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The Development of Generalized Public Bicycles in China and Its Role in the Urban Transportation System

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Abstract: Public bicycle service has experienced 15 years of development in Chinese cities, and mainland China is the world's largest public bicycle market. Choosing to use public bicycles is becoming more and more a daily habit of residents. Broadly speaking, public bicycles in Chinese cities include both public bikes with service stations and shared bicycles without service stations. Based on historical review and years of accumulated data, this paper reviews the development of general public bicycles in Chinese cities in the past 15 years. And the role of general public bicycles in China's urban transportation system is analyzed. Finally, from the perspective of urban construction and management, some suggestions for the future development of public bicycles are put forward.

Keywords: Public bicycle; urban transportation; Chinese cities

1 Introduction

As for most China's urban residents, public bike or bike sharing has become a vehicle commonly seen in their daily life. However, both public bike system with service stations and Internet sharing bikes without service stations provide generalized public bike services. In the broad sense, public bike refers to a network-based self-service and short-distance bike rental system oriented towards multiple groups in public occasions [1]. It belongs to personalized mass transportation. Except for special cases, public bike service in the paper means generalized public bike.

Public bicycle services in Chinese cities can be traced back to 2005. From 2005 to 2019, in less than fifteen years, it has become the world's largest public bicycle service market. For the majority of Chinese urban residents, public bicycles have been integrated into our city and life, becoming one of the main daily travel choices. In the past 15 years, public bicycles have experienced several stages of development in Chinese cities? How to understand the role of public bicycles in the transportation system of Chinese cities, and to meet the needs of public bicycle development from the perspective of urban construction and management? As urban public bike service in China develops fast, it is hard to analyze the role of public bike service in China's urban transportation system with comprehensive data analysis results, and besides, any research in specific time scope cannot keep up with latest changes in reality. Therefore, the paper consults perennial survey data and related research results to discuss the development of generalized public bike service and its function in China's urban transportation system from historical perspective and then raise suggestions to improve bike transportation mode from urban construction and management perspective.

2 Methodology

Analysis in this research is based on the author's survey about generalized public bike service in Beijing, Shanghai and Hangzhou in 2009, 2012 and 2018. Former two surveys target at users' use condition for public bikes with service stations (user sampling survey) and the survey in 2018 targets at students' use condition for public bikes without service stations (full-sample sampling survey).

In September 2009, the research team conducted a stochastic questionnaire survey on users of public bikes with service stations in Shanghai, Hangzhou and Beijing, and respectively collected 192, 276 and 154 valid questionnaires. In July 2017, the research team conducted an online survey on users of public bikes with service stations in Shanghai and collected 230 valid questionnaires. Meantime, the research team summarized Shanghai public bike system users' characteristics after removing the information of dormant users (who never used the card after registration or who never used public bikes within half a year) from backstage system.

In June 2018, in three college campuses of Hangzhou, the research took students as the research subject and performed a questionnaire survey on bike sharing use condition. Finally, 422 valid questionnaires had been collected.

Moreover, the research also adopts Shanghai Mobike bike sharing users' data sample in 2016, including 306000 Mobike bikes and 17000 users' use condition data from August 1st 2016 to August 30th 2016.

3 The Development of Generalized Public Bicycles in China

The origin of public bike can be traced back to Europe more than fifty years ago. However, the widely acknowledged urban public bike system with service stations did not seek fast growth worldwide until 2007. According to foreign scholars, public bike is a mobility strategy in response to urban transportation crisis in contemporary times [1]. By deeply integrating bike with transportation system, it actually provides a choice of transportation, makes bike more convenient and attractive to users, and consequently increases the use of bike. Upon the introduction of this public bike system to China, more and more municipalities find that public bike system helps improve urban green transportation ratio, alleviate urban transportation issue and play a vital role in arousing public awareness and popularizing bike transportation mode. China becomes the fastest-growing region in the development of public bike system with service stations in the world. In 2016, China released a creative urban public bike system without service stations. From then on, bike sharing not only quickly rose to fame in Chinese cities, but also spread across the world. Retrospecting the development history of public bike service in China, the urban public bike development in China could be generalized by five stages [2–6].

In the first stage in 2005–2007, the first guardian public bike system came into being in China. At the same time, Beijing built the first public bike system.

In the second stage in 2008–2016, public bike system with service stations was incorporated into the public transportation system in some cities. Under the advocacy of local government, public bike entered the explosive growth period. Chinese mainland became world's largest market of public bike with service stations. Pursuant to related statistics, by September 2016, there were more than 1.2 million[1] public bikes with service stations in China mainland.

