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Investigating users' perspectives on the development of bike-sharing in Shanghai

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Abstract

High levels of car dependence have caused tremendous challenges for sustainable transport development. Transport planners, therefore, seek ways of replacing motor vehicles, as well as increasing the proportion of active travel. The bike-sharing scheme can be seen as an effective way of doing so, particularly in Asian cities. The aim of this paper is to investigate users' perspectives on the development of bike-sharing using Shanghai as an example. Semi-structured interviews are used to examine the main factors motivating and impeding the development of the bike-sharing scheme in Shanghai. Our findings show that convenience, saving time and financial savings are the major motivations; whereas problems with bicycles being poorly maintained and abused by users, operational issues, financial issues and an unsuitable business model are the major obstacles. In addition, the findings also suggest that a public and private partnership could be the best option for running a sustainable bike-sharing scheme with clear areas of responsibility. Financial incentives, a bicycle-friendly infrastructure, regular operational management and supportive policies should be prioritised. In order to achieve the targets set by the Shanghai Master Plan 2035, transport planners and policymakers should integrate the bike-sharing scheme within the wider active travel system.

Keywords

Sustainable transport development; Transport planning; Active travel; Bike-sharing; Transport policy; Shanghai

Highlights

- Convenience, saving time and financial savings are the major reasons motivating people to use shared bicycles.
- Problems with bicycles being poorly maintained and abused by users, and operational issues are the major obstacles.
- A public and private partnership could be the best option for running a sustainable bike-sharing scheme.
- Financial incentives, a bicycle-friendly infrastructure and supportive policies should be prioritised.

1. Introduction

Recent transport policies have focused on addressing car-dependence related problems such as traffic congestion, traffic incidents, air pollution, climate change and low levels of well-being and liveability (Banister, Akerman, Nijkamp, Stead, Dreborg, & Steen, 2000; Cao, Chen, & Hickman, 2017; De Vos, 2018; Hickman & Banister, 2014; Hickman, Lopez, Cao, Mella-Lira, & Biona, 2018). Policies based on ‘push and pull’ measures have been introduced to fulfil sustainable transportation policy requirements (Nocera & Cavallaro, 2011). As a new means of mobility, the bike sharing scheme has been encouraged by policymakers in order to decrease travel frequency and travel duration, as well as reducing the carbon dioxide emissions associated with motor vehicles, thus accelerating the development of sustainable travel (Banister, 2008; Chan & Yao, 2008; Hickman & Banister, 2014; Pucher, Dill, & Handy, 2010; Zhang & Mi, 2018). Bicycle-sharing schemes provide short-term rental from docking stations to highly-frequented destinations without responsibility for bike ownership (Shaheen, Guzman, & Zhang, 2010). Currently, policymakers in many cities in Europe, Asia and America regard shared bicycles as offering a new and important approach to enhancing sustainable mobility, especially in urban areas (Attard & Shiftan, 2015; Midgley, 2011; Pucher, Dill, & Handy, 2010; Pucher & Buehler, 2012; Yang, Sahlqvist, McMin, & Griffin, 2010). Bicycle-sharing schemes have gained popularity due to the range of benefits they offer: a decrease in CO₂ emissions, cost savings, reductions in various diseases and improved cultural continuity¹ (Borjesson & Eliasson, 2012; Fishman, Washington, & Haworth, 2014; OECD, 2002; Shaheen, Guzman, & Zhang, 2010; Zhang & Mi, 2018).

This paper aims to enrich the knowledge pool about bike-sharing schemes using the case of Shanghai. From the 1980s up to the turn of the twenty-first century, the bicycle was the traditional method of travel in Shanghai due to its flexibility, convenience and low cost (Akar & Clifton, 2009). Since the beginning of the twenty-first century, however, China has developed rapidly, and bicycles have gradually been replaced by motor vehicles. Average bicycle ownership in China decreased from 197 bikes per hundred households in 1993 to 113 bikes per hundred households in 2007 (China Statistical Bureau, 2009). In Shanghai, cycling as a proportion of overall travel also declined from 67% in 1981 to 15.7% in 2015 (Pan, 2017; Zhang, Zhang, Duan, & Bryde, 2015). The over-dependency on private vehicles for travel has led to increased traffic congestion, high levels of greenhouse gas emissions and serious air and noise pollution during the same period (Zhang, Zhang, Duan, & Bryde, 2015). Fortunately, the advent of the bike sharing scheme in Shanghai coincided with the launch of Shanghai’s 2035 Master Plan which aims to create a more sustainable city (Ma, Lan, Thornton, Mangalagu, & Zhu, 2018). Local authorities now regard reducing car dependency and promoting sustainable travel as a priority (Bai, Shi, & Liu, 2014; Qi, 2015). Against this background, the bike-sharing scheme in Shanghai created a means of transforming unsustainable transport development into a sustainable trajectory (Cohen, Almirall, & Chesbrough, 2016). Shanghai became the world’s largest bike-sharing city with 280,000 shared-bicycles at the end of 2016 (Shanghai government, 2016). Subsequently, 13 shared bicycle companies entered the bike-sharing market and made more than 1.7 million shared bicycles available between January and August 2017 (Ma,

¹ In this context, improved cultural continuity means a growing acceptance of the need to use more sustainable modes of travel.

Lan, Thornton, Mangalagiu, & Zhu, 2018). However, according to a report produced by the Shanghai Municipal Transportation Commission, the number of shared bicycles in the system available per month had dropped from 1.7 million in 2017 to 440,000 in March 2019 (Shanghai Municipal Transportation Commission, 2019).

Both the public sector and policymakers are concerned about the reasons behind the decline and have therefore started exploring approaches which could help overcome the barriers to developing the bike-sharing scheme, such as bicycle theft, poor bicycle maintenance, oversupply of bicycles, uneven distribution of bicycles, the heavy burden on public resources, crowded streets and limited bike parking spaces, lack of supportive infrastructure for shared bicycles and financial constraints.

In order to gain a comprehensive understanding of the development trajectory of the bike-sharing scheme in Shanghai, from its emergence and growth to its current state of decline, it is essential to analyse shared bicycle users' perspectives, as users' perceptions and their awareness of such schemes play a significant role in promoting sustainable mobility (Attard & Shiftan, 2015). However, only a few previous studies have adopted a bottom-up approach to investigating the scheme's development, but even they have tended to focus on identifying the factors that either encourage or impede the development of bike-sharing schemes, such as in the context of Greece (Bakogiannis, Siti, Tsigdinos, Vassi, & Nikitas, 2020). Various studies have used quantitative methods to quantify the benefits and barriers, or discuss the effects of policy implementation on operational management, and those were set mainly in the North American context (Bullock, Brereton, & Bailey, 2017; Ma, Lan, Thornton, Mangalagiu, & Zhu, 2018; Otero & Rojas-Rueda, 2018; Qiu & He, 2018; Shaheen, Martin, & Chan, 2012; Shaheen, Martin, Chan, Cohen, & Pogodzinski, 2014; Zhang, Zhang, Duan, & Bryde, 2015; Zhang & Mi, 2018). However, there is still ambiguity with regard to shared bicycle users' requirements and concerns about schemes such as the one in Shanghai. It is difficult to explore these using quantitative methods, as the research focuses on exploring users' insights in depth. The role of both the public sector and private companies is also unclear. As the bike-sharing scheme in Shanghai has so far been market-oriented rather than government-run, policymakers and bicycle manufacturing companies are not prepared to guarantee its operation and regulation (Salice & Pais, 2017). Although there have been some basic reviews of running a bike-sharing scheme (Fishman, 2016; Midgley, 2011; Ricci, 2015), specific policy suggestions for how Shanghai's bike-sharing scheme can be improved are lacking.

