Research on Sharing Bicycle Service Quality Evaluation Based on Improved IPA

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Abstract. With the gradual implementation of the standardization and remediation measures of the sharing bicycle market, it is increasingly important for sharing bicycle platform to maintain a competitive advantage by improving service quality. Taking the campus sharing bicycle as the research object, used exploratory factor analysis method to further improve the evaluation indicators through the physical design of the bicycle body and the safety factors of the riding process, and finally established a service quality evaluation index system of 5 dimensions and 20 factors based on SERVQUAL scale. Taking Wuhan University as an example, the Weizhao Deng's partial correlation coefficient method is used to analyze the improved IPA model, and the priority of the improved factors is refined. On this basis, some suggestions are provided for improving the quality of sharing bicycles services.

1. Introduction
Since the sharing bicycles emerged in various cities, there have been reports of negative news about these, such as uncivilized parking and affecting urban road traffic. This improper platform service guidance has affected urban planning and construction, and has caused significant losses to the company, resulting in negative brand influences and the loss of users. With the gradual introduction of the management policy for the sharing bicycle market, the initial price advantage will no longer exist. The sharing bicycle service platform need to attract and retain customers, and its service quality will become the core competitiveness [1]. Therefore, systematic evaluation of the sharing bicycle service level is conducive to understanding its current situation, identifying its advantages and disadvantages, and thus comprehensively improving the service quality of the sharing bicycle platform.

There are many researches on the evaluation index of sharing bicycle service quality. Scholars at home and abroad have studied from the aspects of usage experience, usage characteristics, and user portraits. In terms of usage experience, Shaheen emphasizes safety, limited circulation of public facilities, cost-based technical feasibility, and user comfort by comparing the evolutionary processes and business models of the first three generations of sharing bicycles [2]. Fishman came up with the convenience, accessibility, and safety are the most important factors when investigating the sharing of bicycles in Australia. And security is a decisive factor in attracting users, accessibility is especially important in maintaining user retention [3]. In terms of usage characteristics, Fuller conducted a user
satisfaction evaluation analysis from the perspective of demographic characteristics and travel characteristics by studying the sharing bicycle system in Canada, and found that the distance between the rental points and the rental point within 250 meters can promote the user satisfaction degree [4]. Coincidently, when studying the quality of sharing bicycle service in Spain, Molina-Garcia proposed that the distance from people to the rental point would directly affect whether people choose to use sharing bicycles, which emphasizes the accessibility of sharing bicycle systems to users [5]. In the user portraits, Fuller suggested that user’s age is mostly between 18 and 24, and the education level is relatively high, Fishman also found this. Moreover, Bordagaray believed that the cost of sharing bicycles will affect people's early attempts [6]. However, the existing research does not consider the impact of riding safety guarantee on the satisfaction of service quality evaluation, and the adopted IPA model is the traditional four-quadrant interval, and the prediction accuracy is relatively low. At the same time, in the face of a large number of sharing bicycle brands in the market, the design of its visual impact should not be ignored, and the design that meets the perceptual needs of consumer products is more likely to be favored [7]. However, no scholars in China have used this as a measure to study the satisfaction of sharing bicycles.

At present, the most widely used service quality evaluation system models are the SERVQUAL evaluation model and the SERVPERF evaluation model. There is no substantial difference in the scale structure between both of them, but the evaluation method has changed. The former was proposed by three scholars PZB based on the theory of total quality management, and divided the factors affecting service quality into five dimensions including 22 indicators—reliability, assurance, empathy, tangibility, responsiveness [8]. The latter is the improvement of the scholar Cronin & Taylor based on the SERVQUAL model [9], which avoids the customer's subjective distinction between service expectation and service perception, directly investigates the customer's actual perception, and does not involve the allocation of index weights. Therefore, the survey results have higher accuracy. Comprehensive considerations, this paper uses the SERVQUAL model's scale structure and SERVPERF model evaluation method to analyze the results of the questionnaire survey. Considering that different indicator dimensions and factor impact weights are different, IPA analysis is introduced to combine direct performance with impact weight. In the calculation of index weights, the respondent's evaluation of the importance of the indicators may be affected by the satisfaction of the indicators, so the self-reported importance cannot reflect the true feelings of the respondents [10]. Based on this, this paper uses Weizhao Deng partial correlation coefficient method to evaluate the importance, so that the survey data is relatively reliable.

Firstly, according to the usage process of sharing bicycles, this paper summarizes the dimensions and indicators of relevant influencing factors, and takes the sharing bicycle design and riding safety as the key points. Based on the SERVQUAL and SERVPERF models, the initial service quality evaluation index system is established and pre-investigation is vehicleried out. After that a service quality evaluation system with 5 dimensions and 20 indicators is formed. Secondly, the satisfaction evaluation index is obtained by one-way analysis of variance, and its importance is obtained by Weizhao Deng’s partial correlation coefficient method. Finally, the improved IPA model is used to identify key improvement factors and sub-priority factors, and put forward relevant countermeasures.

