. Demographic information such as age, gender, income, education and occupation is collected in the beginning of the survey. Secondly, the survey asks respondents lifestyle and travel characteristics, for example the commuting time and distance, the transportation they choose for commuting, chores and entertainment. In this part, people need to answer the transportation mode



they normally choose before the DBSS appeared and after to evaluate the behaviour change. Thirdly, the data of bike usage characteristics are collected, including the trip purpose, frequency, length and other related figures when people use the DBSS. Finally, the attitude scale form helps to assess the opinion and perception of users towards DBSS. There are also several open questions in the last part to give respondents greater freedom to answer in a way that suits their interpretation.

### **3.2.2.2 Sampling method**

Sampling is the process of choosing in a systematic fashion a sub-set of cases from which data will be collected from the pool of all those potentially relevant to the research being conducted (Aldridge & Levine 2001, p61). However, the unit of study will not be all individuals, but individuals of specific interest. The purpose of sampling is to make observations and statistical inferences about such individuals (Bhattacharjee 2012). In order to gain an accurate picture of the theoretical population an appropriate sampling method needs identifying. The probability samples are possible to express the mathematic probability of sample characteristics being reproduced in the population of interest has an equal chance of being part of the sample. It requires the existence of some sort of sampling frame and importantly the concrete overall size must be known (May 2011). However, this is not the case in this research, because no sampling frame is available.

This thesis uses a non-probability sample, because the statistical accuracy may be less of a concern than being “fit for purpose”. Purposive sampling occurs where a selection is made according to a known characteristic, in this case - the Beijing citizens who regularly use the DBSS. Whilst the population in Beijing and the DBSS users are widely distributed, snowball sampling and convenience sampling are also helpful when obtaining substantial survey data.

As for the sample size, there are many factors that should be considered and the goal for most researchers is to gather enough data to undertake meaningful analyses (May 2011). In order to be able to measure differences or variability in the sample and to use these findings as estimates of the population, 260 samples who frequently use the DBSS are selected in this research. The overall background range of samples is comprehensive and balanced, however the number is relatively small compares to the residents in Beijing, which might cause some bias of the research outcome.

### **3.2.2.3 Distribution method**

The Internet is increasingly seen as offering many advantages over more traditional methods of research, and as such may be expected to become a more prominent feature of empirical reports as

time progresses. Bryman (2016) states that as the most common way, conducting survey through the Internet has high-efficiency and reduces cost than other methods. The online survey software operators such as SurveyMonkey, Google Form and Wenjuanxing have the ability to provide a high level of anonymity which increases self-esteem whilst reducing social anxiety and social desirability (Joinson 1999; Fox et al. 2003;).

This thesis also used an online survey to collect data on DBSS users. The survey form is designed by author and uploaded in to the platform of Wenjuanxing (<https://www.wjx.cn>). Wenjuanxing is the most popular online survey tool in China. Just like the SurveyMonkey, Wenjuanxing provides free, customizable surveys, as well as a suite of paid back-end programs that include data analysis, sample selection, bias elimination, and data representation tools. Wenjuanxing is in Chinese language and suitable for the research conducted in Beijing, because respondents could fill the online form easily and quickly. The survey will be distributed by social media, for example the Wechat, a Chinese multi-purpose messaging and social media app, which is one of the world's largest standalone mobile apps by monthly active users, with over 1 billion monthly active users (Wechat, 2018). The advent of social media networks has greatly contributed to these changes and has become the place where people on the Internet are. In light of this new social movement, Kayam and Hirsch (2011) propose that social media networks can and should be viewed as the potential way of reaching participants in social studies research.

There is a pilot survey phase before the formal distribution. Once the survey design was completed and prior to distribution to the sampling frame, a pilot study was undertaken on 15 people. The pilot survey enables the researcher to check the wording of the questions, the responses and the layout. From the feedback the researcher is able to alter the questionnaire to remove any found issues (McLafferty 2010). From this the pilot questionnaire suggested alterations were implemented and identified flaws were eliminated. Thus, the questionnaire was ready to be sent to the sample.

The time-span of respondent recruitment is 2 weeks. In this study, once the recruitment postings had been made, the survey administration and recording of responses was self-running. The survey is posted in the social media groups, and public pages, thus people who are eligible and interested in the topic could fill the form whenever they are convenient. However, since the sample size is relatively small and the time-span is relatively short, the outcome may have some negative bias.

### **3.2.3 Semi-structured interview**

To address the RQ4 and RQ5, namely the assessment and recommendation part of this research,

semi-structured interview is selected. Miles and Gilbert (2005) state that the purpose of semi-structured interviews is to gain the information which is needed through talking to people about what they think about and they have experienced. Semi-structured usually have schedules in advance and a series of predetermined opening questions (DiCicco & Crabtree, 2006). The interviewer also has “latitude” to enquire further questions (Bryman, 2016); Meanwhile, interviewees are encouraged to answer more freely in the semi-structured interview. In addition, there are still clear themes and questions in the interview, while the respondents have the opportunity to provide more information from their own perspective (Bryman 2016).

In the beginning, to have a comprehensive view from all stakeholders, the author plans to invite six experts, two of which are urban planners, two of which are from DBSS companies, and two of which are government officers from related departments or NGO groups. Because the purpose of this research is to propose suggestions for cities to cooperate the DBSS with companies and communities, and a research question is to explore the different viewpoint from the governmental officials, experts, DBSS companies and NGO groups about the current situation. However, after many times of tough try, all the DBSS companies have refused to participate the interview because of the confidential problem and public relation regulation; Moreover, it is unable to get contacted with the officers from city level’s departments due to the bureaucratic procedures. At last, to ensure the authenticity and availability of the information, two planners (experts in transportation), one local community worker from subdistrict office and one Mobike Hunter from the - Mobike Hunter’s Volunteer Network agreed to participated the semi-structured interview. The participants were asked about the problems they faced with cycling and development of the dockless bike sharing system in the city. Planners and community worker’s interview are about their insights on the DBSS and its impact towards the city’s sustainable development and the potential approach for cities to cooperate with this new trend. The interview of Mobike Hunter is related to the research potential ways to solve the problems that DBSS has brought. The full interviewees list and script can be found in Annex 3.

### **3.2.4 Data collection**

In this study, the data is generally from three main sources: documentation, survey, and interview. To achieve the five research questions, different methods are used to collect the targeted data. The conceptual framework of the survey is investigated from three aspects (Figure 4). The data about the residents’ characteristics is collected by the survey, and triangulated by the documents of the companies’ report. The data of shared bikes’ characteristics is partly from the survey and partly from the semi-structured interview. The questions about the accessibility, cost, usage, satisfaction and other

subjective terms are asked in the survey, while information about the maintenance and disposal procedures are mainly from media and news reports. Thirdly, the data of neighborhoods' characteristics is relatively complicated to collect. The information about traffic infrastructures and traffic mode is from the documentation, people's perception of the neighborhood is from survey, and the policies and institutional perspective is from the interview.

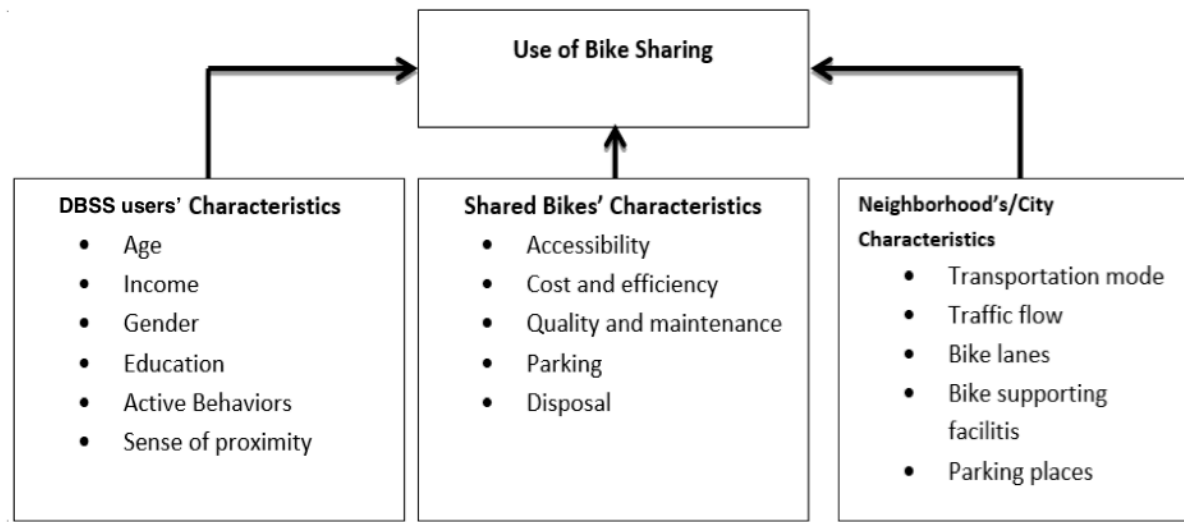


Figure 4 The research conceptual model and the related indicators

### 3.2.5 Data analysis

The main goals in survey analysis are the creation of illuminating accounts, persuasive narratives and plausible explanations, grounded in the survey findings, concerning the social structures, groups, grounded in the survey findings (Aldridge & Levine 2001, p136). However, there is a strong possibility that the researchers have their own understanding, conviction, and theoretical orientations, thus they are undeniably influenced by what they have observed. According to Miles and Huberman (1994), the analysis is defined as three coincident events: data reduction, display, and conclusion. Analysis of survey data tends to be through the use of a computer utilizing a number of statistical analysis software packages. In this case, SPSS is used for descriptive, analytical and contextual analysis.

In terms of qualitative methods, Morse and Field (1995) states there are four cognitive processes: comprehension, synthesis, theorization, and re-contextualization. Thus the qualitative approach is often employed in researching detailed information, for instance, the results of semi-structured interviews in the case study. Thematic analysis, defined as “a distinctive cluster of techniques” (Bryman 2016), was employed in this study for data analysis. The in-depth interviews were digitally

recorded (in Chinese) and fully transcribed. Afterward, the analysis of the transcripts involved three stages: familiarization, thematic analysis, and interpretations.

There is a distinct tradition in the literature on social science research methods that advocates the use of multiple methods, which is also called "triangulation". Triangulation is the combination of methodologies in the study of the same phenomenon to improve the accuracy of the judgments by collecting different kinds of data (Jick 1979). The analysis in this thesis is based on the primary data gathered from survey, interview and secondary data from other documentation. All the data enrolled the triangulation to verify the validity and reliability.

### **3.3 Ethical considerations**

According to Bulmer and Solomos (2001), ethical issues can be defined as “The principled sensitivity to the rights of others”. It reveals the responsibility of research beyond the academic concern. On the one hand ethical activities have the ability to avoid potential harm to the individual and communities (Israel and Hay 2006). On the other hand, they represent the experience of the researcher to minimise the problems.

The topic of this thesis related to people’s behaviour and attitudes, which did not involve any illegal behaviour. Ethical issues are carefully considered in this thesis. As regards the recruitment procedures, the target group in this project did not include any vulnerable groups. The project was spread by the social media and conducted online. Meanwhile, all the interviewees who participated in the survey were asked for permission to conduct the interview and questionnaires. Besides this, all respondents were informed that they can withdraw from the study at any time and that the survey is entirely anonymous. The participation is voluntary and the data will only be used in this thesis. No observation was conducted. There was no potential risk for any respondent, neither physical nor psychological. An ethical approval form for this thesis was completed before conducting the survey. The author is responsible for the integrity of the research process. This thesis fully followed the Research Integrity and Governance Code of Practice according to the relevant University/ School Research Ethics Committee.

### **3.4 Research limitations**

In this research, the main limitation is the sampling method. Compared to the inhabitants and DBSS users in Beijing, the sample size in this research is relatively small (n=260) due to the time and

financial restrictions. It has negative impacts on the statistical analysis procedures possible with the data. Furthermore, as the survey is spread through the social media, though the respondents are random, it has high possibility to be a cluster of similar age people or with the similar background. Besides, the interviews failed to include the members from companies and city level's officer in the research, which means it missing the first-hand data from the market and government's perspective. Considering the limitation of both interviews and survey, the respondents tend to give the answer that the researcher wants. In other words, the gap between the survey result and the actual behaviour needs to be considered. Moreover, the outcome of the research might only reflect the situation in the selected case. To increase the validity and reliability of convenience samples, the feasibility studies and pilot research are taken in advance. Triangulation also helped to control the validity (both internal and external) and reliability of research, since the findings from the questionnaire will be verified by interview and documentary research.

