Open Journal of Social Sciences, 2020, 8, 260-273
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

Based on Binary Logit Model Analysis on Characteristics of Sharing Bicycle Travel Taking Fucheng District of Mianyang City as an Example

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How to cite this paper: An, T. T., & Hou, L. G. (2020). Based on Binary Logit Model Analysis on Characteristics of Sharing Bicycle Travel Taking Fucheng District of Mianyang City as an Example. *Open Journal of Social Sciences, 8,* 260-273.
https://doi.org/10.4236/jss.2020.84019

Received: December 18, 2019
Accepted: April 17, 2020
Published: April 20, 2020

Abstract

The study of urban shared bike travel characteristics is the premise of sustainable development of shared bike. In this paper, using the form of a questionnaire, the citizens of Fucheng District of Mianyang City were investigated and obtained 98 Valid data. Analysis of travel characteristics is based on survey data, and studies the factors affecting the use of shared bicycles, combined with the establishment of travel behavior theory Logit model, with the aid of SPSS Calculate with software. The results showed that women were more likely to choose shared bike trips than men; those who chose shared bikes tended to be younger; those who shared bikes were more favored by students and office workers; those with higher education levels were more likely to choose shared bike trips; and those with higher education levels were the most significantly affected.

Keywords

Slow Motion System, Shared Bicycle, Travel Characteristics, Logit Model, Mianyang City

1. Introduction

As one of the "new four great inventions" in China, shared bicycle has aroused extensive attention of many scholars at home and abroad (Wei, Mo, & Liu, 2018). This paper analyzes the problems of shared bicycle parking, deposit safety and vehicle maintenance, and puts forward concrete solutions from different angles (Wang, Yu, & Dun, 2018). This paper studies the optimal scheduling problem of shared bicycle, analyzes the factors affecting the demand of shared bicycle, and proposes an optimal scheduling scheme based on multi-objective programming (Yu, 2018). Using analytic hierarchy process to screen out the index which has a greater impact on the demand of shared bicycle LM Neural network gets the weight of each index, and gives reasonable suggestions for the forecast of shared bicycle demand (Wang, 2018). Based on the location information of shared bikes and other data, visually revealed the laws of residents' travel hotspots and spatial and temporal characteristics (Wang, Li, Xu, Ma, & Wei, 2018). Considering the age distribution, the market demand model of shared bikes was established, and the release model of shared bikes was established by Markov chain to determine the number of release points of Shared bikes (Gan, Zhang, Huang, & Hu, 2018). Aiming at the shortage of shared bicycle intelligent parking points in rush hour, a parking point assignment algorithm based on improved genetic algorithm is proposed (Shi, Chen, & Xu, 2019). Based on the analytic hierarchy process (AHP), this paper studies the influence and development of shared bicycle and shared car on urban traffic (Wang, 2019). An ARIMA model was proposed to predict the bicycle demand and status at the station by analyzing the number of bicycles and local population movement data in the Barcelona community (Kaltenbrunner, Meza, Grivolla, et al., 2010). The linear regression model was used to forecast the demand of bicycle in New York City (Singhvi, Singhvi, Frazier, et al., 2015). Based on the historical data of Zhongshan public bicycle system, the influence of scenic spots on travel demand and the ratio of site demand to supply are studied by using multiple linear regression model (Zhou, Wang, Zhong, et al., 2018). The proposal is based on MART Regression and Lasso. The final destination and vehicle duration were predicted by two regression models. Summarizing the literatures, it is found that domestic and foreign scholars pay more attention to the sharing of bicycle policy, the status quo, demand, the number of drop points and optimal dispatching, and lack of exploration of the characteristics of riders (Zhang, Pan, Li, et al., 2016).

Therefore, this paper will study the characteristics of shared bicycle travel from the perspective of traffic planning, in order to analyze the factors affecting the development of shared bicycle. Based on the travel behavior theory, a binomial choice of shared bicycle travel was established Logit based on the survey data, the model parameters were calibrated to determine the significant factors affecting the shared bicycle travel decision.