2. Research design

2.1. Research method design

The importance-performance analysis (IPA) proposed by Martilla & James [11] is the means of investigating the user's satisfaction and attention to the indicators of the study subjects, according to the findings to sort and reflected in a four-quadrant map comprehensively. Indicators belonging to different quadrants have different attributes, so that the existing problems of the research object and the priority of solving the problem can be quickly located. In IPA map, the different methods of selecting the center point may result in a large deviation of the result. Many scholars such as Azzopardi & Nash believe that the central point will affect the predictive validity [12]. Bacon uses the data, the scale as the center and
the diagonal model to compare the 15 sets of data sets, and obtains the prediction method of the diagonal model better than other methods [13].

The diagonal model used by Bacon is based on the quadrant, adding a 45° diagonal line across the origin and running through the first and third quadrants. With importance as the horizontal axis X and satisfaction as the vertical axis Y, as shown in Fig. 1, the shaded portions are all “key improvement” areas, and the areas outside the shaded portion in the first quadrant are “continue to remain”, and the shadow area in the third quadrant is “low priority” and the “excessive performance” area is unchanged.

![Figure 1. IPA model](image1)

![Figure 2. Improved IPA model](image2)

However, considering that the satisfaction of the factors in the third quadrant is low, the importance evaluation is lower than the mean value. The uniform division of the area into the key improvement areas will lead to too many key improvement factors, resulting in unclear prioritization. At the same time, it is not conducive to accurately identify the factors that need improvement. Therefore, this paper improves the diagonal model of Bacon, dividing the lower part of the 45° oblique line into “secondary priority” and the rest as “low priority”, as shown in Figure 2, so that the improved order of related factors has a clearer level.

2.2. Design of initial index system for campus sharing bicycle service quality evaluation

The factors affecting the quality of sharing bicycle on campus are multi-sided and multi-level, and there are also complicated relationships among various factors. This paper follows the principles of systemic, conciseness, hierarchy and orientation, and determines the 7 dimensions--aesthetics, remediation, reliability, convenience, friendliness, safety and economy.

These seven dimensions summarize the emphasis of the evaluation system, and its primary and secondary indicators are detailed in Table 1.
Table 1. Sharing bicycle service quality evaluation initial index system

| Quality dimension | Indicator factor                        | Item number |
|-------------------|-----------------------------------------|-------------|
| Aesthetic         | Attractive body design                   | A1          |
|                   | APP interface is clear and concise       | A2          |
|                   | QR code printing is clear                | A3          |
| Remedial          | The deposit refund is processed in time  | B1          |
|                   | Repair and complaint handling in time    | B2          |
| Reliability       | Accurate vehicle positioning             | C1          |
|                   | Accurate route and time recording        | C2          |
|                   | Parking area guides clear                | C3          |
|                   | Enough vehicles in various regions       | C4          |
| Convenience       | APP does not flash back                  | D1          |
|                   | Registration and recharge procedures are quick and easy | D2          |
|                   | Vehicle is not faulty                    | D3          |
| Friendliness      | Reasonable credit system                 | E1          |
|                   | Regularly launch preferential policies   | E2          |
|                   | Different user groups different use prices | E3          |
|                   | Provide sports consumption data          | E4          |
|                   | Improve ride comfort                     | E5          |
|                   | Provide kinds of vehicles                | E6          |
| Safety            | Personal information is not leaked       | F1          |
|                   | Payment environment ensures security      | F2          |
|                   | Safety guarantee during the riding process | F3          |
| Economy           | Reasonable deposit amount                | G1          |
|                   | Reasonable price of usage                | G2          |

2.3. Questionnaire design

The questionnaire is divided into three parts. The first part is the basic information of the respondent, including gender, education, and monthly disposable amount. The second part is the travel information of the respondent, including usage frequency, average usage time and average search time. The third part is the interviewer's service quality perception survey starts from seven dimensions: aesthetics, resilience, reliability, convenience, friendliness, safety and economy, including 23 sub-projects. Because there are a large number of college students in Wuhan with the rich school types, and students have a wide range, the overall knowledge level is relatively high, the cognitive bias of service quality is small. Therefore, this paper selects sharing bicycles in Wuhan universities as the research object. The survey used the Likert five-point scale to assign values to the project. The highest level is “very satisfied”, which is 1 point; the lowest level is “very dissatisfied”, which is 5 points.

3. Pre-research and correction of indicator system

In the pre-investigation stage, the paper designed questionnaires for 23 projects in the above 7 dimensions. A total of 130 questionnaires were distributed and 118 questionnaires were collected, of which 111 were valid questionnaires. The recovered data was processed using SPSS 19.0, and the score-total score correlation analysis was used to correct the factors with lower correlation with the whole. When the simple correlation coefficient is less than 0.4, it should be eliminated [14]. It can be seen from Table 2 that the correlation coefficient of each factor is greater than 0.4 when the confidence level is 95%, so it is not rejected.
Table 2. Pre-research factors score-total score correlation coefficient