This paper is intended to fill the aforementioned gaps and examine the bike sharing scheme in the context of Shanghai from the users' perspective. Semi-structured interviews and thematic analysis are used to understand factors which have an impact on different stages of the bike sharing scheme's development in Shanghai (i.e. its emergence, acceleration and decline). The analysis of the shared bicycle users' perspective contributes to the existing literature in three ways: 1) It adds to the existing research in relation to people's motivations for using the bike-sharing scheme; 2) It identifies additional hindrances to use of the bike-sharing scheme based on the existing literature; 3) It explores how further improvement should be implemented in terms of sustainable business development, regulated operation and active third-party involvement. It also enriches the study of trends in the development of bike-sharing schemes, specifically in a Chinese city. It analyses users' preferences and concerns in order to formulate a model for a user-centred bike sharing scheme. It can also provide

policy recommendations for running successful and financially sustainable, market-oriented dockless bike-sharing schemes in other cities worldwide.

The rest of the paper is structured as follows: Section 2 reviews the existing literature on the benefits of bike-sharing schemes, as well as the determining factors and implementation issues. Section 3 describes the data collection and methodology. Section 4 presents the results and findings. Finally, Section 5 offers conclusions and provides suggestions regarding policy implications and further research, which could help to develop an improved bike-sharing scheme in Shanghai.

2. Literature Review

The motivations for bike-sharing schemes, the determining factors behind them, and operational and implementation issues are discussed in the following sections.

2.1. The motivations for bike-sharing schemes

In general, there are two types of bike-sharing schemes (Shaheen, Guzman, & Zhang, 2010). The first is known as the docked bike-sharing scheme, which means that bicycles can be borrowed from one docking station, used and then returned to another docking station (e.g. Santander Cycle Hire in London). Some Western cities, such as Washington, D.C., Montreal, Berlin and Paris, operate docked bike-sharing schemes (Gu, Kim, & Currie, 2019). The second type is the dockless bike-sharing scheme which has no fixed stations. Users can simply locate and unlock the bicycles from anywhere using a smartphone app (Fishman, 2016). These are common in some Chinese mega cities, such as Shanghai, Beijing and Guangzhou.

DeMaio (2003) identified three generations of bike-sharing schemes. The first generation began with the White Bikes in Amsterdam. The second generation was introduced in Copenhagen in 1995. However, both the first and the second-generation schemes had problems with theft of bicycles due to the fact that user information was anonymous (Zhang, Shaheen, & Chen, 2014). Subsequently, a third-generation scheme was introduced with an improved customer tracking system involving user interface technology which resolved the bicycle theft problems (DeMaio, 2004). This then led to a fourth generation of dockless bike-sharing schemes which were larger in terms of scale and location (Manzi and Saibene, 2018; Pucher, Dill, & Handy, 2010). Fourth generation dockless bike-sharing schemes are more flexible and convenient to use (Shaheen, Guzman, & Zhang, 2010).

The major social motivation behind bike-sharing schemes is to make travel more convenient and reduce traffic congestion (Fishman, Washington, & Haworth, 2014; Sener, Eluru, & Bhat, 2009; Shaheen, Zhang, Martin, & Guzman, 2011; Shaheen, Martin, & Chan, 2012; Transport for London, 2011). Commonly, bike sharing schemes provide point-to-point-trips, round trips, and instant access through docking stations, which facilitate connectivity to and from public transit points (Shaheen, Martin, & Chan, 2012). Many studies have also proved that reducing travel time is one of the main economic motivations for using bike-sharing schemes (Buehler & Hamre, 2014; Fishman, Washington, & Haworth, 2014; Martin & Shaheen, 2014). The reduced travel time is always allied with improved connectivity between origins and destinations, including the first and last mile travel distance (Hickman & Vecia, 2016; Shaheen,

Martin, & Chan, 2012). Hence, the savings in terms of both commuting time and leisure time may contribute to creating additional working time and other economic benefits (Bullock, Brereton, & Bailey, 2017; Metz, 2008; Spurling, Spurling, & Cao, 2019).

Another important motivation for bike-sharing schemes is the public health benefits that they offer (Rojas-Rueda, de Nazelle, Teixidó, & Nieuwenhuijsen, 2013; Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014). Inactivity is estimated to add between 150 and 300 euros per citizen to public health costs in developed countries (WHO, 2004). Using shared bicycles is an effective way of partaking in physical exercise. Doing so not only helps to reduce expenditure on healthcare, but also to improve public health in general (Qiu & He, 2018). For instance, riding a bicycle for over 30 minutes a day can help to decrease the risk of heart disease, type-2 diabetes, breast cancer and colon cancer (Bize, Johnson, & Plotnikoff, 2007). It should be mentioned that the health benefits outweigh the health risks, such as exposure to air pollution and traffic accidents (Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014). If local governments can reduce the level of these risks, the health benefits may be even greater (Otero & Rojas-Rueda, 2018). Although it is impractical to quantify all the health benefits resulting from bike-sharing schemes, the distinct contribution they make to physical exercise for commuting and other trips should not be underestimated.

In environmental terms, bike-sharing schemes help to reduce energy consumption and emissions (Mi, Meng, Guan, Shan, Liu, Wang, Feng, & Wei, 2017). The study of bike sharing schemes worldwide has shown that the percentage of citizens who have switched from travelling by private cars to shared bicycles in Washington, D.C. and in Lyon is 16% and 7%, respectively (Shaheen, Guzman, & Zhang, 2010). As a result, these cities have seen corresponding reductions of 37,000 and 7,720 kilograms of CO₂ emissions per day (ibid.). The positive environmental impacts of bike-sharing schemes are similar in Asia. Shanghai is a developed city that has experienced rapid economic growth. Zhang and Mi (2018) estimate that CO₂ emissions from the transport sector stood at 42 Mt in 2015, accounting for 24 per cent of the year's total emissions. In fact, the bike-sharing scheme in Shanghai had saved 8,358 tonnes of petrol and decreased CO₂ and NO_x emissions by 25,240 and 64 tonnes, respectively, in 2016 (Zhang & Mi, 2018). Although the data cannot cover all the environmental benefits derived from bike-sharing schemes, it does help to illustrate their sustainability.

Shaheen, Guzman, and Zhang (2010) summarise the benefits of bike sharing as: flexible mobility, emission reductions, physical activity benefits, reduced congestion and fuel use, and individual financial savings and support for multimodal transport connections. These six key points are the core motivating factors for bike-sharing schemes according to the literature. The growth in bike-sharing schemes has made the wider public aware of their social, environmental, economic and health value.

