Investigation and Analysis of Travel Behaviors of Sharing Bicycles in Wenzhou

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***Abstract*—** Bicycle-sharing systems are a new type of transportation service that provides bicycles for shared use; they allow users to rent a bicycle at one station, ride it, and return it to another station in the same city. In this paper the author explores the travel behaviors of the sharing bicycles system in Wenzhou using big data analysis. Taking the survey results of sharing bicycles users in Lucheng District of Wenzhou and the operations of 181 sites in 20 days as the analysis object, using data analysis software and other tools to analyze the form characteristics of sharing bicycles, including the daily use of single bike, the busiest station and the most idle stations. According to the analysis, the time between lease and return in Wenzhou observes the law of lognormal distribution. Based on the analysis results, he author puts forward some suggestions to the current sharing bicycles service systems, for the systematic network distribution of lease sites and optimal management of hierarchy scheduling.

***Keywords*—** Sharing Bicycles, Trip Distance, Large Data Processing, Travel Characters.

I. INTRODUCTION

The Public Bicycles System (PBS), which originated in Europe, began to enter China in 2007, and began to pilot in large cities such as Beijing, Hangzhou and Wuhan, and gradually expanded to other provincial capital cities and small and medium-sized cities. The operation of the public bicycles system formally integrates bicycles into the field of public transport, seamlessly butt the slow traffic and public transport, and crack the "last kilometre" problem at the end of the traffic, and achieve a better city with low carbon travel. In 2012, the Ministry of housing and Construction issued the guidelines for the planning and design of urban walking and bicycle traffic systems. By 2016, the total amount of public bicycles in China has reached about 500000, exceeding the total of other countries in the world.

The sharing bicycles transportation system in various cities in China has obvious regional characteristics. In accordance with the requirements of "one planning, step by step", Hangzhou launched the first sharing bicycles system project in China in 2015, which mainly serves the citizens and tourists in the field. As of 2017, a total

of 85 thousand and 800 sharing bicycles were put into operation in the city, with a free trial service within 1 hours, with a daily usage of 300 thousand people.

Xi'an began to invest in sharing bicycles in 2016, up to now 52 thousand, more than 500 thousand public cards, and the average daily trial number reached 230 thousand. In the opinion polls, 95.3% of the citizens expressed satisfaction with the system. Xi'an sharing bicycles are the main supplement to the subway and bus, to solve the last 2 kilometers trip problem of the station and home, and take the subway export, the bus hub and the large area as the main points.

II. THE PRESENT SITUATION OF SHARING BICYCLES IN WENZHOU

Sharing bicycles system took the lead in operation in Lucheng District in 2016. In 2017, Ouhai, Longwan and economic development zones kept up with the construction and made rapid development. By the end of 2017, there were 22018 sharing bicycles in Wenzhou and 738 sharing bicycles services.

In view of the distribution planning of all kinds of sharing bicycles, the Wenzhou municipal government has recently approved the special plan for urban sharing bicycles in Wenzhou. The planning and layout of the sharing bicycles in the urban area and the annual implementation plan are made, and the planning proposals for the non pile sharing bicycles are given.

The goal is to build "a wide range of sharing bicycles and the bus department." A sharing bicycles rental system with orderly connection, convenient use and green environment for riding environment. According to the plan, by 2020, the number of sharing bicycles planning service points in urban planning year is 1143, with a total of 34254 bicycles and 30860 piles, which can achieve the goal of the sharing bicycles station point in the population intensive area of 200 meters, and attract more people to choose sharing bicycles.

At present, there are also some problems in the operation of the sharing bicycles system in Wenzhou. For example, the number of sites in the densely populated

area is not enough to meet the needs of the residents to borrow and return the car.

Because of the tide phenomenon, there will be a two-way flow imbalance in the peak period of the morning and evening, and the demand for a few stations in a single direction is large, In the other direction, there is a large demand for parking, and some sites appear empty, users can not borrow cars, some sites are full of full status users can not return the car; the site of the demand for vehicles depends on artificial experience, lack of

platform data support, intelligent management level to be improved.