| Factors | Score-total score correlation coefficient | Factors | Score-total score correlation coefficient | Factors | Score-total score correlation coefficient | Factors | Score-total score correlation coefficient |
|---------|------------------------------------------|---------|------------------------------------------|---------|------------------------------------------|---------|------------------------------------------|
| A1      | .546**                                  | C2      | .549**                                  | E1      | .513**                                  | F1      | .601**                                  |
| A2      | .538**                                  | C3      | .569**                                  | E2      | .588**                                  | F2      | .617**                                  |
| A3      | .553**                                  | C4      | .615**                                  | E3      | .533**                                  | F3      | .569**                                  |
| B1      | .581**                                  | D1      | .592**                                  | E4      | .432**                                  | G1      | .578**                                  |
| B2      | .580**                                  | D2      | .599**                                  | E5      | .559**                                  | G2      | .596**                                  |
| C1      | .597**                                  | D3      | .588**                                  | E6      | .604**                                  |         |                                         |

The Cronbach’s Alpha coefficient method further tests the internal consistency of each factor. As can be seen from Table 3, the coefficient coefficients of each factor are concentrated in the range of 0.918 to 0.920. If any one of them is removed, the Alpha coefficient of the other items will increase. It can be considered that the internal consistency is good and there is no need to delete item.

Table 3. Pre-research Cronbach’s Alpha coefficient

| Factors | Cronbach’s Alpha | Factors | Cronbach’s Alpha | Factors | Cronbach’s Alpha | Factors | Cronbach’s Alpha |
|---------|------------------|---------|------------------|---------|------------------|---------|------------------|
| A1      | .920             | C2      | .919             | E1      | .920             | F1      | .918             |
| A2      | .920             | C3      | .919             | E2      | .918             | F2      | .918             |
| A3      | .920             | C4      | .919             | E3      | .919             | F3      | .918             |
| B1      | .919             | D1      | .918             | E4      | .920             | G1      | .918             |
| B2      | .919             | D2      | .919             | E5      | .919             | G2      | .919             |
| C1      | .918             | D3      | .919             | E6      | .919             |         |                 |

The factor analysis can test whether the dimension setting of the indicator system and the attribution of the factors are reasonable, and whether there are overlapping factors. After calculation, the KMO value is 0.822, which is greater than the acceptable 0.7. In Bartlett’s spherical test, p<0.001, means that the correlation matrix between variables is not a unit matrix. There is a certain correlation between variables, and factor analysis can be performed.

Table 4. Pre-research explained total variance

| Ingredient | Initial eigenvalue | Total % of variance | % of cumulative | Extract square sum loading | Total % of variance | % of cumulative | Rotation square sum loading | Total % of variance | % of cumulative |
|------------|--------------------|---------------------|-----------------|----------------------------|---------------------|-----------------|----------------------------|---------------------|-----------------|
| 1          | 8.517              | 37.028              | 37.028          | 37.028                     | 37.028              | 37.028          | 3.564                     | 15.497             | 15.497          |
| 2          | 1.514              | 6.581              | 43.609          | 6.581                      | 43.609              | 6.581          | 3.291                     | 14.308             | 14.308          |
| 3          | 1.344              | 5.842              | 49.452          | 5.842                      | 49.452              | 5.842          | 2.639                     | 11.474             | 11.474          |
| 4          | 1.228              | 5.341              | 54.793          | 5.341                      | 54.793              | 5.341          | 2.275                     | 9.893              | 9.893           |
| 5          | 1.048              | 4.557              | 59.350          | 4.557                      | 59.350              | 4.557          | 1.881                     | 8.177              | 8.177           |

Stevens believes that when the number of factors is between 10 and 30, the component with the eigenvalue greater than 1 can be selected as the principal component [14], and this conclusion is highly recognized. As shown in Table 4, the five principal components are selected, and the cumulative contribution rate is 59.350%. It does not satisfy the recommendation that the cumulative contribution rate should reach 60% in the social science research field which is proposed by Hair [15]. Therefore, the scale structure is corrected by screening the maximum factor load of each factor.

Generally, the smaller the sample size, the higher the factor load requirement. The sample size of this pre-study is 111, so 0.5 is selected as the extraction standard, and the principal component orthogonal rotation method is used for analysis. The rotation component matrix is shown in Table 5. The largest factor load of “D2 registration and recharge procedures are simple and fast”, “E3 different
user groups different use prices”, “F1 personal information is not leaked” are 0.491, 0.432, 0.430 respectively, cannot be extracted into any of the main components, so these are removed.