2. Overview of Study Area and Study Methods

2.1. Overview of the Study Area

Figure 1 shows the scope of the study area. The Fucheng District is an important part of the central city of Mianyang City. It is located in the west of the central part of Mianyang City, Sichuan Province. The capital of Chengdu 98 km. Resident Population of Fucheng District in 2017 92.87 Ten thousand people, high

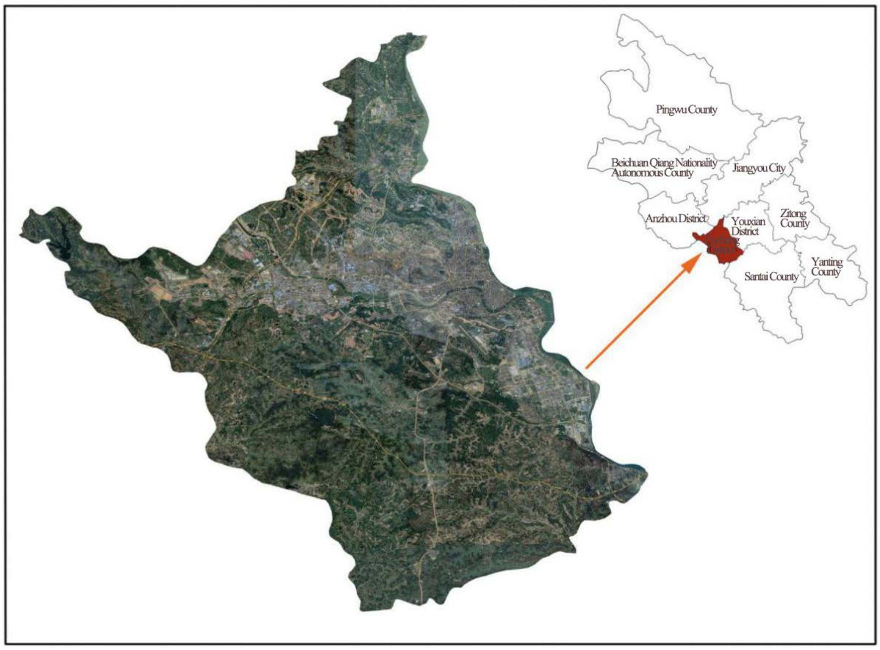

Figure 1. Study area map.

urbanization rate 77.71% male to female sex ratio 1:1, 60 near the mouth of the elderly over the age of 150,000 people. Large-scale commerce, residential areas, health institutions, schools and other facilities in the region are relatively complete. However, the public transport system in the study area is still not perfect, there are few bus lines, the phenomenon of shared bicycles, and the lack of systematic planning of bicycle lane system. The research on the characteristics of shared bicycle travel is the basis of reasonable launch of shared bicycle and scientific planning of non-motorized road, which can effectively solve urban traffic problems.

2.2. Research Methods

2.2.1. Questionnaire Method

Based on the collection of field survey questionnaire, a total of 98 valid data on the use of shared bicycles were obtained from Fucheng District of Mianyang City. The questionnaire contained two types of information: personal characteristics and travel characteristics. Personal characteristics included whether to use shared bicycles, gender, age, education level, occupation type, travel characteristics including riding hot spots, travel purpose, riding duration, frequency of use, and expected drop point. The contents of the questionnaire are shown in Table 1 to Table 2

As can be seen from the analysis of the returned questionnaire, i.e. 98 According to gender, among the survey subjects: 45 Male position, 53 Female gender ratio is similar 1:1 (see Table 3, Table 4); by whether or not shared bikes were used, where 76 Shared bicycles have been used by some people, 22 The survey object has not used shared bicycle, so the prevalence of shared bicycle in

Table 1. Information on personal characteristics.

Whether shared bicycle is used or not	Gender	Occupation	Age	Level of education
Yes	Male	Students	Under 20	Junior high school and below
No	Female	Self-employed	20 - 30 years	High school/technical secondary school
		Staff member of the company	30 - 40	College/Bachelor
		Public institutions	40 - 50 years	Postgraduate and above
		Freelance occupation	50 - 60 years	
		Other	Over 60	

Table 2. Travel characteristics information.

Weekly riding frequency	Riding duration/time	Travel purpose	Use hotspot area	Desired Drop Point
≤1 time	5 minutes	Commute	Residential area	Bus station
1 - 2 times	5 - 10 minutes	Up and Down	Near bus stop	Residential area
3 - 5 times	10 - 20 minutes	Official business	School	Learning
6 - 10 times	20 - 30 minutes	Shopping and entertainment	Commercial District	Office area
More than 10 times	More than 30 minutes	Leisure Fitness	Public Service Area	Commercial District
		Other	Other	Park Scenic Area
				Other attractions

Table 3. Gender data collection.

Gender	Number of patients
Male	45
Female sex	53

Table 4. Whether shared cycling data collection is used.

