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Research Paper

A survey of bike-sharing in Chengdu, China

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Abstract: *Since the invention of shared bikes, shared bikes have been rapidly popularized in a few years, greatly facilitating the travel of citizens and effectively solving the"Last kilometer" travel problem, and has had the certain alleviation function to the city traffic jam question. However, due to its rapid development, shared bike in the market, but also brought a series of problems and challenges. In the face of these problems, Chengdu has taken active measures to promote the orderly development of bike-sharing by means of intelligent supervision, total quantity control and license plate distribution, and to realize shared governance.*

In order to have a deep understanding of the actual operation of shared bikes in Chengdu, this paper conducts a comprehensive and detailed investigation, and makes a detailed analysis of the development of shared bikes, the status of citizens' cycling habits, the distribution characteristics of vehicles and the existing problems. Through the statistics and analysis of the data over the years, an appropriate mathematical model is established to predict the development trend of Chengdu and the number of shared bikes in the next five years. The analysis results show that shared bikes in Chengdu have become an important way for citizens to travel, and its convenience, environmental protection and economy have been widely welcomed by the general public. However, in the process of use, shared bikes have also exposed some problems, such as indiscriminate parking, vehicle damage and maintenance problems, which need the joint efforts of the government, enterprises and all sectors of society to deal with.

In order to further improve the use efficiency and resource utilization of shared bikes, Chengdu can use big data analysis to accurately grasp the common travel time and place of citizens and reasonably plan the intensity of the bikes, so as to effectively relieve traffic pressure and promote the sustainable development of the city.

Key words: *shared bikes; status quo; problems and solutions; quantity forecast; Chengdu city*

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I. Background and meaning

1.1 research background

Since its launch, bike-sharing has reshaped the travel concept of the public with a brand-new concept. As a sustainable way of travel, shared bike is increasingly widely used in the urban transportation system. By 2021, the number of bike-sharing users in China had reached 300 million. By the end of September 2022,31 provinces, autonomous regions and municipalities directly under the Central Government had used shared bikes, and more than 400 cities above the county level, with about 14.9 million vehicles. The number of registered bike-sharing users reached 1.295 billion, and the average daily order volume exceeded 44.7 million [1] vehicles. Especially in Chengdu, the core city located in western China, the bike-sharing market is showing a strong momentum of development and has become an indispensable part of [2] in the transportation field.

In order to have a deep understanding of the current situation of shared bikes in Chengdu, this study uses questionnaire survey, field visit, data analysis and other methods to conduct an in-depth investigation on the development of shared bikes in Chengdu. The survey results show that the bike-sharing market in Chengdu has begun to take shape, and the public's recognition of shared bikes has steadily increased. The comfort, economy and environmental protection of bike-sharing have been recognized by the public, and more and more people choose to use shared bikes for travel. At the same time, bike-sharing companies are also constantly improving their services and user experience, including increasing vehicle investment, optimizing route planning, and improving vehicle maintenance.

The data analysis of shared bikes in Chengdu is of great significance to the city management agencies, which can accurately regulate the number and spatial distribution of shared bikes, and improve the efficiency of

urban traffic and user comfort. Through the research on the status quo of bike-sharing industry in Chengdu, it can provide reference for other cities and promote the healthy development of bike-sharing industry [3].

However, the development of bike-sharing in Chengdu also faces some problems. Such as random discarding and maintenance management is not perfect. Traffic management planning and administrative intervention are the key to the boom in bike-sharing. Through the investigation of the status quo of shared bikes in Chengdu, it provides information basis for urban management units, supports the precise adjustment of policies, and plays a positive role in improving traffic efficiency and user experience, alleviating traffic congestion, reducing exhaust emissions, and improving residents' travel satisfaction.

The successful experience and lessons of Chengdu bike-sharing can also provide reference and reference for other cities [4]. Local localities can learn from the successful experience of Chengdu in the field of bike-sharing, analyze its management mode and operation mode, and make corresponding adjustments to promote the progress of the bike-sharing industry and accelerate the process of intelligent and convenient urban transportation.