Table 5. Rotation component matrix of pre-research

| Factors | Ingredient | 1  | 2  | 3  | 4  | 5  |
|---------|------------|----|----|----|----|----|
| A₁      | .105       | .223| .819| .036| .171|
| A₂      | .172       | .111| .730| .094| .105|
| A₃      | .188       | .210| .643| .183| .032|
| B₁      | .167       | .383| .501| .191| .121|
| B₂      | .155       | .138| .191| .792| .165|
| C₁      | .118       | .658| .232| .180| .215|
| C₂      | .225       | .534| .273| .100| .188|
| C₃      | .224       | .759| .025| .032| .227|
| C₄      | .108       | .720| .234| .081| .112|
| D₁      | .218       | .593| .298| .367| -.154|
| D₂      | .491       | .469| .151| .097| -.029|
| D₃      | .614       | .150| .092| .160| .279|
| E₁      | .571       | -.007| .287| .477| -.118|
| E₂      | .441       | .260| .093| .611| -.006|
| E₃      | .282       | .432| .239| .108| .306|
| E₄      | .055       | .154| .058| .724| .432|
| E₅      | .168       | .220| .140| .306| .728|
| E₆      | .402       | .262| .157| -.002| .610|
| F₁      | .399       | .137| .244| .210| .430|
| F₂      | .622       | .320| .108| .052| .052|
| F₃      | .737       | .089| .246| .211| .175|
| G₁      | .585       | .151| .321| -.005| .280|
| G₂      | .647       | .256| .013| .166| .236|

Table 6. Revised rotation component matrix

| Factors | Ingredient | 1  | 2  | 3  | 4  | 5  |
|---------|------------|----|----|----|----|----|
| A₁      | .823       |    |    |    |    |    |
| A₂      | .734       |    |    |    |    |    |
| A₃      | .652       |    |    |    |    |    |
| B₁      | .511       |    |    |    |    |    |
| B₂      | .636       |    |    |    |    |    |
| B₃      | .557       |    |    |    |    |    |
| B₄      | .743       |    |    |    |    |    |
| B₅      | .730       |    |    |    |    |    |
| B₆      | .602       |    |    |    |    |    |
| B₇      | .505       |    |    |    |    |    |
| B₈      | .625       |    |    |    |    |    |
| C₁      | .605       |    |    |    |    |    |
| C₂      | .798       |    |    |    |    |    |
| C₃      | .745       |    |    |    |    |    |
| C₄      | .741       |    |    |    |    |    |
| D₁      |            |    |    |    |    |    |
| D₂      |            |    |    |    |    |    |
| E₁      | .738       |    |    |    |    |    |
| E₂      | .637       |    |    |    |    |    |
| E₃      | .567       |    |    |    |    |    |
Table 6 is obtained by retaining the maximum factor load amount of each factor in the corrected rotation component matrix. As shown in Table 8, the corrected principal component is still five, and the total variance is explained as 61.398%. According to the comparison, after the pre-investigation questionnaire is reduced in dimension, the secondary items of remediation and convenience are classified as reliability. At the same time, due to the initial index system established in the previous period, the “E1 credit score system” is classified improperly. Good credit scores, the fare and the deposit will affect each other and should be attributed to the economy. After the factors are deleted and reclassified, a service quality evaluation index system including five dimensions and 20 sub-items of aesthetics, reliability, friendliness, safety and economy is formed. See Table 7 for details.

Table 7. Revised indicator system

| Dimension | Indicator | Item Number |
|-----------|-----------|-------------|
| Aesthetic | Attractive body design | A1 |
|          | APP interface is clear and concise | A2 |
|          | QR code printing is clear | A3 |
| Reliability | The deposit refund is processed in time | B1 |
|          | Repair and complaint handling in time | B2 |
|          | Accurate vehicle positioning | B3 |
|          | Accurate route and time recording | B4 |
|          | Parking area guides clear | B5 |
|          | Enough vehicles in various regions | B6 |
|          | APP does not flash back | B7 |
|          | Vehicle is not faulty | B8 |
| Friendly | Regularly launch preferential policies | C1 |
|          | Provide sports consumption data | C2 |
|          | Improve ride comfort | C3 |
|          | Provide kinds of vehicles | C4 |
| Safety   | Payment environment ensures security | D1 |
|          | Safety guarantee during the riding process | D2 |
| Economic | Reasonable deposit amount | E1 |
|          | Reasonable price of usage | E2 |
|          | Reasonable credit system | E3 |

Table 8. Revised explained total variance

| Ingredient | Initial eigenvalue | Extract square sum loading | Rotation square sum loading |
|-----------|-------------------|-----------------------------|-----------------------------|
|           | Total | % of variance | % of cumulative | Total | % of variance | % of cumulative | Total | % of variance | % of cumulative |
| 1         | 7.815 | 37.215 | 37.215 | 7.815 | 37.215 | 37.215 | 3.385 | 16.118 | 16.118 |
| 2         | 1.491 | 7.099 | 44.314 | 1.491 | 7.099 | 44.314 | 3.086 | 14.695 | 30.813 |
| 3         | 1.335 | 6.358 | 50.672 | 1.335 | 6.358 | 50.672 | 2.600 | 12.379 | 43.192 |
| 4         | 1.226 | 5.839 | 56.511 | 1.226 | 5.839 | 56.511 | 2.281 | 10.864 | 54.055 |
| 5         | 1.026 | 4.887 | 61.398 | 1.026 | 4.887 | 61.398 | 1.542 | 7.343 | 61.398 |

4. Evaluation and Analysis of Campus Sharing Bicycle Service Quality

4.1. Data collection and analysis

Questionnaire design was carried out according to the revised indicator system. In this questionnaire survey, a total of 273 questionnaires were distributed and 273 questionnaires were returned, of which 251 were valid questionnaires, and the sample size was more than 10 times the number of factors, in line with Stevens' conclusion on sample size [14]. The number of questionnaires collected is valid.

