Analysis of the Willingness to use Shared Bicycles on Campus Based on the Extended TAM Model ——Taking Henan Polytechnic University as an Example

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Abstract. Sharing bicycles into the university campus provides a new and convenient way for teachers and students to travel. In order to explore the influencing factors of the willingness to use shared bicycles on campus, based on the Technology Acceptance Model (TAM), three factors of perceived characteristics of shared bicycles on campus are introduced: perceived convenience, perceived preference and perceived safety. An extended TAM model is constructed and research hypotheses are proposed. Taking the students in the south campus of Henan Polytechnic University as the research object, the data were collected by questionnaire survey. Finally, using AMOS software to construct a structural equation model of the willingness to use shared bicycles on campus, test the research hypothesis and analyze the results of the model. The research shows that perceived usefulness and perceived safety have no significant impact on the willingness to use shared bicycles. Perceived convenience and perceived preference have a significant impact on the willingness to use shared bicycles. Among them, perceived preference has the greatest impact on the willingness to use. Through this conclusion, relevant improvement suggestions are put forward for the operation and management of shared bicycles on campus, hoping to provide reference for relevant campus shared bicycle operation and management personnel.

Keywords: Campus bike sharing, willingness to use, the extended TAM model, structural equation model

1 INTRODUCTION

In 2015, China 's two major bike-sharing companies Mobike and ofo, were established one after another. Shared bikes were quickly rolled out in major cities. By consulting relevant literature, the current research on the willingness to use urban shared bikes has been relatively mature. Fishman et al.[1] takes the residents of Brisbane, Australia as the research object, and discusses the influence of spontaneity, safety and terrain/weather on residents ' choice of shared bicycles. The results show that mandatory helmet legislation will reduce people 's spontaneous use, and bad weather or terrain will also affect residents ' choice of shared bicycles. Faghih et al.[2] explored the use of shared bicycles

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in Montreal, Canada. The results show that people are more willing to use shared bikes (work / school) when commuting, and the frequency of using shared bikes on weekends is much lower than that on weekdays. Based on the Technology Acceptance Model and the Theory of Planned Behavior, Yang Honglin et al.[3] explored the influence of five factors of Xi'an residents' perceived ease of use, perceived usefulness, behavioral attitude, subjective norm and perceived behavioral control on the willingness to use shared bicycles. From the three perspectives of shared bicycle product service system, social influence and innovation diffusion, Chen Chuanhong et al.[4] explored the influence of five factors on the willingness to use shared bicycles: perceived convenience, perceived ease of use, access convenience, personal innovation and social influence. The results show that perceived convenience, perceived ease of use and social influence all significantly affect the willingness to use shared bicycles. Taking the built-up area of Xi 'an as the research area, Li Zhongqi et al.[5] examined the impact of service convenience and perceived risk on the willingness to use shared bicycles. The results show that service convenience and its three sub-dimensions (accessibility, transaction convenience and subsequent convenience) have a significant positive impact on the willingness to use, and perceived risk and its three sub-dimensions (economic risk, privacy risk and physical risk) have a significant negative impact on the willingness to use. Based on the theory of planned behavior, Li Jun et al.[6] explored the impact of latent variables such as subjective norms, perceived behavior control, environmental concerns, and policy support on the use of shared electric bicycles.

With the popularity of shared bicycles in the city, some university campuses have also begun to introduce shared bicycles to meet the travel needs of students on campus. Although some scholars have studied the operation and management of shared bicycles in colleges and universities, there are still few studies on the willingness to use shared bicycles on campus. Compared with the urban environment, the campus has unique characteristics, and the research on urban shared bicycles is not fully applicable to the campus environment. Therefore, this paper aims to explore the influencing factors of college students ' willingness to use shared bicycles on campus from the perspective of shared bicycle users in colleges and universities. By referring to relevant literature and conducting field trips in the southern campus of Henan Polytechnic University, based on TAM theory (perceived usefulness), this paper introduces three latent variables of perceived preference, perceived safety and perceived convenience to form an expanded TAM model. On this basis, a questionnaire survey is carried out and the results are analyzed. In addition, the structural equation model is used to further explore the influence of latent variables. The research and analysis of the influencing factors of college students ' willingness to use shared bicycles on campus will help the relevant managers of shared bicycles on campus to adjust the operation strategy according to the specific operation of shared bicycles on campus, and promote the development and promotion of shared bicycles on campus.