1.2 significance of studying

In the field of urban transportation, shared bikes have become one of the most popular modes of travel for residents since their birth. Its low-carbon and environmental protection characteristics can effectively relieve the pressure of urban traffic and increase the mobility of urban traffic in a convenient and innovative way.

However, in the rapid development of shared bikes, some problems have gradually become prominent. In Chengdu, the wide application of shared bikes has brought new challenges to urban management, such as disorderly parking and delayed maintenance, which has brought obvious problems to urban management. Therefore, it is very important to conduct an in-depth investigation and data analysis of the current situation of shared bikes in Chengdu. [5].

Through data analysis, the distribution characteristics and usage frequency of shared bikes can be understood, so as to provide quantitative basis for scheduling and management strategies. This will help determine the hot areas of shared bikes and excess parking areas, which can better balance the supply and demand of services.

The investigation of the use of shared bikes in Chengdu can reveal the frequency and degree of recognition of shared bikes, so as to deepen their understanding of "sharing". At the same time, the analysis of the constraints in the operation of shared bikes, such as non-standard parking and complex car rental process, can provide some useful suggestions for the management of shared bikes.

The government, enterprises and citizens all play an important role in the management of bike-sharing in Chengdu. The government should strengthen the formulation and enforcement of regulations, and implement strict control strategies and supervision mechanisms to ensure the compliance operation of shared bikes. At the same time, enterprises should also improve the level of vehicle management and maintenance, improve the quality of traffic services, to meet the travel needs of citizens. Citizens should consciously abide by the traffic rules, take good care of the shared bikes, and jointly maintain a good traffic order.

The study on bike-sharing management aims to provide case studies and strategic references for industry regulators. In order to ensure the safety and convenience of citizens, stricter supervision measures should be implemented and the management system of bike-sharing enterprises should be improved. Enterprises should increase technical improvement, improve vehicle quality, pay attention to the development of intelligent dispatching system, and improve service efficiency. In addition, users should strengthen their safety awareness, consciously abide by the traffic rules, and practice civilized travel behavior.

To see the regulation and sustainable development of the bike-sharing industry, the cooperation between the government and enterprises must be strengthened. The government should first implement policy support and market supervision, guide enterprises to increase investment and innovation, and promote the sustainable development of the industry. Enterprises should actively respond to government policies, constantly improve service efficiency, improve user interactive experience, and expand market share. At the same time, Chengdu citizens should also assume the responsibility of protecting public property and maintaining the city's collective environmental sanitation.

II. Analysis of development status quo

This study uses a questionnaire survey method combining online and offline. In addition, this study is supplemented by field observation and data analysis to conduct a systematic and in-depth study on the use of shared bikes in Chengdu. The data mainly comes from diversified channels such as questionnaire survey, field observation records and data of bike-sharing platform to ensure the comprehensiveness and accuracy of the research.

As the economic and cultural center of the western region, Chengdu's bike-sharing market also shows a booming development trend, attracting many well-known brands at home and abroad, including Qingju,

Meituan and Hello. According to statistics, the total number of shared bikes in Chengdu has exceeded 1 million, with the average daily cycling population of 2.2 million and over 5 million people. The utilization rate of shared bikes ranks first in China. This series of figures not only show the popularity of shared bikes in Chengdu, but also reflect the citizens' recognition and acceptance of green travel methods.

In the process of investigation, the in-depth analysis of the use of shared bikes in different regions of Chengdu was focused on. Not only carefully observed the spatial distribution characteristics of shared bikes, but also, the average cycling time of users was evaluated through quantitative analysis, so as to fully understand the users' cycling behavior. Through comparative analysis of these data, it can be found that the usage patterns of shared bikes in different regions are significantly different. The utilization rate of shared bikes in some regions is significantly higher than that in other regions, and the average cycling time of users also shows different characteristics.