(1) Reliability and validity analysis and factor analysis
Table 9. Cronbach’s Alpha of the campus sharing bicycle service quality

| Dimension | Cronbach’s Alpha | Standardization of Cronbach’s Alpha | Dimension | Cronbach’s Alpha | Standardization of Cronbach’s Alpha |
|-----------|------------------|------------------------------------|-----------|------------------|------------------------------------|
| Aesthetic | .743             | .741                               | Safety    | .753             | .758                               |
| Reliability | .780             | .780                               | Economic  | .643             | .645                               |
| Friendly  | .790             | .792                               |           |                  |                                    |

It can be seen from Table 9 that the coefficients of each dimension are greater than 0.6, so the internal consistency is also obtained. From the overall and dimensional coefficients, it can be seen that the reliability of the questionnaire results is high and has a good use value. After the validity analysis, the KMO value was 0.881 (>0.7), the Bartlett spherical test’s significance p<0.001, and the degree of freedom was 253. Therefore, it is suitable for factor analysis.

By establishing a service quality evaluation index system with 20 sub-items of 5 dimensions, the principal component analysis method is used to extract the explanatory variation with the eigenvalue greater than 1, and the orthogonal selection of the maximum variance is performed. From the results of the questionnaire recovery, the cumulative contribution rate is greater than 60%, indicating that the extracted principal components are representative. The specific feature values and cumulative contribution rates are shown in Table 10.

Table 10. The explained total variance of the campus sharing bicycle service quality

| Ingredient | Total | % of variance | % of cumulative | Total | % of variance | % of cumulative | Total | % of variance | % of cumulative |
|------------|-------|---------------|-----------------|-------|---------------|-----------------|-------|---------------|-----------------|
| 1          | 6.023 | 37.643        | 37.643          | 6.023 | 37.643        | 37.643          | 2.597 | 16.230        | 16.230          |
| 2          | 1.365 | 8.531         | 46.174          | 1.365 | 8.531         | 46.174          | 2.130 | 13.311        | 29.540          |
| 3          | 1.205 | 7.534         | 53.708          | 1.205 | 7.534         | 53.708          | 2.062 | 12.889        | 42.430          |
| 4          | 1.058 | 6.612         | 60.320          | 1.058 | 6.612         | 60.320          | 2.024 | 12.649        | 55.078          |
| 5          | 1.005 | 6.283         | 66.604          | 1.005 | 6.283         | 66.604          | 1.844 | 11.526        | 66.604          |

Table 11. Rotation component matrix of campus sharing bicycle service quality

| Factors | Ingredient | 1   | 2   | 3   | 4   | 5   |
|---------|------------|-----|-----|-----|-----|-----|
| A1      | A2         | .824|     |     |     |     |
| A2      | A3         | .755|     |     |     |     |
| A3      | B1         | .583|     |     |     |     |
| B1      | B2         | .741|     |     |     |     |
| B2      | B3         | .579|     |     |     |     |
| B3      | B4         | .563|     |     |     |     |
| B4      | B5         | .768|     |     |     |     |
| B5      | B6         | .717|     |     |     |     |
| B6      | B7         | .558|     |     |     |     |
| B7      | B8         | .661|     |     |     |     |
| B8      | C1         |     |     |     | .592|     |
| C1      | C2         |     |     |     | .770|     |
| C2      | C3         |     |     |     | .814|     |
| C3      | C4         |     |     |     | .721|     |
| C4      | D1         |     |     |     | .560|     |
| D1      | D2         |     |     |     | .647|     |
| D2      | E1         |     |     | .514|     |     |
| E1      | E2         |     | .501|     |     |     |
| E2      | E3         |     | .644|     |     |     |
| E3      |
In this analysis, the load factor of the sub-item is large. If 0.35 is selected as the standard, too many factors will be selected out. Therefore, the load factor is extracted with 0.5 as the standard, and the obtained rotating component matrix is shown in Table 11.

It can be seen from Table 10 that a total of five principal components are extracted, which is consistent with the number of dimensions of the modified index system, indicating that the research is feasible. The maximum variance method is used to orthogonally rotate the factors. The rotated component matrix obtained after 10 iterations is as shown in Table 11. Combined with the indicators represented by each factor, the five principal components are the same as the modified index system which are aesthetics, reliability, friendliness, safety, and economy respectively. It can be seen from the various load factors that the most important thing in the aesthetics is that “the body design is attractive”. The most important thing in reliability is “reporting and complaints are handled in time”. The most important thing in the friendliness is “improving the riding comfort”. The most important thing in safety is “safety protection during the riding process”. The most important thing in economy is “the credit rating system is reasonable”.

(2) One-way ANOVA

One-way ANOVA can test basic information including gender, education level, monthly disposable amount, and the impact of travel information including usage frequency, average usage time, and average vehicle search time on overall and individual factor satisfaction. Degree. The specific results are shown in Tables 12, 13, and 14.