## **4. Results and findings**

This chapter presents the result from the selected data collection method. The findings and analysis are explored in a logical sequence based on the research questions. Firstly, the background of the DBSS's growing popularity in Chinese cities (RQ1) is introduced in Section 4.1. Secondly, by presenting the respondents' social demographic characteristics, travel characteristics and shared bikes' characteristics generated from the survey, Section 4.2 illustrates how DBSS has influenced the citizens' life (RQ2). Thirdly, by analyzing the respondents' attitude towards shared bikes, Section 4.3 talks about the residents' perceptions towards the DBSS in Beijing (RQ3). Afterwards, Section 4.4 tries to assess the contribution of Beijing's DBSS to the urban sustainable mobility development (RQ4) using the data from interview and second-hand documents. Finally, the recommendations for cities to coordinate DBSS in a sustainable way (RQ5) are elaborated in Section 4.5.

### **4.1 Why has DBSS become increasingly popular in China in recent years?**

#### **4.1.1 The development of public bike sharing program in China**

Many cities in China have implemented public bicycle sharing programs (PBSP) as a strategy to promote low-carbon transportation policy. The first PBSP in China was launched for profit in Beijing in 2005 by a private bicycle enterprise - The Fangzhou Bicycle (Beijing) Co., Ltd. While this program developed very slowly, it did not gain much attention and has ended in 2011 because of the Fangzhou Bicycle (Beijing) Co., Ltd's Bankruptcy. PBSP in Hangzhou, which launched in May 2008, is notably larger (2674 stations and 65,000 bikes at the end of February 2012) and has led to a surge of bikesharing activity in the nation. As of February 2012, there were 151 public bikesharing programs operating around the world, with over 245,116 shared bicycles and 13,748 stations (Zhang et al. 2014). Chinese municipal governments have heavily subsidized the development of PBSP to encourage non-motorized transport and offer a flexible, convenient, and low-cost mobility options to the people.

As a subsidized public service, PBSP in China has been constructed and operated either under a government-run (GR) model and public-private partnership (PPP) model. The main difference among the existing PBSP in China is related to their operational and business model (Table 7). Lohry and Yiu (2014) discovered that GR systems have been more effective than PPP systems in achieving



higher bike utilization, ridership, and population served. Because the financial incentive structure under the PPP model often leads to results that have conflicts of interest between private companies and the government. GR systems, on the contrary, are under official transport agencies that are accountable to following the government's desire to make PBSP function as a viable transport option instead of a profit-making business.

Table 7 PBSP and business models in China (Zhang et al. 2014, p330)

Business model	Revenue sources	Deposits and usage fees	City	Date started	Stations	Bicycles
Hangzhou model	<ul style="list-style-type: none"> <li>Non-profit;</li> <li>Public transit agency establishes a state-owned company to manage bikesharing services;</li> <li>Government provides land for stations and integrates bikesharing with public transport;</li> <li>Government provides supportive policies;</li> <li>The company receives revenue from advertisements from bikes and billboard at stations.</li> </ul>	Governmental subsidies; advertisements on bikes and billboards at stations; member/non-member user fees.	Hangzhou	May 2008	2,674	65,000
			Jiangyin	September 2008	30	900
			Zhoushan	October 2009	12	500
			Tongliang	October 2009	20	500
			Zhuzhou	June 2011	500	10,000
Wuhan model	<ul style="list-style-type: none"> <li>Non-profit;</li> <li>Private enterprise provides services under government guidance;</li> <li>Government provides land for stations;</li> <li>Government provides supportive policies;</li> <li>Enterprise takes full responsibility for profits and losses;</li> <li>Enterprise receives revenue of advertisements on bikes and billboards at stations.</li> </ul>	Bank loans; advertisements on bikes and billboards at stations; member/non-member usage fees.	Yantai	July 2010	60	2000
			Guangzhou	August 2009	113	5,000
			Wuhan	April 2009	1,218	70,000
Shanghai model	<ul style="list-style-type: none"> <li>Non-profit;</li> <li>Enterprise provides bikesharing services;</li> <li>Government purchases services for public;</li> <li>Government and enterprise share the revenue of advertisements from bikes and billboards at stations.</li> </ul>	Municipality funding; advertisements on bikes and stations.	Nanchang	August 2009	80	6,000
			Chizhou	October 2009	50	1,500
Shanghai model	<ul style="list-style-type: none"> <li>Non-profit;</li> <li>Enterprise provides bikesharing services;</li> <li>Government purchases services for public;</li> <li>Government and enterprise share the revenue of advertisements from bikes and billboards at stations.</li> </ul>	Municipality funding; advertisements on bikes and stations.	Shanghai	September 2008	574	19,100
			Shanghai	September 2008	574	19,100

#### 4.1.2 The rise of dockless bike sharing scheme in China

Since the second half of 2016, the dockless bike sharing system (DBSS), a new initiative of sharing economy, have blossomed in major cities and become a hit in China. Until the mid-2017, the total amount of venture capital for the bicycle industry in China has reached \$2 billion, and more than 40 bike-sharing companies have been established which makes the market tempting but fierce. Mobike and Ofo - two of the biggest players in the market - recently raised a combined \$1.3 billion in new funding (Lipton 2017).

Specifically, DBSS start-ups in China are enjoying surging growth with a simple concept: users download an app on their smartphones, which allows them to locate and unlock a nearby bike. When the trip is completed, riders are encouraged to park at any public bike rack or public location that does not interfere with pedestrians or traffic. It's a very different model than traditional public bike

programs, where users must pick up and drop off bikes at fixed, designated docks (Figure 5). Moreover, these sharing bikes are very cheap, with providers charging as little as 15 cents USD for every 30 minutes. Once you deposit a first sum of money (normally around 15-40\$, and it's refundable) into your account in the app, you can pay directly from the app with your smartphone once you finish every ride (Lipton 2017).

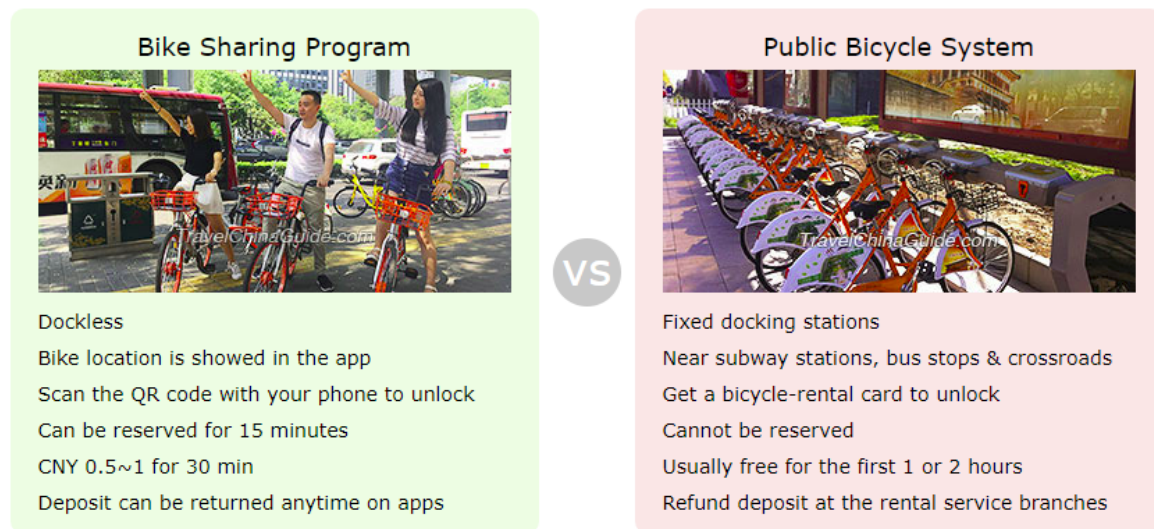


Figure 5 The comparison between the new bike sharing system and traditional public bicycle system (Source: <https://www.travelchinaguide.com/lifestyle/>)

### 4.1.3 The reasons of the popularity of DBSS

There are many reasons for the success of DBSS. Firstly, shared bikes mobilize the urban bicycle inventory market through the sharing economy's internet innovation model. Before the emergence of DBSS, there are few bicycle-related products, but most bicycle rental industries are only for entertainment and fitness. There is no commercial operation model with “shared economy” as the core. Learnt from the and Didi, a large number of investors have begun to shift their sights to the shared economy. The industry's operating model is becoming clearer for sharing bicycles.

The popularity of mobile payment also accelerate the popularity of DBSS. In the past two years, the "payment war" has been extremely fierce, and payment platforms like Wechat and Alipay have risen to snatch up the market. In order to compete for users, payment platforms must rely on strong and convenient payment scenarios. DBSS is a perfect new area with high frequency of use, low user decision-making, and good user habits, and it is an appetite for payment platforms. As a result, the major payment platforms have worked together to advertise for shared bicycles to increase exposure and facilitate the use of DBSS in all aspects and clear (Campbell 2018).

Thirdly, as the environment became China's biggest cause of social unrest, the government has changed track and began promoting more sustainable policies, as well as a more high tech economy. In this context, a home-grown technology based approach to greening China's cities became a no brainer - particularly given dockless bicycle companies did not charge city governments for the service, as there is no infrastructure to install (Lyon 2018).

Apart from the above reasons, the growing demand of the short trip provided by bicycles is also a vital factor. China is known as the bicycle kingdom and almost everyone in the country rides bicycles. It has the world's largest bicycle production market and consumer market (Zhang et al. 2014). This brings about the good consumer effect to the public acceptance of bicycles. More importantly, the "last mile" of transportation has always been a urban problem. Obviously buses and taxi trips cannot meet this demand. A large number of office workers urgently need an affordable and convenient means of transportation. This laid both the consumers and providers foundation for the emergence of DBSS.

## **4.2 What impact has DBSS had to Beijing and residents' daily life?**

This research got 260 respondents in two weeks through the online survey platform, Wenjuanxing, in line with the sampling method described in Section 3.2.2.2. The whole distribution and survey procedure is based on Internet and social media, so only people who were interested and invited joint the research. To describe the impact that DBSS has brought, this section will introduce the finding from the survey, which includes the DBSS users' characteristics, behavior, and behavior change.

### **4.2.1 Users' characteristics**

A total number of 260 survey respondents have been collected and the detail of users' social demographics is shown in Table 8. Women and men are equally represented 52% of the participants are young (18-30), 48% are middle-aged (30-60) and very few senior participants (60+). The result implied that the DBSS users are popular in all age groups, particularly the active younger groups. Meanwhile, majority of respondent had academic education (75% bachelor's degree or above). Refer to the average monthly income in Beijing, which is 7706RMB based on Beijing Municipal Human Resources and Social Security Bureau, the participants were among various income levels apart from the no income group (15%); 44% lower than the average wages, and 41% higher than the Beijing

average monthly income. As for the occupation, most of them are students, staff in public institutions or enterprises and professional workers who don't need too much manual labour. As for the participants' commuting figures, it can be find that half of the participants commute under 40 minutes per day, and 58% less than 10 kilometers (Figure 6).