2 MODEL CONSTRUCTION AND RESEARCH HYPOTHESIS

2.1 Model Construction

By combing the relevant literature, the theory of willingness to use has been developing. First, the rational behavior theory (TRA) proposed by American scholars Fishbein and Ajzen[7] laid the theoretical foundation. By 1991, Ajzen[8] introduced perceptual behavior control variables on this basis, forming the theory of planned behavior (TPB). In the existing research, TPB theory is widely used, but the development of computer is rapid, and the model needs to be improved in information technology. In 1986, Davis[9] proposed the Technology Acceptance Model (TAM), which removed the variable of subjective norm basing on TPB theory, added two variables of perceived usefulness and perceived ease of use, and adjusted the relationship between variables. At the same time, it also introduced external factors, which made the model have stronger explanatory power.

The main two latent variables in the TAM model are perceived usefulness and perceived ease of use. Perceived ease of use refers to the user 's subjective perception of the difficulty of using a new technology. Considering that the campus shared bicycle is easy and convenient to operate, and the users are college students with strong acceptance ability, and through reading the literature, it is found that in many studies, the impact of perceived ease of use on the willingness to use is not significant. Therefore, when constructing the model, this study no longer takes the latent variable of perceived ease of use into account. At the same time, combined with the characteristics of campus shared bicycles, the three latent variables of students ' perception of the characteristics of campus shared bicycles: perceived preference, perceived convenience, and perceived safety [10] are included, constructing an extended TAM model. The model of this study is shown in Figure 1.

2.2 Research Hypothesis

The basic assumption of TAM is that perceived usefulness and perceived ease of use have a significant impact on the willingness to use. Based on the extended TAM model proposed in this paper, combined with relevant theories, research hypotheses of this paper are proposed.

H1: The perceived usefulness of campus bike-sharing users has a significant positive impact on their willingness to use;

H2: The perceived convenience of campus bike-sharing users has a significant positive impact on their willingness to use;

H3: The perceived safety of campus shared bicycle users has a significant positive impact on their willingness to use;

H4: The perceived preference of campus bike-sharing users has a significant positive impact on their willingness to use.

2.3 Structural Equation Model

The concept of willingness to use cannot be directly measured, and this variable is called a latent variable. If you want to measure the latent variables, you need to rely on the observed variables. The structural equation model is a model that can simultaneously deal with latent variables and their corresponding observed variables. Structural equation model is a multivariate statistical method based on factor analysis and path analysis. In the study of willingness to use, structural equation model is widely used. The structural equation consists of two parts: the measurement model and the structural model. The measurement model characterizes the relationship between latent variables and observed variables, and the structural model describes the relationship between latent variables.

The relationship expressed by the measurement model is shown in Equations (1):

$$\begin{aligned} X &= \lambda^x \xi + \delta \\ Y &= \lambda^y \eta + \varepsilon \end{aligned} \tag{1}$$

In the formula (1): X is an exogenous observation variable; Y is the endogenous observation variable; ξ is the exogenous latent variable; σ is the measurement error of the exogenous latent variable; η is the endogenous latent variable; ε is the measurement error of endogenous latent variable; λ^x、λ^y are the factor loading matrices.

The relationship represented by the structure model is shown in formula (2):

$$\eta = \beta\eta + \gamma\xi + \zeta \tag{2}$$

In the formula (2): β is the path coefficient matrix between endogenous latent variables; γ is the path coefficient matrix between exogenous latent variables and endogenous latent variables; ζ is the residual term of the endogenous latent variable.

Based on the constructed theoretical model, the initial structural equation model of the willingness to use shared bicycles on campus can be constructed by using AMOS software, as shown in Figure 2.