This study comprehensively demonstrates the current situation of shared bikes in Chengdu, which can provide an important reference basis for operators, and help to formulate targeted regional operation mode, optimize vehicle configuration and improve service quality. Through this survey and data analysis, a series of guiding conclusions and suggestions can be drawn, which provide important reference for the future planning and management of shared bikes in Chengdu. This paper is committed to having a positive impact on the operation of shared bikes in Chengdu and contributing to the role of improving the urban travel environment.

2.1 Brand and quantity

With the development of the sharing economy, shared bikes are developing rapidly in Chengdu. Today, in the streets and lanes of Chengdu, the yellow, green and blue shared bikes have become a beautiful scenery of the city.

In Chengdu, after bike-sharing fierce competition from many brands, it has been basically stable than Meituan Qingju Hello. These three brands continue to improve the service quality, such as optimizing vehicle design, increasing the number of vehicles, improving supporting facilities, so as to attract more users and provide better choices for citizens. On the other hand, shared motorcycles are now each brand, regardless of high or low.

In short, the increasing brand and number of bike-sharing bikes in Chengdu provide citizens with a more convenient and green way to travel. While enjoying the convenience brought by shared bikes, we also need to pay attention to the problems in the development process, and jointly promote the healthy development of the bike-sharing industry.

2.2 coverage area

In Chengdu, the coverage rate of shared bikes has been increasing. Currently, Chengdu's shared bikes have covered most of the core areas, including downtown areas, commercial areas, residential areas, parks and scenic spots. These shared bikes provide a convenient and green way for citizens to travel, and have been welcomed and loved by the general public.

In addition, Chengdu is constantly introducing new policies to further promote the development of shared bikes. For example, we will increase support for bike-sharing companies and improve the utilization rate and service quality of shared bikes. At the same time, the management and supervision of shared bikes will be strengthened to ensure the safety and comfort of citizens.

In short, Chengdu will continue to increase its support and investment in bike-sharing in the future to promote the healthy development of the bike-sharing industry.

2.3 Distribution characteristics

Shared bikes are found everywhere in Chengdu. On the whole, the main distribution characteristics are as follows:

(1) The central area is densely distributed

The central area of Chengdu, such as Chunxi Road, Tianfu Square and other bustling commercial areas, has a large number of shared bikes and dense distribution. This is mainly because of the large population flow in these areas, the frequent commercial activities, and the large travel demand for citizens. The dense distribution of shared bikes provides a convenient and environmentally friendly way for citizens to travel, and also promotes the development of commercial activities.

(2) Extensive coverage of transportation hubs

Shared bikes are also widely available at transportation hubs such as railway stations and subway stations in Chengdu. These areas are important nodes for citizens to travel. The emergence of shared bikes has successfully solved the problem of "the last kilometer" for everyone, effectively alleviated traffic congestion and improved travel efficiency.

(3) Orderly layout of residential areas

In the residential area of Chengdu, the layout of shared bikes is relatively orderly. Generally speaking, a certain number of shared bikes will be set up in large residential areas such as residential areas and apartment buildings to meet the travel needs of residents. The layout of these shared bikes not only facilitates the daily travel of citizens, but also promotes the green travel atmosphere in the community.

2.4 Citizens cycling habits

With the popularity of shared bikes, the way people travel in Chengdu has changed significantly. As a convenient and environmentally friendly means of transportation, shared bikes provide citizens with more travel options. This part will further understand the travel needs and behavioral characteristics of citizens through cycling time, distance and purpose.

(1) Cycling time

Chengdu residents ride shared bikes mainly in the morning and evening rush hours, namely from 7 am to 9 am and from 5 pm to 7 PM. These two periods are the peak hours for citizens to go to work and from school, and shared bikes have become the first choice means of transportation for many people. In addition, the cycling time on weekends and holidays is relatively scattered, and citizens are more willing to ride around the cityses and do leisure exercise in their leisure time.

(2) Cycling distance

The distance of Chengdu citizens to ride shared bikes is mainly within 5 kilometers, which is mainly related to the travel needs of citizens and the scale of Chengdu. Shared bikes have significant advantages for short trips, such as saving time and avoiding congestion. In addition, with the progress of bike-sharing technology, such as the popularity of shared electric bikes, the cycling mileage of citizens is also gradually increasing.