Whether shared bicycle is used or not	Number of patients
Yes	76
No	22

Fucheng District of Mianyang City is high 78%, However, there are still a few people who do not choose to use shared bicycles (see Table 4); by age: 20 those under the age of 18 Bit, 20 - 30 Yrs is 35 bit, 11 position 30 - 40 age, 40 - 50 of the age of 21 man, 50 - 60 And 60 Above the age of 8 According to the occupation, there are 33 students, 10 self-employed persons, 15 employees of the company, 11 employees of public institutions and 13 freelancers (see **Table 5**); according to the level of education, there are 11 persons with junior high school diploma or below, 31 persons with senior high school/technical secondary school diploma, 55 persons with junior college/technical college diploma and only 1 person with post-graduate diploma or above. The educational level is concentrated in the range of high school to undergraduate, which is consistent with the overall educational level of Mianyang City residents and has research significance, as shown in **Table 6**.

2.2.2. Binary Logit Model

The logit model is a discrete choice model based on utility maximization. This model is quick to solve, and can not only predict in the sample, but also accurately predict the data out of sample. The logit model assumes that the random terms of the utility function are independent of each other and follow the same Gumbel distribution. The main theoretical basis of Logit model is the theory of utility maximization. Random utility theory is the assumption that the traveler is the basic unit of traffic behavior and decision-making, and the traveler always chooses the option with the greatest perceived utility (Jalina, Li Feng., 2017).

The conditions for the traveler n to choose scheme i are as follows

$$u_{in} > u_{jn}, i \neq j; i, j \in A_n$$

Table 5. Age * occupational data collection.

		Occupation						
		Students	Self-employed	Staff member of the company	Public institutions	Freelance	Other	Total
Age	Under 20	18	0	0	0	0	0	18
	20 - 30 years	15	3	10	1	5	1	35
	30 - 40 years	0	3	4	3	0	1	11
	40 - 50 years	0	4	1	6	6	4	21
	50 - 60 years	0	0	0	1	2	5	8
	Over 60	0	0	0	0	0	5	5
	Total	33	10	15	11	13	16	98

Table 6. Level of education.

		Number	Percent	Percentage of Valid	Cumulative Percent
Valid	Junior high school and below	11	11.2	11.2	11.2
	High school/Secondary school	31	31.6	31.6	42.9
	College/Bachelor	55	56.1	56.1	99
	Postgraduate and above	1	1	1	100
	Total	98	100	100	

In: u_{in} The utility of choosing scheme *i* for the traveler *n*; u_{jn} the utility of choosing scheme *j* for traveler *n*; A_n For a collection of selection schemes.

Utility is a random variable that is assumed to be a function of the following variables: outgoing individuals, choice characteristics, selected environments; which can be expressed as

$$u_{in} = v_{in} + \varepsilon_{in}$$

where: v_{in} Fixed term of the utility function for choosing scheme *i* for traveler *n*. ε_{in} Choose the random term of the utility function of scheme *i* for the traveler *n*.

According to the theory of utility maximization, the probability that a walker *n* chooses scheme *i* p_{in} can be expressed as follows

$$p_{in} = prob\left(u_{in} > u_{jn}, i \neq j; i, j \in A_n\right) = prob\left(v_{in} + \varepsilon_{in} > v_{jn} + \varepsilon_{jn}\right)$$

$$0 \leq p_{in} \leq 1, \sum_{i \in A_n}^{n} p_{in} = 1$$

where: A_n For a collection of selection schemes.

The question of "whether to choose a shared bicycle as the mode of travel" is studied by commuters. Only "choose" $y = 1$ and "do not choose" $y = 0$. These two dependent variables take values, so the binomial choice model, namely BL model, is selected. For the convenience of parameter estimation and comparison, the utility function of $y = 0$ is 0 (i.e., the choice limb of the shared bicycle is not selected as the reference choice limb), and the utility function of $y = 1$ is $V\left(V = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n\right)$.

The probability of $y = 1$ is

$$P\left(y = 1\right) = \frac{\exp\left(v\right)}{1 + \exp\left(v\right)}$$

The probability of $y = 0$ is

$$P\left(y = 0\right) = \frac{1}{1 + \exp\left(v\right)} \quad \text{ff}$$

Thus, the model can ultimately be expressed as $U = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$ Where β_0 - β_n parameter calibration by maximum likelihood and testing its significance are needed.