2.2. The determining factors behind bike-sharing schemes

The overarching concern for bike-sharing schemes is the issue of safety (Bakogiannis, Siti, Tsigdinos, Vassi, & Nikitas, 2020). In well-developed bike-sharing countries, such as Britain, North America, Australia and Greece, concerns about safety issues have become the main barrier to active participation in the bike-sharing program (Bakogiannis, Siti, Tsigdinos, Vassi, & Nikitas, 2020; Fishman, Washington, &

Haworth, 2012a; Fishman, Washington, & Haworth, 2012b; Garrard, 2009; Horton, Rosen, & Cox, 2007). Most importantly, cycling at high speed and people's unwillingness to wear helmets may result in serious injuries (Fishman, 2016; Hu, Lv, Zhu, & Fang, 2014; Schepers, Fishman, den Hertog, Wolt, & Schwab, 2014). Other concerns, such as a lack of attention towards cyclists, limited bicycle infrastructure facilities, traffic accidents with vehicles, having a bad bicycle-riding experience, and a low level of cycling proficiency can all discourage the usage of shared bicycles (Fishman, Washington, & Haworth, 2012a, b). If bike-sharing schemes were introduced with more supportive measures such as a bicycle-protection infrastructure, this could facilitate an environment that was more conducive to riding shared bicycles (Buck & Buehler, 2011; Fishman & Schepers, 2018). Moreover, if awareness of and cautiousness towards cyclists were improved, the crash risk would be lower (Jacobsen, 2003).

In addition, there are also some socio-demographic and built environment impacts to consider in relation to bike-sharing schemes (Rixey, 2013; Wang, Lindsey, Schoner, & Harrison, 2012). Rixey (2013) identified that socio-demographic factors, such as job density, population density, education and income, can play an important role in bike-sharing schemes. In cities in Europe, North America, China and Australia, users are much more willing to use the shared bicycles if the docking station is relatively close to them and easy to access (Fishman, Washington, & Haworth, 2014; Shaheen, Martin, & Chan, 2012; Wang, Lindsey, Schoner, & Harrison, 2012). In terms of built environment attributes, a higher road density and larger block size will lead to a lower percentage of cyclists (Zacharias, 2005). Very often, a lower job-housing balance, less diversity of land use and/or lower destination accessibility will have the same consequence (Zhao, 2014).

Meanwhile, the role of cultural factors should not be neglected either (Aldred, 2013; Aldred & Jungnickel, 2014). The general perception is that 'good cyclists' are those who have a higher level of skills and knowledge, while 'bad cyclists' are those who fail to meet these requirements (Skinner & Rosen, 2007). However, stigmatised images of cyclists show that neither cyclists who exhibit too much prowess by cycling at high speed nor bad cyclists who are associated with ignorance and incompetence have positive connotations. Although the trend for cycling has increased in many cities, some stereotypes still persist. For instance, an analysis conducted by the Department for Transport (2010) revealed three common features of different groups of cyclists from the perspective of other road users: 1) Cyclists often lack a sense of abiding by the law and have little 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. The stigmatised classification of cyclists has resulted in a form of cultural hierarchy (Daley & Rissel, 2011). Therefore, cultural discrimination poses a barrier to popularising the wider usage of shared bikes among the public for their daily travel.

2.3. Operational and implementation issues

Many business models have been created for providing and managing bike-sharing services by a wide array of stakeholders, such as local governments, advertising agencies, transport agencies, for-profit and non-profit bike providers (DeMaio, 2009; Shaheen, Guzman, & Zhang, 2010). An ideal bike-sharing scheme business model is

based on making its service accessible and convenient, and then selling it to local residents either for their 'last mile' travel distance needs, or to tourists for sight-seeing, or to companies for advertising their products on shared bicycles (Zhang, Zhang, Duan, & Bryde, 2015). In fact, running a bike-sharing scheme is a highly complex undertaking. Lewis and Roehrich (2009) found that developers are required to strike a balance between infrastructural complexity such as hardware, and transactional complexity such as knowledge. Overall, creating a sustainable and effective business model should take into consideration design, development, implementation and operation, and how these relate to service design, infrastructure design and integration within wider transport planning (Shaheen, Guzman, & Zhang, 2010).

A well-organised bike-sharing scheme also needs to consider operational issues (Fishman, Washington, & Haworth, 2013; Fishman, Washington, & Haworth, 2014). In order to be successful, bike-sharing systems need to provide real-time bicycle information, create more bike-sharing stations, improve bicycle maintenance, and enhance anti-theft technologies (Shaheen, Zhang, Martin, & Guzman, 2011). In addition, as a large number of users rely on shared bicycles to access employment, it is crucial to reorganise the distribution of shared bicycles effectively using intelligent real-time technology (Pfrommer, Warrington, Schildbach, & Morari, 2014). Bicycles inevitably become concentrated in the business districts of cities, and many communities lack bicycles, especially during peak time (Fishman, Washington, & Haworth, 2013). In order to address this problem, operators should re-distribute bicycles across the network according to demand. For example, motorised trucks and vans can be used to re-distribute bicycles to different docking stations throughout the day, in order to obtain a relatively equal distribution (Fishman, Washington, & Haworth, 2014). However, the re-distribution of bicycles presents a significant challenge due to the dynamic and time-varying nature of bicycle demand (Ai, Li, Gan, Zhang, Yu, Chen, & Ju, 2019; Liu, Shen, & Zhu, 2018). For instance, in Shanghai, shared bicycle companies mainly distribute the bicycles around public transit points, particularly in the central areas of the city (Zhang & Mi, 2018). These companies normally hire low-cost labour to redistribute the shared bicycles after the midnight. However, during the daytime, no one has specific responsibility for re-distributing the bicycles from areas where there is an excess to areas where there are too few, at a fixed frequency. This leads to an uneven distribution of shared bicycles on a daily basis, particularly during peak hours.

Policies also play a significant role in popularising the use of shared bicycles and reducing air pollution caused by over-reliance on private vehicles (Zhang & Mi, 2018). Generally, the most effective way of achieving shared mobility involves the local government working as a promoter and user, by collaborating with scheme operators rather than only serving as a supervisor or regulator (Akyelken, Banister, & Givoni, 2018; Nikitas, 2019). The public sector may also consider the implementation of bike-sharing systems when developing new urban projects. In the process of attempting to turn car dependency into a bike-sharing culture, governance must play a role in promoting the sustainable development of bike-sharing schemes (*ibid.*). If governments expect citizens to take full responsibility for the management of the shared bikes, or perhaps encourage them to become self-regulating (Miller & Rose, 1990), bike-sharing schemes will fail to become fully incorporated within the public transport system (Aldred, 2012).

In summary, successful bike-sharing schemes are normally subsidised by local governments or other private companies such as advertising agencies, who cooperate in order to reduce greenhouse gas emissions, relieve traffic congestion, increase transport network accessibility and improve public health (DeMaio, 2004). They also require interdependent, multi-embedded and intangible relationships between stakeholders (Frow & Payne, 2011; Mills, Purchase, & Parry, 2013) as well as close partnerships between public transit and bike-sharing schemes (Shaheen, Martin, & Chan, 2012).

2.4. Summary

The development of bike-sharing schemes has attracted significant interest within the existing literature. The literature mainly focuses on the following three aspects of bike-sharing schemes (see Table 1): 1) the motivations for using bike-sharing schemes; 2) the determining factors that influence bike ridership; 3) daily operational and political issues associated with bike-sharing schemes. Findings suggest bike-sharing schemes have been used as an effective tool for first and last mile trips. Shared bicycles are easy to use, and users can save time on commuting. In addition, bike-sharing schemes can also promote physical activity and reduce greenhouse gas emissions. However, concerns about safety risks, demographic and built environment factors such as low population density, and cultural factors such as the stigmatisation of cyclists, will be more likely to deter people from using bike-sharing schemes. Thus, running a successful bike-sharing scheme is a complex undertaking. Shared bicycle companies need to adopt a sustainable business model, and cooperate with local governments on daily operational issues such as the daily delivery, maintenance, and re-distribution of shared bicycles. As discussed above, most of the current literature explores the key features of and operational issues associated with bike-sharing schemes, but overlooks the perspective of individual users. This paper therefore fills the gap by specifically investigating users' perspectives on a bike-sharing scheme, using Shanghai as a case study.

