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The development of bike sharing in Shanghai: from emerging, boosting to shrinking

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Being a dissertation submitted to the Faculty of The Built Environment as part of the requirements for the award of the MSc Transport and City Planning at University College London: I, Yinxue Lyu confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Contents

List of Figures

List of Tables

Abstract

With the trend of global warming, replacing motor vehicles with other low emission mobility modes has become mainstream worldwide. A bike sharing scheme is a typical sustainable transport mode. Whilst much of the literature focuses on discussing the benefits, barriers, business model and other operational factors, most existing research also applied modelling to examine origins to destinations. However, the user's perspectives, which can play a significant role in developing a bike sharing scheme, are often being neglected. In order to fill the aforementioned research gap, the aim of this dissertation is to analyse the key factors which have impacts on the development of the bike sharing scheme in Shanghai from emergence, expansion to reformation. Semi-structured interviews are used to understand the story behind the development. Thematic analysis is used to analyse the specific factors that motivate or impede the implementation of the bike sharing scheme, and also give suggestions for improvements. The findings show that convenience, time saving and financial saving are the main reasons motivating users to use shared bicycles. At the same time, the bicycle problems, operational problems, financial controversies pose barriers to developing the bike sharing scheme in Shanghai sustainably. Under this condition, the interview findings also suggest that a public and private partnership may be the best option for running the bike sharing scheme with clear responsibility. In terms of policy implications, local governments and public sectors should have provided support for bicycle companies and integrate the bike sharing scheme into a wider transport planning system.

1. Introduction

1.1 Research background

Since Henry Ford manufactured the first automobile that most middle-class Americans could afford, transport in the 20th century went through an earth-shaking change (Ford, 1924). The high dependency on motors has caused a series of transport problems such as traffic congestion, shortage of parking areas, low level of well-being and liveability, air pollution, climate change and a high risk of traffic incidents (Banister, 2008; Hall, 2014; Hickman and Banister, 2014; Hickman et al., 2017; Newman and Kenworthy, 1999). An official report figures that nearly 40% of greenhouse gas emissions and 70% of environmental pollution in European cities is caused by motorized vehicles (European Environment Agency, 2010). Furthermore, the sedentary lifestyle-caused 'obesity epidemic' has posed threats to health (Pendakur, 2011; Woodcock et al., 2014). Thus, developing a sustainable mobility approach becomes important in terms of urban planning (Banister et al, 2000; Hickman et al., 2013). Sustainable mobility is normally associated with the reduced use of private vehicles and increased accessibility especially for low-income groups (Zhang et al., 2015). Sustainable mobility modes such as public transport, cycling and walking are encouraged, aiming to decrease travel frequency, travel length as well as reducing the carbon dioxide emission of motor vehicles, accelerating the development of sustainable travel (Banister, 2008; Hickman et al., 2009; Pucher et al., 2010).

Under this trend, replacing cars with shared bicycles has been regarded as an important approach in many cities of Europe, Asia and America to enhancing sustainable mobility especially in urban areas (Midgley, 2011; Pucher et al. 2010; Pucher and Buehler, 2012; Yang et al. 2010a). Shaheen et al. (2010, p.1) define the bike sharing system as an "environmentally friendly form of public transport" without responsibility to the bike ownership. Most of current sharing bike schemes provide short-term rental from docking stations to high frequency destinations (ibid). A public bike sharing scheme becomes a good option for existing cyclists and potential users because the subscription or rental costs are low (Martens, 2007). This new scheme has gained popularity due to its environmental, economic and social benefits, including the decreased CO2 emissions, cost savings, reductions of various diseases and improved cultural continuity

(Borjesson and Eliasson, 2012; Fishman et al., 2014; OECD, 2002; Shaheen et al., 2010; Zhang and Mi, 2018). According to the "Bike Sharing World Map", there have been 1328 bike sharing programs in operation worldwide, and there are 405 under construction in 2017 (DeMaio and Meddin, 2017).

In China, from the 1950s to the 1970s, bikes started to be used by citizens. From the 1980s to the turn of the 21st century, travelling by bicycle was the mainstream in Shanghai due to its flexibility, convenience and low cost (Akar and Clifton, 2009). During that period, it was estimated that over 400 million bicycles were in use. Since the 21st century, China has developed rapidly, and bicycles have been replaced by cars, motorbikes and public transport. China Statistical Bureau (2009) finds that the average bicycle ownership in China has decreased from 197 bikes/hundred households to 113 bikes/hundred households between 1993 to 2007. As a result, Shanghai suffered from over-dependency on private vehicles for travel, which posed a heavy burden on network capacity and led to high greenhouse gas emissions with serious air pollution (Zhang et al., 2015). Fortunately, the bike-sharing scheme has helped to change this situation and brought bicycles back to the centre stage. The governments and citizens are aware of these environmental issues, and opt for shared bicycles as a sustainable travel mode (Zhao, 2013). The bike sharing scheme even becomes a trend in many cities of China (O'Brien et al., 2014). At the end of 2016, Shanghai became the world's largest bike sharing city (Shanghai government, 2016) with 280,000 shared bicycles. However, in 2018, the number of shared bicycle reduced sharply (Xinhua, 2018). Thus, people may pay attention to barriers of developing the bike sharing scheme such as bicycle theft, limited supportive infrastructure, high expenditure of technology innovation, insufficient funding, safety issues, irregular operation and management process (Shaheen et al., 2011).

1.2 Research aim and questions

Overall, the bike sharing scheme in Shanghai evolved from emerging, boosting to shrinking. Building on users' perspectives, the dissertation will try to find out the motivating factors of bike sharing in economic, environmental and social aspects as well as the influential factors that have already hindered the implementation of the bike sharing scheme for further improvement. To achieve the stated aim, the dissertation

will assess the bike sharing scheme in Shanghai as a case study and will solve these research questions:

1. What are the motivating factors of using shared bicycles from users' perspectives?
2. What are the determinant factors making the bike sharing scheme in Shanghai go downhill from users' perspectives?
3. What can be done to improve the bike sharing scheme in Shanghai?

1.3 Structure of the dissertation

This dissertation focuses on a study of the bike sharing scheme in Shanghai as a new mobility approach. This dissertation consists of five chapters. Chapter 1 will introduce the research background, research aim and questions. Chapter 2 will review the existing literature on the development stage of bike sharing schemes, the benefits of bike sharing schemes and other influential factors. Then, it will identify the research gap for this dissertation. Chapter 3 will illustrate the rationality behind choosing Shanghai as a case study and introduce the background. Chapter 4 will explain the methodology for collecting and analysing data. Chapter 5 will show the research results and analyse the findings. Finally, Chapter 6 will conclude the findings and mention the contributions to practice and research. These may be helpful to develop a better bike sharing scheme in Shanghai.

2. Literature Review

2.1 The history of bike sharing schemes

Until now, it has been recognized that there are four generations of bike sharing schemes (Shaheen et al., 2010). DeMaio (2003, 2004) firstly identified three generations of bike sharing schemes. The first generation began on July 28, 1965, in Amsterdam with the White Bikes. Unlocked bikes were located in public areas for free use. Regulation and planning process were weak in that "free bike system" generation (Shaheen et al., 2010), so bikes were finally abandoned or stolen, leading to the failure of the program.

The second generation was born in 1991 in Farsø and Grenå, Denmark, and in 1993 in Nakskov, Denmark (Nielse, 1993) and became a large-scale program in Copenhagen in 1995. The Copenhagen bikes were featured for the coin deposit system. Compared with the first generation, this generation was more formalized with fixed stations, under the operation of a non- profit organization. However, neither the first nor the second bike sharing generation had a theft problem due to the anonymous user information. Thus, the later generations learned from them and improved the customer tracking system (DeMaio, 2003; DeMaio, 2004).