III. DATA SOURCES

Based on the 20 days' operation data of the sharing bicycles system in Wenzhou in August 2016, 10763245 operations records were obtained.

Each travel record includes vehicle number, vehicle number SN, start / end time, lent site / return site name and station number, card type and other information, as shown below :

Order NO.	Bike NO.	UID	Start Time	Start Lat	Start Long	End Time	End Lat	End Long	Trace Point
78387	158357	10080	2016/8/20:06:57	121.348	31.389	2016/8/4 6:02:45	121.348	31.389	#121.354, 31.391#121.355,31.391#...
891333	92776	6605	2016/8/29:19:09	121.508	31.279	2016/8/29 19:31	121.489	31.271	#121.489, 31.270#121.489,31.271#...
76435	347335	8135	2016/8/30:12:49	121.467	31.32	2016/8/4 13:03	121.447	31.318	121.447,31.317#121.447,31.318#...

Table 1: Data Table for Sharing bicycles

This paper analyses the operations data of 20 days about sharing bicycles of the above 180 sites, and analyzes the characteristics of the system lending and return vehicle, such as the time characteristics, the frequency characteristics and the turnover rate, which will help to deepen the understanding of the sharing bicycles system and understand the running rules of the system, and make clear the main influencing factors for the system travel.

It is helpful for the operation and management department to take effective measures to improve the service level of the sharing bicycles system and the satisfaction of the users to the system. It is of great significance for the sustainable development of the sharing bicycles system to control the management cost of the system properly.

IV. ANALYSIS OF TRAVEL BEHAVIORS OF SHARING BICYCLES

A. Age

According to the survey information, the distribution of different age groups is quite different. Among the users of sharing bicycles, the age of 18-50 is about 80%, of which 19-35 are the majority. The population aged 50 or above is about 20%, accounting for only 1% of those aged over 65.

B. Travel Space and Time Distribution

According to the survey, the distribution range of bike sharing varies greatly, mainly in the morning and in the evening, the peak time is concentrated in the densely populated and transportation hub area. Combining with the public.

According to the analysis of the results of the survey on bicycle use, 69.2% of the public said that they had ever had a bicycle accident. It can be seen from the situation that there is no usable vehicle in a specific period of time. Sharing is very important. There is a problem of unreasonable distribution of time and space for bicycles. Due to a certain period of time, a large number of people use bike sharing, which leads to the collective transfer of bike sharing, leading to the emergence of the phenomenon. The number of bike sharing in one place is increasing rapidly, which is difficult to manage, while the resource of bike sharing in another place is lacking.