Table 1

Summary of current literature.

Research topics	Key ideas	Key references	Key findings
The motivations for bike-sharing schemes	<ol style="list-style-type: none"> 1. Convenient and save time 2. Health benefits 3. Environmental awareness 	<ol style="list-style-type: none"> 1. (Fishman, Washington, & Haworth, 2014; Shaheen, Martin, & Chan, 2012) 2. (Rojas-Rueda, De Nazelle, Teixidó, & Nieuwenhuijsen, 2013; Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014) 3. (Mi, Meng, Guan, Shan, Liu, Wang, Feng, & Wei, 2017; Shaheen, Guzman, & Zhang, 2010) 	<ol style="list-style-type: none"> 1. They can either enable users to reach their destinations sooner than travelling by other means of public transport or provide feeder services for public transit. 2. Cycling can reduce the risk of diabetes mellitus, certain cancers, and cardiovascular diseases. 3. Compared to other transport modes, cycling uses far less fuel and reduces greenhouse gas emissions.
The determining factors behind bike-sharing schemes	<ol style="list-style-type: none"> 1. Safety issues 2. Socio-demographic and built environment factors 	<ol style="list-style-type: none"> 1. (Fishman, Washington, & Haworth, 2012a; Fishman, Washington, & Haworth, 2012b) 2. (Rixey, 2013; Wang, Lindsey, Schoner, & Harrison, 2012) 	<ol style="list-style-type: none"> 1. Safety concerns are the main factor that deter people from using bike sharing schemes. 2. The closer that docking stations are located to city attractions, the more willing people are to use shared bicycles.
Other issues	<ol style="list-style-type: none"> 1. Business models 2. Daily operation 3. Policies and strategies 	<ol style="list-style-type: none"> 1. (DeMaio, 2009; Shaheen, Guzman, & Zhang, 2010) 2. (Fishman, Washington, & Haworth, 2013; Yang, Sahlqvist, McMinn, & Griffin, 2010) 3. (Akyelken, Banister, & Givoni, 2018; Shaheen, Martin, & Chan, 2012) 	<ol style="list-style-type: none"> 1. An ideal business model should consider both internal factors, such as the design of facilities, and external factors such as sustainable growth. 2. Efficient management of delivery, implementation, maintenance, and redistribution is required. 3. Local governments should collaborate with operators to play a supportive role in operating bike-sharing schemes.

3. Methodology

Qualitative research seeks to interpret meanings from subjects' perspectives, explanations, feelings, and descriptions, and is a research strategy which focuses mainly on words (Bryman, 2016; Neuman, 2014). Thus, the semi-structured interview method was chosen in order to collect the qualitative data (Punch, 1998; Ritchie & Lewis, 2003). Data was collected by asking respondents a series of open-ended questions about specific issues (Bryman, 2016; Robson, 2002). The semi-structured interview allows for in-depth discussions with the interviewees (Bryman, 2016). In this case, the findings of the semi-structured interviews enabled us to better understand users' perspectives on the development of bike-sharing in Shanghai. The interviewees were recruited through purposive sampling, thus allowing us to rely on our own judgment in selecting interviewees to participate in the research, in order to achieve breadth of understanding with limited resources (Patton, 2002). This sampling method was used to select interviewees who have experience of bike sharing and who were willing to express their opinions about those experiences (Bernard, 2002; Creswell & Plano Clark, 2009).

Semi-structured interviews were conducted with 45 participants, comprising 26 males and 19 females (ratio: 58% male to 42% female). The purposive sampling method offers an efficient means of finding knowledgeable and reliable informants (Snedecor, 1939; Tongco, 2007). Interviewees were selected on the basis of their job types or employment status, which included engineer, doctor, researcher, student, housewife and unemployed; and their age groups which ranged from 21 to 50 years old (20% of interviewees were aged from 21 to 25; 7% were aged from 26 to 30; 31% were aged from 31 to 35; 18% were aged from 36 to 40; 11% were aged from 41 to 45; and 13% were aged from 46 to 50). The aforementioned data are summarised in Table 2.

More than 13 million residents of Shanghai have used the bike sharing system (Ma, Rong, Mangalagiu, Thornton, & Zhu, 2018). The majority of users in Shanghai rely on the bike-sharing scheme to travel the first and last transit miles between their home or workplaces and the nearest public transport stations. To some extent, the 45 interviewees selected represent different types of shared bicycle users in Shanghai. Each interview lasted between 45 and 90 minutes, and the interviews were carried out during May and June 2019. A list of interview topics can be found in Appendix 1. The interview material was analysed using NVivo 11 software. NVivo is a qualitative data analysis computer software program which helps researchers to organise responses to unstructured or open-ended interview questions, for example, and analyse them in order to identify key themes and gain insights into the content by importing qualitative data from Word and/or Excel with a range of nodes. The nodes provide a simple structure for coding and identifying research themes (Zamawe, 2015). NVivo can allocate segments of interview material to particular themes and help researchers examine relationships between the themes identified (Cassell & Symon, 2004). It also helps to ensure the reliability and relevance of the qualitative data collected (Bernard, 2002).

Table 2

Profiles of participants.

Number	Sex	Age	Job
1	female	21-25	clerk
2	female	21-25	student
3	female	21-25	student
4	female	21-25	transport planner
5	female	21-25	student
6	male	21-25	transportation engineer
7	male	21-25	investment manager
8	male	21-25	transportation engineer
9	male	21-25	transport planner
10	female	26-30	financial manager
11	male	26-30	estate agent
12	male	26-30	doctor
13	female	31-35	astro-engineer
14	female	31-35	teacher
15	female	31-35	accountant
16	female	31-35	financial analyst
17	female	31-35	transport planner
18	male	31-35	teacher
19	male	31-35	sales
20	male	31-35	financial analyst
21	male	31-35	audit executive
22	male	31-35	manufacturing engineer
23	male	31-35	sales
24	male	31-35	accountant
25	male	31-35	city planner
26	male	31-35	researcher
27	female	36-40	trader
28	female	36-40	clerk
29	female	36-40	financial analyst
30	male	36-40	teacher
31	male	36-40	product manager
32	male	36-40	IT engineer
33	male	36-40	doctor
34	male	36-40	architect
35	male	41-45	doctor
36	female	41-45	researcher

37	female	41-45	housewife
38	male	41-45	IT engineer
39	male	41-45	architect
40	female	46-50	clerk
41	female	46-50	financial analyst
42	female	46-50	electrical engineer
43	male	46-50	transportation engineer
44	male	46-50	unemployed
45	male	46-50	manufacturing engineer

Thematic qualitative data analysis (see Figure 1) was used to identify the main themes that emerged from the users' perceptions (Braun & Clarke, 2006). First, the researcher acquired an understanding of the context and familiarised himself with the data. Second, the researcher organised and analysed the data using NVivo 11. Third, the data extracts were sorted according to different themes. Next, the researcher reviewed and identified the essence of each theme. Lastly, a final report was produced that addressed the research questions.