In the third stage in 2014–2016, OFO and Mobike were successively founded, and Internet thinking was incorporated into sharing traveling service concept. It marked the rise of public bike sharing without service stations. Different from former public bike sharing with service stations, Mobike defined new service as "bike sharing". It did not set up any bike stations, but managed bikes with GPS chip and

[1] According to the statistical data and launched information of each city, not including 7 systems in Hong Kong and Taiwan area, also not including the bike sharing systems (without service station) such as Mobike and OFO.

computer chip-controlled automatic lock. Users could search the bike and unlock it via phone app, and place it in any public bike parking area after use. In this process, the system would charge deposit and calculate the use fee as per time. Based on the network technology, Mobike offered door-to-door service, and removed the constraints of station so that users could get access to bike sharing service without regional threshold nationwide.

In the fourth stage in 2016–2017, bike sharing marched into almost all major Chinese cities on a large scale, and entered the high-tide period. Substantial companies and fund swarmed into the bike sharing market. According to relevant statistics [7–9], bike sharing users in China promptly increased from 2.45 million in 2015 to 18.86 million in 2016, with a year-on-year growth rate of 670%. By June 2017, there were over 106 million bike sharing users. The number of users presented explosive growth momentum.

In the fifth stage in 2017–late 2018, with the cooling and adjustment of market, a large number of medium and small-sized bike sharing service companies exited the market, and the bike sharing market layout led by few major service companies basically took shape. In consequence, bike sharing converted from primary disorderly release to delicacy management and sought an efficiency service profit model. In addition to bike sharing, many cities began to provide moped sharing service. In China, both moped and bike were classified as non-motor vehicle applicable for the same road space. It proved that public bike service was moving towards a more refined market and larger scope of service. Even so, in line with the incomplete statistics of the Ministry of Transport, there were around 70 global network bike rental companies (bike sharing operating companies) in the country, and approximately 16 million bikes were available on the market. As part of generalized public bike system, bike sharing affected the general development of national public bike system. Apart from such drastic change in service mode, influence of the rapid rise and fall of bike sharing on urban space and management could also prove this point.

4 Role of Public Bike Service in China's Urban Transportation System

4.1 With a Wider Coverage, It Has Become One of the Main Daily Transportation Modes

Survey results in three places in 2009 indicate that earlier public bikes with service stations mainly serve medium and low-income group (52%–68%) aged 20–40, especially corporate employees. Male users (54.91%) outnumber female users (45.09%). Shanghai backstage data in three years later reveals that public bike users' (except dormant users) gender ratio is in a balanced state (51% male users and 49% female users), but male users show higher will for the use of public bikes. Comparing with the level in 2009, users' age presents a rising tendency. Due to the expansion and promotion of public bike service, public bike covers a wider scope of service and its service target is more balanced. As indicated by the questionnaire, more medium-income users (around 40%) have become the main users of public bike system. Whereas, as a result of the promotion of bike sharing system in all cities via network phone app, users' age distribution shows a younger trend once again. Related studies also discover that bike sharing service mainly targets at young and middle-aged users aged 20–40 [10]. Young people and well-educated people tend to choose bike sharing service for traveling. Among all the other factors, education has the foremost influence [11].

Whereas, as per the coverage scope of public bike service, public bike users rarely make up 10% of gross population in the city or region even in its heyday. Taking Minhang District of Shanghai for example, the backstage data of Shanghai Minhang public bike system in 2012 proves that only 230,000 users applied for public bike card, accounting for less than 10% of gross population. Whereas, the explosive growth of bike sharing greatly expands the service scope of public bike. By February 2017, more than 30 bike sharing companies in Shanghai released 450,000 bikes to the market, but there were more than 4,500,000 users. It means that 18.5% Shanghai residents were then public bike users.

The research subsequently compares users' use frequency for public bike service. In 2012, though at least 20% respondents in questionnaire stated that public bike was their main transportation means in daily life, 30.95% users were dormant users among all 230,000 registered users in Minhang District of Shanghai. Among the remaining 158,800 users, only 3.85% of them used public bike for more than one

time everyday. According to the statistics of Mobile in August 2016, Mobike had around 9600 daily users on average, approximately accounting for 56.7% of registered users. It meant that over half registered users were accustomed to Mobike traveling mode. As to the use frequency of Mobike users, around 80% users used the bike once a day, and daily riders' use frequency was 1.96 times [12]. The survey in three college campuses of Hangzhou in 2018 also suggested that daily public bike users made up 56%. Though the low use ratio of earlier public bike system users in Minhang District is related to local residents' free application policy, such series of changes reflect that most urban public bike service users in China have taken public bike as the main transportation modes after decades of development. In view of bike sharing users' coverage, the research considers that public bike service has become China's urban residents' main traveling mode which seizes an important status in transportation system.