The travel time of sharing bicycles is multimodal, with obvious early and late peak. The morning peak is concentrated in 7:00-9:00, accounting for% of the total daily travel volume, mainly commuter travel, traffic concentration and single purpose. The evening peak is concentrated in 17:00-19:00, which accounts for 50% of the total daily travel volume. As can be seen from the chart, the morning and evening peaks have lasted for 2 hours, and there are two small peaks at noon, accounting for 20% and 15% of the total daily trips. According to the card data, the time distribution of people using sharing bicycles is similar to the time distribution used by the above network. The working days are concentrated in the working day, and the peak peak is 1 times higher in the morning and evening peak. Compared with the weekend, it is very gentle, and the use of time is more concentrated than the working day, the morning peak lag is about 1 hours, and the evening peak is about 1 hours ahead.
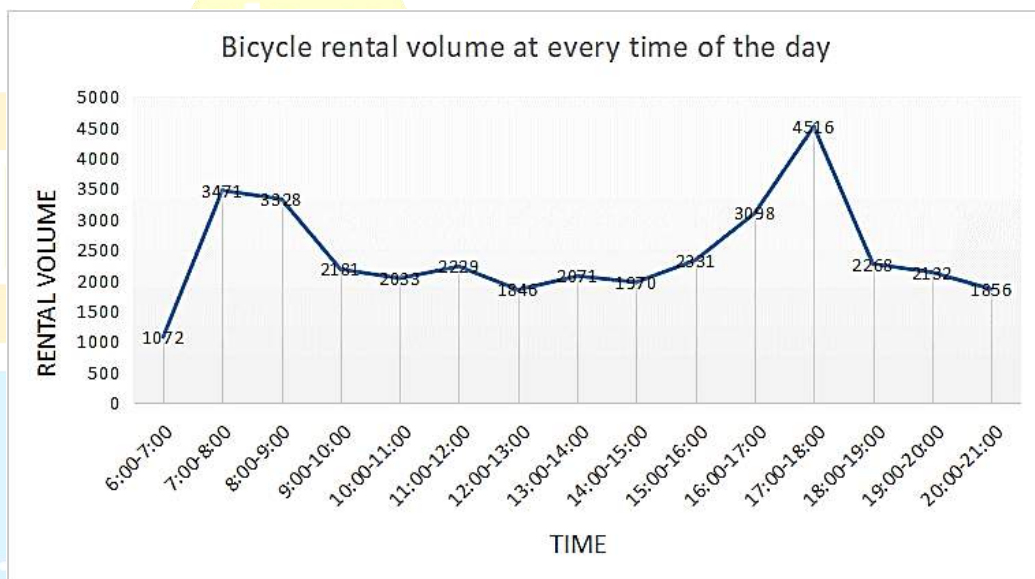
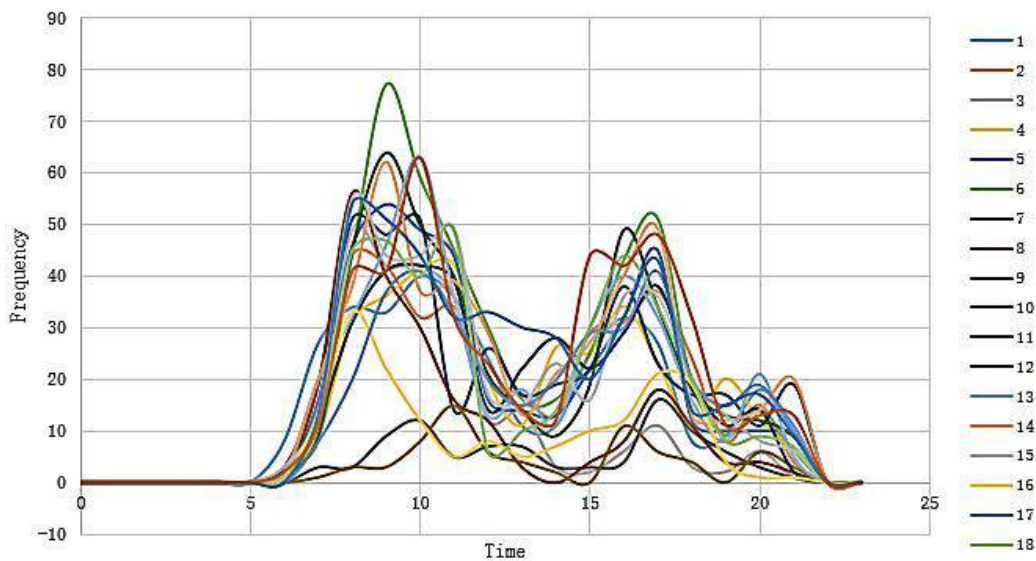