(3) Purpose of cycling

The purposes of cycling shared bikes are diverse, mainly including the following aspects: commuting, leisure and exercise, short trips, and sightseeing.

III. Analysis of the data

Through the investigation and data analysis of the status quo of shared bikes in Chengdu, a series of meaningful conclusions and suggestions can be drawn, and these data will be of great significance for the future planning and management of shared bikes in Chengdu [10]. In this paper, the data analysis method is a very critical step, [11].

3.1 The use of shared bikes

The usage of shared bikes was counted, as shown in Figure Figure 3.1.

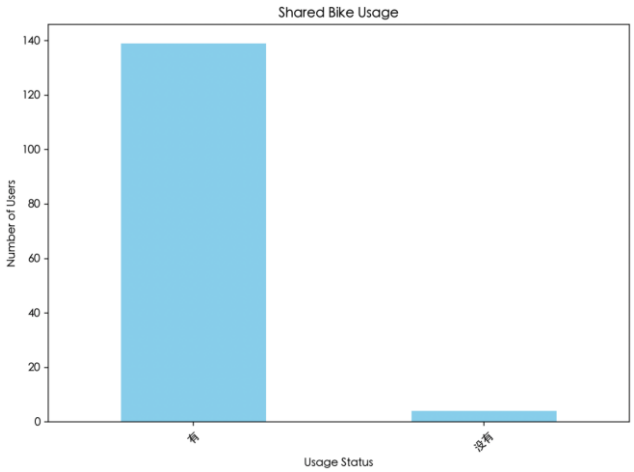

Figure 3.1 Usage of shared bikes

It is clear from Figure 3.1 that the number of people who have used shared bikes far exceeds that of those who have not. This phenomenon can reflect that shared bikes, as a low-cost and convenient way of travel, have been favored by the general public. Compared with traditional vehicles, shared bikes do not need to worry about parking Spaces, traffic congestion and other problems, and can meet the demand of short distance travel more quickly and flexibly, so they are welcomed by more people.

In addition, the popularity of shared bikes has also benefited from its convenient way of use and

flexible rental mode. The rental and return of the bikes can be completed through the mobile App, without planning the route or buying tickets in advance, which greatly lowers the threshold of travel, and enables more people to easily enjoy the convenience brought by the shared bikes.

Therefore, it can be seen from the use of shared bikes has become an important choice for citizens to travel now, providing new possibilities for urban travel, and improving the traffic conditions in the city to a certain extent.

3.2 age distribution

Through the questionnaire, the age distribution of shared bike users was counted and visually displayed, as shown in Figure 3.2 and Figure 3.3.