This paper investigates users' perspectives on all the development stages of bike-sharing in Shanghai. The bike-sharing scheme in Shanghai was set up in 2016, expanded in 2018 and declined in 2019. When the bike-sharing scheme emerged in 2016, many people gained benefits from this new mode of mobility and it attracted a large group of users. However, too many companies entered the market in 2017, which caused a number of operational and management problems. Consequently, many users stopped using shared bicycles from 2018 onwards. In order to learn lessons from its success and failures, this study primarily discusses three themes: 1) the positive aspects of the bike-sharing scheme in Shanghai; 2) the flaws in Shanghai's bike-sharing scheme; 3) how the scheme could be improved. First, the interview findings showed that the main motivations for using the bike-sharing scheme in Shanghai were convenience, saving time and financial savings. For instance, the bike-sharing scheme can serve as a feeder for public transport because the rental cost is affordable and users can easily use their smartphones to scan a QR code to lock or unlock bikes. Second, the interview findings revealed that the users' dissatisfaction with the shared-bicycle scheme mainly arose from the poorly maintained state of the bicycles, operational issues and financial issues². We analysed a series of problems that occurred after the explosive growth of shared bicycles in 2018, which illustrate the negative impacts of the unsustainable development model used. For example, many shared-bicycle companies went bankrupt because of the over-supply of bicycles in the market and the breakdown of the capital chain. Third, the interview findings also suggested that a public and private partnership could provide the best solution to the future development of the shared-bicycle system. Hence, the focus is now on building a sustainable business model integrated with effective policy interventions and clear lines of responsibility for local governments, bicycle companies and users.

² Financial issues refer to the risk that bicycle users may not get their prepaid deposit back if a shared-bicycle company went bankrupt.

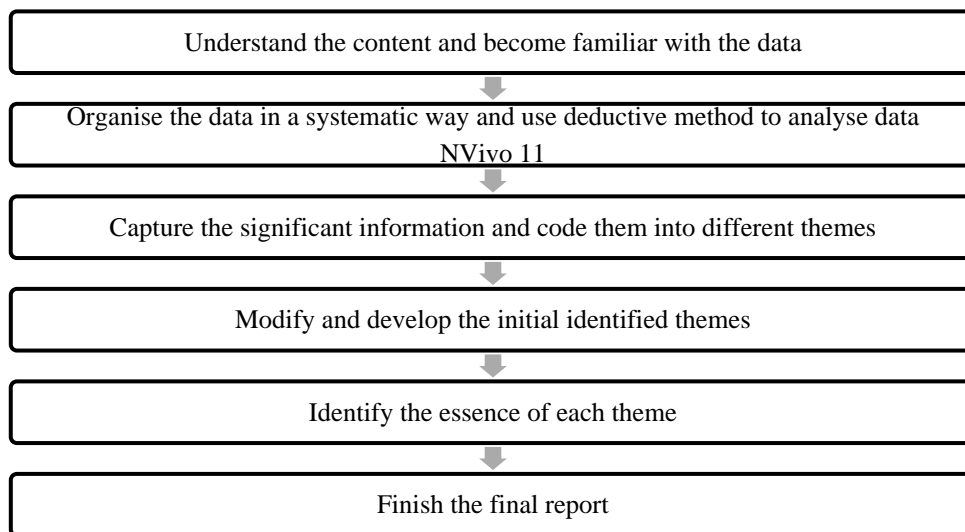


Fig.1. The six steps of thematic analysis

(Source: Authors, adapted from Maguire and Delahunt, 2017)

4. Research Findings and Discussion

4.1. The positive aspects of the bike-sharing scheme in Shanghai

4.1.1. Convenience

According to the interviews, convenience was found to be the main motivation for using the bike-sharing scheme. Convenience can be divided into three aspects: 1) Ease of finding a bicycle; 2) Ease of using a bicycle; and 3) Ease of reaching a destination. For example, in the city centre, there are large numbers of bicycles available; thus, it is quick and easy for people to find and use them. Essentially, users can find shared bicycles of various brands at high-demand locations, such as near underground stations and within business districts. It is important for people to be able to find a bicycle easily during the rush hour, so that they do not have to waste time looking for one. Many interviewees felt that the registration process was quite simple, as users can locate, borrow, lock/unlock, and pay for a bike via their smartphones.

“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 see the location of bicycles on your mobile phone. After you make the reservation, the system will reserve it for 15 minutes for you to find the bike. Scan the QR code on the bicycle, and the lock is automatically unlocked. The whole process takes less than five minutes.”

(Interviewee 38, male. 07/06/2019)

The bicycle-sharing scheme makes it easier for people to access public transport too. Thus, this new mode of shared mobility contributes to providing better links to destinations. Those who use the underground or buses to get to work may typically have to travel several miles between home, their place of work and the underground station or bus stop (e.g. first and/or last mile issues). The many dockless bicycle stations allow people to borrow and return bikes from different places without having to worry about

‘parking’, i.e. finding a docking station. In this case, by providing a feeder service to the destination, the shared bicycle offers a better alternative than walking to a station, for example, due to its convenience and flexibility.

“As an ordinary shared bicycle user, 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 customers’ demand.”

(Interviewee 26, male, 15/06/2019)

4.1.2. Saving time

Saving time is another important reason for residents to exchange public transport for shared bicycles, particularly for short-distance trips. Due to increases in population and car ownership, the phenomenon of traffic congestion on roads and crowded underground stations is very common in mega cities, such as Beijing and Shanghai. Those who travel by car or bus spend considerable time sitting in traffic jams while people who take the underground often have to wait for the next train. By contrast, many interviewees appreciated the fact that the bicycles enabled them to move freely and flexibly without being delayed by the traffic conditions. Riding a shared bicycle was also described as a pleasant experience by some of them. Furthermore, underground trains and buses can only operate on fixed routes. In most instances, they have to cover several stops that may not provide the shortest route to passengers’ destinations. By contrast, riding a shared bicycle offers users a means of reaching their destination by the fastest and most direct route. Thus, shared bicycle users neither have to waste time queuing on trunk roads due to traffic congestion, nor on travelling along indirect routes.

“For the same distance, riding a shared bicycle can reach the destination in 10 minutes while driving may take double the time.”

(Interviewee 7, male, 12/06/2019)

“It is convenient to ride a bicycle in the city. Reaching the destination by riding a shared bike can save me 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 30, male, 01/06/2019)

4.1.3. Financial savings

As well as saving time, shared bicycle users can also save money. In Shanghai, the shared bicycle rental fee is less than one Chinese yuan per hour (1 Chinese Yuan \approx 0.11 Pounds Sterling), which is affordable for most people. On one hand, those who only occasionally travel by bicycle do not need to spend substantial amounts of money on buying a brand new bicycle; for instance, those sold by the well-known bicycle brand Giant would cost over a hundred pounds. On the other hand, for shared bicycle users who are only making short-distance trips within a couple of kilometres, doing so by taxi or other modes of public transport would cost far more than one Chinese yuan. Therefore, in terms of expenditure, most of the interviewees regarded the bike-sharing scheme as the best option.