Figure 1: Example of rental volume a day
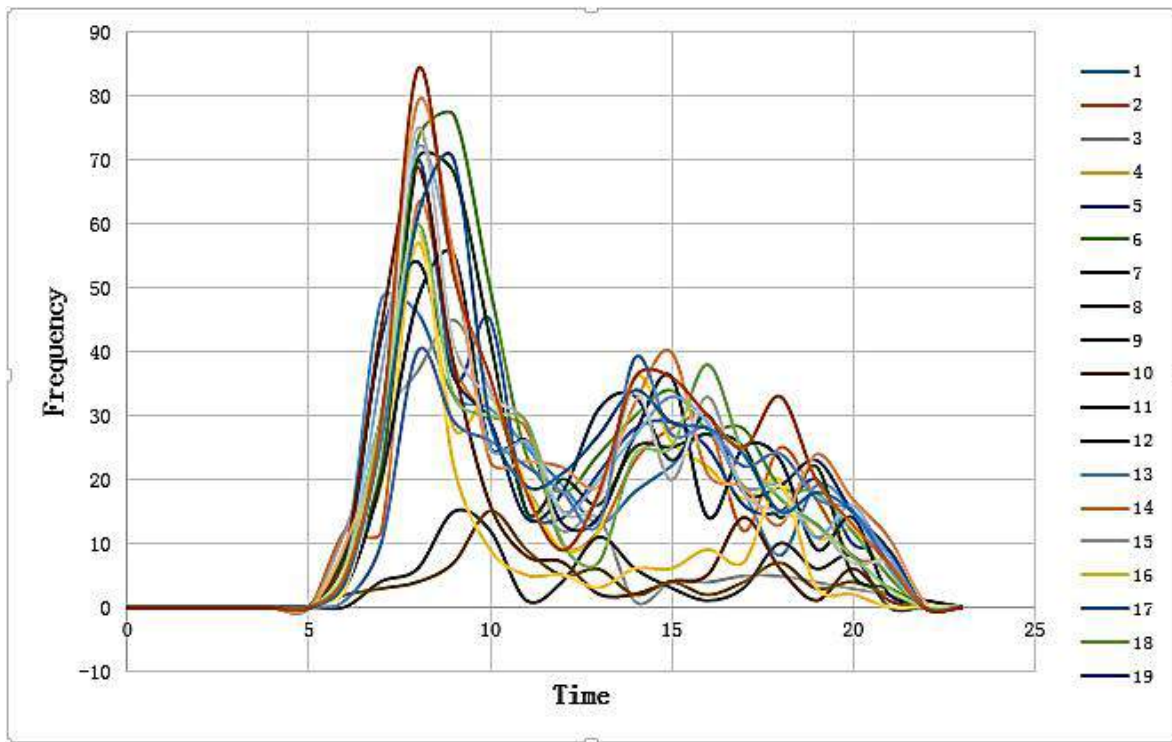

Figure 2: Example of rental volume a day

Figure 3: Restitution Frequency

C. Travel Mode and Purpose
There are three ways to use sharing bicycles:

The first type of travel is the "full model", that is, the user takes the sharing bicycles as the only travel tool, about 78% of the trip, usually "home - Public Bike - Destination". This method is generally used for short distance travel within 3 kilometers. The main purpose is shopping, commuter and service. It mainly takes the place of residents' walking, short bus, private bike and private car, with an average riding time of 12.8 minutes. The whole course mode usually occurs in the area, sometimes it reaches the destination directly, sometimes it is a multi point continuous trip, and it is short to stay in the middle for shopping or work, with a variety of purposes.

The second model is "transfer mode", the majority of users transfer between sharing bicycles and buses, 20% of travel can be classified as this type, usually "home - Public Bike - subway station / bus station - (public bike) - unit" model. The average riding time is 10.9 minutes and commuting is 89%.

The third model is "round-trip mode". Users borrow sharing bicycles at the same service point. Only 2% of the trip belongs to this type. It usually takes the "starting point - sharing bicycles - starting" way. There may be a stop in the middle, and there is no fixed destination and

route, and it belongs to non-utilitarian travel. The average riding time of the model is 22.5 minutes.

D. Travel Distance and Time Consumption
Sharing bicycles travel distance mainly concentrated in 1-4km, the proportion reached 56%. The proportion of travel within 1km is 20%, and the travel proportion of 7km is less than 10%. It can be seen that the advantages of sharing bicycles are mainly reflected in the short distance travel within 1-4 kilometers.
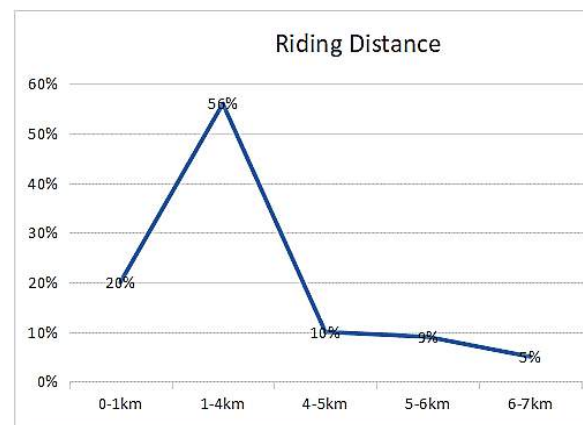