After improving the system, a new IT-based generation bike sharing scheme was born in 1996 at Portsmouth University and the launch of Vélib' in Paris with 7,000 bikes symbolized the technological improvements (Shaheen et al., 2010). This generation applied advanced technology including smartcards, on-board computers, mobile phone access, telecommunication systems and electronic locks. It was marked as a milestone in the development of bike sharing schemes and acted as a pioneer generation for bike sharing further expansion in terms of scale and location (Pucher et al., 2010).

The fourth generation is focused on the demand-responsive, multi-modal systems (Shaheen et al., 2010). The main goal is to improve the service to respond to user demands with improved efficiency, sustainability and usability, and integrate with wider transport services by smartcards (Frade and Ribeiro, 2014; Shaheen et al., 2010). Also, the technological mechanisms and price incentive systems are optimized to fulfil the innovation of bicycle demand-responsive relocations and self-rebalancing (Shaheen

et al., 2012). However, the fourth generation bike sharing scheme is still evolving that has not been fully developed (ibid).

2.2 The motivations of bike sharing schemes

The major social motivation of bike sharing schemes is to improve convenience and relieve traffic delay (Fishman et al., 2014; Sener et al., 2009; Shaheen et al., 2011; Shaheen et al., 2012; Transport for London, 2011). Commonly, bike sharing schemes provide point-to-point-trips, round-trips, and instant access through docking stations, which will facilitate the connectivity to and from public transits (Shaheen et al., 2012). Many researches have also proved that saving travel time is one of the economic motivations for using bike sharing schemes (Buehler and Hamre, 2014; Fishman et al., 2014; Martin and Shaheen 2014). The reduced travel time is always allied with improved connectivity between origins and destinations, including the first and the last mile travel distance (Shaheen et al., 2012). Hence, the savings on both commuting time and leisure time may contribute to extra working time and other economic benefits (Bullock et al., 2016).

Another important motivation of bike sharing schemes is about public health (Rojas-Rueda et al., 2013; Woodcock et al., 2014). Inactivity is estimated to add 150 to 300 euro per citizen to public health cost in developed countries (WHO, 2004). Under this situation, using shared bicycles is recommended for physical exercise. It will not only help to reduce expenditure on healthcare but also improve public health (Boland and Murphy, 2012). For instance, to keep riding a bicycle over 30 minutes a day may help to decrease the risk of heart disease, type-2 diabetes, breast cancer and colon cancer (Bize et al., 2007). It should be mentioned that health benefits outweigh health risks such as exposure to air pollution and traffic accidents (Woodcock et al., 2014). If local governments can lower the level of these risks, the health benefits may be greater (Otero et al., 2018). Although it is impractical to quantify all the health benefits brought by a bike sharing scheme, its distinct contribution to physical exercise on commuting and other trips really accounts.

The environmental motivation of bike sharing schemes is reduced energy consumption and emissions (Mi et al., 2017). The study of bike sharing schemes worldwide has shown that the figure of citizens who have transferred from travelling by private cars

to shared bicycles in Washington, D.C. and in Lyon is 16% and 7% respectively (Shaheen et al., 2010). As a result, 37,000 and 7,720 kilograms of carbon dioxide emissions per day are reduced (ibid). The positive environmental impacts of the bike sharing scheme are similar in Asia as well. As a developed city, Shanghai has witnessed rapid economic growth. Zhang and Mi (2018) estimate that CO_2 emissions from the transport sector is 42 Mt, accounting for 24 percent of total emissions in 2015. In fact, the bike sharing scheme in Shanghai saved "8358 tonnes of petrol and decreased CO_2 and NO_X emissions by 25,240 and 64 tonnes, respectively" in 2016 (Zhang and Mi, 2018, p.299). Although the data cannot cover all the environment benefits brought by bike sharing, it can show its sustainability.

In summary, Shaheen et al. (2010) summarize the benefits of bike share as "flexible mobility, emission reductions, physical activity benefits, reduced congestion and fuel use, individual financial savings and support for multimodal transport connections (quote from Fishman et al., 2014, p.14)". These five points are the core motivating factors of bike sharing schemes based on the literature. The growth of bike sharing schemes has made the wider public aware of their social, environmental, economic and health value. In terms of the users, which points are more attractive and convincing for them require more research to determine.

2.3 The determinant factors of bike sharing schemes

The overarching concern of a bike sharing scheme is the safety issue (Bernstein, 2014). In well-developed bike sharing countries such as Britain, North America and Australia, worries on safety issues become the main barrier to participating actively in the bike sharing program (Fishman et al., 2012a; Fishman et al., 2012b; Garrard, 2009; Horton et al., 2007). First of all, high cycling speed and people's unwillingness to wear helmets may result in severe crashes (Fishman, 2016; Hu et al., 2014; Schepers et al., 2014). Other concerns are listed as follows:

1. lack of attention towards cyclists;
2. limited bicycle infrastructure facilities;
3. traffic accidents with vehicles;

4. bad bicycle riding experience;

5. low level of cycling skills (Fishman et al., 2012a; Fishman et al., 2012b).

If bike sharing schemes are introduced with more supportive measures such as bicycle-protection infrastructure and value initiatives, it may create a friendly environment for riding shared bicycles (Buck and Buehler, 2011; Fishman and Schepers, 2018). For instance, local authorities can support public bike sharing through cycling infrastructure such as buffered bicycle lanes, bicycle tracks, and bicycle boulevards (Pucher and Buehler, 2005).

Next, are the socio-demographic and built environment factors (Rixey, 2013; Wang et al, 2012). Rixey (2013) has identified that socio-demographic factors such as job density, population density, education and income will play an important role in bike sharing schemes. In cities of Europe, North America, China and Australia, users will be much more willing to use the shared bicycle if the docking station is closer to them and easy to access (Fishman et al., 2014; Shaheen et al., 2012). For example, docking stations with food stores or restaurants nearby will attract more bike users than those with non-food-related businesses (Wang et al., 2012). In terms of built environment factors, Zacharias (2005) concludes that higher road density and larger block size will lead to a lower cycling percentage. Very often, lower job–housing balance, less diversity of land use or lower destination accessibility will cause the same consequence (Zhao, 2014). Thus, it is more useful to increase the number of stations than increase the existing stations' capacities (Imani et al., 2014).

Meanwhile, the culture-related factors can not be neglected (Aldred, 2013; Aldred and Jungnickel, 2014). "Good cyclist" is always associated with prowess and speed while "bad cyclist" is related with poverty and incompetence (Aldred, 2013). Aldred (2013) states that "good cyclists" are expected to possess a higher level of skills, knowledge and stuff, so "bad cyclists" are those who are failing to meet these requirements (Skinner and Rosen, 2007). Although cycling becomes a trend in many cities, in the society there still exists a stereotype of cyclists. An analysis by the Department for London (2010) revealed that: 1) cyclists often lack a sense of law and lack concern for their own and other road users' safety; 2) cyclists have low competence and knowledge of the road rules; 3) cyclists are unlicensed and uninsured. This interesting clarification

and stereotype of good and bad cyclists will lead to the form of hierarchy (Daley and Rissel, 2011). It shows that culture-related cycling discrimination poses a barrier to popularizing the wide usage of shared bike in the public for daily transport. In order to promote cycling under different contexts, Aldred (2013, p.268) advocates that "cycling with other social identities should be understood: culture (and politics) matters in shaping how cycling is understood and experienced differently by people of different classes, genders and races".

2.4 Other issues of bike sharing schemes

Many business models have been created for providing and managing the bike sharing services by wide stakeholders such as local governments, advertising agencies, transport agencies, for-profit and non-profit bike providers (DeMaio, 2009; Shaheen et al., 2010). An ideal bike sharing scheme business model has its own value that is based on making its riding service accessible and convenient, then selling them to local residents for solving last mile transport distance demands or to tourists for going sight-seeing or to companies for advertising their products on shared bicycles (Zhang et al., 2015). In fact, running a bike sharing scheme is very complex. Lewis and Roehrich (2009) find that developers are required to interact between infrastructural complexity such as hardware and transactional complexity such as knowledge. Overall, building a sustainable and effective business model ought to consider design, development, implementation and operation, relating to service design, infrastructure design and integration of wider transport planning (Shaheen et al., 2010).