3. Analysis of Study Results

3.1. Analysis of Shared Bicycle Travel Characteristics

3.1.1. Travel Purpose Analysis

Figure 2 shows an analysis of the use of shared bicycle travel purposes, most of which are daily commuting. In the survey, 76 people used shared bicycles, of which 26% were usually commuting. Shopping and recreation, leisure and fitness accounted for 24% and 22.9%, 8.3% of people travel for the purpose of going to school, 4.2% of people travel for business.

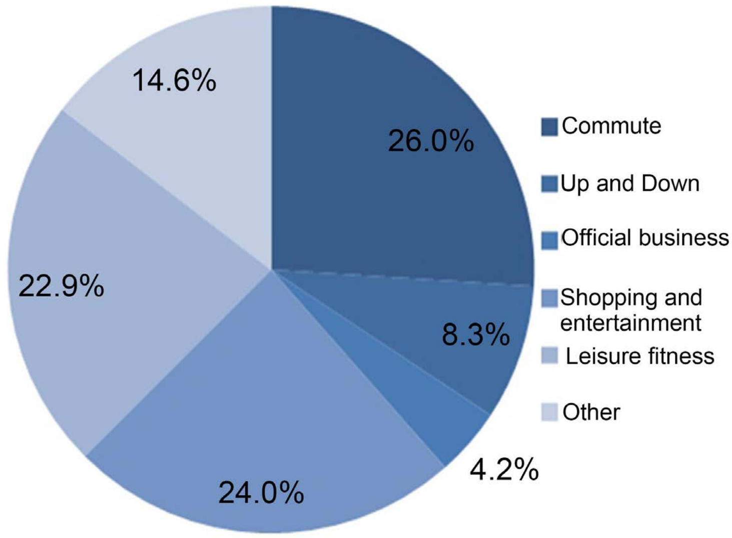

Figure 2. The purpose of sharing bicycle travel.

3.1.2. Hot Area Analysis for Ues

Figure 3 is a pooled analysis of the use of shared bicycle hotspots among the 76 people who chose to use shared bicycles, with 37% of the population using shared bicycles in residential areas, 17.6% in commercial areas, followed by 15.7% in the vicinity of bus stops, and 13.9%, 8.3% in public service areas and schools, respectively. Hot-spot areas tend to be residential and commercial, used for commute, shopping and entertainment. There is a relatively high proportion in the vicinity of bus stations, and shared bicycles are used as connecting traffic to provide convenience for residents to travel. The proportion of schools is relatively low, considering that most of the students go to school for parent pick-up.

3.1.3. Analysis of Frequency of Use per Week

Figure 4 shows an analysis of the proportion of the frequency of weekly use among the 76 people who chose to use shared bicycles. 38.2% of the population used it 3 - 5 times per week, and 27.6% and 22.4% used it less than or equal to 1 and 1 - 2 times per week, respectively. More than 6 rides per week were less common. It can be seen that residents use shared bicycles about three times a week in their trips, and travel choice to share bicycles has become the main mode of daily commuting for residents.

3.1.4. Duration per Ride

Figure 5 shows an analysis of the length of time per ride for residents who chose to use shared bicycles, with 5 - 10 minutes accounting for 32%, 10 - 20 minutes accounting for 24%, more than 30 minutes accounting for 18%, and 5 and 20 - 30 minutes each accounting for 13%, the lowest proportion. It can be seen that the average duration of each ride of residents is in the range of 5 - 20 minutes, which indicates that shared bicycles are mainly used as a tool for short distance travel to improve traffic congestion, transportation access and environmental pollution. It greatly facilitates people's daily life.

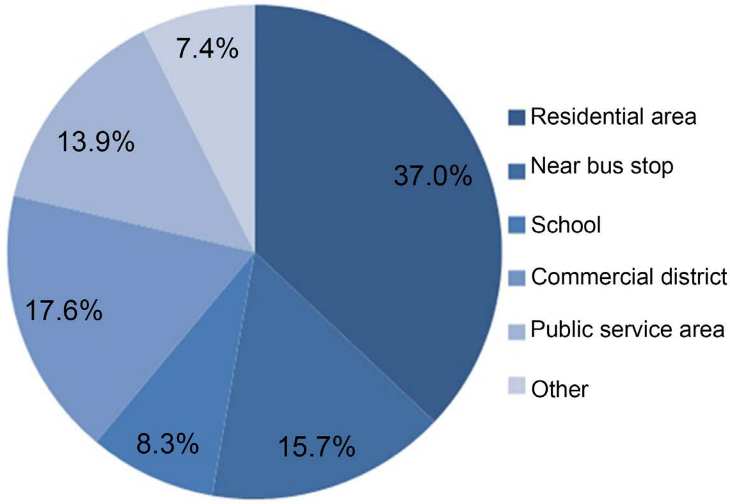

Figure 3. Shared bike hot spot area.