Table 8 Social demographics of participants (n=260)

<b>Social Demographics</b>	<b>Categories</b>	<b>Count</b>	<b>Percentage</b>
<b>Gender</b>	Female	147	57%
	Male	113	43%
<b>Age</b>	Under 20	6	2%
	21-25	73	28%
	26-30	58	22%
	31-35	18	7%
	36-40	25	10%
	41-45	21	8%
	46-50	26	10%
	51-55	26	10%
	Above 56	6	2%
<b>Highest education degree</b>	High school degree or under	12	5%
	Associate college degree	25	10%
	Bachelor degree	122	47%
	Master degree or above	101	39%
<b>Monthly income (RMB)</b>	No income	39	15%
	Below 2500	12	4%
	2500-5000	43	17%
	5000-7500	59	23%
	7500-10000	50	19%
	10000-15000	29	11%
	Above 15000	28	11%
<b>Occupation</b>	Student	53	20%
	Staff in public institution	38	15%
	Staff in enterprise or corporate	104	40%
	Professional worker	31	12%
	Service personnel	5	2%

Freelancer	17	7%
Retired	9	3%
Other	3	1%

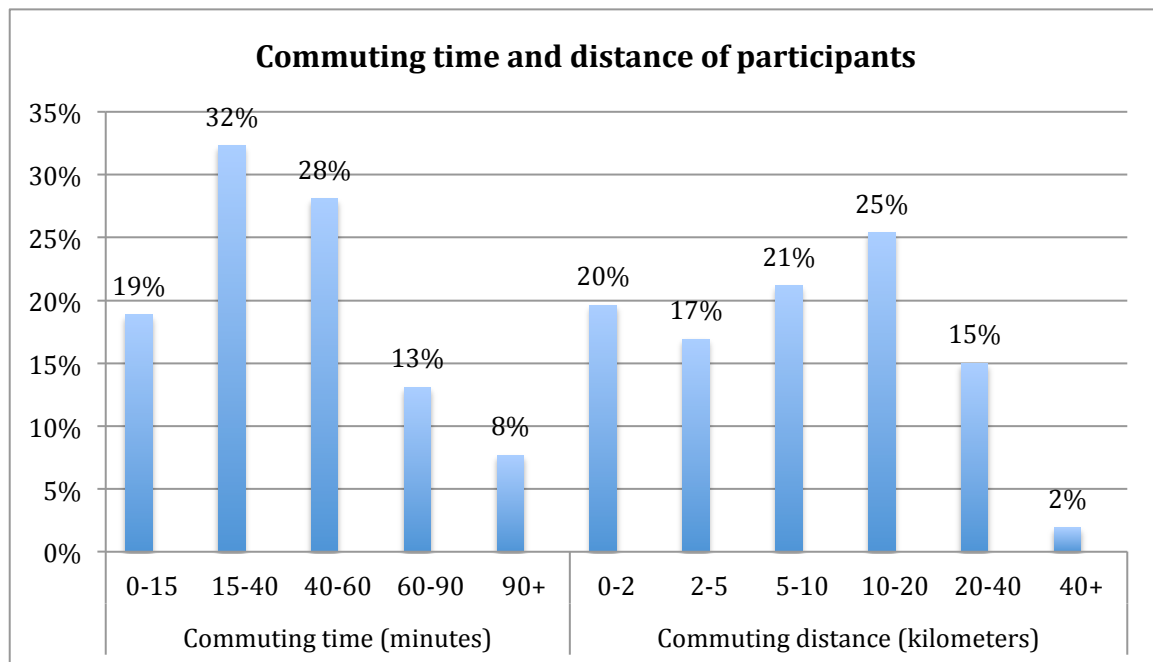


Figure 6 Commuting time and distance of participants

#### 4.2.2 Users' behavior and behavior change

##### ● How people use the DBSS?

The survey shows that 38% users are frequent users of DBSS, and only 14% participants never use the DBSS. People choose DBSS most because its convenient and time-saving characteristics. For these non-users, however, their reasons to refuse the DBSS are most about their daily need, deposit money and private information.

The travel characteristics for those DBSS users are shown in the Table 9 below. In most circumstance, the shared bikes are used for short time and distance interval. 60% of respondents finish their trip in less than 10 minutes and 91% by 20 minutes. Two third of users use DBBS for 1-3 km distances. It means that majority of the users use DBSS for their last mile travel. Most common cycling time is 7-9am and 5-7pm for commuting which equals the rush hour in Beijing. Two third of trips are for commuting and one third is for leisure and everyday chores. It is also revealed that hybrid transportation modes were popular. Nearly half of the users always transfer other public transportation like metro (89%) and bus (54%).

Table 9 Travel characteristics of DBSS users (n=260) (\*=multiple choice)

Travel characteristics of DBSS users	Categories	Count	Percentage
<b>Frequency of using DBSS</b>	Everyday	37	14%
	Several times per week	62	24%
	Several times per months	80	31%
	Very few	45	17%
	Never	36	14%
<b>Reasons for not using the DBSS*</b>	Don't want to provide the private information	11	31%
	Don't want to pay the deposit	13	36%
	The App operation is too troublesome	7	19%
	Procedures (registration, certification, payment) are too complicated	9	25%
	Can't ride bike	9	25%
	Shared bikes are not good to ride	3	8%
	Can't find the shared bikes	2	6%
	Don't have this need	17	47%
	Other	3	8%
<b>Reasons for using the DBSS*</b>	Cheap	90	40%
	Time-saving	144	64%
	Convenient	211	94%
	Healthy	77	34%
	Environmental-friendly	90	40%
	Other	8	4%
<b>The purpose that you use the DBSS*</b>	Commuting	148	66%
	Leisure	130	58%
	Chores (like shopping)	72	32%
	Exercising	42	19%
	Other	9	4%
<b>Time slot for using DBSS*</b>	Before 7am	12	5%
	7-9am	107	48%
	9-11am	51	23%
	11am-1pm	45	20%

	1-5pm	51	23%
	5-7pm	117	52%
	7-9pm	50	22%
	After 9pm	18	8%
<b>Average time for using DBSS</b>	0-5min	27	12%
	5-10min	110	49%
	10-20min	73	33%
	Longer than 20min	14	6%
<b>Average distance for using DBSS</b>	0-1km	38	17%
	1-3km	150	67%
	3-5km	33	15%
	5km+	3	1%
<b>Do you transfer to other transport when using DBSS</b>	No	31	14%
	Sometimes	84	38%
	Always	109	49%

### ● How DBSS changes people's life?

In the survey, people are asked to choose their transportation mode in the city for different purpose before and after the DBSS appeared. From the Figure 7 below we could find that, the change of car-use and motorbike-use is not significant before and after the DBSS appeared. The usage of bikes as the transportation for commuting purpose is doubled; meanwhile walking and usage of public transport have slightly declined. The transportation mode change of chore purpose trip and entertainment purpose trip are similar as the commute purpose, which has the same soaring on bike uses (more than doubled).

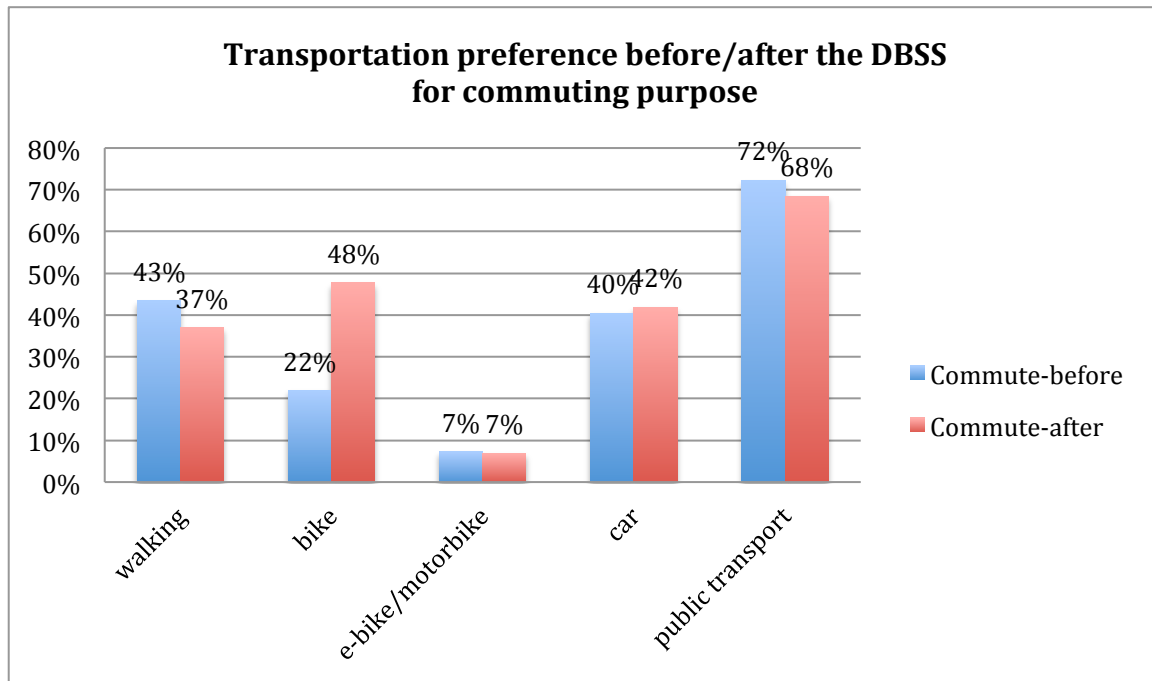


Figure 7 Transportation preference before/after the DBSS for commute purpose

*“The cost of bike sharing is much lower than either buying a bicycle or take the bus or taxi. It is more economical for me to share the bicycle, and at the same time, it is also beneficial to reduce the risk of being stolen.” (Participant A, reflected from the survey)*

However, most users indeed agree that the DBSS has changed their life (66%). Changes are reflected in the following aspects. 44% users agree that the DBSS has extended their travel distance range, and users agree that the DBSS has reduced the time restriction (57%) and save the travel time (76%) for going out. At the same time, 58% think the DBSS has reduce their travel budget.

### 4.3 What are residents’ perceptions towards the DBSS in Beijing?

#### ● Users satisfaction with DBSS in different aspects

Though the general satisfaction is relatively good (Figure 8), the DBSS companies need to pay more attention to the quality of the bikes since 30% users express low or very low satisfaction about it. For the factors that lead to dissatisfaction, 45% users choose the “pedals or the chain does not work properly”, 35% blame on the “unsuitable seat”, 35% reflect “the handle bar or the break doesn’t work properly”. The channels for reporting the errors also need to be improved. Because over 63% respondents always see the broken or wrongly-parked shared bikes on the street, but only 22% choose to report the error every time. Parking is another severe problem that users are not satisfied.



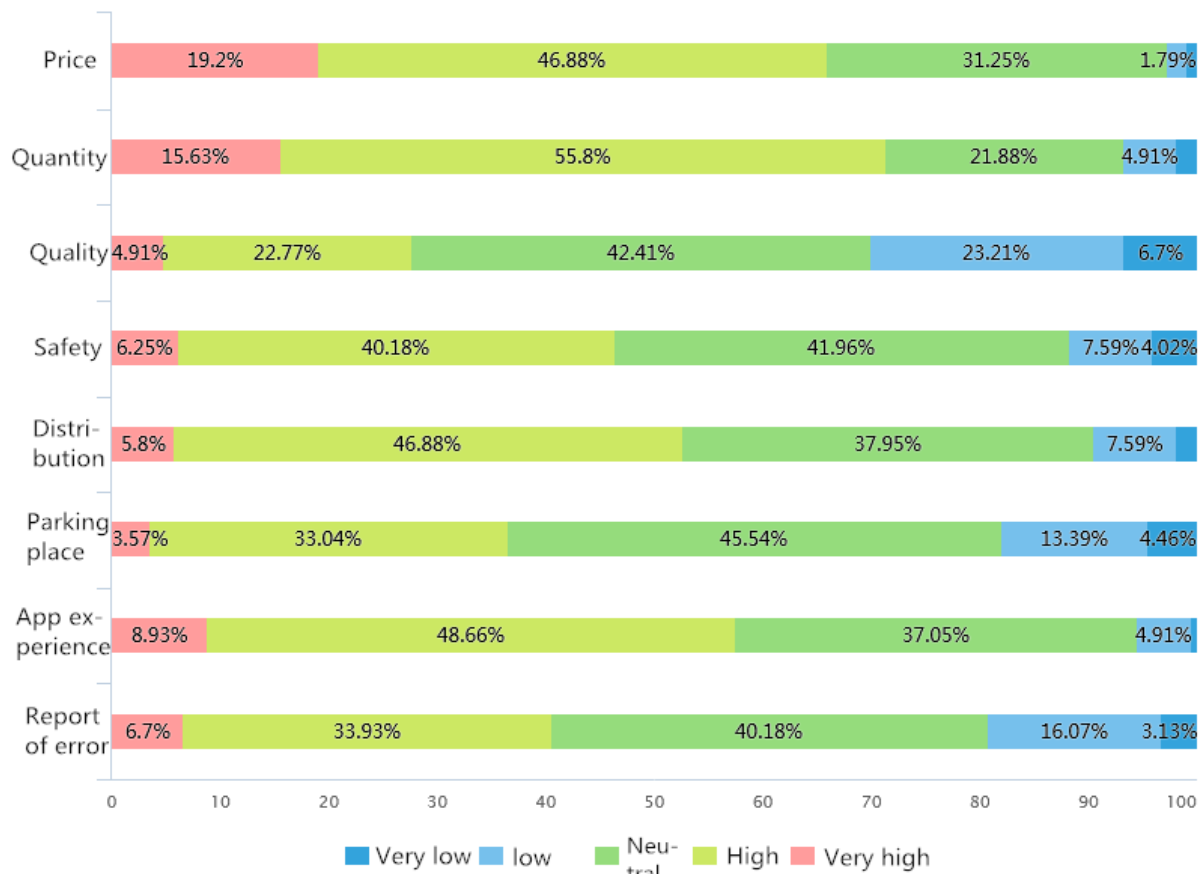


Figure 8 Participants' satisfaction with DBSS in different aspects

## ● Users perceptions towards DBSS in different aspects

*“For the short-distance travel, the advantages of shared bikes are the flexibility and speed. Compared to driving or taking a taxi or bus in the rush hour in a large- and medium-sized cities, riding a shared bikes could apparently save your time.” (Participant B, reflected from Survey)*

*“I don’t need to look around for a parking place while finally arrive their destination, because these bikes are “floating” without any dock. And I could always ride a bike when I’m too tired to walk and enjoying the street views at the same time.” (Participant C, reflected from Survey)*

Before the DBSS, 52% users think the previous transportation could fulfill their need, while after the launching of DBSS, the number increased to 70%. Nevertheless, only 44% users shows that the bicycle lanes in Beijing could fulfill their need, and for bicycle parking lots the number is even lower (40%). 64% users call for special parking place for shared bikes, and the hottest spots they mentioned are around metro/bus stops, neighborhood, office buildings and shopping malls. People are overall optimistic on more than 90% participants think the DBSS helped to solve the “last mile” problem; 65% agree it helps to improve the environment; 64% agree it mitigate the traffic congestion of the city.