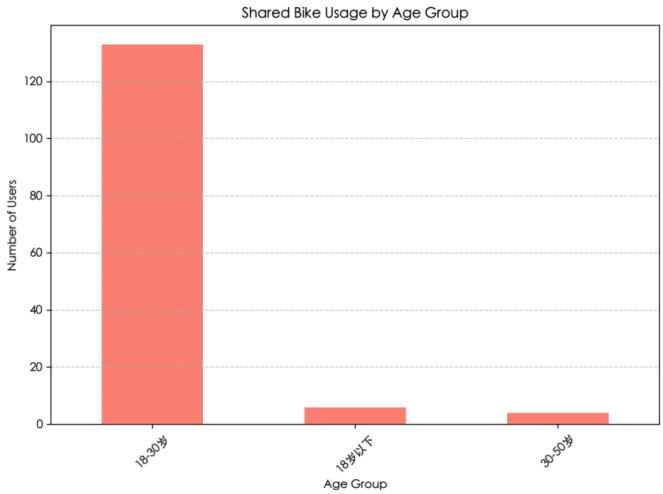

Figure 3.2 Bar graph of the age distribution

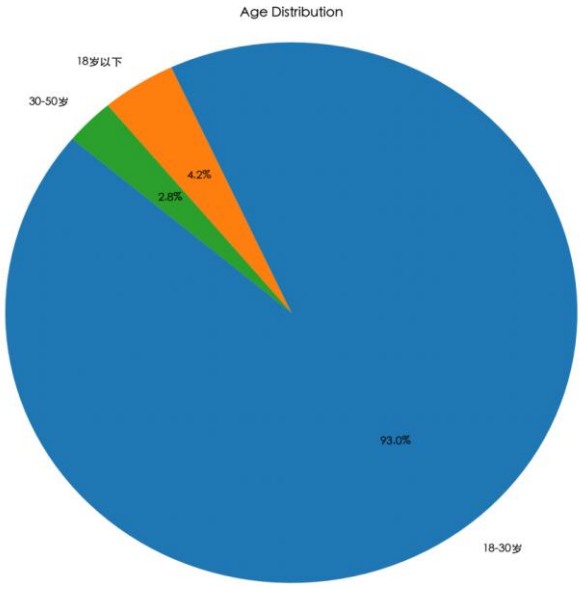

Figure 3.3 Pie chart of age distribution

As can be seen from Figure 3.2 and Figure 3.3, the age group between 18 and 30 years old is the main group of users of shared bikes. This may be related to the faster pace of life and the considerable work pressure of contemporary young people, which makes them pay more attention to the convenience and efficiency of travel. The flexible surname and fast speed of shared bikes can meet their needs for short and medium distance travel in cities, so they are favored by this age group. The use of shared bikes decreases as age increases or decreases, which may be because older people are more likely to use stable and comfortable vehicles, or minors may prefer to walk safer and be less dependent on shared bikes.

Therefore, differentiated services and promotion strategies can be conducted according to the needs of people of different age groups. For example: primary and secondary schools, nursing homes around the

reduction, office buildings, universities can increase the amount of investment and so on.

3.3 Use the reason

The reasons for the use of shared bikes were counted, and the visual results were shown in Figure 3.4 and Figure 3.5.