### Table 12. Basic information single factor analysis results

| Category              | Option                  | Frequency | Frequency | Mean | SD  | F-Value | P-Value |
|-----------------------|-------------------------|-----------|-----------|------|-----|---------|---------|
| Gender                | Male                    | 150       | 59.76%    | 2.33 | .843| 1.599   | .373    |
|                       | Female                  | 101       | 40.24%    | 2.24 | .843|         |         |
| Education             | College                 | 31        | 12.35%    | 2.12 | .887| 1.325   | .379    |
|                       | Bachelor                | 213       | 84.86%    | 2.31 | .920|         |         |
|                       | Master and Ph.D.        | 7         | 2.79%     | 2.47 | .992|         |         |
| Monthly disposable amount | Less than 1000 rmb   | 39        | 15.54%    | 2.12 | .931|         |         |
|                       | (1000~2000)rmb         | 166       | 66.14%    | 2.39 | .925|         |         |
|                       | (2000~3000)rmb         | 20        | 7.97%     | 2.59 | .989|         |         |
|                       | (3000~4000)rmb         | 7         | 2.79%     | 2.03 | .706|         |         |
|                       | More than 4000 rmb      | 19        | 7.57%     | 2.17 | .854|         |         |

Note: * indicates significant at the 5% statistical level. (The same below, no longer annotate)

### Table 13. Travel information single factor analysis results

| Category       | Option                  | Frequency | Frequency | Mean | SD  | F-Value | P-Value |
|----------------|-------------------------|-----------|-----------|------|-----|---------|---------|
| Use frequency  | Every day               | 36        | 14.34%    | 2.37 | .898|         | .794    |
|                | Every week (3~5) times  | 79        | 31.47%    | 2.24 | .932|         | .589    |
|                | Every week (1~2) times  | 69        | 27.49%    | 2.23 | .980|         |         |
|                | Every month (2~3) times | 30        | 11.95%    | 2.25 | .834|         |         |
|                | Once a month or more    | 37        | 14.74%    | 2.30 | .977|         |         |
| Average use time | Within 10 minutes  | 89        | 35.46%    | 2.28 | 1.048|         |         |
|                | (10~30) minutes         | 141       | 56.18%    | 2.23 | .969|         | .1748   |
|                | (30~60)minutes          | 16        | 6.37%     | 2.64 | .981|         | .286    |
|                | More than an hour       | 5         | 1.99%     | 2.48 | .844|         |         |
| Average search time | (1~5)minutes  | 96        | 38.25%    | 2.18 | .841|         | .4723   |
|                | (6~15)minutes           | 111       | 44.22%    | 2.26 | .872|         | .034    |
|                | (15~30)minutes          | 35        | 13.94%    | 2.39 | 1.036|         |         |
|                | More than 30 minutes    | 9         | 3.59%     | 3.19 | 1.184|         |         |
Table 14. Single factor analysis of service quality evaluation

| Factors | Basic Information | Travel Information |
|---------|-------------------|--------------------|
|         | Gender | Education | Monthly disposable amount | Use frequency | Average use time | Average search time |
| A1      | 2.924* | 2.698* | .690 | .467 | 1.783 | 9.785* |
| A2      | .470   | 1.413   | .860 | .377 | 1.803 | 8.292* |
| A3      | 1.342  | 1.188   | .949 | .118 | 2.822* | 6.178* |
| B1      | 2.011  | 1.233   | .710 | .396 | 3.289* | 12.189* |
| B2      | .193   | .529    | 1.123 | 2.369* | 2.074 | 6.139* |
| B3      | .644   | 2.746*  | 1.129 | .935 | 3.390* | 1.105 |
| B4      | 5.150* | 1.341   | 1.067 | .396 | 1.561 | 2.704* |
| B5      | 5.65   | 1.055   | .494 | 1.050 | 1.884 | 4.021* |
| B6      | .503   | .312    | .803 | .379 | 2.904* | 8.008* |
| B7      | 2.132  | .295    | 1.221 | .697 | 3.851* | 1.007 |
| B8      | .000   | .539    | 1.251 | .475 | .588 | 9.028* |
| C1      | 1.189  | .637    | 1.193 | .984 | .993 | 4.670* |
| C2      | .936   | 1.771   | 1.373 | .383 | .564 | 2.637* |
| C3      | 5.161* | 4.759*  | 1.744 | .321 | 1.983 | 6.482* |
| C4      | 1.437  | 2.339   | 3.379* | .610 | 2.129 | 3.849* |
| D1      | .086   | 1.147   | 2.938* | .313 | 2.562* | 2.300 |
| D2      | .151   | .330    | 1.736 | 1.053 | 2.137 | 4.589* |
| E1      | 4.486* | .326    | 1.536 | .484 | .672 | 1.460 |
| E2      | 4.032  | .799    | 2.423* | 1.517 | .622 | 2.196 |
| E3      | .179   | 1.877   | .896 | 1.509 | .146 | 1.250 |