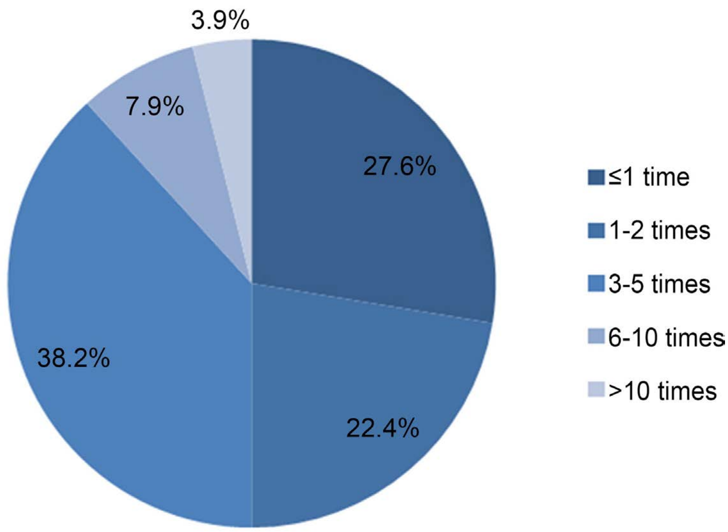

Figure 4. Weekly use of shared cycling frequency.

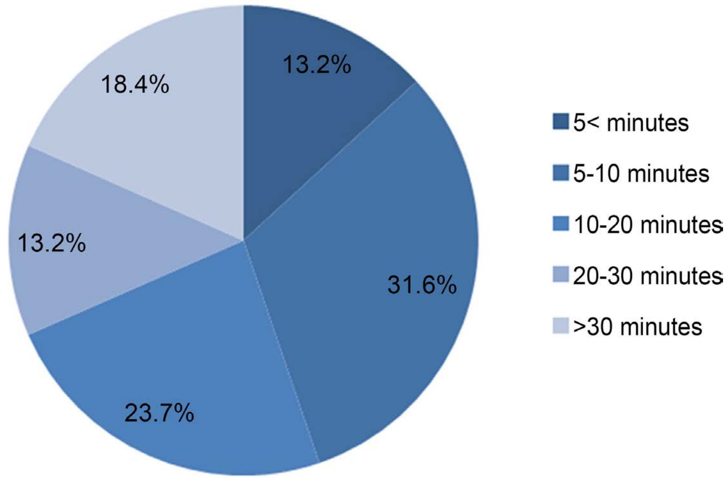

Figure 5. Duration per ride.

3.1.5. Resident Expected Drop Point

Figure 6 is the location where residents expect to share bicycle drop points in order to improve travel efficiency. 35.8% of people want to share bicycle drop points in residential areas, 19.5% expect to share bicycle drop points in commercial areas, and 15.4% expect to share bicycle drop points in bus stations. 12.2% of the people suggested to put in the school district, and 8.1% and 1.6% of park and other attractions, respectively. This shows that whether the residential areas, commercial areas and the residents choose to use shared bicycles is closely linked. Provide reasonable suggestions for shared bicycle placement by resident participation.

3.2. Analysis of Influencing Factors of Shared Bicycle Travel

3.2.1. Age Influencing Factors

Figure 7 shows the proportion of people in different age groups who choose to use shared bicycles. It can be seen that the proportion of people in the age group of 20 to 30 years who use shared bicycles is the highest, the proportion of people in the age group of 40 to 50 years and under 20 years is higher, and the proportion of people in the age group of over 50 years who use shared bicycles is relatively low. Shared cycling has a high popularity among youth groups and is gradually accepted by middle-aged groups.

3.2.2. Gender Influencing Factors

Figure 8 shows the proportion of males and females among the 76 respondents who would use shared bicycles. As can be seen, there were 52.6% females and 47.4% males who would choose to share bicycles, with little difference in the proportion, but females were more likely to choose shared bicycles overall than males.