## 4.4 To what extent could Beijing's DBSS contribute to its urban sustainable mobility development?

To measure the contribution of DBSS on Beijing's sustainability mobility development, this section elaborates the sustainability assessment from three aspects- environmental, economic and social aspects. All three aspects will be critically assessed from multi-dimensions based on the indicators that reviewed in Section 2.1.

### 4.4.1 Environmental impact

As reviewed in Section 2.2, bicycles have its own advantages especially in regard to its environmental friendly characteristics (Cahill 2010; Levett 1996). So as it stands, DBSS should have helped with the improvement of urban environment. However, the results of survey and interview raised some doubts on this assumption.

First of all, many people considered that the DBSS has increased the cycling in the city and it seems reasonable fuel consumption and greenhouse emission have been reduced. Meanwhile, the DBSS companies also claimed that the DBSS has made great effort on saving the energy, reducing greenhouse gas emissions and saving the urban space (Mobike White Paper 2017).

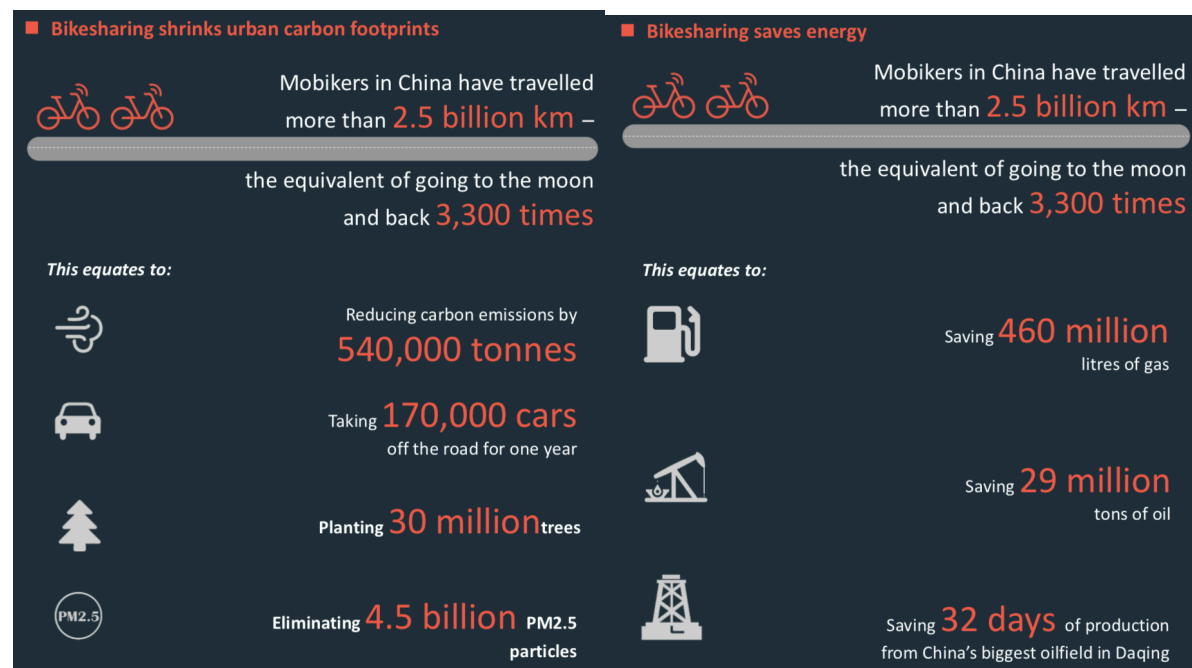


Figure 9 The statistics of bikesharing and its equitation to resource and environment data in Mobike Whitepaper (Mobike White Paper 2017)

*“The Mobike Company used their own conversion method and their users data to write the Mobike Whitepaper (2017). They simply replaced the riding mileage to the driving mileage, and advertise how they contribute to the environment based on this figure. This calculation is not scientific and reliable at all. Because the hypothesis that people change their transport from car to shared bikes is not always truthful.” (Mr. Wang, Planner)*

The evidence could also be found from the survey- the results didn't show that the residents have replaced cars with bikes. From the Figure 7 (Chapter 4.2.2) we could find that, the change of car-use and motorbike-use is not significant before and after the DBSS appeared. The usage of bikes as the transportation for commute purpose is doubled, meanwhile walking and usage of public transport have slightly declined. The transportation mode change of chore purpose trip and entertainment purpose trip are similar as the commute purpose. It might imply that the DBSS is an extra transportation option for citizens to use, but it is unrealistic, or at least not in a short term, to control the usage of cars only by DBSS.

There is another critical voice argues that the DBSS is not environmentally sustainable because it is neither “sharing economy” nor “circular economy”. The difference between the so-called “bike-sharing” and the traditional sharing economy is that there are no spare resources in the shared bike model. All the bicycles are bought by the DBSS companies to meet market demand, which is different from the original intention of sharing economy (Rui, 2017). Moreover, some experts believe that the startups are too busy chasing territory and investment to focus on providing a good service: “You see thousands of bikes parked everywhere around the city and many are not working because nobody takes care of them - the city's beauty has been destroyed” (Mead, 2017).

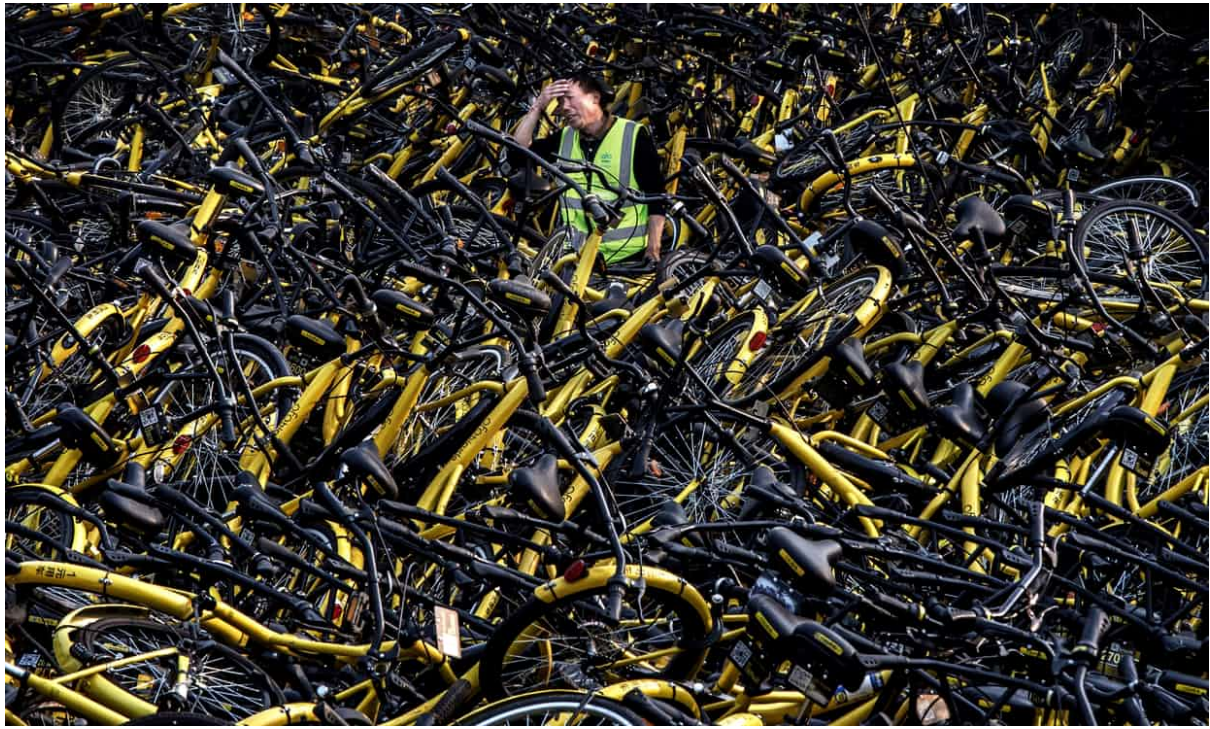


Figure 10 A mechanic from bike share company Ofo stands amongst damaged bicycles needing repair in Beijing. (Photograph: Kevin Frayer/Getty Images. Source: <https://www.theguardian.com/uk-news/2017/nov/25/chinas-bike-share-graveyard-a-monument-to-industrys-arrogance>)

*“Sometimes, government just drag away the wrongly-parked shared bikes to the shared bikes landfills without any warning. And if companies want to get these bikes back to the normal market, it is hard to negotiate with the government because of its low efficiency and high cost. Companies also pay more attention to the quantities rather than the qualities in the initial phase, because they need to occupy the local market and expanded fast. So those lack-of-care bikes become cities’ foundling.” (Mr. Wang, planner)*

After some companies exit the market, the shared bikes they put on the street are abandoned and caused the huge resource waste and environmental pollution. Bike vandalism and theft have also become a recurrent issue. Vandals have often targeted the bikes, placing them on trees or even destroying them by setting them on fire. And currently, there is no efficient way to prevent the criminal activities. As Spinney and Lin (2018, p12) discussed, “on a conceptual level, the abandoning of bikes anywhere on the streets is emblematic of the maximisation of private utility (saving time and effort) over collective utility (the ability of other users to easily use the public realm).

#### 4.4.2 Economic impact

Generally speaking, this new bikesharing services is a more advanced innovation with valuable economic impact on cities' sustainable transportation development. DBSS has expanded the scope of public transport services, allowing residents to choose from a wider range of lifestyles and work areas.

In China, the new scheme DBSS, different from the traditional public bikes, is completely provided by the private companies. The market gives the DBSS inherent advantages - efficiency. The DBSS compares to the public bikes provided by local government or joint venture between government and private, provide a cheaper, convenient, and comprehensive services.

The survey result shows that 65% of the participants agree that the DBSS have changed their daily life; 56% think the DBSS reduces the time limits for going out, and 76% think it saves the traveling time; Meanwhile more than half participants think the DBSS helps them to save the traveling budget. DBSS also has obvious advantage to ease the traffic congestion. From the report of Mobike White Paper (2017), in Beijing, for trips shorter than 5km, 92.9% of trips are quicker by shared bike + public transport; for trips longer than 5km, 23.7% of trips are faster by shared bike plus public transport.

In most cases, DBSS is a good solution to the "last mile problem" and has a significant feature on connecting to other public transportation. In Beijing 81% of the Mobike trips start a bus station, 44% of trips start near a metro station (Mobike White Paper 2017). The DBSS has expanded the service scope of the metro stations and facilitated metro services to more citizens. If we set the distance range when the house rent is reduced to 80% as the so-called "new metro area", the so-called "new metro area" will extend from 900m around the metro station to 1650m from the year of 2013-2015 to 2016-2017 (Metrodatateam 2017). The expansion of this service range has naturally expanded the scope of the "new metro area" and structural changes have taken place in the urban rental housing market. Furthermore, DBSS as a basic transport facility spatially reconstructs our urban structure, which in turn affects our lives in more ways.

However, from the perspective of the DBSS companies, is this model economically sustainable? As an enterprise, to put shared bikes into market is not a purely public welfare investment, and the final point is still for profit. In the beginning, the huge initial investment does not affect the recovery of its cost. Just like the previous car-hailing app, with the crazy money-burning mode, these new bike sharing apps quickly occupy the market. Most bike sharing apps require of paying the deposit as a credit/mortgage to rent the bike, which constitute a small part of the capital return. The bike sharing

apps also brings web traffic that will attract advertisements. Moreover, the large-scale production and technological upgrade of the shared bikes reduce the production and repair cost.