A well organised bike sharing scheme also needs to consider the operational issues (Fishman et al., 2013; Fishman et al., 2014). The bike sharing systems are believed to provide real-time bicycle information, placing more bike sharing stations, improving bicycle maintenance, and enhancing bicycle antitheft technologies (Shaheen et al., 2011). In addition, as a great number of users rely on shared bicycle to access employment, it is crucial to rebalance the shared bicycle distribution properly. Bicycles inevitably become concentrated in business areas of cities, and many communities lack bicycles especially in peak hours (Fishman et al., 2013). In order to get rid of this predicament, operators should move bicycles across the network. For example, motorized trucks and vans can be used to re-distribute bicycles to different docking

stations throughout the day, to gain a relative equal distribution (Fishman et al., 2014). However, rebalancing by motor vehicles will add more greenhouse gas emissions (Fishman et al., 2013). As a result, some better approaches are suggested. Yang et al. (2010b) suggest offering rewards for users and encourage them to park the bicycle to docking stations with a low rate. Besides the incentives, Pfrommer et al. (2014) consider integrating intelligent technology to re-distribute the vehicles.

In order to popularize bike sharing schemes, policies play a significant role in increasing the use of the shared bicycle and reducing air pollution caused by motors (Zhang and Mi, 2018). The local government should work as a vital institution cooperating with operators to practice shared mobility (Akyelken et al., 2018). It will be better if the local government works as a promoter and user rather than a supervisor or regulator. The public sectors can also be the customer of bike sharing schemes and consider the usage of bike sharing systems when developing new urban projects. During the process of turning car dependency into a bike sharing culture, political leadership and ideologies will determine the outcome of bike sharing scheme (ibid). When policies focus on the responsibilities of private citizens, and encourage them to become self-regulating (Miller and Rose, 1990), this "hollow state" will "contribute to the ongoing failure to see cycling as part of the core transport network (Aldred, 2012, p.101)". Successful bike sharing schemes are normally subsidised by local government or other private companies such as advertisement agencies, cooperating to reduce greenhouse gas emissions, relieve traffic congestion, increase transport network accessibility and improve public health (DeMaio, 2004). In addition, an excellent bike sharing scheme requires interdependent, multi-embedded and intangible relations between stakeholders (Frow and Payne, 2011; Mills et al., 2013) as well as close partnerships between public transit and bike sharing schemes (Shaheen et al., 2012).

2.5 Summary

The development of bike sharing schemes has been an engaging topic in the existing literature. This dissertation mainly reviews the evolving stages of bike sharing schemes, the motivating factors of using shared bicycles, the determinate factors that will influence bike ridership, and other operational and political issues (see Table 1). The world has witnessed the rapid development of bike sharing schemes since 2016 and

there are many scholars who have investigated the bike sharing scheme. However, these papers mainly use quantitative methods (Mi et al., 2017) or choose cities of North America, Europe and Australia (Akyelken et al., 2018; Fishman et al., 2014; Midgley, 2011; Pucher et al. 2010; Pucher and Buehler, 2012; Shaheen et al., 2010; Shaheen et al., 2012;). In the context of China, most of the current literature studies the bike sharing scheme in Hangzhou (Shaheen et al., 2011; Yang et al. 2010b), but only a few studies have investigated the perspective of the users in terms of what attracts them to use shared bicycles and what impedes them from continuing this sustainable travel mode, in particular in the context of Shanghai. However, Shanghai is one of the most developing cities of China even in the world, which means that the bike sharing scheme in Shanghai should have its unique characteristics differing from other systems that are worth discussing. Thus, this dissertation aims to fill the gap, examining the bike sharing development of Shanghai.

Table 1 : summary of the literature review (source: by author)

Research topics	Key ideas	Key references	Key findings
The motivations of bike sharing schemes	1. convenient and time-saving 2. health benefits 3. environmental awareness	1. (Fishman et al., 2014; Shaheen et al., 2012) 2. (Rojas-Rueda et al., 2013; Woodcock et al., 2014) 3. (Mi et al., 2017; Shaheen et al., 2010)	1. It can either enable users to reach their destinations sooner than travelling by other public transport means or provide feeder services for public transit. 2. Cycling can reduce the risk of diabetes mellitus, certain cancers, mortality and cardiovascular diseases. 3. Compared to other transport modes, cycling can reduce a great amount of fuel use and greenhouse gas emissions.
The determinant factors of bike sharing schemes	1. safety issues 2. socio-demographic and built environment factors 3. culture-related factors	1. (Fishman et al., 2012a; Fishman et al., 2012b) 2. (Rixey, 2013; Wang et al, 2012) 3. (Aldred, 2013; Aldred and Jungnickel, 2014)	1. Safety concerns is the top reason why people hesitate using bike sharing schemes. 2. The closer docking stations are located to city attractions, the more people are willing to use shared bicycles. 3. A stereotype of cyclists poses barriers to popularizing bike sharing schemes.
Other issues	1. business models 2. daily operation 3. policies and strategies	1. (DeMaio, 2009; Shaheen et al., 2010) 2. (Fishman et al., 2013; Yang et al, 2010a) 3. (Akyelken et al., 2018; Shaheen et al., 2012)	1. An ideal business model should consider both internal factors such as the design of facilities, and external factors such as the sustainable growth. 2. Efficient management of delivery, implementation, maintenance, and rebalancing are all required. 3. Local governments should play a supportive role in operating bike sharing schemes with the operators.

3. Case study

Shanghai is located in the middle of China's east coast, with nearly 25 million residents living in 6340 Km^2 territory. The city central areas have around 1000 p/ha density and suburban areas have approximately 20 p/ ha density (Pan, 2017). Shanghai has a high level of private car ownership and one of every two citizens travels by car with 20% of trips in central Shanghai (ibid). The share of cycling declined from 67% in 1981 to 15.7% in 2015 (Zhang et al., 2015; Pan, 2017). After realizing the trend of global warming, bicycles are promoted again. The public bike sharing scheme provides dock-less bicycle rental services. The bicycles are located within bike parking areas planned by the local government. They are equipped with a microchip, a location based service system and theft prevention mechanisms. By using the mobile app, people can unlock the bicycle and are charged automatically according to the time of use (Ma et al., 2018).

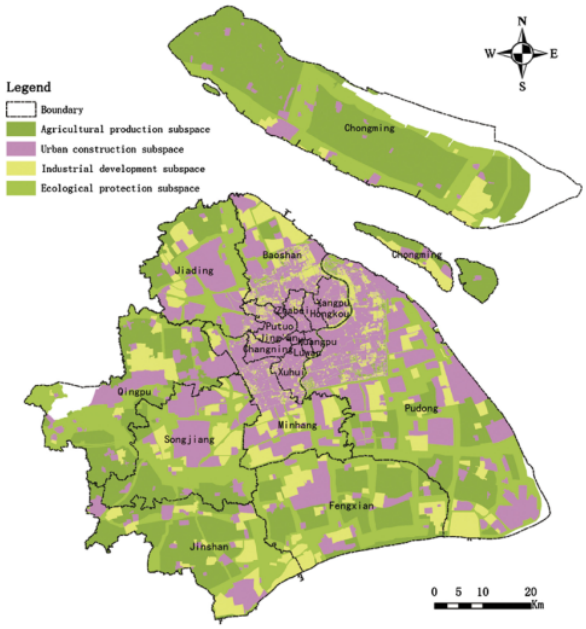

Figure 1 : case study map

(source: Shi et al., 2013, p.29)

The development of the bike sharing scheme in Shanghai has gone through stages from emerging, boosting to shrinking. A bike sharing program in Minhang district in 2009 was seen as a starting point. Then, the launch of the Mobike in April 2016 was regarded as the emergence of the bike sharing scheme in Shanghai. Attracted by the huge

business opportunities, numerous companies joined in the bike sharing scheme to share the market in 2017 (Figure1). The bike sharing scheme was spreading across five districts. There were 1.5 million shared bikes with 7.5 million registered users and Mobike and Ofo were two leading operators (Ma et al., 2018). However, the prosperity did not last stably. There appeared many problems such as an oversupply of bicycles, an unfair delivery of bicycles, a heavy burden on public resources, crowded streets and parking spaces. It was inevitable that the bottleneck period came due to the bad bicycle maintenance, the lack of regular operation and management, and the financial insufficiency. The bike sharing scheme has gradually declined since 2018 in terms of the frequency of use, the amount of delivery and the topicality. At present, Mobike has become the only shared bicycle company without bankruptcy.