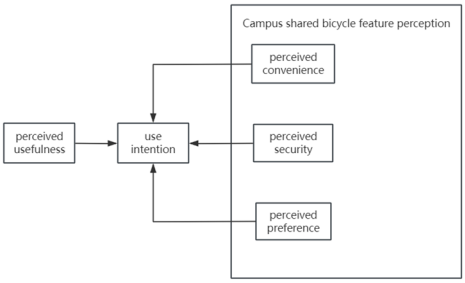

Fig. 1. Research model of willingness to use.

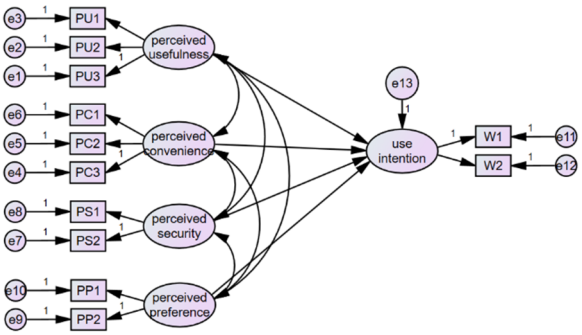

Fig. 2. Initial structural equation model diagram

3 RESEARCH METHODS AND DATA SOURCES

3.1 Questionnaire Design and Survey

The questionnaire is mainly composed of two parts: the first part is the basic personal information, including gender, grade, monthly living expenses, etc.; the second part is the experience of sharing bicycles on campus. The second part is the main part of the questionnaire. The Likert five-level scale is used for investigation. The variable settings are shown in Table 1.

This survey takes the students in the south campus of Henan Polytechnic University as the research object, and collects the questionnaire by combining online and offline methods. First, use WeChat and QQ to issue questionnaires, and then issue questionnaires to students who travel during the period of large travel volume on campus, and let them scan the two-dimensional code of the questionnaire to fill in the questionnaire. To ensure that the students who fill out the questionnaire are widely distributed, avoid focusing only on a certain area, make the filling of the questionnaire more credible and the error is smaller, the questionnaire is mainly distributed in the dormitory building, teaching building, restaurant and other student-intensive places. Finally, 186 questionnaires were collected, and 177 final questionnaire data were obtained by checking and analyzing the invalid and untrustworthy data. Usually, if there are multiple latent variables in the questionnaire survey, and the sample size of the survey data is more than five times the number of measurement questions, the number of questionnaires meets the requirements. Therefore, the number of valid questionnaires in this paper is up to standard.

Table 1. Latent variable and observation variable setting table.

Latent variables	Mark symbolic	Observation variables
Perceived usefulness	PU1	Shared bicycle is very helpful for my daily travel in school.
	PU2	Using shared bicycles can improve my travel efficiency.

	PU3	I think it is necessary to use shared bicycles for on-campus travel.
Perceived convenience	PC1	Shared bicycle scheduling efficiency is high, easy to find a bicycle.
	PC2	It is easy to find parking points. (many parking points)
	PC3	Shared bikes are easy to unlock.
Perceived security	PS1	I don 't think there will be any traffic accidents while cycling on campus.
	PS2	When riding, it will not cause personal injury due to bicycle failure.
Perceived preference	PP1	I think the pricing of shared bicycles is reasonable.
	PP2	Compared to buying a bike / electric car, I think using bicycles are more affordable.
Use intention	W1	I am willing to use shared bikes on campus.
	W2	I would like to recommend bike-sharing to friends and classmates.

3.2 Reliability and Validity Analysis of the Questionnaire

SPSS software was used to test the reliability and validity of the questionnaire data. The reliability test is to evaluate the consistency of the scale and analyze whether the test items in the scale can reflect the purpose of the questionnaire. Generally, Cronbach's α is used as the evaluation index. When the value is greater than 0.7, it can be proved that the reliability of the questionnaire is in line with the requirements. The reliability values of each latent variable are shown in Table 2. The test results show that the Cronbach 's α values of each latent variable are all greater than 0.7, so the reliability meets the requirements.

Table 2. The reliability value of each latent variable.