*“The companies are not about the sustainable transport, they are primarily about data mining. When the companies found that they cannot minimize the data, then the investment is just pull out. The companies actual business model itself is not sustainable and profitable. Operators intend to use the data to reshape the relationship between themselves and the municipality in ways that move further away from flat and cooperative power relations to more uneven relations.” (Mr. Spinney, planner)*

From explosive growth at the beginning of the year, to a series of bankruptcies by year's end, 2017 witnessed the roller coaster of China's bike-sharing business during the ups and downs. The industry boasted almost 60 bike-related startups over the last 18 months, nevertheless, by the end of November 2017, at least six well-known bike-sharing startups had shut down, and more than RMB 1 billion (USD 150 million) in deposits could not be refunded to users (Zhao 2017). In the long run, with the wide spread of the new business mode, the recovery of funds is quite substantial. Hopefully, by optimizing the cost and mining profit-points, bike sharing companies will gradually meet the profitability.

#### **4.4.3 Social impact**

From the social sustainability perspective, DBSS gives residents another opportunity to go anywhere, anytime they want to go, without think about the far walking distance. This increases residents' frequency of travel and frequency of exchanges, improving the vitality and utilization of urban space. It also helps the health of the residents. The positive impact of DBSS is to improve the access and reduce the exclusion, but the negative impact is that the DBSS shows to be relatively unequal and unsafe.

DBSS has markedly improve the accessibility from door to door. After the introduction of DBSS, users reported a decline in auto-rickshaw trips of 53%. The illegal auto-rickshaw is a common transport to deliver people from the metro station to their home. They are widely practiced despite repeated attempts by government to stamp them out. Just take one instance of a metro station in Beijing, in Spring 2016, just before the emergence of DBSS, there were 200 auto-rickshaws, drivers were each completing 40+ trips and earning up to 200+ RMB per day. But after the growth in popularity of DBSS, just 50-60 auto-rickshaws remain, and 70% of unlicensed drivers have changed jobs (Mobike White Paper 2017).



The inequality can be found both among age and income (Table 12). The senior citizens are hardly engaged into the DBSS, because the service is totally based on the smartphone and online-payment, and many old people don't have access to these new technologies. The relationship between income level and frequency of DBSS cycling was investigated by regression test, and there was strong correlation between the two variables ( $p < 0.01$ ). It means that no-income or low-income groups tend to use the DBSS more frequently.

Safety is another big issue for DBSS. 77% respondents think that the drivers do not have the concession for riders, and they feel unsafe while riding the shared bikes. At the same time, many pedestrians also feel their walkways has been invaded by the moving or stopped bikes. 72% participants agree that the parking disorder has become the eyesore of the street and made the city messy, meanwhile 61% consider the shared bikes taking too much public space.



Figure 11 Shared bicycles block a pathway in Jiuxianqiao, Chaoyang district, Beijing, on July 14, 2017. (Source: <https://www.theatlantic.com/photo/2018/03/bike-share-oversupply-in-china-huge-piles-of-abandoned-and-broken-bicycles/556268/>)

*“In our sub-district, most streets are Hutong, so the alleys are very narrow. If the shared bikes parked in the Hutong community, the streets will become even narrower. The bikes invade the residents’ car-parking lots and walking pedestrians, and residents are angry about it. So we have*

*to hire the people from property management company to clean up the inner Hutong, move the shared bikes into the vacant places, or at least put them in order.” (Ms. Sun, Community worker)*

There is a major issue about the “right-of-way” since the emergence of DBSS. Ideally, motor vehicles, non-motor vehicles, pedestrians should go its own ways, enjoy their respective rights in the corresponding areas, and other traffic participants should not infringe them. However, over the years, Chinese cities’ urban planning has always placed the priority of car traffic. As motor vehicle ownership continues to grow, non-motorized vehicles and pedestrian access are severely squeezed. Many cyclists have the bad experience while riding the bikes. For example, there is a lack of isolation between motorized and non-motorized lanes, resulting in vehicles often passing by others’ lane. Due to the limited place for riding, many cyclists have to ride on the sidewalk (Qiu 2016). The mutual disrespect has led to the chaos on the urban streets.

## **4.5 How could cities coordinate DBSS in a sustainable way?**

DBSS has entered the public view since the end of 2016. DBSS seems to have become part of public transportation or public facilities. However, due to low technical barriers, shared bicycles have experienced savage growth in less than two years. DBSS comes with various disputes and queries. Since nowadays, a large number of shared bikes with disorderly parking, serious damage and the over-supplied has become a new urban management issue. Some cities have already begun to issue policy documents. However, to solve this complicated problem, it is still facing a long way of refined management and scientific decision-making. This section tries to raise some ideas for cities to coordinate the DBSS in a more sustainable way from an institutional perspective.

### **4.5.1 Government: infrastructure and regulation**

According to the statistical data from the Beijing traffic department, the number of dockless shared bikes in Beijing had soared from approximately 700,000 to 2,350,000 in 4 months from April 2017 to September 2017 (Pan et al., 2017). However, problems such as disorderly parking, quality and safety have restricted the development of the industry. The lesson is that to avoid the “tragedy of commons” and uncoordinated individualistic action in a transport network, we need the government interference (Ruan et al., 2014). The DBSS, as a “disruptive innovation”, do not absolve cities from the principles of sound city planning, street design, and realizing the value of public spaces.

Due to the historical reason, the Chinese-style urban space and traffic planning mode of "wide roads,



big blocks and sparse roads" has been fixed (Yang, et al. 2018). Bicycle was regarded as inefficient mobility in the past, thus the transport planning didn't pay much attention to the design of the bicycle infrastructures and facilities. However, with the rapid growth of DBSS, the preparation of special plans for bicycles need to put on the agenda as soon as possible to ensure the construction of bicycle facilities. In the planning process, local authority should set a clear quantitative target with the data support, and solve the specific problems facing problems with focal points by stages.

On the other hand, government also plays a vital role in investment of bike infrastructure and supporting facilities like bike lanes, parking lots, and bike signals to make citizens feel convenient, safe and comfort while cycling. Bicycle infrastructure construction needs to focus more on the daily travel environment in the city, especially the cyclists' rights, dangerous points, and end-breaking roads, to achieve greater effectiveness.

*"Sometimes, our government is too slow to react when facing a new disruptive innovation. They are afraid of changing, and sometimes shirk responsibility when something goes wrong. The lack of regulation and attention caused the barbric growth of DBSS in the beginning and caused numerous problems that government can no longer ignore. However, DBSS start-ups might lost their strength due to the governments' rough control and management. DBSS is a insightful reflection for the comtemporany urban planning and governance in China."* (Mr. Wang, planner)

Chinese government issued guidelines in August 2017 by the Ministry of Transport to regulate DBSS services, including forbidding children under 12 using the shared bikes; operators have to buy insurance for users; customers need to register with their real name, etc. (Hu, 2017). On 15th September 2017, Beijing Municipal Commission of Transport (2017), released the "Guidance for the development of standardized sharing bicycles in Beijing (Trial)". Based on extensive investigations and studies and with the actual conditions in the municipality, the administrative departments of various districts, industry associations and DBSS enterprises have formulated the "Technical Specifications for Bike Sharing Systems Technology and Services" and the "Technology Guidelines for Bicycle Parking Area Settings". The policy documents provide a comprehensive, detailed, and solid policy guarantee and normative guidance to encourage the healthy development of DBSS. Under new changes, the local Beijing government will order bike-sharing companies to be regulated and supervised by municipal authorities. The firms will also be made to pay accident insurance for users.

*"It is not enough to publish these regulations. What is more important is how to implement them and supervise them."* (Mr. Wang, planner)

#### 4.5.2 Companies: maintenance and cooperation

The DBSS companies are now facing the trouble of the vicious competition within the industry. As for the current shared bicycle model, we can hardly see the improvement of bicycle utilization efficiency. Instead, many companies mass-produce new bicycles and put them on the market. This commercial competition among companies is merely to expand the market and squeeze out other competitors. It has deviated from the good intention of "sharing." As a result, the number of bicycles is bound to far exceed the Pareto equilibrium level (Bullock et al. 2017). It could not improve the utilization efficiency of social idle resources but caused a tremendous waste of resources. Recently, 6 of 30+ operators just went bankrupt, which might be a signal of the bubble bursting. Many of China's shared bike users have fallen as victims of defaults on their deposit refunds, after operators went bankrupt. No party has claimed responsibility for refunding public deposits. From our survey, we can also find that 70% respondents think the providers couldn't maintain the shared bikes on time and cause enormous waste of the resource (Pan et al. 2018).

Previously, some DBSS companies found that compared to repair the bikes, to produce new bikes is even cheaper. That's why they would rather let the "zombie bikes" spread on the street and blindly produce new bikes (Birtles 2017). The new guidance released in September clearly defined the standard on the shared bicycle recovery and maintenance. It suggests enterprises to regularly recondition the shared bicycles and keep the shared bikes' serviceability rate above 95%. Shared bikes should generally put in use for three years and then they should be updated or scrapped; DBSS enterprises should own or rent parking spaces to meet the needs of vehicle turnover and maintenance (Beijing Municipal Commission of Transport, 2017).

Beijing has also controlled the total amount of shared bicycles in the city. The promulgation of this policy just precisely led enterprises to devote more energy and investment to maintenance and management rather than manufacturing. Thus, some experts believe that if companies adjust their business focus to the quality and maintenance of the bikes, the overall burden will not increase too much (Wang 2017).

*"It's good to see companies start to share their data with institutions for research purpose. Because they are valuable for transport planning. But the business model is about minimizing and selling the data. So I'd like to see more cooperation between companies and government, though I think government should buy it. However the privacy is a big issue when using this data." (Mr. Spinney, planner)*

On the other hand, the result revealed that there is fear of social exclusion in the current DBSS; to include marginalized low-income groups who cannot afford cell-phone, those who cannot work with cell-phone or those who even prefer not to have cell phone, DBSS requires more comprehensive software. New tools such fingerprint recognition program or urban transport card can help.

#### **4.5.3 Citizens: education and culture**

Education and various activities could help to encourage the good behavior and cultivate a cyclists-friendly environment. Those can initiate from government, market, civil society, or together. It is not enough to rely solely on infrastructure to enhance the attractiveness of bicycles. Bicycles are closely linked to the social symbolic effect and the level of income. As the rise of residents' income levels, bicycles often embody the "cheapness", which hinder the social acceptance and popularity of bicycles. We also interviewed some non-users of DBSS and asked them the reason that they rejected this service. Many of them said they don't know how to ride the bikes or the bike is not a need in their life. Therefore, to encourage more people to cycle and to enable the cyclists to feel as pride and satisfied as the car groups, large-scale publicity and education need to be carried out, so as to change people's view and make the bicycle becoming a part of the daily life style and the organic component of the city image. On the other hand, to guide the safe and right cycling/driving behavior, and create a bike-friendly environment, schools, NGOs and local communities could help with the supervision and education.

For instance, the vandalism acts towards shared bikes spawned a spontaneous civic group - "bicycle hunters"-

*"We use the APP GPS information, to retrieve those illegal placed, abandoned, or stolen bikes. By reporting the violations of out-of-service or damaged bikes through the APP, the bike hunters could gain some rewards and at the same time, assisting the orderly operation." (Mr. Zhao, Mobike Hunter)*



Figure 12 A group of volunteers in Beijing returning stranded and damaged shared bikes to more central locations. (Bryan Denton for The New York Times. Source: <https://www.nytimes.com/2017/09/02/world/asia/china-beijing-dockless-bike-share.html>)

Moreover, some shared bikes operators have already set credit system to encourage better behavior by rewarding user's credits for reporting broken or illegally parked bikes; and demerits for correspondingly bad behavior. If your score drops too low, your next ride could become much more expensive (Denyer 2017).

*"We regard bike hunting as a treasure hunting game. We enjoy the procedure of finding the stranded and damaged bikes, reporting them. It seems that we could contribute to the urban environment and society in our own way. The reward from the APP is not the main reason for us. The hunters in our volunteer groups become good friends and even become couples." (Mr. Zhao, Mobike Hunter)*

#### 4.5.4 Hybrid governance

The national guideline put forward that it is necessary to adhere to the principle of multi-party governance and give full play to the joint efforts of the government, enterprises, social organizations, and the public. There must be coordination on three levels to achieve the continuous innovation for

DBSS (Li et al. 2017).