From the data of Table 12, Table 13 and Table 14, it can be seen that when the confidence level is 95%, different gender has significant influence on “body design”, “accurate track and time record”, “improving riding comfort” and “reasonable deposit amount”. Among them, male satisfaction is low, female satisfaction is high, and fluctuation is small. Different educational background has significant influence on “body design”, “vehicle positioning accuracy” and “riding comfort improvement”. College students have the highest satisfaction and master degree or above has the lowest satisfaction. Respondents with different monthly disposable amounts have significant effects on “providing a variety of vehicles for selection”, “paying environment safety” and “reasonable vehicle prices”. Among them, (3000-4000) rmb group has the highest satisfaction and (2000-3000) rmb group has the lowest satisfaction. Different frequency of use has a significant impact on “the speed of repairing and complaint handling”, among which the satisfaction of people who use it every day is the lowest, and the satisfaction of people who use it (2-3) times per month is the highest. It may be that the people who use less frequently have insufficient follow-up experience of it, and have certain judgment deviation, but if they still encounter faulty vehicles next time, they may have greater dissatisfaction, which also leads to the highest average satisfaction of this part and the largest inner standard deviation also. Different average usage time has significant influence on “body QR code”, “deposit refund speed”, “vehicle location accuracy”, “number of vehicles in each area”, “stable operation of APP”, and “payment environment safety”. Among them, the lowest satisfaction is the average usage of (30-60) minutes, and the highest satisfaction is the average usage of (10-30) minutes. Different vehicle search time has significant influence on 14 factors, which shows that this feature is extremely important. The respondents whose vehicle search time is (1-5) minutes have the highest satisfaction, and those whose vehicle search time is more than 30 minutes have the lowest satisfaction.

Through one-way ANOVA, the relationship between the basic information and travel information of the respondent and the perception of the quality of the campus sharing bicycle service, as well as the degree of influence on certain factors can be obtained. To further identify the factors that are in urgent need of improvement, IPA analysis is required for processing.
4.2. **IPA Location Map Analysis**

The calculation method of satisfaction mean value and standard deviation is the same as the one-way ANOVA in the previous section. Replace the importance of self-report with the extended importance [16]. The calculation method of the extended importance degree is Weizhao Deng’s partial correlation coefficient method. Satisfaction evaluation of individual factor (IS) takes logarithm \( \ln \) to make it linearly distributed, then takes \( \ln (IS) \) as an independent variable, overall satisfaction (OS) as a dependent variable to perform multiple regression analysis and to calculate the partial correlation coefficient between OS and \( \ln (Si) \) [17], the specific calculation results are shown in Table 15.

| Factors | Mean | SD  | Sequence | Importance value | Sequence |
|---------|------|-----|----------|------------------|----------|
| A1      | 1.98 | .859| 1        | 0.083            | 3        |
| A2      | 2.14 | .919| 2        | 0.058            | 15       |
| A3      | 2.18 | .844| 4        | 0.057            | 16       |
| B1      | 2.27 | 1.008| 8        | 0.097            | 1        |
| B2      | 2.40 | .994| 17       | 0.074            | 9        |
| B3      | 2.27 | .980| 8        | 0.076            | 8        |
| B4      | 2.17 | .857| 3        | 0.067            | 13       |
| B5      | 2.39 | .881| 16       | 0.071            | 11       |
| B6      | 2.32 | .966| 11       | 0.074            | 9        |
| B7      | 2.21 | .885| 7        | 0.035            | 20       |
| B8      | 2.45 | .982| 18       | 0.078            | 5        |
| C1      | 2.32 | .919| 11       | 0.057            | 16       |
| C2      | 2.19 | .823| 5        | 0.054            | 18       |
| C3      | 2.36 | .895| 14       | 0.085            | 2        |
| C4      | 2.36 | .899| 14       | 0.062            | 14       |
| D1      | 2.28 | .826| 10       | 0.071            | 11       |
| D2      | 2.55 | .969| 20       | 0.080            | 4        |
| E1      | 2.46 | .957| 19       | 0.077            | 6        |
| E2      | 2.32 | .914| 11       | 0.077            | 6        |
| E3      | 2.19 | .945| 5        | 0.051            | 19       |

As can be seen from Table 15, the attractive design of the body helps the user to find the target vehicle in the first time. From Tables 13, 14, the shorter the search time, the higher satisfaction of the user. Secondly, the simpler the page, the more convenient it is for online interaction, and its sound experience is more likely to attract new user groups. The higher the accuracy of the itinerary, the stronger the reliability of the brand. The slower the repair and complaint handling, the more unfavorable the vehicle's intact impression and more bad vehicles, and even seriously affect user satisfaction. At the same time, the reasonable deposit amount is questioned, the satisfaction is extremely low. And the processing speed of the refund of the deposit is of the highest importance, indicating that the current amount of the deposit is high, and the use fare is also judged by most respondents as unreasonable. On the other hand, the user's evaluation of the extended importance of the exercise consumption data is low, and it may be considered to ban the function. The importance of safety protection during cycling is ranked 4th, but the satisfaction mean value is the lowest, indicating that the related companies are not in place, and even corresponding protection measures have not been introduced. And as an experiential service, the importance of comfort is self-evident, and the mainstream bicycles at this stage share poor bicycle comfort, which will seriously affect the user experience. In order to prioritize the improvement factors, IPA positioning analysis is required.
The arithmetic mean values of the satisfaction and the importance of each factor calculated by Table 15 are 0.068 and 2.292, respectively. Taking (0.068, 2.292) as the origin, the X-axis is the extended importance, and the Y-axis is the satisfaction, and the IPA positioning map is established, as shown in Figure 3.