Latent variable	PU	PC	PS	PP	W
Cronbach's α	0.965	0.826	0.911	0.731	0.896

The validity test is to test the correctness of the questionnaire data. When it is tested, it is mainly to look at two values. One is the KMO value. If the KMO value and 1 are closer, it proves that the validity is very good, the more it meets the requirements, and the factor analysis is more credible. The other is Bartlett 's spherical test. After data processing and analysis by software, the value of KMO is 0.848, which meets the requirements. The significance P value of Bartlett's sphericity test is 0, which is significant at the level and has high validity.

3.3 Descriptive Statistical Analysis of Questionnaires

Personal attribute: 53% of the students surveyed were male and 47% were female, with a balanced male-female ratio. According to the grade of the respondents, the proportion of freshmen and sophomores is higher. Freshmen account for 37% and sophomores account for 29%. The reason is that considering that seniors are about to graduate, the survey is focused on freshmen and sophomores. The monthly disposable living

expenses of the respondents are mostly between 1000 and 1200 yuan (43%), less than 800 yuan (6%) and more than 1500 yuan (7%), which is consistent with the actual situation. Most of the respondents spend less than 5 yuan (38%) or 5-10 yuan (43%) on transportation every week. This shows that students are not willing to always spend their money on travel. The situation of respondents owning transportation: 64% of the respondents have no private transportation, and the number of people who own bicycles is comparable to that of electric vehicles. Among the scores of each item of willingness to use, the perceived usefulness score was the highest, and the perceived preference score was the lowest; in perceived convenience, PC1 scored the lowest (3.44), and PS1 (3.59) scored lower than PS2 (3.78) in perceived security. The overall score of willingness to use is higher. The average score of each item option on the willingness to use is shown in Figure 3.

4 HYPOTHESIS TESTING AND RESULT ANALYSIS

4.1 Model fitting and Correction

Before conducting hypothesis testing, the model needs to be structurally tested by AMOS software to ensure the accuracy of data analysis. [11]There are five main requirements for model fitting: the chi-square degree of freedom ratio (CMIN/DF) is less than 3, the root mean square error of approximation (RMSEA) is less than 0.08, and the goodness of fit index (GFI), comparative fit index (CFI), and normative fit index (NFI) are all greater than 0.9. Import the data into the initial structural model diagram, the fitting indexes do not meet the standards, so the model needs to be corrected. Correction index provided by AMOS software is the M.I. value. Firstly, find out the residual terms (e5 and e6) corresponding to the maximum M.I. value, then connect the two with the double arrow correlation line, and finally run. The modified model fitting degree and structural equation path diagram are shown in Figure 4. It can be seen from Figure.4 that except that RMSEA is slightly larger than 0.08, other indicators meet the requirements, and RMSEA is less than 0.1, which indicates that the model fits well. Therefore, the fitting degree of the modified model meets the requirements.

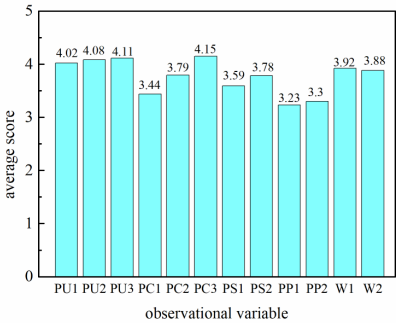

Fig. 3. Average score distribution of observed variables.

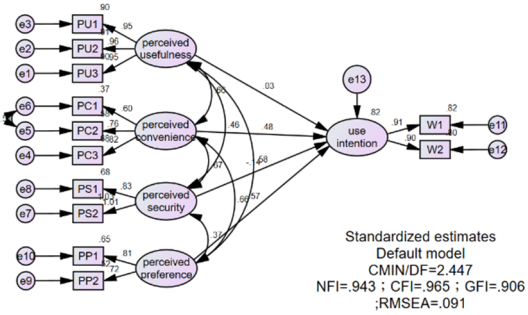

Fig. 4. Revised structural equation path diagram.

4.2 Path Analysis and Hypothesis Testing

After the fitting index of the model meets the relevant requirements, the path analysis of the model can be carried out. By analyzing the path coefficient and the significant coefficient between the latent variables, it is confirmed whether the research hypothesis proposed above passes the test. The results of structural equation path analysis are shown in Table 3.