### ● Synergy of transportation mode

DBSS alone itself cannot achieve the revival of bicycles. To promote the bicycles, the holistic green traffic solution should be provided to the public through the optimization of the connection and integration between the bicycles and various public transport.

*“Many Chinese cities have issued guidance on the regulation of shared bicycle services, setting up a “black list for riding”, piloting geo-fences, planning of banned parking areas, and enforcing real-name registrations to standardize the development of shared bicycles, but with little success. Cycling brands have responded with the introduction of their own governance, such as developing geo-fences and artificial data platforms, etc., which have certain results in the short term. In the long run, if there is no unified control and standard, old problems cannot be eradicated. Therefore, a unified management governance system platform should be established to achieve accurate management of bicycle placement and operation.” (Mr. Wang, planner)*

For example, local authorities could incorporate the infrastructure investment with private sector companies. In the past, each DBSS company was basically independently managed and did not communicate with each other. As a result, the number of bicycles in the parking area was excessive and not properly divided. The establishment of a systematic DBSS management platform could enable the unified management of different brands of shared bicycles. Its back-end system platform can also be open to all DBSS companies. In this way, shared bikes can be put into places where people gather and flow, such as bus stations, large squares, and stations near subways. If the number of bicycles exceeds the standard or the bikes are in short supply, they can use the backstage management system to conduct scientific and directional and effective operation and maintenance.

### ● Synergy of information

It is also helpful to promote comprehensive research on multi-source multidimensional data (open data, data sharing and public crowdsourcing data). By combining the traditional data and new data, it could support the process of decision-making.

*“It’s good to see companies start to share their data with institutions for research purpose. Because they are valuable for transport planning. But the business model is about monetizing and selling the data. So I’d like to see more cooperation between companies and government. Though I think government should buy it, because it’s their responsibility to improve the urban infrastructures, and the companies could provide very useful data on when, where and how people*

*go and stop. However the privacy is a big issue when using this data.” (Mr. Spinney, planner)*

Since according to the new guideline, all shared bikes have to equip with the GPS chips, the companies could share their transportation data on where people ride their bikes to, and park. With the help of the empirical data, government could make a better decision on where to build the new bike tracks, parking lots and public realm improvements (Geave 2017). In practice, Mobike and Beijing Institute of Urban Planning and Design have signed a cooperation agreement. The big data will support the planning of Beijing's pedestrian and bicycle lanes during the 13th Five-Year Plan period. It will also assist with the planning of parking lots and parking spots and select and support Beijing 3,200 km bike lanes' construction (Ouyang, 2017).

### ● Synergy of participants

Encourage all stakeholders including enterprises, government, the public, social organizations and so on in the process to achieve the win-win cooperation.

*“We have different Wechat group to discuss how to improve the dockless bike sharing system in different cities. There are officers from the Mobike company, experts, users, and general people who are interested in helping with the issues in this online discussing group, so that our voices can be heard by the company. We also submitted our opinions and suggestions to relevant departments of city government, at the stage of releasing the trial requirements for comments. Actually, our final goal is that, one day in the future, we don't have any bikes to hunt.” (Mr. Zhao, Mobike Hunter)*

The participation of the public in urban DBSS management can, on the one hand, improve the public's awareness, quality and ability of democratic participation, self-management, and self-service; on the other hand, it can also promote the transformation of urban government functions and ensure the democratic and scientific public decision-making. It is conducive to the construction of a public service-oriented government that combines the concepts of responsibility, service, and the rule of law. In addition, the public participation in management also facilitates the implementation of government policies and accelerates the standardization of DBSS (Xiong 2017).

## **5. Conclusion and recommendation**

### **5.1 Brief summary**

With the emergence of sharing economy, the popularity of the mobile payment, the environment awareness and the inherent market demand, the DBSS has led a trend of bicycle revival in Beijing, which is becoming a role model for all of China. These new kind of dockless shared bikes with great advantages of flexibility in short trips are just the ones that could solve the commuters' "last mile" problem. However, people are still worried about its safety and quality. Considering sustainability criteria, the DBSS was expected to have positive impacts on reduction in greenhouse gas emission, elimination of pollution and health risks. However, the result of survey shows that the shared bikes are not the alternative for the frequent car-users. Nevertheless, it has also yielded negative consequences such as blocked sidewalks and vandalism of the bikes. Oversupply has led to graveyards of bikes, and deep concerns about quality control, maintenance, and management of these systems. If there is no efficient way to avoid the bad treatment towards shared bikes and abasement of public space, it has tend to become a curse than a bless. Moreover, though the DBSS has incredibly increased the accessibility within the urban mobility framework, the seasonal and tidal phenomenon calls for a more efficient way to dispatch and distribute the bikes. And the business model of the DBSS companies seems not very sustainable and profitable. Publics are also worried about their quality and safety, especially the issues of "right of way". How to coordinate and solve these problems is not only related to the future direction of DBSS, but also related to the vital interests of the general public. Therefore, it is the general trend to emphasize that governments, enterprises, and the public participate in multi-party cooperation and build a synergic governance networks to carry forward the advantages and avoid the negative effects of the new bike sharing system.

The city government should improve the construction of bicycle traffic network, standardize the parking place setting of bicycles, and strengthen supervision and law enforcement of illegal activities. Operators should implement the responsibility of DBSS parking management, popularize and apply technologies such as geo-fencing, take comprehensive measures such as economic rewards and punishments and credit records, and guide users to regulate parking. At the same time, strengthen the publicity and education to guide the mutual respect among drivers, cyclists and pedestrians through public service advertisements, theme education and volunteer activities. Users themselves are encouraged to enhance their awareness of cycling etiquette, abide by traffic regulations, and abide by social ethics. The three-level coordination, namely the synergy of transportation mode, information

and participants is recommended for the DBSS's future healthy development and efficient hybrid governance.

## **5.2 Recommendation for further research**

In this research, the characteristics of users, users' behavior and users' perceptions towards DBSS are analyzed by the survey. However, since survey is a general method for collecting big amount of data, the profound and comprehensive views from specific users are lacked. The online sampling and distribution method may also cause the bias in this research. Future research may fill the gap by conducting in-depth interviews with various background users and generate more ideas from their perspective by qualitative methods. Moreover, though the actual performance of DBSS is being criticized assessed in this research, there are still many issues have not been solved on evaluate the DBSS's sustainable mobility. For example, directions for further studies may include the research about the quantified index, which could measure the performance of DBSS towards sustainability in different cities.

In this research, only 4 interviewees are agreed to join the research, and representative from company or local authority is excluded. So the research lack of the direct views from government and company's perspective. Thus, more detailed operations and management advice need to be proposed in the further research, so that the government and the DBSS companies could coordinate better in the future. For example, how could improve and implement the regulations more efficiently, how to use the companies' technology and data to planning the city, etc.

Since, this research only focus on Beijing as the single case study, there might be other cases that could be studied and compared to reveal the differences in DBSS's contribution in different city scale. Moreover, with the expanding of DBSS companies to other parts of the world, it requires appropriate coordination between the local government and the private firms to avoid the potential chaotic situations. By learning the Chinese experience presented in this research, further study may focus on how to develop the DBSS in worldwide cities, and what are the obstacles they are facing and how to solve them in different contexts. DBSS and its healthy development and governance need more valuable investigation in the further research.



## Reference

- Abraham, J., 1994. Bias in Science and Medical Knowledge: The Opren Controversy. *Sociology* 28(3), pp. 717-736.
- Aldridge, A. and Levine, K. eds., 2001. *Surveying the social world*. Buckingham: Open University Press.
- Banister, D., 2007. Sustainable transport: challenges and opportunities. *Transportmetrica*, 3(2), pp.91-106.
- Banister, D., 2008. The sustainable mobility paradigm. *Transport policy*, 15(2), pp.73-80.
- Beijing Guidance, 2017. The Normative Guidance for Encouraging the Development of Shared Bicycles in Beijing Municipality (Trial). Beijing Municipal Traffic Commission and other 10 municipal departments. Retrieved from: <http://zhengce.beijing.gov.cn/library/192/33/50/438650/1283011/> [Accessed 10th April, 2018].
- Bhattacharjee, 2013. "Social Science Research: Principles, Methods, and Practices" (2012). Textbooks Collection. Book 3.
- Birtles, B., 2017. China's Oversupply of Shared Bikes Creating Piles of Broken, Unused Bicycles on City Streets. *ABC News*. Retrieved from <http://www.abc.net.au/news/2017-05-21/chinas-oversupply-of-shared-bikes-clogging-up-city-streets/8543720> [Accessed: 10th May, 2018].
- Black, W.R., 2010. Sustainable transportation: problems and solutions. New York: Guilford Press.
- Bryman, A., 2016. *Social research methods*. 5th ed. Oxford: Oxford University Press.
- Bueno, P.C., Vassallo, J.M. and Cheung, K., 2015. Sustainability assessment of transport infrastructure projects: A review of existing tools and methods. *Transport Reviews*, 35(5), pp.622-649.
- Bullock, C., Brereton, F. and Bailey, S., 2017. The economic contribution of public bike-share to the sustainability and efficient functioning of cities. *Sustainable cities and society*, 28, pp.76-87.
- Bulmer, M. and Solomos, J., 2001. Conceptualizing multi-ethnic societies. *Ethnic and Racial Studies* 24(6), pp. 889-891.

- Campbell, C., 2018. The Trouble with Sharing: China's Bike Fever Has Reached Saturation Point. Time. Retrieved from: <http://time.com/5218323/china-bicycles-sharing-economy/> [Accessed: 5 April 2018].
- Cahill, M., 2010. *Transport, environment and society*. McGraw-Hill Education (UK).
- Cavill, N. and Davis, A., 2007. Cycling and health-what's the evidence?. London: Cycling England
- Chinese National Information Center, 2017. Bike Sharing Industry Employment Research Report. Retrieved from <http://www.sic.gov.cn/News/250/8452.htm> [Accessed: 5 April 2018].
- Corcoran, J. and Li, T., 2014. Spatial analytical approaches in public bicycle sharing programs. *Journal of transport geography*, 41, pp.268-271.
- Crotty, M., 1998. The foundations of social research: Meaning and perspective in the research process. Sage.
- Daley, M. and Rissel, C., 2011. Perspectives and images of cycling as a barrier or facilitator of cycling. *Transport policy*, 18(1), pp.211-216.
- DeMaio, P., 2009. Bike-sharing: History, impacts, models of provision, and future. *Journal of public transportation*, 12(4), pp.3.
- Denyer, S., 2017. China is Introducing a New Bike-share System in Cities Around the World. But Not Everyone's Thrilled. *The Washington Post*. Retrieved from [https://www.washingtonpost.com/world/asia\\_pacific/china-exports-its-bike-sharing-revolution-to-the-us-and-the-world/2017/08/31/474c822a-87f4-11e7-9ce7-9e175d8953fa\\_story.html](https://www.washingtonpost.com/world/asia_pacific/china-exports-its-bike-sharing-revolution-to-the-us-and-the-world/2017/08/31/474c822a-87f4-11e7-9ce7-9e175d8953fa_story.html) [Accessed: 10th May, 2018].
- DiCicco, B. B and Crabtree, B.F., 2006. *The qualitative research interview*. Medical education, 40(4), pp.314-321.
- Dieronitou, I., 2014. The ontological and epistemological foundations of qualitative and quantitative approaches to research. *International Journal of Economics*, 2(10), pp.1-17.
- ECMT., 2000. Sustainable Transport Policies. Paris: OECD.
- Fishman, E., 2016. Bikeshare: A review of recent literature. *Transport Reviews*, 36(1), pp.92-113.
- Fishman, E., Washington, S. and Haworth, N., 2013. Bike share: a synthesis of the literature.