Figure 4: Riding Distance

Sharing bicycles account for more than 19% of their travel time in less than 10 minutes, and 63% of them travel in 20 minutes. The consumption of sharing bicycles increased first and then decreased, while the

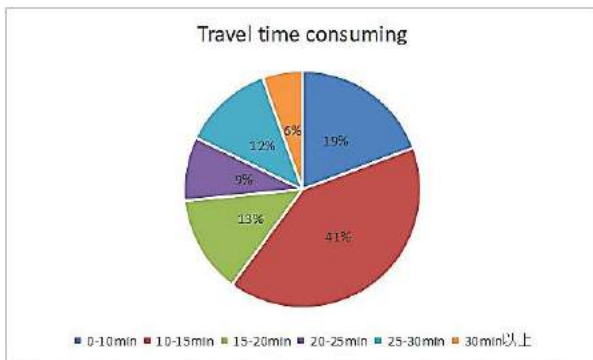average travel time was 16.15 minutes. Travel time showed a significant downward trend after 30 minutes.

Figure 5: Travel time consuming

Sharing bicycles have great advantages in short distance travel. When the travel distance is 1~4km and the use time is 15~30min, the probability of the traveller to choose the sharing bicycles is more likely. When the travel distance is more than 4km and the travel time is more than 30min, the traveller is more inclined to choose the motorized transportation way because of the restriction of the physical and travel efficiency.

E. Destination Analysis

Through the questionnaire on the purpose of sharing bicycles travel, the question is: what kind of purpose do you use sharing bicycles for? (multi choices) ①. Shopping ②.Entertainment ③.Exercise ④.Commute⑤. Excursion ⑥. Other. According to the questionnaire, commuting and shopping are the two most important purposes of travel.

Table 2: Questionnaire

Which purpose do you use sharing bicycles for?					
(Multi Choices)					
Shopping	Enternament	Exercise	Commute	Excursion	other

F. Travel Mode
By analyzing the travel data of the above 180 sites, it is concluded that:

1) The Busiest 5 sites
The busiest 5 sites are the following sites: Street Park, Five Horse Gourmet Forest, Kai Tai Department Store, Sports Centre West and Medical College.

2) The Most Idle 5 Sites
The most idle sites are the following sites: Women's Children's Center, Wangjiang Road, Guanghua Bridge Intersection, Lafite Resort Hotel, Three Bridges and Times Seascape.

3) Peak and Valley Distribution of One Week
The number of people using sharing bicycles was the highest on Tuesday every week, and the number of sharing bicycles on Saturday was the least.

4) Average Number of Times Used One Day
Each bike is used on an average of 10.3 times a day.

5) Sites Distribution
For the same situation of lenting and returning stations, the number of vehicles lent 10~20 times a day is mostly. The average duration of each vehicle is 15~25 minutes.

V. CONCLUSION
This paper taking the sharing bicycles system in Lucheng District of Wenzhou as an example, this paper systematically investigates the impact of the system on the residents' travel in Lucheng district since its implementation, in order to provide reference for the development of the sharing bicycles industry in Wenzhou and China. The data based on the sample of user's credit card data and the field questionnaire survey are based on the characteristics of the network operation and the characteristics of the residents.

In terms of network operation characteristics, it is found that the use time distribution of different sites of different types of land use is different: traffic land, residential land and public land type have the characteristics of double peak type use time distribution, in which the double peak intensity of traffic land outlets is close, while the late peak of residential and public land outlets is high. Slightly weaker than the morning peak; commercial land use only the morning peak, no late peak. This can be used as a reference for the allocation of sharing bicycles.

In terms of residents' travel characteristics, commuter and shopping are the main purposes of people's use of sharing bicycles. Because of the relatively rigid demand for these purposes, the frequency of sharing bicycles is not high, an average of 2 times a day. Therefore, in the

future, the promotion of sharing bicycles travel can be placed on leisure and exercise purposes, which requires cooperation in improving riding environment.