It can be seen from Table 3 that the path coefficient of perceived convenience is 0.480, and the significance P is *** (P<0.05), indicating that perceived convenience positively and significantly affects the willingness to use, that is, H1 passes the test; the path coefficient of perceived preference is 0.570, and the significance P is *** (P<0.05), which also shows that perceived preference has a significant positive impact on the willingness to use, that is, assuming that H4 passes the test; the significance P value of perceived usefulness is 0.754, and the significance P value of perceived security is 0.091, that is, P>0.05, indicating that the impact of perceived usefulness and perceived security on the willingness to use is not significant, so H2 and H3 are not tested. The path coefficient of perceived preference is the largest, so the perceived preference has the greatest impact on the willingness to use. This further enriches the influencing factors of the willingness to use shared bicycles on campus.

Table 3. The results of path analysis.

Path relationship	Estimate	S.E.	C.R.	P
Use intention←perceived usefulness	0.026	0.070	0.313	0.754
Use intention←perceived convenience	0.480	0.186	3.300	***
Use intention← perceived security	-0.139	0.066	-1.689	0.091
Use intention←perceived preference	0.570	0.100	5.007	***

The impact of perceived usefulness on willingness to use is not significant, which indicates that even if students feel that sharing bicycles on campus is useful and helpful for their daily travel (for example, sharing bicycles can greatly improve the efficiency of travel when travel is urgent), they will not choose to use them when they travel in peacetime due to various reasons. For example, when traveling with companions, companions do not choose to share bicycles, and they do not use shared bicycles due to the

influence of companions; moreover, when students want to use shared bikes to travel, they will not use shared bikes because they cannot find available shared bikes around their location or find bikes for too long. Similarly, the impact of perceived safety on willingness to use is not significant, which indicates that even if bike-sharing users think it is safe to use bike-sharing on campus, they will not choose bike-sharing as a result. For example, students consider that it costs 1 yuan or 1.5 yuan for each use of bicycles. If they use them frequently, it is also a large cost for them, so they naturally reduce the use of bicycles. In addition, the path coefficient between perceived safety and willingness to use is negative. The reason may be that, (1) As the above analysis: even if students feel that it is safe to use bicycles on campus, they will not choose to share bicycles due to certain factors. (2) Even if students feel that there is a certain danger in using shared bicycles on campus (for example, there is a safety risk in using shared bicycles when there is a large flow of people during class hours), they will still choose to share bicycles under certain travel needs.

5 CONCLUSION

This paper enriches the research on the willingness to use shared bicycles on campus. Based on the extended TAM model, this paper explores the influence of the four latent variables of perceived usefulness, perceived convenience, perceived security and perceived preference on the willingness to use. The results show that perceived convenience and perceived preference have the most significant impact on the willingness to use, while perceived usefulness and perceived security have little impact on the willingness to use. Therefore, the relevant management personnel of shared bicycles can improve the operation and management of shared bicycles on campus from these two perspectives. the scores of the two observed variables of the latent variable of perceived preference are very low. And perceived convenience has the greatest impact on the willingness to use. Therefore, the relevant personnel of campus shared bicycles should take some preferential activities on the cost of shared bicycles. For example, when the number of students using shared bicycles per week or per month exceeds a certain value, they can get free rides, thus reducing the travel cost of students. In addition, among the latent variables of perceived convenience, the observation variable of 'shared bicycle scheduling efficiency is high, and it is convenient to find a bicycle' has the lowest score. Therefore, it is extremely urgent to improve the scheduling efficiency of shared bicycles so that students can find shared bicycles at the fastest speed when they want to use shared bicycles, and improve their travel efficiency. For example, at the time of class, improve the efficiency of bicycle scheduling in the area where the dormitory building is located, because during this period, the bicycles in the dormitory area often fail to meet the needs of students. By improving the operation of shared bicycles, promote the development of shared bicycles on campus. This paper only discusses the influence of Henan Polytechnic University students ' perception of the characteristics of campus shared bicycles on their willingness to use. In the follow-up study, some other influencing factors can be introduced, such as subjective norms, behavioral attitudes, etc., to further improve the research content. In addition, expanding the sample

size and obtaining more data will make the results more representative and more reliable.

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