- Transport reviews*, 33(2), pp.148-165.
- Fox, J., Murray, C. and Warm, A., 2003. Conducting research using web-based questionnaires: Practical, methodological, and ethical considerations. *International journal of social research methodology*, 6(2), pp.167-180.
- Gao, Y., 2016. China's response to climate change issues after Paris Climate Change Conference. *Advances in Climate Change Research*, 7(4), pp.235-240.
- Geave, J., 2017. Dockless Bike Sharing and Relearning. *Transport Futures*. Retrieved from <https://transportfutures.co/dockless-bike-sharing-and-relearning-ebd60359d507> [Accessed 10th May, 2018].
- Gillham, B., 2000. *Case study research methods*. London: Bloomsbury Publishing.
- Goldman, T. and Gorham, R., 2006. Sustainable urban transport: Four innovative directions. *Technology in society*, 28(1-2), pp.261-273.
- Gössling, S. and Choi, A.S., 2015. Transport transitions in Copenhagen : Comparing the cost of cars and bicycles. *Ecological Economics*, 113, pp.106–113.
- Guba, E.G. and Lincoln, Y.S., 1994. Competing paradigms in qualitative research. *Handbook of qualitative research*, 2(163-194), pp.105.
- Guidelines, 2017. Technical guidelines for setting parking areas for bicycles. Beijing Municipal Traffic Commission. Retrieved from: <https://www.weibo.com/ttarticle/p/show?id=2309404153633913591745> [Accessed 10th April, 2018].
- Guiding Opinions, 2017. Guiding Opinions on Encouraging and Regulating the Development of Internet Rental Bicycles. Central Ministry of Transport, and other 9 central departments. Retrieved from: [http://www.gov.cn/xinwen/2017-08/03/content\\_5215640.htm](http://www.gov.cn/xinwen/2017-08/03/content_5215640.htm) [Accessed 10th April, 2018].
- Handy, S., Wee, B. Van & Kroesen, M., 2017. Promoting Cycling for Transport : Research Needs and Challenges Promoting Cycling for Transport : Research Needs and. *Transport Reviews*, 0(0), pp.1–21.
- Heinen, E., Van Wee, B. and Maat, K., 2010. Commuting by bicycle: an overview of the literature.

*Transport reviews*, 30(1), pp.59-96.

Hillman, M., Solomon, J. and Maughan, R.J., 1992. *Cycling towards health and safety*. Oxford University Press.

Horwitz, J., 2017. Chinese cities are saying “enough already” to bike-sharing services run rampant. Retrieved from: <https://qz.com/1058438/chinese-cities-saying-enough-already-to-chaos-generated-by-bike-sharing-services-like-ofo-and-mobike/> [Accessed: 5 April 2018].

Hull, A. and O’Holleran, C., 2014. Bicycle infrastructure: can good design encourage cycling?. *Urban, Planning and Transport Research*, 2(1), pp.369-406.

Israel, M. and Hay, I., 2006. *Research ethics for social scientists*. London: Sage.

Jick, T.D., 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly*, 24(4), pp.602-611.

Joinson, A., 1999. Social desirability, anonymity, and Internet-based questionnaires. *Behavior Research Methods, Instruments, & Computers*, 31(3), pp.433-438.

Juhel, M., 2012 Sustainability Toolkit for Transport Projects. World Bank. Regrieved from: <http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1256925359923/6530040-1317835544254/SustainabilityToolkit-PIARC2011-with-notes.pdf> [Accessed: 5 April 2018].

Kayam, O. and Hirsch, T., 2012. Using social media networks to conduct questionnaire based research in social studies case study: Family language policy. *Journal of Sociological Research*, 3(2), pp.57-67.

Kelly, A.P., 2016. Social research methods. University of London International Programmes Publications Office, United Kingdom.

Kennedy, C., Miller, E., Shalaby, A., Maclean, H. and Coleman, J., 2005. The four pillars of sustainable urban transportation. *Transport Reviews*, 25(4), pp.393-414.

Koglin, T., 2015. Organisation does matter—planning for cycling in Stockholm and Copenhagen. *Transport policy*, 39, pp.55-62.

Larsen, J., 2017. The making of a pro-cycling city: Social practices and bicycle mobilities. *Environment and planning A*, 49(4), 876-892.

- Levett, R., 1996. Cycling and Sustainable Development: An overview. Topic Paper. National Cycling Strategy Appendix, London, Department of Transport.
- Li, H., Wu, Y., Liang, J., Duan, B., and Wang, P., 2017. Return Bicycles to Cities: From Bike-sharing to Data Ecosystems. Retrieved from [http://www.bikehome.cc/news/20171028/566752\\_1.html](http://www.bikehome.cc/news/20171028/566752_1.html) [Accessed 10th May, 2018].
- Lin, J.R. and Yang, T.H., 2011. Strategic design of public bicycle sharing systems with service level constraints. *Transportation research part E: logistics and transportation review*, 47(2), pp.284-294.
- Lipton, J., 2017. Bike-sharing boom in China pedals to new heights. CNBC. Retrieved from <https://www.cnbc.com/2017/07/18/bike-sharing-boom-in-china-pedals-to-new-heights.html> [Accessed: 1 May, 2018].
- Litman, T. and Burwell, D., 2006. Issues in sustainable transportation. *International Journal of Global Environmental Issues*, 6(4), pp.331-347.
- Lohry, G.F. and Yiu, A., 2015, February. Bikeshare in China as a public service: Comparing government-run and public-private partnership operation models. In *Natural Resources Forum*, Vol. 39, No. 1, pp. 41-52.
- Lyon, B., 2018. How did China fall in love with dockless bikeshare? CityMetric. Citymetric. Retrieved from <https://www.citymetric.com/transport/china-fall-love-dockless-bikeshare-cycling-3807> [Accessed: 1 May, 2018].
- Mabry, L., 2008. Case study in social research. *The SAGE handbook of social research methods*, pp.214-227.
- May, A.D., 2013. Urban transport and sustainability: The key challenges. *International journal of sustainable transportation*, 7(3), pp.170-185.
- May, T., 2011. *Social research*. Maidenhead, Berkshire, England: McGraw Hill, Open University Press.
- May, T. and Crass, M., 2007. Sustainability in transport: Implications for policy makers. *Transportation Research Record: Journal of the Transportation Research Board*, (2017), pp.1-9.

- Mead, N.V., 2017. Uber for Bikes: How 'Dockless' Cycles Flooded China - and are Heading Overseas. *The Guardian*. Retrieved from <https://www.theguardian.com/cities/2017/mar/22/bike-wars-dockless-china-millions-bicycles-hangzhou> [Accessed 10th May, 2018].
- Metrodatateam., 2017. Bike- sharing Redefined the "Subway room"?. Retrieved from [http://www.sohu.com/a/193031969\\_274982](http://www.sohu.com/a/193031969_274982) [Accessed 10th May, 2018].
- McLafferty S., 2010. Conducting Questionnaire surveys. In Clifford et al (eds.) *Key methods in Geography*. 1st edition, Sage pub, London. pp. 77-88.
- Miles, J. and Gilbert, P., 2005. A handbook of research methods for clinical and health psychology. Oxford: Oxford University Press.
- Miles, M.B. and Huberman, A.M., 1994. *Qualitative data analysis: An expanded sourcebook*. London: Sage.
- Mobike White Paper, 2017. The Mobike White Paper: Bike-Share in the City. Mobike. Retrieved from: <https://mobike.com/sg/blog/post/mobikewhitepaper>. [Accessed 10th April, 2018].
- Mobike White Paper, 2018. The Mobike Second White Paper: How Cycling Changes Cities. Mobike Retrieved from: <https://mobike.com/sg/blog/post/cycling-changes-cities> [Accessed 10th April, 2018].
- Morse, J.M. and Field, P.A., 1995. Qualitative research methods for health professionals. London: Sage.
- Neuman, L.W., 2002. Social research methods: Qualitative and quantitative approaches.
- O'Leary, Z., 2004. The essential guide to doing research. London: Sage.
- Ouyang, S., 2017. Mobike launches urban mobility institute Chinadaily. Retrieved from: [http://www.chinadaily.com.cn/china/2017-04/12/content\\_28900644.htm](http://www.chinadaily.com.cn/china/2017-04/12/content_28900644.htm) [Accessed 10th May, 2018].
- Pan, H. 2011. Evolvment and Sustainable Development of Urban Biking Traffic Policy in China. *Journal of Urban Planning*, (4), pp.82-86.
- Pan, J., Lu, T., Liu, J., &Tian, W., 2017. Behind the Bike-sharing: Increase 1.65 million in 4 Months. *Beijing News*. Retrieved from

- [http://www.bj.xinhuanet.com/bjyw/2017-09/18/c\\_1121679168.htm](http://www.bj.xinhuanet.com/bjyw/2017-09/18/c_1121679168.htm) [Accessed 10th May, 2018].
- Pan, L., Cai, Q., Fang, Z., Tang, P. and Huang, L., 2018. Rebalancing Dockless Bike Sharing Systems. *preprint arXiv:1802.04592*.
- Piatkowski, D.P. and Marshall, W.E., 2015. Not all prospective bicyclists are created equal: The role of attitudes, socio-demographics, and the built environment in bicycle commuting. *Travel behaviour and society*, 2(3), pp.166-173.
- Potter, S., 2007. Exploring approaches towards a sustainable transport system. *International Journal of Sustainable Transportation*, 1(2), pp.115-131.
- Buehler, R. and Pucher, J., 2012. International Overview: Cycling Trends in Western Europe, North America, and Australia. *City cycling*, pp.9-29.
- Qiu, Z., 2016. Crime and Punishment of the Bike-sharing. *First Financial*. Retrieved from <http://www.yicai.com/news/5191474.html> [Accessed 10th May, 2018]
- Ruan, Y., Hang, C. C., & Wang, Y. M., 2014. Government's Role in Disruptive Innovation and Industry Emergence: The Case of the Electric Bike in China. *Technovation*, 34(12), pp.785-796.
- Rui, M., 2017. Bike-sharing is a Pseudo-sharing Economic and the Turning Point has Arrived. *China Europe International Business School*. Retrieved from <http://news.hexun.com/2017-11-17/191679081.html> [Accessed 10th May, 2018].
- Savan, B., Cohlmeier, E. and Ledsham, T., 2017. Integrated strategies to accelerate the adoption of cycling for transportation. *Transportation research part F: traffic psychology and behaviour*, 46, pp.236-249.
- Shaheen, S., Guzman, S. and Zhang, H., 2010. Bikesharing in Europe, the Americas, and Asia: past, present, and future. *Transportation Research Record: Journal of the Transportation Research Board*, (2143), pp.159-167.
- Shannon-Baker, P., 2016. Making paradigms meaningful in mixed methods research. *Journal of Mixed Methods Research*, 10(4), pp.319-334.
- Shen, Y., Zhang, X. and Zhao, J., 2018. Understanding the usage of dockless bike sharing in Singapore. *International Journal of Sustainable Transportation*, pp.1-15.
- Sørensen, C.H., Gudmundsson, H. and Leleur, S., 2013. National sustainable transport

planning-concepts and practices.

- Specification, 2017. Shared Bike System Technology and Service Specification. Beijing Municipal Traffic Commission. Retrieved from: <https://www.weibo.com/ttarticle/p/show?id=2309404153633913591745> [Accessed 10th April, 2018].
- Spinney, J. and Lin, W.I., 2018. Are you being shared? Mobility, data and social relations in Shanghai's Public Bike Sharing 2.0 sector. *Applied Mobilities*, pp.1-18.
- Sultana, S., Salon, D. and Kuby, M., 2017. Transportation sustainability in the urban context: a comprehensive review. *Urban Geography*, pp.1-30.
- Sun, G. and Zacharias, J., 2017. Can bicycle relieve overcrowded metro? Managing short-distance travel in Beijing. *Sustainable Cities and Society*, 35, pp.323-330.
- Tashakkori, A. and Creswell, J.W., 2007. The new era of mixed methods. *Journal of Mixed Methods Research*, 1, pp.3-7
- Teddlie, C. and Tashakkori, A., 2009. Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences. California: Sage.
- Tolley, R., 2003. Sustainable transport. Cambridge: Woodhead publishing.
- Un-Habitat, 2013. Planning and design for sustainable urban mobility: Global report on human settlements 2013. Routledge.
- Wechat., 2018. Wikipedia. Retrieved from: <https://en.wikipedia.org/wiki/WeChat> [Accessed: 8 April 2018].
- Xiong, J., 2017. "Sharing bikes" chaos and multi-center cooperation governance. *Legal System and Society*, 25, pp.063.
- Yang, X.H., Cheng, Z., Chen, G., Wang, L., Ruan, Z.Y. and Zheng, Y.J., 2018. The impact of a public bicycle-sharing system on urban public transport networks. *Transportation Research Part A: Policy and Practice*, 107, pp.246-256.
- Yin, Robert.K., 2017. Case study research and applications: Design and methods. California: Sage publications.