Figure 2 : shared bicycle companies in Shanghai
(source: https://www.huxiu.com/article/214370.html)

Furthermore, the birth of the Shanghai bike sharing scheme coincided with the launch of the Shanghai 2035 master plan that aims to create a sustainable and innovative city. Also, according to the national Five Year Plan from 2006 to 2010, low carbon development has become the strategic priority in China (Qi, 2015). Shanghai is regarded as a pioneer city to implement the bike sharing scheme, as the local government has launched many policies to control private car ownership, and encourage using electric vehicles (Ma et al., 2017). With the joint effort of public and private sectors, Shanghai is moving on a more sustainable and low-carbon path (Bai et al., 2014)

The bike sharing scheme in Shanghai is worth analysing because it owns distinctive characteristics compared with other programs around the world. First, the bike sharing scheme of Shanghai is convenient, unconstrained and flexible. In this case, this mode can not only solve the first and last travel distance problems but also build a niche to twist the unsustainable transport development to sustainable trajectory (Cohen et al., 2016). Second, the bike sharing scheme in Shanghai is run by for-profit providers. The focus of these bicycle companies is economic benefits and business opportunities rather than the bike sharing scheme or sustainability namely, which is contrary to most public bike sharing schemes worldwide (Salice and Pais, 2017). Third, the bike sharing scheme in Shanghai depends on behavioural norms and public goods to keep stability, reliability and efficiency since it has been operated by private companies without many public interventions. As a consequence, major controversies are raised between commercial goals and operational issues such as road and parking space regulation, real-time services, theft prevention, unhealthy competition and over-speedy expansion. Researching these features and controversies may contribute new findings to existing studies.

4. Methodology

4.1 Semi-structured interview

This chapter outlines the methodology that was used to collect the data to answer the research questions of this dissertation. As Robson (2011) described, researchers must consider what kind of information is required, how to gain the information and what are the sources of information when choosing the research method. The dissertation responded to three questions:

1. What are the motivating factors of bike sharing schemes from the users' perspectives?

2. What are the determinant factors making the bike sharing scheme in Shanghai go downhill from the users' perspectives?

3. What can be done to improve the bike sharing mode in Shanghai in the following decade?

It was obvious that these questions seek to understand what people thought, felt and believed, so an interview was the best method (Robson, 2011). Bryman (2004) clarified three types of interview: structured interview, semi-structured interview and unstructured interview. Among them, the structured interviews were going through under the same question structure, order and phrase; semi-structured interviews covered a series of general questions but did not emphasize the order of questions; and the unstructured interviews only contained a series of topics rather than specific questions with different and informal structure.

It could be seen from this that this research emphasized words in terms of perspectives, explanations, feelings, descriptions rather than quantification of data (Bryman, 2008; Neuman and Lincoln, 2006). They were non-numerical data used for solving general research questions. It collected data by providing a series of questions "that are in the general form of an interview guide [with the ability] to vary the sequence of questions (Bryman, 2016, p.201)" among interviewees to address specific issues (Bryman, 2008). However, quantitative data collection methods used numerical data responding to structured research questions, conceptual frameworks and designs (Punch, 1998). After

comparing the rationale and the limitation of the qualitative and quantitative method, semi-structured interview was chosen for qualitative data collection (Ritchie et al., 2014).

The interviews were undertaken with clear thinking (Robson, 2002). When conducting the interview, the interviewer not only recorded and took notes of the interviews, but also held an open and critical attitude towards the collected words. Then, the interviewer integrated and structured the information, and eliminated the personal subjective opinions and biases.

4.2 Sampling

Semi-structured interviews were conducted in this research with 45 interviewees. Each interview lasted between 45 and 90 minutes. Aiming to find representative samples, the interviewees came from different working fields with differing life experience, age and gender. Some of them worked in the field of transport, economics, city planning, and some of them were common users who are students, teachers, doctors, engineers, etc. They could represent the wide user group of the bike sharing scheme in Shanghai (see Appendix A).

4.3 Interview questions

The findings of the interviews are discussed in the next chapter and interview questions are included in Appendix B. The main topics included within the interviews were as follows: the interviewees' understanding of the bike sharing scheme in Shanghai; the benefits of the bike sharing scheme; the key motivations for them to use shared bicycles; the current situation of the bike sharing scheme in Shanghai; the reasons for not using shared bicycles; the future improvements of the bike sharing scheme in Shanghai in terms of business behaviour, governmental behaviour and individual behaviour.

4.4 Thematic analysis

A six step thematic qualitative data analysis was a fundamental approach used for identifying the main themes of the key actors' perceptions. Then the researcher screened out the data to key ideas (Marshall and Rossman, 1999). The six step thematic

qualitative data analysis prescribed by Braun and Clarke (2006) was to identify, analyse and discuss the qualitative data relating to the research questions in a flexible, interpretable and concise approach. The six steps are shown as follows (Maguire and Delahunt, 2017):

1. Gain a comprehensive understanding of the content and become familiar with the data. This step provides the foundation for the subsequent analysis.
2. Organize the data in a systematic way and identify the preliminary codes.
3. Capture the significant information and code them into different themes.
4. Modify and develop the initial identified themes.
5. Identify the essence of each theme.
6. Finish the final report.

The process of data analysis was a continuous procedure, which may be simple when collecting the data, but became more complex during the thematic qualitative data analysis. So, the researcher recorded and summarized the key idea of each interviewee on each interview question. Then the researcher clarified the findings into three dimensions corresponding to three research questions. After defining and analysing the themes, the researcher gained a better understanding of the research questions based on the statements of interviewees. The qualitative data were identified into three themes. The first theme was the positive side of the bike sharing scheme in Shanghai relating to the first research question (interview question 3,4,6). The second theme was the negative side of the bike sharing scheme in Shanghai relating to the second research question (interview question 4,5,7). The third theme was the suggestions for improving the bike sharing scheme in Shanghai relating to the third research question (interview question 8,9,10).

4.5 Research ethics

The research followed four roles (American Psychological Association, 2019) to lower the level of ethic risks:

1. To obtain the consent from research participants;
2. To minimize the risk of doing harm to participants;
3. To ensure participants' anonymity and data's confidentiality;
4. To avoid deceptive practices.

The dissertation included semi-structure interview methodology, so the original data were assessed under these roles. Also, the analysis was objective and avoided discussing politically sensitive topics.

5. Findings and discussion

5.1 The positive side of the bike sharing scheme in Shanghai

5.1.1 Convenience

According to the interviews, it was found that convenience is the top motivation for using the bike sharing scheme. Convenience is shown in three aspects: 1) easy to find a bicycle; 2) easy to use the bicycle; 3) easy to reach the destination. In the city centre, there is a great number of delivered bicycles, so people can quickly find them. Basically, users can find shared bicycles of various brands at high demand locations such as Underground stations and business districts. Finding a bicycle in rush hours is very convenient, avoiding wasting time. Then, the registration process is simple, and users can finish all the process of locating, borrowing, locking, and paying on a mobile phone.