“The rental fee for the shared bicycle is relatively lower than any other

public transport modes, so I feel happy to use it twice a day.”
(Interviewee 11, male, 10/06/2019)

“I choose to use the shared bicycle due to the low cost, and I do not need to pay for parking and daily maintenance.”
(Interviewee 4, female, 13/06/2019)

4.2. The drawbacks of Shanghai’s bike-sharing scheme

Before discussing the drawbacks of Shanghai’s bike-sharing scheme, it is necessary to provide some background information about it. When the scheme launched in 2016, there were 13 shared bicycle companies with 1.7 million shared bikes between them, and a total of 7.5 million registered users. The scheme reached its peak in 2017 but, subsequently, the number of shared bicycles decreased consistently, falling to just 440,000 in 2019. Prior to the decline, Mobike and Ofo were the two leading operators, accounting for over 80% of the market share between them. They covered all 16 districts of Shanghai, but the distribution varied significantly between different districts. Although the shared bicycle companies were responsible for the daily maintenance of the bicycles, their maintenance capacities could not meet the demand. At the same time, local governments had only minimal involvement in the bike-sharing scheme because it was primarily market-oriented. Many shared bicycles that got damaged were simply abandoned without being repaired. The scheme operated the whole year round, for 24 hours a day. During the period of rapid development, users were charged for the amount of time that the bicycle was in their possession, regardless of where they unlocked and parked their bicycles. Competition between the shared bicycle companies was very intense, as users could switch between different companies without incurring any penalties. All the shared bicycle companies had their own app which made the system less user-friendly, because users potentially had to have several different apps on their phones and ensure that they used the correct one each time they hired a bicycle.

4.2.1. Problems with the bicycles

Although the dockless bike-sharing scheme offers a very convenient method of travel, it is unclear to both bicycle providers and users who should take responsibility for maintaining the bikes. Most interviewees thought that shared bicycles were often poorly maintained, in some cases leading to serious damage and a high loss rate. For example, sometimes when users wanted to use a shared bicycle, they found the seat was damaged or missing or the lock could not be opened by scanning the QR code. This meant that they then had to waste time looking for another bicycle. The interview findings also revealed that even bicycles in relatively good condition were sometimes hard to ride because of uninflated tyres or other wear-and-tear issues. Furthermore, because neither the public nor the private sector takes full responsibility for running and regulating the scheme and tracking the daily operation and maintenance of shared bicycles in Shanghai, it is difficult to monitor users’ behaviour effectively. As a result, some interviewees complained about unqualified or inconsiderate shared bicycle users not taking responsibility for their behaviour, even if they damage a bicycle or park it in an inappropriate place, because they know that there is no means of tracking or punishing them. Consequently, a certain amount of shared bicycles have been stolen and modified for personal use or sold illegally. Such instances of inappropriate behaviour are caused by a lack of social responsibility among users.

“Personally speaking, some shared bicycle users lack self-regulation and the bicycles are not well maintained. The loss rate of shared bicycles in Shanghai is so high that I often see damaged bicycles along the street. Besides, it will cause much inconvenience in rush hours if a user gets a bike in poor condition.”

(Interviewee 15, female, 03/06/2019)

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

(Interviewee 10, female, 15/06/2019)

4.2.2. Operational problems

The main operational problems involve daily operational issues, in particular the uneven delivery of bicycles, limited cycling facilities and the lack of regulation. The bicycles are unevenly distributed between different districts. Figure 2 shows an excess of shared bicycles in the transit centre of Huangpu District, caused by over-supply. A large number of bicycles are parked in public parking spaces and pedestrian lanes but not being used. In contrast, there are only a limited number of shared bicycles available in suburban areas. For example, the supply of shared bicycles in the area around the University of Shanghai for Science and Technology in Yangpu District is insufficient to meet the demands of students travelling to or from the nearest local underground station at Aiguo Road (see Figure 3). Thus, Figures 2 and 3 clearly illustrate examples of the problems caused by the uneven spatial distribution of shared bicycles in Shanghai. Suburban areas with a high population density contain a wide range of shared bicycle users, because suburban citizens are more heavily dependent on shared bicycles for conveying them to public transport transit points than residents who live in the city centre.

“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 takes me more than ten minutes on foot to get to the nearest bicycle in the area.”

(Interviewee 23, male, 09/06/2019)



Fig. 2. Excess of shared bicycles in the city centre

(Source: Authors)



Fig. 3. Scarcity of shared bicycles in suburban areas

(Source: Authors)

With the growing popularity of shared bicycles, this new type of shared travel mode has become increasingly accepted by the public. However, the research findings show that there are limited numbers of bicycle lanes and bicycle parking areas. Although the shared bicycle providers state that bicycles must be parked in the specified parking areas, it is still difficult to find formal bicycle parking areas. Furthermore, the scheme is inadequately supervised and regulated. With no laws or regulations to prevent it, users often park their shared bicycles randomly, including in inappropriate public places, such as pavements, bus stops, green spaces, and even underground station entrances. The phenomenon of parking bicycles arbitrarily and a lack of supportive cycling infrastructure have caused dissatisfaction among shared bicycle users. Moreover, because public resources and space are limited, these operational problems not only exacerbate the chaos and over-crowding of the current transport system, but also affect other motor vehicle users and pedestrians. It was found that there are no specific rules for the parking of shared bicycles. Some bicycles are parked close together or even left propped up against trees. This can cause problems for pedestrians if bicycles are left in places where they block pedestrian lanes or access (see Figures 4 and 5).

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

(Interviewee 42, female, 09/06/2019)



Fig. 4. Unregulated parking

(Source: Authors)



Fig. 5. An occupied pedestrian lane

(Source: Authors)

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

(Interviewee 3, female, 11/06/2019)

“I gave up using the shared-bike scheme 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 for public transport planners.”

(Interviewee 30, male, 01/06/2019)

4.2.3. Financial issues

Another problem associated with the bicycle-sharing scheme is its unsustainable and unfeasible business development model. The research has shown that a few of the smaller bike-sharing companies are unsustainable in the long-term, which has led to financial losses for shared bicycle users. There are four reasons behind this phenomenon: 1) The operating costs and depreciation costs are high, which means a large amount of initial outlay is required to keep the business running; 2) The rental fee for shared bicycles is low, which limits the amount of profit that can be made; 3) Shanghai’s bike-sharing scheme is not subsidised by the local government, so there are no incentives from the public sector; 4) The entry threshold for the bike-sharing market is low; thus, there is fierce competition between bike-sharing providers. In this challenging market environment, numerous bike-sharing companies have gone

bankrupt. As a result, some interviewees who had previously paid a deposit to those companies have been unable to recover their money. In addition, poor service caused by fierce competition has made users lose confidence in the bike-sharing scheme. Subsequently, the remaining few companies with monopolies have started to increase the bike rental fees substantially without improving their service. As a result, some users on lower incomes are no longer able to afford the fees and have stopped using the cycle-hire scheme.

“The business model of the bike-sharing scheme is unstable with high risk. It cannot guarantee survival in a fluctuating market, which will affect users.”

(Interviewee 22, male, 08/06/2019)

“Intense competition exists between various shared bicycle companies, which has led to lower prices and a worse service. Fewer and fewer people want to continue using it.”