- Zietsman, J. and Rilett, L.R., 2002. *Sustainable transportation: Conceptualization and performance measures* (No. SWUTC/02/167403-1). Southwest University Transportation Center, Texas Transportation Institute, Texas A & M University.
- Zhang, H., Shaheen, S. A., & Chen, X., 2014. Bicycle evolution in China: From the 1900s to the present. *International Journal of Sustainable Transportation*, 8(5), pp.317-335.
- Zhang, Y. and Mi, Z., 2018. Environmental benefits of bike sharing: A big data-based analysis. *Applied Energy*, 220, pp.296-301.
- Zhao, P. & Li, S., 2017. Bicycle-metro integration in a growing city: The determinants of cycling as a transfer mode in metro station areas in Beijing. *Transportation research part A: policy and practice*, 99, pp.46-60.
- Zhao, P., 2014. The impact of the built environment on bicycle commuting: Evidence from Beijing. *Urban Studies*, 51(5), pp.1019-1037.
- Zhao, Y.R., 2017. 5 Chinese bike-sharing startups bankrupted in 2017. AllTechAsia. Retrieved from: <https://alltechasia.com/5-bike-sharing-startups-went-bankrupt-2017/> [Accessed: 18 May 2018].
- Zhijun, F. and Nailing, Y., 2007. Putting a circular economy into practice in China. *Sustainability Science*, 2(1), pp.95-101.
- Zhu, W., Zhai, B. and Jian, D., 2017. Evaluating the Bicycle Travel Environment in a Changing Bicycle Culture: Case Study of Shanghai, China. *Journal of Urban Planning and Development*, 143(3), pp.5.

## Annexes 1 – List of documents

Documents	Source	Notes
Guiding Opinions on Encouraging and Regulating the Development of Internet Rental Bicycles (Guiding Opinions 2017)	Central Ministry of Transport, and other 9 central departments	State-level policy document which seeks to encourage and regulate the development of Internet rental bicycles
The Normative Guidance for Encouraging the Development of Shared Bicycles in Beijing Municipality (Trial) (Beijing guidance 2017)	Beijing Municipal Traffic Commission and other 10 municipal departments	Beijing municipal-level policy document to regulate and coordinate the sustainable development of shared bikes
Shared Bike System Technology and Service Specification (Specification 2017)	Beijing Municipal Traffic Commission	Beijing municipal-level specification which comprehensively regulates the shared bikes standards, company operations, government supervision platforms, and information system security.
Technical guidelines for setting parking areas for bicycles (Guidelines 2017)	Beijing Municipal Traffic Commission	Beijing municipal-level guideline document which clarifies the parking area setting forms and facilities standards
The Mobike White Paper: Bike-Share in the City (Mobike White paper 2017)	Mobike with the support of Tsinghua University's China New Urbanization Research Institute	The report highlights how the return of bikes to China's cities (and now further) is transforming urban transport patterns and lifestyles.
The Mobike Second White Paper: How Cycling Changes Cities (Mobike White paper 2018)	Mobike with the support of World Resource Institute	Insight on how cycling becoming more accessible in our cities can impact and change our cities for the better; and thereby significantly improves the quality of life of their residents.

## Annexes 2 – Questionnaire

### Beijing Municipal Shared Bikes Users' Usage, Attitude, and Perception on Dockless Bike Sharing Scheme

Dear participants,

Hello! I'm a student of the EU Erasmus Joint Master PLANET Europe project and I'm doing a research on the dockless bike sharing scheme (DBSS) in Beijing. Thank you for taking the time to complete this questionnaire. This survey is for academic research purposes only and has no commercial use. The purpose of this questionnaire is to study the characteristics of DBSS users in Beijing, the attitude of users to DBSS, and the characteristics of DBSS in Beijing, and the impact of DBSS on the city. This questionnaire is answered anonymously. The information in the questionnaire will be kept strictly confidential. The answers are only used for statistical analysis. Please rest assured to answer every question in the questionnaire truthfully. Thank you for your support!

#### I. Basic information

1. What is your gender?

A. Male B. Female

2. What is your age?

A. 0-20 B. 21-25 C. 26-30 D. 31-35 E. 36-40 F. 41-45 G. 46-50 H. 51-55 I. 56+

3. Where is your living place? \_\_\_\_\_

4. What is your highest degree?

A. Below secondary school B. High school C. Bachelor D. Master or above

5. What is your monthly income (after-tax, Rmb)?

A. No income B. 0-2500 C. 2500-5000 D. 5000-7500 E. 7500-10000 F. 10000-15000  
G. 15000+

6. What is your occupation?

A. Student B. Staff in public institution C. Staff in enterprise or corporate

D. Professional worker E. Service personnel F. Freelancer G. Retired H. Other \_\_\_\_\_

## II. Life and travel mode

7. How long does it take from your home to work? \_\_\_\_\_ min

8. How far is from your home to your working place? \_\_\_\_\_ kilometers

9. How much physical activities do your job requires?

A. Very little B. Little C. Moderate D. High E. Very high

10. Please select the types of vehicle(s) that you own. (multiple)

A. Private car B. Bicycle C. E-bike D. Motorcycle E. None F. Other \_\_\_\_\_

11. Please choose your main transportation mode in the city.

	On Foot	Cycling	Ebikes/ Motobikes	Public transport	Private cars
Before Beijing DBSS was launched, how did you usually <b>travel to work</b> ?					
Before ..... <b>travel for chores</b> ?					
Before ..... <b>travel for leisure</b> ?					
After Beijing DBSS was launched, how did you usually <b>travel to work</b> ?					
After ..... <b>travel for chores</b> ?					
After ..... <b>travel for leisure</b> ?					

## III. Shared bike usage

12. How often do you use the DBSS?

A. Nearly everyday B. Several times a week C. Several times a month

D. Very few time E. Nearly never

14. The distance that you normally use the shared bikes? \_\_\_\_\_ kilometers

15. The time that you normally use the shared bikes per day? \_\_\_\_\_ minutes
16. Which time periods do you usually use the shared bikes? (multiple)
- A. Before 7am B. 7-9am C. 9-11am D. 11am-1pm E. 1-3pm F. 3-5pm  
G. 5-7pm H. 7-9pm I. After 9pm
17. The reason that you start to use the DBSS. (multiple)
- A. Cheap B. Time-saving C. Convenient D. Healthy  
E. Environmental-friendly F. Trendy G. Other \_\_\_\_\_
18. The purpose that you normally use the DBSS. (multiple)
- A. Commuting B. Leisure C. Everyday works such as shopping  
D. Exercising E. Other \_\_\_\_\_
19. Can you find the available shared bikes when you need them?
- A. No B. Occasionally C. Normally D. Definitely
20. Where do you think are difficult to find the bikes? \_\_\_\_\_
21. Do you transfer to other transport when you use the DBSS?
- A. Yes B. Occasionally C. Always
22. What kind of transport do you transfer? (multiple)
- A. Bus B. Subway C. Car D. Other \_\_\_\_\_
23. Where do you normally park the shared bikes? \_\_\_\_\_
24. Where do you think are suitable to park the shared bikes? \_\_\_\_\_

#### IV. Attitude towards shared bikes

25. What do you think about the following views about shared bikes?	Strongly disagree				Strongly agree
It has influenced my lifestyle	1	2	3	4	5
It has increased numbers of my trips					
It has increased my willing to go out					
It has enlarged my travel space range					
It has reduced the time limit of my travel					
It has reduced my daily travel time					
It has reduced my travel budget					
It has decreased my dependency on other transportation					
The previous transportation could already fulfill my need before the launching of DBSS					
The current transportation could fulfill my need after the launching of DBSS					
The bicycle lanes in my city can fulfill my need					
The bicycle parking lots can fulfill my need					

The DBSS help to ease the traffic congestion					
The DBSS help to alleviate the environmental problem					
The DBSS helped to solve the “last mile” problem					
I’m optimistic about the DBSS’s future development					
I will continue use the DBSS in the future					
Compared to the DBSS, I prefer to use my own bicycles					
Compared to cycling, I prefer to other transportation mode					

26. The satisfaction with the DBSS	Very little				Very high
Satisfaction with the price of shared bikes	1	2	3	4	5
Satisfaction with the number of shared bikes					
Satisfaction with the quality of shared bikes?					
Satisfaction with the safety of shared bikes?					
Satisfaction with the distribution of shared bikes?					
Satisfaction with the parking of shared bikes?					
Satisfaction with the using the APP of shared bikes?					
Satisfaction with the error report rule of shared bikes?					

27. If you are unsatisfied with the DBSS, it is because of which following reasons? (multiple)

- A. No discontent
- B. The APP does not work properly
- C. The pedals or the chain do not work properly.
- D. Brake or the handle is not good.
- E. The lock is not work properly
- F. The seat is not comfort
- G. Couldn’t find the proper bikes
- H. Couldn’t find the parking place
- I. Cars do not care enough about cyclists.
- J. Too expensive
- K. Other \_\_\_\_\_

28. Please select the option that suits you	Never			Always
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How often have you seen uncivilized behavior when using the shared bikes in your way?	1	2	3	4
Will you stop those people if you see it?				
How often have you seen broken or wrongly parked shared bikes in your way?				
Will you report the broken bikes or the wrongly parked bikes?				

29. What problems do you think the shared bikes has brought?	Strongly disagree				Strongly agree
Poor access to other modes of transport	1	2	3	4	5
Disorderly chaos, affecting the city appearance					
Take up too much public space					
Riders do not abide by the rules, disrupting traffic order					
Riders do not take care of vehicles, causing a lot of damage to be lost					
Motor vehicle does not make concessions, riding is not safe					
Bicycle companies do not share maintenance repair recycling, resulting in waste of resources					

30. What solutions do you think could help the problems that shared bikes have brought?	Don't know	Not helpful	Not very helpful	Helpful	Very helpful
The government introduced a bicycle management regulations					
Improve bicycle infrastructure (eg. new parking lot, bicycle lane, signal lights)					
Relevant departments fine and disorderly parking and sabotage					
Enterprises guide the users through the reward and punishment mechanism					
Linked with personal credit					
Strengthen publicity and education					
Regulate and arrange parking with the community, offices and other sectors					

## Open questions

31. Do you have any opinion or suggestion on how to effectively control and share the bicycle?

32. Do you have any comments or suggestions on how to effectively manage shared bike companies?

33. Do you have any comments or suggestions on the future development of shared cycling?

34. If you are interested in further in-depth interview or the research outcome, please leave your email address.



### Annex 3 – Semi-structured Interview Script

Interview wee	Introduction	Script of questions
Mr. Wang (33min)	Chief officer of Innovation Center for Technology, Tsinghua University Planning and Design Institute Responsible	<ol style="list-style-type: none"> <li>1. In your opinion, how does the DBSS contribute to the sustainable mobility from environmental, economic and social aspects?</li> <li>2. How to avoid the negative impacts of DBSS?</li> <li>3. How to achieve a win-win situation, from the institutional perspective?</li> <li>4. What is each party's responsibility?</li> <li>5. Is there potential way to coordinate better?</li> <li>6. Are you optimistic about the future of DBSS?</li> </ol>
Mr. Spinney (27min)	Professor in Cardiff University, Expert on cycling and mobility	<ol style="list-style-type: none"> <li>1. In your opinion, how does the DBSS contribute to the sustainable mobility from environmental, economic and social aspects?</li> <li>2. How to avoid the negative impacts of DBSS?</li> <li>3. How to achieve a win-win situation, from the institutional perspective?</li> <li>4. What is each party's responsibility?</li> <li>5. Is there potential way to coordinate better?</li> <li>6. Are you optimistic about the future of DBSS?</li> <li>7. How do you see the DBSS's overseas expansion?</li> </ol>
Mr. Zhao (51min)	Volunteer of Mobike bike hunter	<ol style="list-style-type: none"> <li>1. Can you introduce your group - Mobike bike hunter? Organizer? Scale? How to participate? How does it operate? 2. How do people contact with each other?</li> <li>3. Why do you join the hunter group and what do you feel after you join it?</li> <li>4. What's the hunters' daily job? How do hunters work?</li> <li>5. Have you face any difficulties when volunteering? How do you solve it?</li> <li>6. Does the hunter group have any communication with the</li> </ol>

		<p>Mobike company and city's government?</p> <p>7. Are you optimistic about the future of DBSS?</p> <p>8. How to achieve a win-win situation, from the institutional perspective?</p> <p>9. What is each party's responsibility?</p> <p>10. Is there potential way to coordinate better?</p>
Ms. Sun (15min)	Community worker of Xidan Street office	<p>1. How do you value the DBSS as a community worker?</p> <p>2. What convenience and inconvenience has DBSS brought to your community?</p> <p>3. How does your community manage and control the DBSS in your community?</p> <p>4. Who is in charge of the DBSS management in your community?</p> <p>5. Is there any regulation or guidance from upper level authority?</p> <p>6. Has your community communicate with the DBSS company? And do you have any cooperation?</p> <p>7. Who is in charge of the DBSS management in your community?</p> <p>8. What's your suggestion and expectation?</p>