![IPA analysis map for campus sharing bicycle service quality evaluation](image)

**Figure 3.** IPA analysis map for campus sharing bicycle service quality evaluation

The improved IPA location map divides the improvement priorities of each area, and the key improvement area factors are sorted by I/P values of each factor. The results are shown in Table 16. The key improvement area priority is C3 > E2 > B6 > B8 > D2 > E1 > B2 > B5.

| Factors | I/P|
|---------|----|
| B2      | 0.0308|
| B5      | 0.0297|
| B6      | 0.0319|
| B8      | 0.0318|
| C3      | 0.0360|
| D2      | 0.0314|
| E1      | 0.0313|
| E2      | 0.0332|

As can be seen from Figure 3, the importance evaluation and satisfaction of the body design are high, indicating that the current mainstream sharing bicycle design meets the user's aesthetic. The importance evaluation and satisfaction of riding safety are low, indicating that the user's security requirements have not been met, and enterprises need to adjust and improve. On the other hand, the improved IPA model screened out that offers a variety of models to choose from as a secondary priority improvement factor, emphasizing the factors of the primary improvement factors, so that the improvement performance can be reflected quickly.

4.3. Suggestions for sharing the quality of bicycle service on campus

(1) Improve the comfort of sharing bicycle seats

The comfort of the seat is directly helpful to enhance the user experience. The seat that is not comfortable enough will reduce the frequency of use, thus reducing the utilization rate of sharing bicycles and indirectly increasing the input cost. From ergonomic point of view, a comfortable and affordable seat should be designed for replacement. At the same time, it is possible to design and produce male and female dedicated sharing bicycles to meet the needs of different user groups.

(2) Set gradient deposit and fare by credit
The existing credit system is relatively complete and reasonable, and the sharing bicycle company can decide whether to exempt the deposit from the user's credit certification. For users whose credits are not up to standard, gradient deposits and fares can be set. The lower the credit, the higher the amount of deposits that users need to pay, thus forming positive feedback.

(3) Reasonable planning of the number of bicycles in each region

According to the online big data, the user activity of different regions in different cities is further analyzed, and the sharing bicycles are reasonably released, and the availability of sharing bicycles is improved without wasting resources as much as possible.

(4) Establishment of maintenance teams by region

Sharing bicycle companies can set up maintenance teams according to regions. When online repairs are made, they can be processed in time. After the repair, the service users will be provided with feedback evaluations to show users that they value their opinions. At the same time, this will also greatly reduce the chances of getting bad vehicles and ensure the safety of users.

(5) Provide life insurance purchase options

In countries such as the Netherlands and the United Kingdom, where public bicycles and sharing bicycles were introduced earlier, the government funded the establishment of a bicycle-only passage to try to ensure the safety of riding and encourage citizens to choose this mode of travel. While emulating other countries is hard to implement in the short term, the sharing bicycle companies can cooperate with insurance companies to provide users with low-cost personal accident insurance purchase options, and ask their purchase intentions before users begin to ride.

(6) Strengthen parking area guidance

The random parking of sharing bicycles has always been one of the factors that have been widely criticized and will have a serious impact on road traffic. Sharing bicycle companies can set up electronic fences through APPs. When users want to park, they must park in the nearest electronic fence, otherwise they will affect their credit scores. This can not only restrict user behavior, regulate parking places, but also does not require external physical construction investment, which has many benefits for the future development of sharing bicycles.

5. Conclusion

Under the coordinated development trend of sharing economy and Internet big data, sharing bicycles as one of the reliable channels for obtaining big data of user behavior can be used for data mining of customer accurate portraits, such as user travel feature and consumption feature in the sharing bicycle system. As a data entry to link goods and services, sharing bicycle will maximize customer value and form a new business management model. The stable development of sharing bicycle enterprises is a necessary prerequisite for realizing this strategic goal. Improving the quality of service is an effective way to promote the development of sharing bicycle enterprises.

Based on the SERVQUAL scale, this paper focuses on the appearance of the vehicle body and the safety guarantee factors in the riding. From the perspective of technical improvement and user experience, the index design of campus sharing bicycle service is carried out in three stages: service process quality, result quality and remediation quality. The quality evaluation index uses Weizhao Deng's partial correlation coefficient method to strip the influence of satisfaction on the user's self-reported importance. The improved IPA model further divides the priority of service quality improvement factors, and proposes suggestions based on theoretical basis and practical utility. At the same time, the optimization of the positioning of the IPA model is improved, which is helpful for the research and development of the IPA analysis method.

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