(Interviewee 37, female, 11/06/2019)

4.3. How can the bicycle-sharing scheme be improved?

4.3.1. Business development

Based on the interview findings, almost all of the interviewees recommended a public-private partnership (PPP) as a way of improving the bike-sharing scheme. The consensus view was that social capital should still be provided for the shared bicycle service, but government-led mergers and acquisitions play an important role in maximising the use of public resources. More specifically, private enterprises should be mainly responsible for its daily operation. Meanwhile, local government and other public sector bodies should support these private enterprises, via effective policies and governance, in order to promote this shared environmentally-friendly transport mode. The interviews also revealed that it is unwise from a business perspective to invest too much capital in the shared bicycle market over a short period to try to maximise profits. Instead, companies need to change the inherent business model which is geared towards seizing the largest market share; they should therefore seek a more effective way to ensure sustainable and stable development. We suggest that different brands should focus on various user groups and provide differentiated services such as sports bicycles and bicycles for disabled people. Because transport is also regarded as a well-being issue, sustainable PPP development would contribute to the growth of a sustainable mode of mobility.

“I feel that the government has to participate actively in the bike-sharing scheme instead of doing nothing. I think that the main purpose of developing the bike-sharing scheme is to serve people rather than chasing profit.”

(Interviewee 12, male, 12/06/2019)

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

(Interviewee 16, female, 04/06/2019)

“This service cannot be driven by the capital market alone. To continue

developing, I believe that we must return to the public and private partnership mode. Public institutions can be served by private companies in a contractual model to ensure that services are prioritised by the public.”

(Interviewee 26, male, 15/06/2019)

4.3.2. Daily operation

There have been a lot of complaints about the way the scheme operates on a daily basis. The interviewees provided some suggestions for improving it and discussed ways to prevent abuses by users. On one hand, bicycle companies must maintain the bicycles, guarantee a high-quality riding experience, improve the real-time location technologies and ensure that users' deposits are returned to them after use. For example, interviewee 19 suggested that companies could consider carrying out maintenance during the winter when there is less demand for bicycles (see below). Analysing user requirements will enable operators to better understand the areas of high demand such as enterprises, factories and schools, particularly in the suburbs where the demand for bicycles far outstrips the supply. Meanwhile, operators should also ensure that, when bicycles are delivered, they are not obstructing cycle or pedestrian lanes and/or vehicle parking areas. Bicycle company managers are strongly advised to help operators to supervise the delivery, maintenance and parking of bicycles. In addition, companies could also increase the range of payment options particularly for older adults and people without smartphones, who could use metro cards or contactless credit/debit cards instead.

“The companies need to improve the reliability of bicycles. They could do the maintenance in winter when fewer people use the bicycles.”

(Interviewee 19, male, 02/06/2019)

“They should increase the coverage of the shared bicycles, especially at factories, schools, and enterprises that are far away from the underground station.”

(Interviewee 2, female, 08/06/2019)

On the other hand, a high-quality bike-sharing scheme not only requires input and support from the bicycle companies, but also needs the cooperation of individual users. It is not enough to rely on users behaving appropriately and considerately, as there is clearly a proportion who do not. A smart reward and punishment system should be introduced, which would apply to all shared bicycle companies and users. For instance, as was suggested in the interviews, well-behaved users who always park their bicycles at the designated areas could receive rewards, such as a free ride within a certain time period, whereas people who park bicycles randomly, damage bicycles or take them for personal use should be penalised, for example by reducing their social credits or charging them double next time they use the scheme. If their score falls below a certain threshold, then they would be banned from using shared bicycles. In this way, responsible users could be rewarded, while the penalties for those who abuse the scheme would act as a deterrent.

“The bicycle companies should filter the users, and say “no” to people with low credit. They could double the payment for those with uncivilised behaviour.”

(Interviewee 38, male, 07/06/2019)

“Incentives are required. Some well-behaved users could get a bonus stored in their online wallet or they could get discounts on bus or underground fares within half an hour after using the shared bicycle.”
(Interviewee 37, female, 11/06/2019)

4.3.3. Role of local government

The problems and controversies discussed above emphasise the importance of government participation. In order to maximise the potential of Shanghai’s bike-sharing scheme, all the interviewees highlighted that the local government should improve the current transport system and integrate it with the bike-sharing scheme in terms of facilities, policies and strategies, as a long-term alternative for mobility.

In terms of facilities, the government should design more segregated cycle parking areas, which will encourage bicycle users to return their bikes to the specified areas. More separated cycle lanes are also needed in order to guarantee the safety of shared bicycle users. Lifts or ramps could be installed to make it easier for users to transport bicycles up and down stairs. Bicycle shelters could also be installed at the roadside. It was also suggested that community groups and staff from shared bicycle companies could help to mitigate the parking chaos.

Since the bike-sharing scheme involves multiple stakeholders, the responsibilities undertaken by each of the stakeholder groups should be defined and implemented clearly and transparently. In relation to the bike-sharing scheme, the government needs to play the role of a user as well as a supervisor. Most interviewees regard the bike-sharing scheme as a public project which requires effective policy interventions. The government should therefore formulate new legislation, including operational regulations, safety regulations, big data management and environmental remediation. For instance, it could determine the market threshold to ensure that the scheme operates effectively, provide better public services and reduce the negative impacts on pedestrians and motor vehicles. Moreover, government officials should cooperate with bicycle companies to set industry standards, and supervise the recycling of damaged/old bicycles, as well as maintaining the current fleet of bicycles.

“It would be better if the bike-sharing scheme is a public project. The public sector should build bicycle-friendly facilities such as bike lanes and establish related laws for protecting the rights of cyclists.”
(Interviewee 16, female, 04/06/2019)

“The shared bicycle services must have official guidance from local governments on parking locations, quantity of bicycles, and maintenance of bicycles just like underground services or bus services, thereby avoiding the insufficient allocation of public resources.”
(Interviewee 22, male, 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 5, female, 14/06/2019)

5. Discussion and Conclusions

This research has examined the development of the shared-bicycle scheme in Shanghai. 45 semi-structured interviews were conducted with a wide range of users who participate in and gain benefits from the bike-sharing scheme. This enabled us to gain an in-depth understanding of the users' preferences and their concerns, in other words, their motivations for and the barriers to using the bike-sharing scheme in Shanghai.

Our findings can contribute to the formulation of policies to improve the bike-sharing scheme (Bachand-Marleau, Lee, & El-Geneidy, 2012; Fishman, 2016; Nikitas, 2019). First, we found that the three main motivations for using the scheme were convenience, saving time and financial savings. These findings are in accordance with the existing literature (Bakogiannis, Siti, Tsigdinos, Vassi, & Nikitas, 2020; Buehler & Hamre, 2014; Fishman, Washington, & Haworth, 2014; Martin & Shaheen 2014; Sener, Eluru, & Bhat, 2009; Shaheen, Zhang, Martin, & Guzman, 2011). Although the mental and physical health and environmental benefits were acknowledged by the interviewees, these do not serve as the main motivation for using the scheme, which contrasts with the findings of studies conducted in Western cities (Transport for London, 2011; Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014). In fact, it was found that shared bicycle users in Shanghai are more concerned about the visible, practical problems and short-term benefits. The problems with the bicycles per se, the inadequate operation and management of the scheme, and the unfeasible business model are the major hindrances to using shared bicycles, which have been hugely overlooked by both service operators and policymakers. Again, our findings differ from those pertaining to Western cities, highlighting safety issues, socio-demographic and built environment factors, and the stereotyping of cyclists (Aldred, 2013; Fishman, Washington, & Haworth, 2012a; Rixey, 2013). Indeed, the 'fast-food' style business model used by the bike-sharing scheme that seeks to maximise profits quickly, and the lack of unified management, are the source of the aforementioned problems.