> *"Everyone who has a mobile phone can be a shared bicycle user, what you need to do is to download the app and register with your ID card number. You can know the location of bicycles on your mobile phone. After you make the reservation, the system will reserve for 15 minutes for you to find the vehicle. Scan the QR code on the bicycle, and the lock is automatically unlocked. The whole process only requires five minutes."*
>
> (Interviewee 20, 07/06/2019)

Sharing bicycles makes it easier to access short distance travel. This new mobility mode contributes to a better link to the destinations. For those who take the underground or bus to access employment, there would normally be several miles between the residence, working areas and underground/bus stations. In this case, using the shared bicycle to the destination rather than going on foot can greatly reduce the chance of being late. Also, the dock-less bicycle stations allow people to borrow and return the vehicle from different places without being concerned about the parking problems.

> *"The bike sharing scheme plays a significant role in solving the problem of "last mile" travel distance by providing flexible choices of rental locations based on customer's demand. Compared to private bicycles parked at the site, the bike sharing scheme really serves the wide public."*

(Interviewee 45, 15/06/2019)

5.1.2 Time saving

Time saving is another important reason why people are glad to use the bike sharing scheme. Due to the increased population and car ownership, the phenomenon of traffic congestion on roads and crowded underground stations is very common in developed cities such as Shanghai. Those who travel by car or bus are stuck on the road and people who take the underground have to wait for the next one. On the other hand, bicycles can go freely and flexibly without being detained by the traffic condition. Furthermore, undergrounds and buses can only operate on the fixed routines. On most occasions, both bus and underground routines cover several stops that are not on the shortest path to passengers' destinations. Riding a shared bicycle can shift themselves to the most direct and fastest approach. Thus, the shared bicycle users neither have to wait in line for a red light when suffering the traffic congestion nor waste time on the indirect routine.

> *"For the same distance, riding a shared bicycle can reach the destination in 10 minutes while driving may cost double time."*

(Interviewee 36, 12/06/2019)

> *"It is convenient to ride a bicycle in the city. Reaching the destination by riding a shared bike can save my waiting time since I do not need to wait for the bus. Instead of worrying about the traffic congestion, I can enjoy the freedom and fun of travelling."*

(Interviewee 2, 01/06/2019)

5.1.3 Financial saving

Besides time saving, using the shared bicycle can also save money. In Shanghai, the shared bicycle rental fee is less than one yuan per hour (0.11 pound), which is affordable to the wide public. On the one hand, for those who occasionally travel by bicycle, it is unnecessary to spend hundreds of dollars to buy a bicycle. On the other hand, for those who take a short trip within three kilometres, taking a taxi or taking other public public

transport modes will cost far more than one yuan. Considering the expenditure, the bike sharing scheme is absolutely the best option.

> *"The rental fee of the shared bicycle is relatively lower than any other public transport modes, so I feel happy to use it everyday."*
>
> (Interviewee 30, 10/06/2019)

> *"I choose to use the shared bicycle because of the low cost, and I do not need to pay for parking and daily maintenance."*
>
> (Interviewee 39, 13/06/2019)

5.2 The negative side of the bike sharing scheme in Shanghai

5.2.1 Bicycle problems

Contrary to the convenience brought by the dock-less bike sharing scheme, there is the unclear responsibility of both bicycle providers and users. The maintenance of a shared bicycle is poor, leading to the serious bicycle damage with high loss rate (Figure 2). For example, sometimes the bicycle seat is bad, and sometimes the lock can not be opened. To those "healthy" bicycles, they are also hard to ride because of the uninflated tires or other wear-and-tear components. Furthermore, due to the irregular operation mechanism of the shared bike scheme, the low-quality user's indecent behaviour cannot be effectively monitored. Users do not need to be responsible for their behaviour even if they break the bicycle or park it in wrong places since no one can track what they have done to the bicycle. Thus, there are many illegal activities such as the theft of shared bicycles for personal use, modifications or sale.

Figure 3 : scrapped shared bicycles in Shanghai

(source: https://web.shobserver.com/wx/detail.do?id=128912)

"Personally speaking, some shared bicycle users lack self-regulation and the bicycles lack maintenance. The loss rate of the shared bicycle in Shanghai is so high that I can often see damaged bicycles along the street. Besides, it will cause many inconveniences in rush hours if the user gets a bike in poor condition."

(Interviewee 9, 03/06/2019)

"I am really annoyed that some users decrypt the password to avoid the payment, and some users even hide the bicycle at their home for personal use. The bad behaviour really has a negative influence on the development of the bike sharing scheme in Shanghai."

(Interviewee 43, 15/06/2019)

5.2.2 Operational problems

The main controversy is about daily operation issues. The problems involve the unreasonable delivery of the bicycle, limited cycling facilities and the lack of regulation.

The bicycles are unevenly dispatched in different regions, there are excessive bicycles in the city centre, but few available bicycles in remote areas (Figure 3, 4). These suburban areas with high density exactly contain a wide range of shared bicycle user groups because suburban citizens are more dependent on the shared bicycle for transferring them to the public transport transits than those in the city centre.

Figure 4：excessive delivery of shared bicycles in the city centre

(source: http://www.changingtrip.com/M/N.aspx?Id=58545)

Figure 5 : few shared bicycles in the suburban areas
(source:http://sh.sina.com.cn/news/m/2017-08-26/detail-ifykiuaz0942726.shtml)

"The layout of bicycles is very unreasonable. Although the city centre is full of bicycles, they are hard to find in the suburbs. It often costs more than ten minutes to find a bicycle in these areas."

(Interviewee 25, 09/06/2019)

With the popularity of shared bicycles, this new type of travel mode has been accepted increasingly by people. However, Shanghai's transport planning sectors have not placed enough emphasis on the bike sharing scheme. There is a limited number of bicycle lanes and bicycle parking areas. Although the shared bicycle providers advocate that bicycles are required to be parked in the parking areas, it is difficult to find so many formal parking areas in daily use (Figure 5). Furthermore, the supervision and regulation of this scheme is insufficient. Without legislation and regulation, it is very common for users to park bicycles randomly in the wrong places, occupying public areas such as sidewalks, bus stops, green lands, and the entrance of underground stations (Figure 6,7). Since the public resources and spaces are limited, these operational problems will not only exacerbate the chaos and crowding of current transport system but also affect other motor vehicle users and pedestrians.

Figure 6 : official parking areas

(source: Spinney and Lin, 2018, p.79)

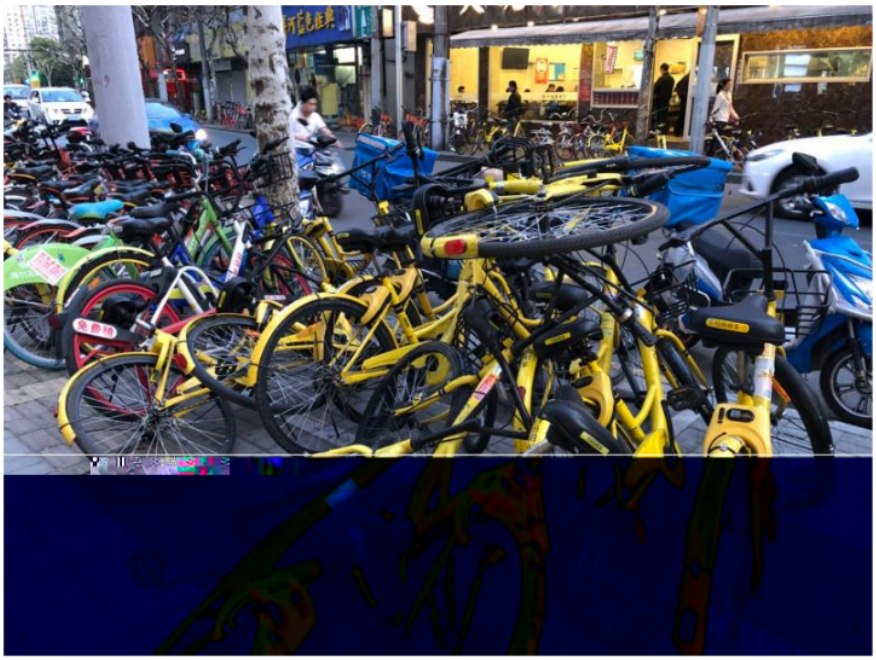

Figure 7 : parking areas without regulation
(source: https://images.shobserver.com/news/news/2018/4/24/6c190b87-4ea6-4f84-ab8e-2522e8ecf18f.jpg)

Figure 8 : an occupied pedestrian lane in Shanghai
(source: http://www.changingtrip.com/M/N.aspx?Id=58545)

"The phenomenon of arbitrarily parking is serious, resulting in a series of problems such as the occupation of public entrances, sidewalks and blind lanes. To those pedestrians, walking on the streets becomes interrupted, unsafe and inconvenient."