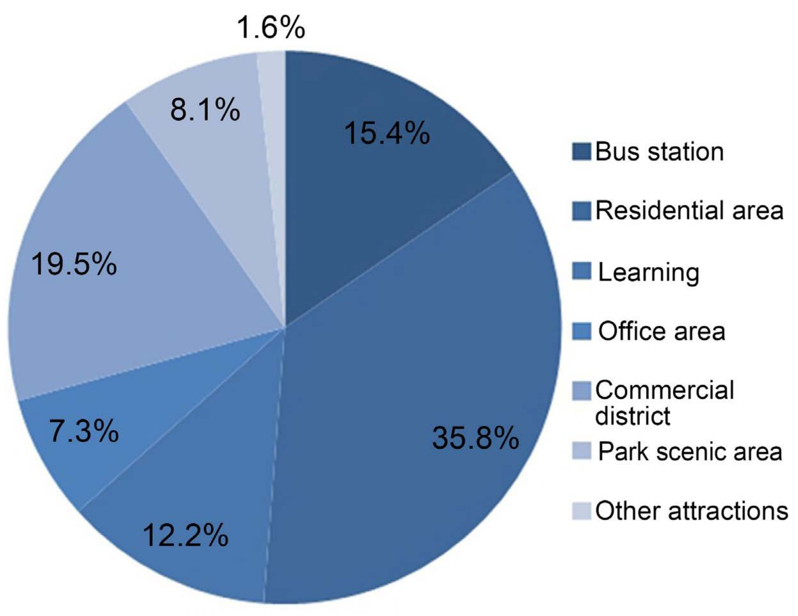

Figure 6. Desired drop point of residents.

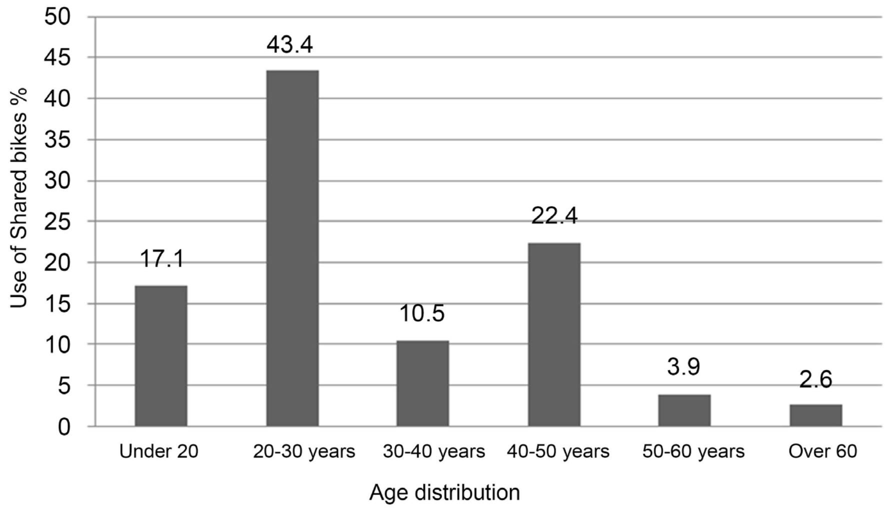

Figure 7. Proportion of shared bicycles used by different age groups.

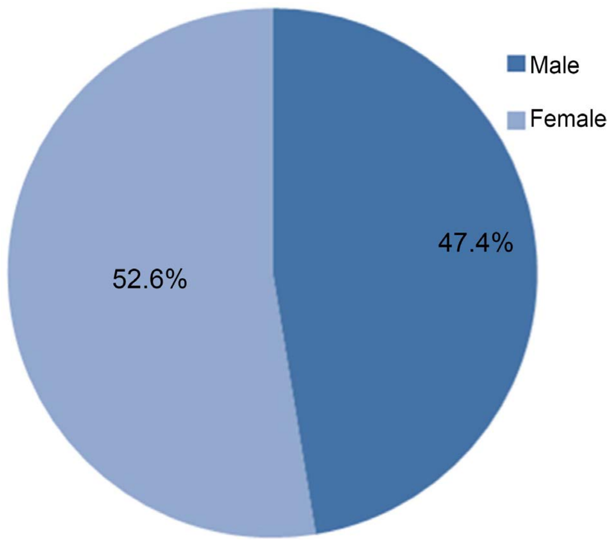

Figure 8. Proportion of gender using shared bicycles.

3.2.3. Factors Affecting Educational Level

Figure 9 shows the use of shared bicycles by people with different levels of education. It can be seen that as the education level of the group increases, the proportion of choosing shared bicycles also increases, which is inseparable from the fact that shared bicycles first use university campus as a user market. In addition, the higher the education level, the more channels for accepting new things and the greater the enthusiasm.