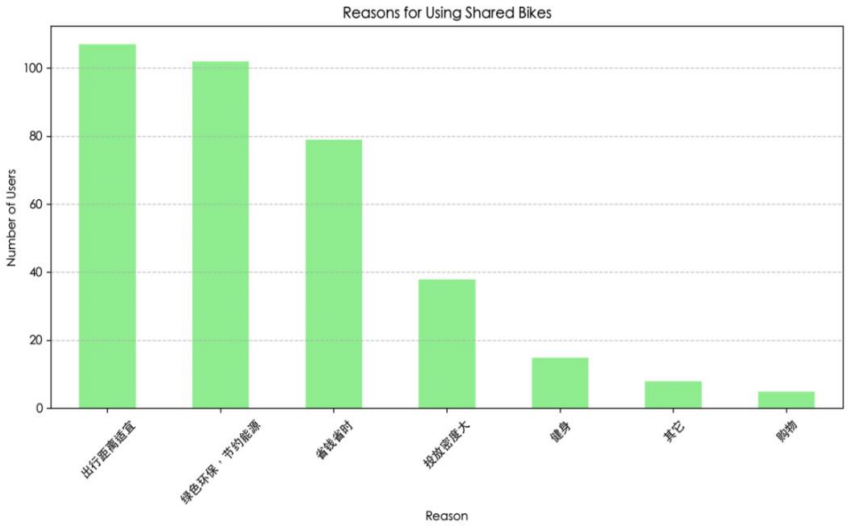

Figure 3.4 Bar chart of reasons of use

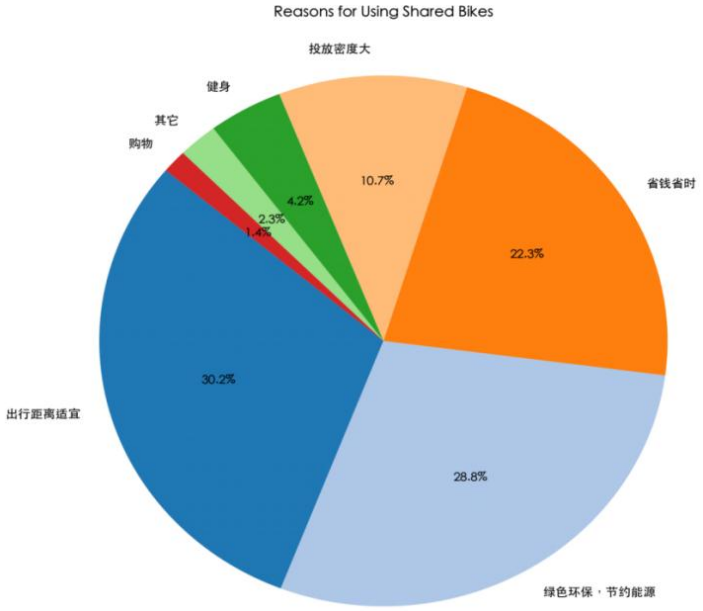

Figure 3.5 Cause pie chart for use

From the bar chart, we can see that the reasons for the use of shared bikes are relatively extensive. It can be seen from the pie chart that travel distance, saving money and time, and environmental protection are the main reasons for use, which shows that shared bikes are gradually popularized and playing an important role in the daily life of citizens. With the acceleration of urbanization and the increasingly prominent problem of traffic congestion, more and more people choose shared bikes as a means of transportation to solve the problem of urban transportation. Shared bikes are characterized by high flexibility and strong convenience, which can meet people's needs for short-distance trips, so they have been widely used.

In addition to daily travel, sports is also one of the main reasons why people choose shared bikes. With the improvement of health awareness and the change of lifestyle, more and more people begin to pay attention to sports and exercise, and choosing shared bikes to ride Tianfu Greenway has become a fashionable way to punch in sports. Through the shared bike, you can not only exercise, but also enjoy the beautiful scenery of Chengdu and get physical and mental pleasure.

Shared bikes have important application value and significance in many aspects. According to different use needs and scenarios, shared bikes provide diversified services and solutions, which brings great convenience to the travel of citizens.

3.4 sex ratio

The sex ratio of users was calculated and the pie chart was displayed, as shown in Figure 3.6.

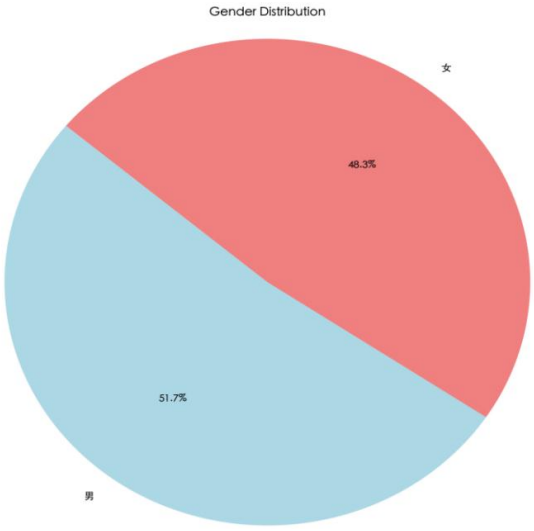

Figure 3.6, sex ratio

As can be seen from Figure 3.6, slightly more male than female users, but the gender distribution is relatively balanced. A slightly higher number of male users may be affected by many factors, such as the higher acceptance of convenient transportation among men, which may also be related to their more frequent needs in commuting, sports and other aspects. The relatively balanced gender distribution indicates that bike-sharing services have made efforts in gender equality and inclusiveness, and are able to attract different gender user groups. This is of positive significance to the sustainable development and market expansion of bike-sharing services, and also lays the foundation for providing more diversified and personalized services.

3.5 Quantity prediction

Through the annual summary report of bike-sharing enterprises in Chengdu, the annual data of shared bikes can be checked. Annual data are shown in Table 3.1.