(Interviewee 27, 09/06/2019)

"At present, there are no supportive bicycle facilities such as well-planned separated bicycle routes. On the other hand, the non-motor vehicle legislation is weak in Shanghai. This phenomenon leads to an unsafe riding environment."

(Interviewee 33, 11/06/2019)

"I gave up using the shared bike due to the lack of cycling infrastructure, the unsafe road environment, etc. The regulation of the bike sharing scheme has to be the key consideration of the public transport planners."

(Interviewee 2, 01/06/2019)

5.2.3 Financial controversies

Another business model-related problem is its unsustainable and unfeasible business development model. Many small shared bicycle companies are unprofitable, and they cannot support themselves for long-term development for many reasons: 1) The operating cost and depreciation cost is high, which means they require a great amount of money to run the business; 2) The shared bicycle rental fee is low, which means they can not earn much money from users; 3) The bike sharing scheme in Shanghai is not subsidised by the local government so that they cannot gain incentives from the public sectors; 4) The bike sharing market entry threshold is low, so the competition among shared bicycle providers is fierce. Under this complex market environment, many companies become bankrupted. The number of bicycles has dropped significantly and rental fee has risen substantially. At this time, members of these bankrupted companies cannot get their deposit back, remaining users have to afford the increased rental fee.

"The business model of the bike sharing scheme is unsteady with high risk. It cannot guarantee the survival from the market shuffling, which will affect users."

(Interviewee 24, 08/06/2019)

"There exists vicious competition between various shared bicycle companies, which has led to lower prices and worse service. Fewer and fewer people would like to continue using it."

(Interviewee 31, 11/06/2019)

5.3 Suggestions for further improvement

5.3.1 Suggestions for the business development

Based on the findings of interviews, almost all interviewees mentioned that the public and private partnership is recommended for the bike sharing scheme. Social capital is still the shared bicycle service provider, but rational mergers and acquisitions will play an important role in maximizing the use of public resources. Private enterprises are mainly responsible for the daily operations. The local government and other public sectors should support private enterprises in terms of policy and management and encourage this environmental-friendly transport mode to reduce carbon emissions. Under this condition, private companies will respond positively. Moreover, it is not a wise business decision to invest too much capital in the shared bicycle market in a short period to earn profits. The companies need to get rid of the inherent business mode that focuses on seizing the market share, instead, they should seek a more effective way to ensure sustainable and stable development. Different brands ought to focus on various user groups and provide differentiated services such as providing sports bicycles, disabled bicycles. Overall, the transport problem is also a livelihood issue. The public and private partnership will accelerate the growth of this sustainable mobility mode.

"I feel that the government has to participate actively in the bike sharing scheme. I think that the main purpose of developing the bike sharing scheme is to serve people instead of chasing profit."

(Interviewee 35, 12/06/2019)

"In term of business development, it is recommended that the companies should cooperate with the government, mainly to ensure that the bicycle can be more standardized and regulated in the public space."

(Interviewee 11, 04/06/2019)

"This service cannot be driven by capital market namely. To continue developing, I believe that we must return to the public and private partnership mode, even the government-led mode. Public institutions can be served by private companies in a contractual model to ensure that services are prioritized by the public."

(Interviewee 45, 15/06/2019)

5.3.2 Suggestions for the daily operation

There are many complaints about the daily operation. Interviewees gave some suggestions for improving the service of the bike sharing scheme and eliminating the bad behaviours of low quality users. On the one hand, enterprises have to update the bicycles, guarantee the high-quality riding experience, improve the real-to-time location technologies and solve the deposit controversies. By analysing the user demands, the bicycle providers can accurately grasp the high-demand bicycle areas and deliver the vehicle. The delivery of the bicycle should also pay more attention to the suburban areas where the supply of bicycles is far below the demand. It is worth noticing that the quantity of bicycles should not outweigh the transport capacity, equipped with bicycle managers and repair stations. In addition, the companies may increase payment methods for the elderly and others who are not able to use the mobile phone. For instance, they can use the metro card or credit card.

"The companies need to improve the reliability of bicycles. They may do the maintenance in winter when fewer people use the bicycle."

(Interviewee 6, 02/06/2019)

"They should increase the coverage of the shared bicycle, especially at factories, schools, and enterprises that are far from the underground station."

(Interviewee 23, 08/06/2019)

On the other hand, a good bike sharing scheme not only requires the effort from the bicycle companies but also needs cooperation from users. To relieve the parking problems, only relying on users to standardize their own behaviours is not sufficiently effective. The bike sharing scheme must have a reward and punishment system. It means that good users who always park the bicycle at pointed areas can receive rewards such as a free-ride opportunity for one time, while bad users who throw the bicycle randomly or destroy the bicycle or hide the bicycle for personal use should get penalties such as the reduction of social credit score or doubled rental fee for the next ride. If the score is lower than standard, then they cannot use the shared bicycle anymore.

"The bicycle companies should filter the users, and say "no" to people with low credit. They can double the payment for those who have uncivilized behaviour."

(Interviewee 20, 07/06/2019)

"Incentives are required. Some well-behaved users can get a bonus stored at their online wallet or they can get discounts on bus or underground within half an hour after using the shared bicycle."

(Interviewee 31, 11/06/2019)

5.3.3 Suggestions for the local government

The discussed problems and controversies emphasise the importance of the government's participation. In order to fulfil the potential of the bike sharing scheme in Shanghai, all interviewees highlighted that the local government has to improve the current transport system in terms of facilities, policies and strategies to settle the bike sharing scheme as a long-term alternative for mobility. From the big picture, the objectives can be optimizing the urban transportation system, promoting the convenience of citizens, encouraging the sustainable travel mode and clarifying the function of shared bicycles in urban transportation.

In term of facilities, the government should design more parking areas, so that users will be more willing to return to these points without going around. More separated cycling lanes are required to guarantee the safety of shared bicycle users. Elevators or slopes can be built for transferring the bicycle upstairs and downstairs. Bicycle stations can be added at the roadside for taking shelter from the rain. Community-organised or government-organised groups are suggested to mitigate the parking chaos.

Since the bike sharing scheme involves multiple departments, the responsibilities of each department should be implemented clearly and transparently. In response to the bike sharing scheme, the role of the government is defined as not only a supervisor but also a user. They should formulate new legitimations including operation regulations, safety regulations, big data management and environmental remediation. For instance, the government can facilitate the market threshold to ensure an orderly operation, provide better public services and reduce the negative influence on pedestrians and motor vehicles. Moreover, they should cooperate with bicycle companies to set industry standards, and supervise the recycling of old bicycles and the updating of new bicycles with unified standards.

> *"It will be better if the bike sharing scheme is a public project. The public sectors will build bicycle friendly facilities such as bike lanes and establish related laws for protecting the rights of cyclists."*
>
> (Interviewee 11, 04/06/2019)

> *"The shared bicycle services must have an official guidance from local governments on parking locations, quantity of bicycles, and maintenance of bicycles just like underground services or bus services, avoiding the unsufficient allocation of public resources."*
>
> (Interviewee 24, 08/06/2019)

> *"Introducing corresponding shared bicycle management regulations will help to develop a more orderly city and ensure that these companies are serving the public."*
>
> (Interviewee 40, 14/06/2019)

6. Conclusions

6.1 Summary

The bike sharing scheme is a sustainable transport mode. This new mode can not only meet the first and last mile transport distance mobility needs but also provides citizens with a new type of convenient, economically efficient, well-managed and eco-friendly way of travel mode rather than other public transit services such as the underground or bus services. In Shanghai, it is also seen as a new practice of a sharing economy. It objectively has improved the efficiency of bicycle usage, and plays an important role in reducing urban resource waste and saving urban space. All the society, government and bicycle companies gain benefits from this new mode. However, most bicycle companies in Shanghai seek to capture revenues from the market for investment or financing and the local government plays little role in management. As a consequence, there remain many problems in terms of operation, management, financial safety and user experience. That is why the bike sharing scheme in Shanghai went downhill after 2018. In order to make the bike sharing scheme a better mode and finally becomes a part of the transport system, local governments should give more supports, bicycle companies should develop a more feasible business model, and the users should standardize their behaviour. This is a three-party-partnership to make the bike sharing scheme a sustainable success.