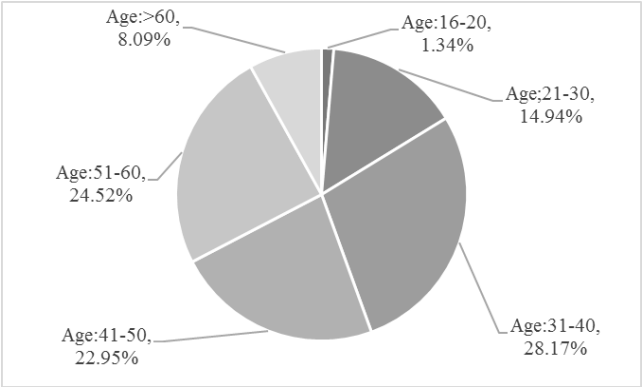

Figure 1: The age composition of the user of the public bicycle system in Shanghai Minhang in 2012

4.2 Public Bike Concentrates on Short-Distance Traveling, and for Commuting Purpose

Considerable survey and statistical data indicate that public bike service concentrates on short-distance traveling. The average traveling duration of public bike users in three cities in 2009 lasted for 20 minutes, and nearly 85% public bike users' traveling duration was controlled within 30 minutes. In 2012, survey data in Shanghai proved that public bike traveling duration lasted for 12.5 minutes on average. With regard to the statistics of bike sharing, Mobike statistics in 2016 indicated that average traveling distance was 1.84 km, 82% traveling distance was within 3.5 km, average traveling duration was 14.8 minutes and 76 % traveling duration was within 20 minutes [13]. In the survey of Hangzhou in 2018, respondents' average bike sharing duration was 14.1 minutes, and 79.7% respondents' traveling duration was within 20 minutes.

As to traveling purpose, commuting has always been the main purpose of public bike service. While besides commuting service, the use ratio of non-commuting purpose will continually increase, and its role in daily traveling will turn more prominent. Survey data in 2009 indicated that the commuting ratio in Shanghai and Beijing was respectively 75.92% and 79.33%. Because of the high ratio of tourism (10.46%) and cultural entertainment (12.97%) traveling, public commuting ratio in Hangzhou was 48.95%. Three years later, nearly half (42.17%) users in Shanghai tended to commute with public bikes (commuting traveling was more than life traveling), and other users (45.65%) had equal use ratio for public bike commuting and life traveling. Thus it can be seen that commuting traveling then was still the main purpose of public bike traveling in Minhang District, and the use ratio of public bikes in daily life traveling is on the rise.

The report issued by Tianjin Urban Planning & Design Institute and Mobike based on Tianjin bike sharing traveling condition in 2017 also indicated that there was no significant change in the traveling purpose of bike sharing. The main purpose was still commuting for work (54.5%) [10]. The traveling ratio of traveling for work and school decreased with the growth of age, while life shopping and exercises increased with the growth of age. In a survey on Hangzhou campus, the ratio of bike sharing commuting traveling also made up 66%.

4.3 Increase Bike Use Ratio, a Major Step to Connect and Supplement Public Transportation System

Operation of public bike system also encourages the popularity of bike. Pursuant to the official statistics of Hangzhou, as of the operation in 2008, the use ratio of public bike is on the rise. In 2011, maximum daily rent of public bike totaled over 347500 times, and daily average rent totaled over 238000 times [6]. Since the operation in Hangzhou in 2008, bike traveling ratio generally declined across similar cities in China, and the non-motorized bike traveling ratio in Hangzhou increased from 33.5% in 2007 to 37.4% in 2009, suggesting that the successful operation of public bike system encouraged the use of bike to some extent. Comparative data for bike sharing in Tianjin also showed that bike traveling ratio increased from 29% in 2016 to 35% in 2017 (including 11% bike sharing service) [10]. The operation of bike sharing service indeed increases the bike traveling ratio in Tianjin.

Survey data results in 2009, 2012 and 2018 proved that public bike service replaced former mode of traveling composed of public transportation, walking and private bike. User survey data in three cities in 2009 showed that among all respondents, 45%–59% users used to choose public transportation (bus + railway) and 20% users used to choose walking. In 2009, around 90% public bike users in the three cities used to be non-public bike users. The survey in 2012 showed that over 70% respondents (commuting traveling: 79.06%; life traveling: 73.17%) replaced other means of transportation except private bike by bike sharing. In a college campus survey in Hangzhou in 2018, around 80% respondents replaced other means of transportation except private bike by bike sharing. Thus it can be seen that public bike well increases the use of bike.