In addition, the findings also provide guidance for improving the bike-sharing scheme in Shanghai and other Asian cities. A successful bike-sharing scheme requires open and active collaboration between both public and private stakeholders, and should involve users, bicycle companies, and local government in order to achieve its full potential and overcome any potential barriers (Banister 2008; Ricci, 2015; Gu, Kim, & Currie, 2019). First, decision makers should fully integrate the bike-sharing scheme within wider urban transport planning to create a cycle-friendly city. They should formulate policies and strategies specifically targeted at cyclists, create an infrastructure for bicycle users with better links, and maintain healthy competition between the bicycle companies to guarantee high-quality operation. Second, bicycle companies should adopt a sustainable business model, which would involve keeping bicycles well maintained, applying advanced technologies and managing daily parking and delivery issues effectively (Zhang, Lin, & Mi, 2019). Third, users should be strongly encouraged to comply with the regulations by raising awareness of the importance of taking care of the bicycles and parking them in the designated areas by means of a reward and punishment system (*ibid.*). Thus, a three-way-partnership constitutes the best way to make the bike-sharing scheme sustainable and successful,

instead of relying on individual efforts, as has been shown by existing studies (Frow & Payne, 2011; Mills, Purchase, & Parry, 2013; Zhang, Zhang, Duan, & Bryde, 2015).

In terms of the policy implications, most successful bike-sharing schemes in European cities are supervised by public authorities and are standardised (Hure & Passalacqua, 2017). This offers a useful lesson for Shanghai's bike-sharing scheme. As policymakers have acknowledged the impact of the bike-sharing scheme, they should strengthen the links and integration between short distance travel by bicycle and the existing public transport system (e.g. first or last mile), by shifting their focus away from planning for the motorised transport system to planning for the active travel system (i.e. cycling and walking). To encourage the use of shared bicycles, policymakers should invest in both 'hardware' and 'knowledge', which is consistent with Lewis and Roehrich's (2009) arguments. The hardware would be used to enhance the bike-sharing scheme through a well-developed bicycle infrastructure, including a protected bicycle lane system and sufficient designated parking areas. Knowledge would involve organising shared bicycle activities to raise public awareness, such as a "shared bicycle festival" or "car free" day. Moreover, official involvement in bicycle management is strongly advocated in order to maximise the value of the bike-sharing scheme and alleviate its negative effects. Local governments should work together with the bicycle companies to evaluate the market demands, service capacity and maintenance requirements of the bike-sharing scheme. The number of shared bicycles must not exceed the service capacity. In this way, the appropriate management and regular maintenance of the shared bicycles can be guaranteed, and therefore the transport network will not become overloaded. In addition, a dynamic pricing scheme should be developed (Pfrommer, Warrington, Schildbach, & Morari, 2014; Zhang, Meng, & Wang, 2019), which sets prices based on both parking location and duration of usage. For example, if people leave their bicycles in an already saturated parking area or park them illegally, they will be penalised with additional charges. On the other hand, if users park their bicycles in areas where demand for shared bicycles outstrips supply, they will receive a price discount the next time they use a bicycle. Moreover, a dynamic pricing scheme could also encourage users to cycle from places where there is an excess of bicycles to places where they are in short supply, thereby effectively helping to re-distribute the shared bicycles. The aforementioned policy implications should enable local governments to encourage bike-sharing schemes and pursue sustainable development. It is also worth mentioning that decision makers need to gain an in-depth understanding of the context specifications, to enable them to formulate appropriate and effective policies that fulfil users' expectations (Nikitas, 2019).

This study suggests six directions for future research. First, further studies could investigate schemes in other Asian cities, especially tier 2 and/or tier 3 cities. Comparisons could be made between bike-sharing schemes in different cities in order to support further research into Chinese bike-sharing schemes. Second, as previously mentioned, shared bicycle users in Western countries are particularly concerned about safety issues and environmental and health benefits (Aldred, 2013; Transport for London, 2011; Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014), while users in Shanghai are more interested in the practical benefits, such as financial savings. The latter regarded the lack of unified, effective management and the unsuitable business model as the main reasons why some have stopped using the bike-sharing scheme. With regard to cultural considerations, shared bicycle users in more cycling-friendly cities may be perceived very differently to those in Chinese cities. This could be regarded as

a limitation. Thus, a comparative study on the impacts of shared bicycles in Chinese cities and other more cycling-friendly cities, such as those in the Netherlands, Denmark and Germany, could be conducted. Third, there is a wide range of shared bicycle user groups in China. Future research could focus on specific user groups, such as commuters living in suburban areas, university students or low-income groups, to help shared-bicycle companies provide different services and products according to individual needs. Fourth, the study could be extended to explore how advanced technology and big data analytics could help to improve the distribution of shared bicycles. These technologies could offer an effective solution to the current problem of the uneven spatial distribution of shared bicycles, particularly in mega cities. Fifth, there is insufficient cooperation between local governments and shared-bicycle companies. Further research could investigate the impacts of governance on developing successful bike-sharing schemes, which may provide insights that would allow a framework for managing bike-sharing schemes to be developed. Lastly, the research approach employed in this research could also be replicated in other cities in order to investigate the development of bike-sharing schemes more generally.

There are huge benefits to be gained from bike-sharing schemes by society, the government and bicycle companies in Shanghai. However, most bicycle companies seek to maximise revenues from the market for investment while policymakers play only a limited role in their management. Consequently, many problems remain in terms of operation, management, financial constraints, safety issues and user experience. This explains why the bike-sharing scheme in Shanghai declined after 2018. In order to develop and improve the bike-sharing scheme so that it eventually becomes part of a sustainable transport system, local government should provide solid backing, bicycle companies should develop a more feasible business model, and users should regulate and standardise their behaviour. So far, the important role played by local government has been overlooked by policymakers in terms of the scheme's operation and implementation, at least in the context of Shanghai. Thus, it now urgently needs to be taken into account.

With regards to the limitations of this research, the interviewees were selected using a purposive sampling approach. Our sample primarily represents bicycle users with different types of jobs. However, there may be other residents who have stopped using bike sharing schemes because of the barriers they encountered, and who were not included in the interviews. Their insights may also be helpful in providing guidance for improving the Shanghai bike sharing scheme, and could thus be included in further research. In addition, a more diverse range of interviewees could be included in further research in order to increase the representativeness of the sample, given that a wide range of people use the bike-sharing scheme.

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Appendix 1. Interview Questions

1. Have you ever used a shared bike in Shanghai?
2. What is your understanding of bike sharing schemes?
3. What pros and cons does the bike sharing scheme bring to Shanghai?
4. Could you share your experience of using a shared bicycle in Shanghai?
5. From your viewpoint, what is the current status of the bike sharing scheme in Shanghai?
6. Based on your experience, what key factors encourage you to use shared bikes in Shanghai (such as convenience, cost saving, saving time, health benefits, and CO₂ emission reduction, etc.)?
7. Based on your experience, what key determinants impede you from using shared bikes in Shanghai (such as safety concerns, poor air quality, lack of shared bicycle-friendly built environment, bicycle maintenance problems, operational and management issues, cultural issues, financial issues, etc.)?
8. Could you provide any suggestions for improving the bike sharing scheme in Shanghai in terms of its daily operation?
9. Could you please provide any suggestions for improving the bike sharing scheme in terms of business development?
10. In order to improve the bike sharing scheme in Shanghai, what do you think would be the best role for the local government to play?