6.2 Key findings

6.2.1 Response to objective 1

From these interview findings, it can be seen that Shaheen's arguments about benefits of the bike sharing scheme are very comprehensive and reasonable (Shaheen et al., 2010).

Table 2 : perspective of users and comment on the literature

(source: by author)

Literature	Interview findings

Flexible mobility supporting for multimodal transport connections	The bike sharing scheme is convenient and easy to access, helping to solve the short-distance traffic problems and alleviate public transportation pressure.
Reduced congestion and fuel use	The bike sharing scheme has a positive impact on reducing car dependence and relieves parking problems, traffic jams, etc.
Individual financial savings	The bike rental price is low and everyone has an access to it.
Physical activity benefits	Riding a bike can develop a more healthy lifestyle.
Emission reductions	The Bike sharing scheme is an environmentally friendly and low-carbon travel mode.

I discovered that the top three reasons why people choose the bike sharing scheme in Shanghai are convenience, time saving and financial saving. This is compliant with the current literature (Buehler and Hamre, 2014; Fishman et al., 2014; Martin and Shaheen 2014; Sener et al., 2009; Shaheen et al., 2011). Furthermore, the interviewees have acknowledged that the bike sharing scheme impacts both mental and physical health positively, and the development of the bike sharing scheme also contributes to a more sustainable city. However, these health benefits and environment benefits do not become the main motivation for people to use the shared bicycle, which is different with the researches in Western cities (Rojas-Rueda et al., 2013; Transport for London, 2011; Woodcock et al., 2014). The users in Shanghai are more concerned more about these visible, close relative and short term benefits.

6.2.2 Response to objective 2

From the interviews, I conclude that the bicycle problems, the inferior operation and management, and the unfeasible business model form the main reasons why people give

up using the shared bicycles and why the bike sharing scheme in Shanghai has gone downhill. This is different from the literature. The existing literature emphasises the safety concern, the socio-demographic and built environment factors, and the bias of cyclists (Aldred, 2013; Fishman et al., 2012a; Rixey, 2013). In Shanghai, users do not consider these factors are such a determinant. However, the fast-food style business model of the bike sharing scheme that seeks to provide services and earn money in a short time and the lack of reliable management from public sectors are the originations of the following problems. Neither the companies nor the public sectors take the charge of maintaining, supervising and regulating the operation of the bike sharing scheme. Under this case, the bicycles are over-launched, the streets are more crowded, the illegal behaviour of some users is indulged and the right and safety of the users are unprotected. These factors have accelerated the shrinkage of this new mode.

6.2.3 Response to objective 3

On the basis of the interviewees' perspective, the bike sharing scheme requires the collaboration between public and private stakeholders involving users, bicycle companies, and local governments. It can be seen that the findings comply with the literature, also the literature provides the guidance for improving the bike sharing scheme in Shanghai (Shaheen et al., 2012; Zhang et al., 2015). Public sectors should incorporate the bike sharing scheme into the urban transport planning to form a cycling-friendly city. The government should formulate targeted policies and strategies, create more infrastructure for bicycle users, keep the healthy competition between the bicycle companies to support the development of the bike sharing scheme. Bicycle companies must adopt a sustainable business model to improve the shared bicycle service, including updating the bicycle, applying advanced technologies and managing the daily operation. It is important to guide the users to comply with regulations by self-regulation, and strengthen their awareness of taking good care of shared bicycles and parking bicycles in the right areas by a reward and punishment system. The joint effort between local governments, bicycle companies and users is a key factor to develop a more sufficient and successful bike sharing scheme.

6.3 Research contributions

This dissertation fills the gap in the bike sharing scheme in the context of Shanghai. It discusses the motivations for using the bike sharing scheme and also the problems that hinder the users from continue to use this new mode. The findings came from the users' perspective because the public is the main stakeholder who take part in and gain benefits from the bike sharing scheme. This research makes a comprehensive study on both the positive sides and the negative sides of the bike sharing scheme, and also provides some suggestions based on the current problems in the context of Shanghai. The previous literature did not include such an investigation, but focuses on a branch of the bike sharing scheme instead of seeing the whole stage from emerging, boosting, shrinking to improving (Ma et al., 2018; Zhang et al., 2015; Zhang and Mi, 2018). Furthermore, it enriches the knowledge pool of the sustainability of the bike sharing scheme. The results indicate that the bike sharing scheme exactly has great benefits in aspects of environment, society and economy. Unlike the safety concerns, the socio-demographic factors and other culture-related factors, the bike sharing scheme in Shanghai has many operational problems. Some of these problems can seriously influence the implementation of this new scheme such as the lack of maintenance, management, regulation and supervision. Under this situation, the dissertation explores the responsibility of the local government, bicycle companies and users. It turns out that public and private partnership may be helpful to relieve these problems and improve the sustainable development of the bike sharing scheme in Shanghai, which is a relatively new area of research.

6.4 Policy implications

The rapid growth of the bike sharing scheme in Shanghai has profoundly affected the urban public transport system and the new mode not only brings positive benefits, but also causes negative barriers. Since the government has acknowledged the effect of the bike sharing scheme, they should integrate the bicycle travel planning with the traditional transport planning system, turning some of the focus on planning for motorized transportation such as cars and public transportation to planning for bicycles. For example, the planners can learn from Copenhagen and Amsterdam where travelling by bicycle has become the mainstream. It is important to facilitate the bike sharing scheme with a well-developed bicycle infrastructure including the protected bicycle lane system and sufficient parking areas. The local government can organise shared

bicycle activities such as a "shared bicycle festival" for education and promotion, encouraging all citizens to use shared bicycles. On the other hand, people have noticed the negative sides of the shared bicycle services. The bike sharing scheme without strong management has brought tremendous pressure to both transport system and living standards. Therefore, effective legislation and regulation, official bicycle managers, multiple reward and punishment methods are advised to maximize the value of the bike sharing scheme and alleviate its negative effects. Decision makers ought to gain an in-depth understanding of the context specifications, and create a good bike sharing scheme as expected.

6.5 Limitations and further research

The data collecting from the semi-structured interviews helps us to understand the bike sharing scheme in Shanghai but there still remain three key limitations of this research methodology. First, the choice of interviewees may not fully represent all shared bicycle users. Only 45 interviewees are involved due to the limited research time and resources. Their statements are normally based on their knowledge and experience instead of academic research, which means that bias may exist. Second, the bike sharing scheme in Shanghai is very complex and unique (i.e., the for-profit business model and flexible dock-less stations). Thus, the finding of this research has a close relationship with the local context but it may not be feasible under other contexts. Third, the dissertation can not list all the positive sides and negative sides of the bike sharing scheme, and cannot provide very detailed suggestions due to the word limit.

These limitations can be eliminated through further research. First, it would be much better to reflect the perspective of the users by arranging a more diverse and wider range of interviews. Second, further research can compare the bike sharing scheme in Shanghai with that in London, New York or other cities to find out the commonalities and differences based on different contexts. Third, this study provides directions for future study. For example, in the future, researchers can use quantitative methods to investigate the impact of the specific factors and build a framework for guiding the development of the bike sharing scheme.