3.2.4. Vocational Influencing Factors

Figure 10 shows a summary of the use of shared bicycles by various occupational groups. Among the six types of occupations, the proportion of students who would choose to share bicycles reached 36.8%, followed by employees of the company, self-employed persons, freelance occupations of public institutions and others. The proportion was not as high as about 12%. When the market for

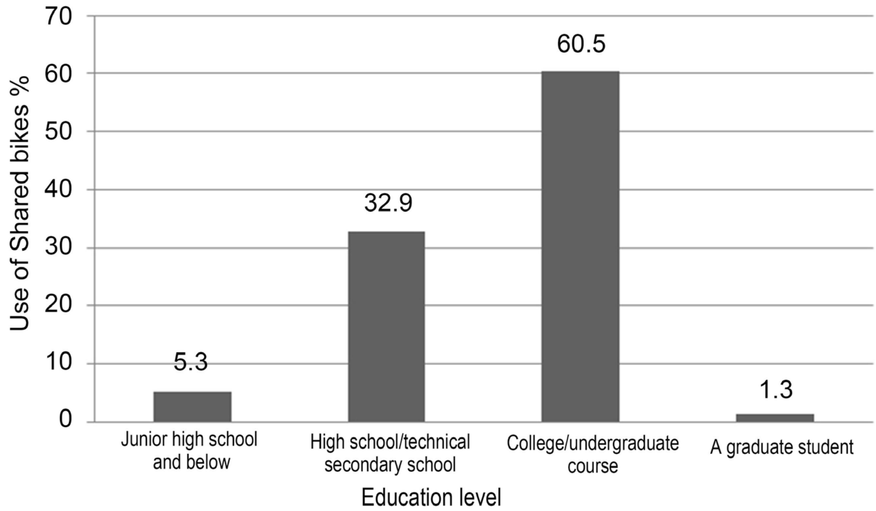

Figure 9. Proportion of shared bicycles used by all levels of education.

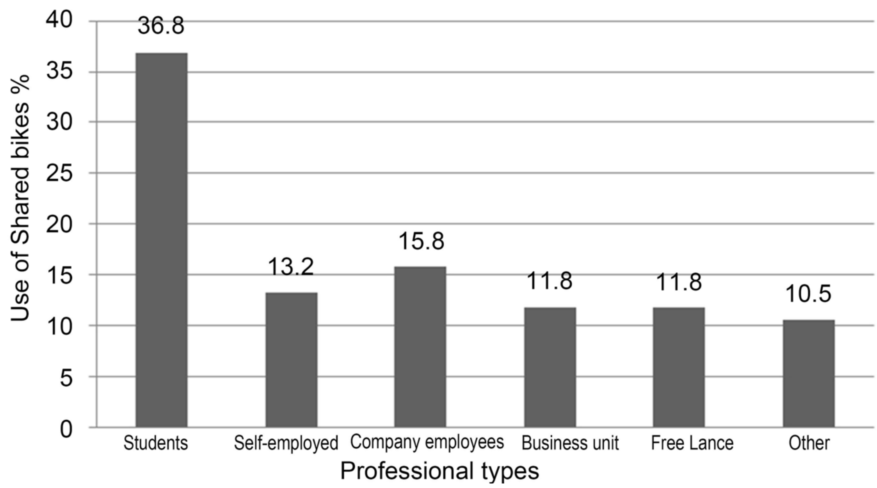

Figure 10. Proportion of shared bicycles used by different occupations.

the development of shared bicycles was developed in the early stage, colleges and universities were selected. Students had earlier exposure to shared bicycles and a wider range. Therefore, the proportion of students who would choose to share bicycles was higher. However, the general education level of employees and public institutions was higher, and they were more likely to accept new things. They also had more access to shared bicycles. The Internet level was also higher, and they preferred to share bicycles.

4. Binary Logit Case Analysis of Model

4.1. Binary Logit Model Cionstruction

Binomial selection was established with data from 98 questionnaires Logit whether or not to choose shared bicycle travel as the dependent variable, and whether or not to choose gender, age, education, occupation as the influencing factors for choosing to use shared bicycle.

Based on the survey data and the established model, a binomial logit regression was performed using SPSS software, and the results are shown in Table 7.