On the whole, the time distribution of the use of the network on the working day also showed the law of Shuangfeng. The peak intensity of the morning and evening peak was about 1 times more than that of the usual time; but there was no obvious peak period of use at the weekend. Correspondingly, there are also pendulum characteristics in time and space, especially in transportation sites. The former ways of sharing bicycles users are mainly walking, bus and private bicycles, and the number of small cars is very small, and the low carbon effect is worth studying in depth. Convenience is the most important reason for people to use sharing bicycles, which is much higher than the time saved by second, while the actual time savings are not significant. People use the sharing bicycles mode can be divided into whole process, transfer, round-trip 3, the whole process is the vast majority. Therefore, the development of sharing bicycles should be maintained, and the advantages of this kind of flexible convenience should be strengthened. Through the layout of the network and the overall layout of the land, people can use sharing bicycles for multipurpose travel.

Government green governance to realize the green development of bike sharing needs appropriate government method. Bike sharing as a quasi-public product, in the case of market failure, the government needs to effectively fulfil its responsibilities to complete the market management, can do the following. ① The government should strengthen the fine management, and the relevant departments should accurately position themselves. They can share the data system with the third-party platform of bike sharing management, cooperate with each other, and master the first-hand data. At the same time, the Ministry of public security, the Ministry of transport and other departments to coordinate planning, avoid overlapping power, slow decision-making, governance procedures tedious, high cost. Reasonable planning of urban layout, strengthen infrastructure construction, ensure that there are stops in areas with large flow of people, reasonably allocate existing resources, and avoid occupying public road resources (blind roads, etc.). ②Improve the relevant laws and regulations. For example, we should formulate corresponding standards and regulations for the emission of pollutants recovered in the later period of bike sharing, make specific treatment for the platform vehicle standards and technical standards, and increase the punishment to the legal level for the tenant of bike

sharing who maliciously destroys the bike. Create a macro external environment for the green development of bike sharing.

VI. SUGGESTIONS FOR DEVELOPMENT

In this paper, taking Wenzhou as an example, taking the data of sharing bicycles brushing card as the main data, this paper discusses the characteristics of sharing bicycles travel along the city of Haiti City, carries out multi-dimensional characteristics analysis and operation evaluation, and gives the operation and scheduling suggestions.

Through the reform of the management process, such as the comfort of the sharing bicycles, the management of the card, and so on, it will provide the people with the humanized service and truly meet the user's needs, thus further improving the turnover rate of the sharing bicycles.

The travel distance of sharing bicycles is mainly concentrated in 1-4km, which is convenient and flexible and has high accessibility. It has the advantages that buses and cars can not be replaced in short distance travel. We should give full play to the advantages of sharing bicycles, combine the sharing bicycles system with regular traffic and BRT, and assist public transport to complete the whole process of public transportation.

Sharing bicycle enters the market with the concept of green and low carbon environmental protection, according to the investigation. In recent years, the development of sharing bicycle enterprises has reached a bottleneck period and also increased the society. It is difficult to be able to manage the public. After explosive growth, sharing bicycles should be found in time. The problem is to focus on more refined management and green development, thus becoming ripening period.

In order to promote the sharing of bicycle resources and environmental friendly traffic workers, we should close the development of the business model and promote the sound B2C e-commerce model. Note the problems of resource waste and invalid allocation in the shared cycle industry chain. Enterprise the industry should implement the theory of "3R" (reduce, reuse, recycle) to share bicycles. IN the industrial chain, we should implement self-regulation, improve green cognition, implement green behavior and innovate Green technology, achieve green performance. The third party platform implements cloud supervision based on technology. The government should also regulate and control and supervise from the macro-level issue

corresponding laws. Law, fine management and publicity of green concept. Sharing economy and "B2C" model. E-commerce is the trend of future economy, and it can solve the problem of sharing bicycle industry. The green development of chain and market launch also provides model examples for other industries, only by realizing the sustainable development and transformation of sharing economy and e-commerce can we realize.

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