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Appendices

Appendix A: interviewees information

number	sex	age	job
1	female	36-40	trader
2	male	36-40	teacher
3	female	36-40	clerk
4	male	31-35	teacher
5	female	31-35	astro-engineer
6	male	31-35	sales
7	female	31-35	teacher
8	male	36-40	product manager
9	female	31-35	accountant
10	female	46-50	clerk
11	female	31-35	financial analyst
12	female	46-50	financial analyst
13	female	21-25	clerk
14	female	41-45	researcher
15	female	36-40	financial analyst
16	male	36-40	IT engineer
17	male	46-50	transportation engineer
18	male	31-35	financial analyst
19	male	31-35	audit executive
20	male	41-45	IT engineer
21	male	46-50	none

22	male	40-42	doctor
23	female	21-25	student
24	male	31-35	manufacturing engineer
25	male	31-35	sales
26	female	31-35	transport planner
27	female	46-50	electric engineer
28	male	31-35	accountant
29	male	46-50	manufacturing engineer
30	male	26-30	estate agent
31	female	41-45	housewife
32	male	36-40	doctor
33	female	21-25	student
34	male	21-25	transportation engineer
35	male	26-30	doctor
36	male	21-25	investment manager
37	male	21-25	transportation engineer
38	male	21-25	transport planner
39	female	21-25	transport planner
40	female	21-25	student
41	male	41-45	architect
42	male	36-40	architect
43	female	26-30	financial manager
44	male	31-35	city planner
45	male	31-35	researcher

Appendix B: Semi-structured interview questions

Interview questions	Research questions met	Existing literature
Have you used a shared bike in Shanghai?	1,2,3	N
What is your understanding of a bike sharing scheme?	1,2,3	(DeMaio, 2009; Shaheen et al, 2010)
What did the bike sharing scheme bring about to Shanghai?	1	(Ma et al., 2018; Zhang et al., 2015)
Can you share your experience of using a shared bike in Shanghai?	1,2	N
From your view, what is the current status of the bike sharing scheme in Shanghai?	2	N
Based on your experience, what facilitated you to use the shared bike in Shanghai (such as convenience, low price, time saving, health benefits, emission reduction, etc.)?	1	(Fishman et al., 2014; Shaheen et al., 2012; Woodcock et al., 2014)
Based on your experience, what impeded you from using the shared bike in Shanghai (such as lack of safety, bad air quality or bad weather, shared bike-unfriendly built environment, bike	2	(Aldred, 2013; Fishman et al., 2012a; Rixey, 2013)

problems, operation and management problems, culture-related issues, financial issues, etc.)		
Your suggestions for improving the bike sharing scheme in term of daily operation	3	(Shaheen et al., 2011; Fishman et al, 2014)
Your suggestions for improving the bike sharing scheme in term of business development	3	(Shaheen et al., 2010; Zhang et al., 2015)
In your opinion, what is the role of the government to improve the bike sharing scheme in Shanghai?	3	(Akyelken et al., 2018; Shaheen et al., 2012)

Appendix C: Risk assessment form

RISK ASSESSMENT FORM

UCL

FIELD / LOCATION WORK

The Approved Code of Practice - Management of Fieldwork should be referred to when completing this form

http://www.ucl.ac.uk/estates/safetynet/guidance/fieldwork/acop.pdf

DEPARTMENT/SECTION BARTLETT SCHOOL OF PLANNING

LOCATION(S) UCL

PERSONS COVERED BY THE RISK ASSESSMENT Yinxue Lyu

BRIEF DESCRIPTION OF FIELDWORK semi-structure interview by phone

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.

If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.

Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT	**The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard**
e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.	Examples of risk: adverse weather, illness, hypothermia, assault, getting lost. Is the risk high / medium / low ? Low

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
☐	work abroad incorporates Foreign Office advice

☒	participants have been trained and given all necessary information
☐	only accredited centres are used for rural field work
☐	participants will wear appropriate clothing and footwear for the specified environment
☐	trained leaders accompany the trip
☐	refuge is available
☐	work in outside organisations is subject to their having satisfactory H&S procedures in place
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES	**Where emergencies may arise use space below to identify and assess any risks**
e.g. fire, accidents	Examples of risk: loss of property, loss of life

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
☐	participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
☐	fire fighting equipment is carried on the trip and participants know how to use it
☒	contact numbers for emergency services are known to all participants
☒	participants have means of contacting emergency services
☒	participants have been trained and given all necessary information
☐	a plan for rescue has been formulated, all parties understand the procedure
☐	the plan for rescue /emergency has a reciprocal element
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EQUIPMENT	Is equipment used?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	the departmental written Arrangement for equipment is followed
☐	participants have been provided with any necessary equipment appropriate for the work
☐	all equipment has been inspected, before issue, by a competent person
☐	all users have been advised of correct use
☐	special equipment is only issued to persons trained in its use by a competent person
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	Is lone working a possibility?	YES	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. alone or in isolation lone interviews.	Examples of risk: difficult to summon help. Is the risk high / medium / low?		

Lone interview

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	the departmental written Arrangement for lone/out of hours working for field work is followed
☐	lone or isolated working is not allowed
☐	location, route and expected time of return of lone workers is logged daily before work commences
☒	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
☒	all workers are fully familiar with emergency procedures
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.
e.g. accident, illness, personal attack, special personal considerations or vulnerabilities.	Examples of risk: injury, asthma, allergies. Is the risk high / medium / low? Low

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	an appropriate number of trained first-aiders and first aid kits are present on the field trip
☐	all participants have had the necessary inoculations/ carry appropriate prophylactics
☒	participants have been advised of the physical demands of the trip and are deemed to be physically suited
☐	participants have been adequate advice on harmful plants, animals and substances they may encounter
☐	participants who require medication have advised the leader of this and carry sufficient medication for their needs
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT	Will transport be required	NO	N	Move to next hazard
		YES		Use space below to identify and assess any risks
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training Is the risk high / medium / low?			

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	only public transport will be used
☐	the vehicle will be hired from a reputable supplier

☐	transport must be properly maintained in compliance with relevant national regulations
☐	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
☐	drivers have been trained and hold the appropriate licence
☐	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
☐	sufficient spare parts carried to meet foreseeable emergencies
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC	**Will people be dealing with public**	**YES**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
☒	all participants are trained in interviewing techniques
☐	interviews are contracted out to a third party
☐	advice and support from local groups has been sought
☒	participants do not wear clothes that might cause offence or attract unwanted attention
☐	interviews are conducted at neutral locations or where neither party could be at risk
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR NEAR WATER	Will people work on or near water?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks

e.g. rivers, marshland, sea. Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

- ☐ lone working on or near water will not be allowed
- ☐ coastguard information is understood; all work takes place outside those times when tides could prove a threat
- ☐ all participants are competent swimmers
- ☐ participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
- ☐ boat is operated by a competent person
- ☐ all boats are equipped with an alternative means of propulsion e.g. oars
- ☐ participants have received any appropriate inoculations
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	Do MH activities take place?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	the departmental written Arrangement for MH is followed
☐	the supervisor has attended a MH risk assessment course
☐	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
☐	all persons performing MH tasks are adequately trained
☐	equipment components will be assembled on site
☐	any MH task outside the competence of staff will be done by contractors
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

SUBSTANCES	**Will participants work with substances**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

☐ the departmental written Arrangements for dealing with hazardous substances and waste are followed

☐ all participants are given information, training and protective equipment for hazardous substances they may encounter

☐ participants who have allergies have advised the leader of this and carry sufficient medication for their needs

☐ waste is disposed of in a responsible manner

☐ suitable containers are provided for hazardous waste

☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS	**Have you identified any other hazards?**	**NO**	**If 'No' move to next section** **If 'Yes' use space below to identify and assess any risks**
i.e. any other hazards must be noted and assessed here.	Hazard: Risk: is the risk		

CONTROL MEASURES	**Give details of control measures in place to control the identified risks**

Have you identified any risks that are not adequately controlled?	**NO**	☒	**Move to Declaration**
	YES	☐	**Use space below to identify the risks and what**