Table 3.1 The total number of shared bikes in Chengdu

YEAR	2017	2018	2019	2020	2021	2022	2023
Quantity	1450000	1800000	1100000	900000	850000	890000	1030000

From these data and relevant surveys, we can see that due to the competition of enterprises and the control of the government, the overall trend of the number of shared bikes in Chengdu roughly increases first and then decreases until it stabilizes. To predict the number of shared bikes, the ARIMA model is used. The forecast results are as follows:

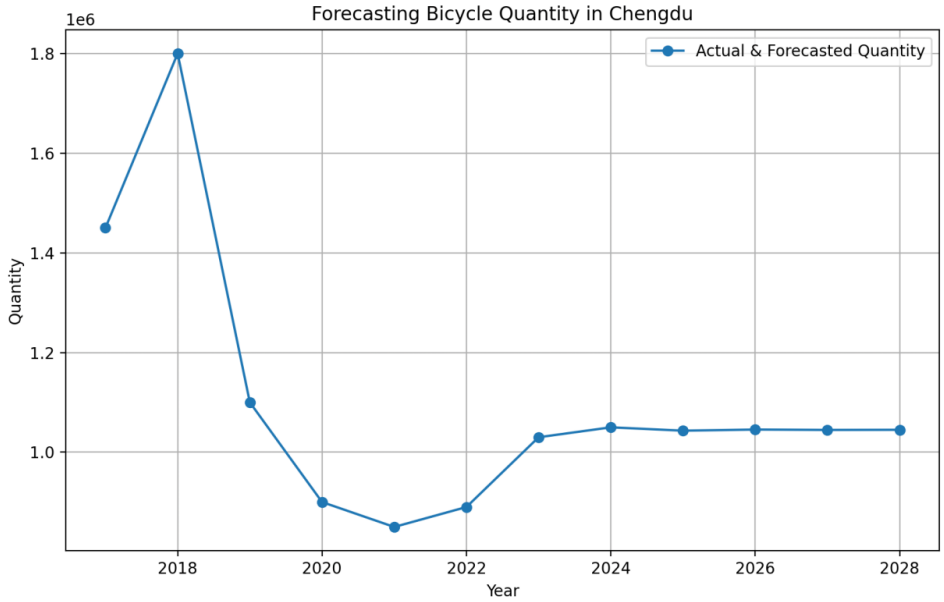

Figure 3.7 Quantity forecast for the next 5 years

Based on the forecast results of the ARIMA model, the number of shared bikes in the next five years is expected to be as follows:
Year 2024: Approximately 1,049,909 shared bikes.
Year 2025: Approximately 1,043,191 shared bikes.
Year 2026: Approximately 1,045,458 shared bikes.
Year 2027: Approximately 1,043,726 shared bikes.
Year 2028: Approximately 1,042,947 shared bikes.
The prediction model of the number of shared bikes in Chengdu reveals that its number will develop in a mode of steady growth. From the data over the years, the number of shared bikes in Chengdu has been kept stable year by year. According to the constructed quantitative prediction model analysis, the growth rate of the number of shared bikes is expected to slow down in the next year, but the overall growth model will remain gradual. Accordingly, Chengdu citizens' dependence on the use of the bike-sharing system will continue to increase, and the healthy development trend of the industry is expected to remain unchanged.

IV. Questions and Suggestions

As a green and convenient way to travel, shared bike is welcomed by Chengdu citizens. However, with the popularity of shared bikes, there are also some problems, such as indiscriminate parking, vehicle damage and theft, and the unbalanced density of delivery.

In many streets, public places and residential communities, you can see all kinds of random parking phenomenon, which not only affects the orderly progress of urban traffic, but also brings a lot of inconvenience to the travel of citizens. First, it affects the road capacity. Random parking of vehicles occupies part of the road, making the road congestion problem more serious, affecting the normal driving of vehicles and the passage of pedestrians. Second, it affects the image of the city. The vehicles are parked randomly all over the streets and alleys, which has a great negative impact on the appearance of the city and reduces the overall quality of the city. Third, there are potential security risks. Unorderly parked vehicles may hinder the fire access, affect the passage of emergency vehicles, and even cause traffic accidents.