The final model was obtained using SPSS regression with significance less than 0.05, and four variables, namely gender, age, and education, were used as variables in the model. The utility function for the traveler to choose a shared bike can be expressed as $U = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$ According to the calibration results, it is possible to obtain

$$U = -1.287 - 0.391X_1 - 0.240X_2 + 0.779X_3 - 0.162X_4$$

4.2. Analysis of Model Results

Controlling for age and education, men were less likely than women to choose sharing bicycles. Women were more likely to choose sharing bicycles. Men were more likely than women to choose faster and shorter travel modes, such as private cars, especially commuting, and men were more likely to arrive at work earlier. Women were more likely to choose more comfortable travel modes. The significance was −0.048, rejecting the null hypothesis that the regression coefficient was 0.

The coefficient of the age variable in the model was estimated to be −0.240, indicating that the older the traveler, the less effective the choice of shared bike, i.e., the less likely the choice of shared bike as a mode of travel. This is also consistent with the actual situation. Sharing a bike requires the use of a mobile phone. Older people are less physically fit and less skilled in the use of smartphones, so they are less likely to use shared bikes than younger people. A significance of 0.037 was used to reject the null hypothesis of a recall coefficient of 0.

The coefficient of educational level in the model was estimated to be 0.779, which showed that the higher the education level of the traveler, the greater the utility of choosing the shared bicycle, that is, the more biased to choose the shared bicycle as the mode of travel. This is also consistent with the actual situation. The group with higher educational level had more opportunity platforms for receiving fresh information; the group with lower educational level did not know the information in time and preferred the choice of traditional transportation. A

Table 7. Binomial logit regression analysis of model.

The variables in the equation									
		B	The S.E.	Wald	Degree of freedom	Significance	Exp (B)	95% C.I. for EXP (B)	
								Lower limit	Upper limit
Step 1 A	Sex	−0.391	0.553	0.499	1	0 ... 0.048	1.478	0.500	4.367
	Age	−0.240	0.271	0.787	1	0 ... 0.037	1.272	0.748	2.162
	Level of education	0.779	0.369	4.466	1	0 … 0.003	0.459	0.223	0.945
	Occupation	−0.162	0.212	0.580	1	0 ... 0.044	1.175	0.776	1.781
	Constant	−1.287	1.533	0.705	1	0 And ... 0.004	0.276		

Note a. In Step 1 Variables entered in. Sig value < 0.05) Significant effect; Sig value Very significant effect (<0.01).

significance of 0.003 was used to reject the null hypothesis of a recall coefficient of 0.

The coefficient of occupation in the model is −0.162, indicating that students and office workers are more effective than freelancers and self-employed workers in choosing to share bicycles. Students and office workers tend to choose to share bicycles, which is consistent with the actual situation. Among the four variables, the significance values of gender, age, education, and occupation were 0.048, 0.037, 0.003, and 0.044, respectively. The effect of education on the choice of sharing bicycle was the most significant, with a significance value of 0.048 for gender having the least effect.

5. Conclusion

As a short-distance travel tool, sharing bicycle is mainly used for commuting, entertainment and shopping, and riding hot spots are concentrated in residential and commercial areas, while residents expect to share bicycle in residential and commercial areas, which is consistent with the analysis results of riding hot spots. It is suggested that shared bicycles be mainly put in residential and commercial areas. As a connecting means of transportation, bus stops are also hot spots, and the riding time range is generally 5 - 20 minutes. It can be seen that the shared bicycle parking places cannot be too far apart to stop near the destination, and cannot be too close to each other to cause waste of public space.

According to binary Logit Model building and SPSS, the results show that gender, age, education level and occupation have a significant effect on sharing bicycle travel. Women are more inclined to choose sharing bicycle than men, and age has a negative effect on the effect of sharing bicycle. Educational level has a positive influence on the utility of choosing shared bicycle, which is inseparable from the operation mode of shared bicycle "Internet +" and the characteristics of initiating on campus. The results of this study are of great significance for bike-sharing enterprises to provide the quantity of bikes, delivery stations and urban traffic planning according to the regional population proportion and the distribution of public facilities. At the same time, the reasonable placement of bicycles also provides residents with great convenience.

Because the distribution group of the questionnaire is mainly concentrated in the area with large human flow in Fucheng District of Mianyang City, the area coverage is small, and the amount of collected data is not large and the representativeness is insufficient, the factors affecting the sharing of bicycle travel behavior are not considered comprehensively, therefore, the above conclusions cannot comprehensively reflect the situation of sharing of bicycle travel in China, and there is still further improvement in this paper.

Funding

This work was supported by the National Natural Science Foundation of China (41701172); the Natural Science Project of Education Department of Sichuan

Province (15ZA0123).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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