Concerning the role of public bike service to public transportation, it does not simply provide the "last mile" service. The connection role of public bike to long-distance public transportation is very significant. Moreover, as the supplement to public transportation, it raises urban green transportation ratio. In 2009, the connection transfer ratio of public bike and respondents in Shanghai and Beijing was respectively 57.59% and 59.33%. Therefore, the public bike system well realizes connection service goal of rail transportation. In 2011, the ratio between annual use amount of Hangzhou public bike system and Shanghai Minhang public bike system /ground public transportation passenger capacity was 6.4% and 9.2% [14].

The research for bike sharing also concludes a similar finding. As shown by the data analysis results of Shanghai Mobike 2016, to some degree, bike sharing expanded the service scope of rail transportation stations. Users used to walk for 600 m within 5 minutes, and now they could ride for around 1500m within 5 minutes. Approximately 70% bike sharing traveling connected rail transportation or bus. Bike sharing service made up over 80% service dead zone for public stations [12]. Related studies in Beijing also display that there are usually two riding gathering area around metro station, respectively within 100-200 m and 600–800 m distance [15]. In particular the former is for the transfer of public bike and metro, and the latter is for the transfer of public bike and other modes of transportation like walking or bus.

As to statistical results, public bike fails to significantly reduce the use of automobile. In 2009, merely 0.52% public bike users used to be private car users in Shanghai, and the ratio in Hangzhou and Beijing was respectively 4.6% and 6.21%. The figure of Shanghai in following three years was still 1.3%.

As to system property, public bike service can supplement private bike traveling, but can't replace stable bike traveling. If the government can improve private bike security, create a better traveling environment and offer better transfer conditions in public transportation hubs, more and more residents will continually use private bike for daily traveling.

Owing to the further development of generalized public bike service in the city and the growing number of urban residents in public bike service, the role of generalized public bike service in China's urban transportation system will be further enhanced. In cities of China, public bike service increasingly becomes a choice of traveling as important as other modes of transportation. Moreover, because of its greater flexibility and strong ability to be connected with other modes of transportation, it greatly improves China's urban residents' traveling mobility and gradually reduces private motorized traveling.

5 Suggestion for the Future Development of Public Bike Service

China's urban public bike service on the one hand plays an increasingly prominent role in overall urban transportation system, and on the other hand poses more questions and challenges to urban construction and management, such as insecure traveling environment, excessive release, appropriation of public road resources and space, user norms and parking management, transportation service standards, maintenance investment, service company access, coordination and management. Aiming at above problems, the paper raises the following suggestions.

5.1 Continually Improve China's Urban Bike Traveling Environment

Public bike traveling must rely on urban bike facility and environment, but cannot exist free from the general context. Amicable bike traveling environment makes for the implementation and promotion of public bike system, and it is also the basic guarantee to ensure the sustainable operation of public bike service. As pointed out by Peter Midgley [16], urban bike infrastructure is of vital importance to public bike service. For public bike service in any city, the key to success is whether the city can provide a wide and continuous bike lane/exclusive lane network. Therefore, in order to propel the healthy development of China's urban public bike service, the first step is to include bike into uniform urban transportation system [17–18], stick to consistent policy to encourage the development of urban bike transportation, and keep improving China's urban bike traveling environment.

5.2 Clarify Public Bike Service Standards and Service Requirements and Establish a Set of Management Mechanisms

Comparing with public bike system with service stations, public bike system without service stations comes across more problems in standards and management. The supreme query against bike sharing is that bike sharing has to pay the cost of appropriated public resources, and its convenience should not affect urban public order. After all, urban space resource is not infinite. As a transportation service product, it requests uniform standards and service requirements. Urban managers have the responsibility to enact a set of regulations on service company access and exit mechanism, key information transparency, and uniform market management.

5.3 Uniform Urban Transportation Policy

Above analysis manifests that public bike service occupies a more and more important position in China's urban transportation system. For artery public transportation represented by rail transportation, public bike service is an efficient connection tool which can replace public transportation in short distance, and compensate the weakness of public service. However, the premise is to include public bike service into uniform urban transportation policy. Additionally, it is also necessary to include public bike and bike sharing into the research of urban transportation system, reinforce the follow-up research on users' use condition, and give pertinent policy support. Only in this way can the city constantly improve and optimize public bike service on account of full comprehension about user demands and use characteristics.

6 Conclusion

Generalized public bike service has developed for more than ten years in China by now. Throughout development for five stages, China has become the largest public bike service market across the world now. While public bike service also exerts increasingly more prominent functions in China's urban transportation system, and becomes one of the main daily traveling modes among China's urban residents. Its role in short-distance traveling and commuting traveling is more significant. Public bike service indeed increases the use ratio of bike, and serves as the major connection and complement to public system, but its role in changing private motorized traveling is still less conspicuous. Consequently, the paper advises to constantly improve bike traveling environment, establish effective standards and management

mechanism and form uniform urban transportation policies in the future.

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