In the process of using shared bikes, due to improper cycling and bad road conditions of some users, the vehicle damage rate is high. Statistics show that the damage rate of some shared bikes is as high as 30 percent. This not only increases the operating costs of enterprises, but also reduces the service life of shared bikes. In many non-downtown areas, shared bikes are also vandalized and privately occupied. These actions not only damage the economic interests of enterprises, but also make many users face the dilemma of no car available. Moreover, some of the theft even involves gang crimes, seriously disrupting the social order.

The dense distribution of shared bikes in urban core areas causes excess vehicles, disordered parking management, and potentially increased traffic congestion, and insufficient availability in urban periphery or distant areas, forcing users to spend more time and travel further to obtain cycling services. The reduction of citizens' travel experience can be traced back to this uneven distribution state, with potential consequences including urban traffic block and environmental pollution.

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Furthermore, this study makes some suggestions for these issues.

In order to solve the phenomenon of disorderly parking, the government departments should take a series of measures. First, to strengthen the urban traffic planning, reasonably plan the parking space, and meet the parking needs of citizens; second, to strengthen the law enforcement of disorderly parking and strictly punish the non-standard parking behavior; third, to guide citizens to travel civilized, standardize parking behavior and create a good traffic environment; and fourth, to promote the intelligent parking system and use the technological means to improve the utilization efficiency of parking resources and alleviate the problem of parking difficulties. In addition, the media should increase publicity to improve the traffic legal concept and civilized travel awareness. All sectors of society should also supervise the indiscriminate parking and contribute to the improvement of the urban traffic environment.

In order to solve the problem of damage and theft of shared bikes, the government should improve the laws and regulations on damage and theft of shared bikes, increase the cost of crime; intensify the crackdown on theft and maintain social order. Bike-sharing enterprises should strengthen publicity and education for users to improve their social responsibility; establish a credit system to punish malicious damage and theft; conduct real-time monitoring of vehicles through technical means, and find out and deal with damage and theft in time. In addition, enterprises can also cooperate with government departments and communities to jointly maintain the operation order of shared bikes.

In view of the density difference of shared bikes in Chengdu, a series of practical and effective adjustment strategies can be designed and implemented. For example, GPS positioning technology, intelligent lock and other equipment can be used to monitor the location and use of vehicles in real time, and vehicles can be timely deployed to avoid the problem of unbalanced density [12]. Data analysis can reveal the precise situation of the demand for shared bikes in each region, and then optimize the adjustment of the delivery strategy. In order to adjust the delivery strategy, an incentive mechanism can be established, such as rewarding enterprises that enhance the distribution of bicycles in areas with insufficient coverage; reduce the amount of bicycles in excessively populated areas and bear the corresponding punishment.

The continuous progress of the bike-sharing market can be achieved by adjusting its launch strategy, which will also stimulate the popularity of green travel in cities and play an important impact on the creation of an urban environment suitable for living and tourism. It is believed that with the joint efforts of the government and enterprises, the problem of bike-sharing in Chengdu will be solved, and shared travel will become an important part of urban development [14].

The future prosperity and development of Chengdu bike-sharing market requires the government, enterprises and all sectors of society to continue to work together. [15]. The government plays an important role in the development of the bike-sharing market. The Chengdu municipal government should actively respond to the needs of the public, formulate and implement relevant policies to ensure the safety of the citizens. Bike-sharing enterprises should strengthen their own internal management, scientifically and reasonably manage the scale of delivery and optimize the service scope [16] according to the market demand and user feedback. With the help of big data analysis, enterprises can also improve the management efficiency of vehicles through technical means, and achieve more accurate [17] delivery. All sectors of society should also actively participate in the governance of the bike-sharing market. In any case, I hope that with the efforts of the government, enterprises and citizens, bike-sharing will play a greater role in the travel of Chengdu, make greater contribution to the green and sustainable development of the city, and jointly promote the bike-sharing market in Chengdu to a higher level.

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